E Scenario results

E.1 Previous Scenario Evaluation Results

This section provides the detailed modeling and costing results for the previously evaluated scenarios. Section E.1.1 presents the community-specific scenario, Section E.1.2 presents the regional scenarios, Section E.1.3 presents the treatment scenarios, and Section E.1.4 presents the integrated scenario.

The results in Appendix E.1 are provided to illustrate the process up to February 2020 by which the Co-Trustees arrived at their recommended options. Only incorrect statements were edited from the version released in February 2020. Feedback noting errors (e.g. number of wells) were incorporated into the second round of analyses provided in Appendix E.2.

Appendix E.2 provides updates to some of the scenarios which were carried forward during a second round of scenario analyses performed during March to July 2020.

Appendix E.3 provides the detailed cost results for the Revised Treatment Scenario. These scenarios would provide treatment for existing drinking water wells, both municipal and non-municipal, at the individual well sites for 2040 population demands.

Appendix E.4 is a summary of the Recommended Options 1, 2, and 3 which align with the recommended options in Chapter 7.

Chapter 6 provides a summary of these results as well as how they were evaluated. Chapter 7 provides recommended options for drinking water supply.

E.1.1 Community-specific scenario

E.1.1.1 Community-specific scenario overview

The community-specific scenario would provide clean drinking water on a community by community basis across the East Metropolitan Area. The scenario alternatives consist of conceptual projects submitted by the local government units (LGUs) through the conceptual project submittal process or communicated in discussions with Wood. These conceptual projects are generally consistent with the community's existing long-term water supply plans and current efforts, with a few exceptions. A summary of the alternatives analyzed for this scenario is included in Table E.1. Each alternative was assessed based on economic and operational feasibility, and cost estimates were developed to compare each alternative.

Under the scenario alternatives, each community would remain autonomous. Residents and businesses would be served by their local municipal water system where feasible. Those residents and businesses on non-municipal wells that could not be connected to the municipal water supply would continue to be served by their groundwater wells with treatment as necessary. This scenario would eliminate the establishment of new regional water systems and work within the existing political boundaries and structure of the East Metropolitan Area.

Assumptions and considerations are provided in Section E.1.1.1. Conceptual projects included in this scenario are provided by each community in Sections E.1.1.2-E.1.1.14. A summary of the scenario is provided in Section E.1.2.

Table E.1. Overview of community-specific scenario alternatives.

	Scenario alternatives		
Community	**1**	**2**	**3**
Afton (Section E.1.1.2)	• Granular activated carbon (GAC) point of entry treatment (POET) systems		
Cottage Grove (Section E.1.1.3)	• High zone WTP to serve Wells 11 and 12 • Intermediate zone WTP to serve Wells 3, 4, 5, 6, 7, 8, and 9 • Low zone WTP to serve Wells 1 and 2, and an additional WTP for Well 10 • Connect neighborhoods to the municipal water system • GAC POET systems • New water tower	• Intermediate zone WTP to serve Wells 3, 4, 5, 6, 7, 8, 9, 11, and 12 • Low zone WTP to serve Wells 1, 2, and 10 • Connect neighborhoods to the municipal water system • GAC POET systems • New water tower	• Intermediate zone WTP to serve Wells 3, 4, 5, 6, 7, 8, 9, 11, and 12 • Low zone WTP to serve Wells 10 and a new Well 13 • Take Wells 1 and 2 out of service • Connect neighborhoods to the municipal water system • GAC POET systems • New water tower
Denmark (Section E.1.1.4)	• GAC POET systems		
Grey Cloud Island (Section E.1.1.5)	• GAC POET systems		
Lake Elmo (Section E.1.1.6)	• New Wells 6 and 7 in north[1] • Connect neighborhoods to the municipal water system • GAC POET systems		
Lakeland/Lakeland Shores (Section E.1.1.7)	• Connect residences to the municipal water system • GAC POET systems		
Maplewood (Section E.1.1.8)	• Connect residences to SPRWS		
Newport (Section E.1.1.9)	*Newport currently has very low levels of PFAS contamination in their municipal and non-municipal wells. They also have sufficient firm capacity to meet 2040 maximum daily demand if either well is taken out of service. As such, no projects for Newport are being evaluated under this scenario. However, interconnects were evaluated under the integrated scenario. *		

	Scenario alternatives		
Community	**1**	**2**	**3**
Oakdale (Section E.1.1.10)	• Expand existing WTP at the Public Works Facility • Route Wells 1, 2, 7, and 8 to WTP • Take Wells 3 and 10 off-line[2] • GAC POET systems	• Expand existing WTP at the Public Works Facility • Route Wells 1, 2, and 7 to WTP • Abandon Well 8 and drill a new well near existing WTP • Take Wells 3 and 10 off-line[2] • GAC POET systems	
Prairie Island Indian Community (Section E.1.1.11)	• Construct WTP to treat the existing well		
St. Paul Park (Section E.1.1.12)	• Make temporary WTP permanent to provide centralized treatment for all 3 wells • Connect residences to the municipal water system • GAC POET systems		
West Lakeland (Section E.1.1.13)	• Drill two new wells • Construct one WTP • Construct a distribution system with two storage tanks • GAC POET systems		
Woodbury (Section E.1.1.14)	• Construct three WTPs • Connect neighborhoods to the municipal water system • GAC POET systems	• Construct two WTPs • Connect neighborhoods to the municipal water system • GAC POET systems	• Construct one WTP • Connect neighborhoods to the municipal water system • GAC POET systems

Notes:

1. Need to consider impacts to White Bear Lake and if a well needs to be located elsewhere that may require treatment.
2. Oakdale has firm capacity to meet 2040 maximum daily demand without Wells 3, 6, or 10.

E.1.1.1.1 Assumptions/considerations

The following assumptions and considerations were used for the community-specific scenario:

- Each community evaluation was simulated with 2040 projected demands with the understanding that any given project could be implemented prior to the year 2040.
- Expedited projects were simulated with the drinking water distribution modeling, but the costs of the expedited project were not included in the final cost estimates.
- Infrastructure required for population growth that does not address PFAS contamination was included in the cost estimates. This could include storage facilities and distribution infrastructure such as water lines, booster pump stations, pressure reducing valves, etc. that may be needed to serve unimpacted areas of development.

Chapter 2 includes assumptions regarding the development and calibration of the drinking water distribution and groundwater models specific to each community and their water demands.

Installing GAC POET systems for non-municipal wells was included in this community-specific scenario for any wells that have been sampled as of October 2019, with a Minnesota Department of Health (MDH) Health Index (HI) value greater than or equal to 0.5 (HI ≥ 0.5). This was applied to all communities with the exception of Woodbury under the Community-Specific Scenario, who proposed to install treatment on any non-municipal well with detectable levels of PFAS (HI>0). For 2020 conditions, all non-municipal wells were assessed to determine which ones could be readily connected to the existing municipal water system through existing water lines or proposed water line extensions. The remaining wells that could not be feasibly connected were provided POET systems based on the previously mentioned contamination levels. Under 2040 conditions, the groundwater model was used to evaluate whether areas of known PFAS impacts would potentially affect additional areas in future years. Particles were inserted into the model and allowed to follow predicted groundwater flow patterns for 20 years into the future from 2020. The areal extent of future impacts predicted by these flow paths was used to estimate the number of additional non-municipal wells that would require treatment (i.e., POET systems). To be conservative, it was assumed that all wells within the predicted PFAS-impacted areas would receive either treatment or be connected to a municipal water system. Those wells outside of the areas of impact would receive GAC POET systems based on the HI constraints mentioned above, excluding those wells that would be sealed and replaced with a connection to the municipal water system.

Section E.3.1.1 includes assumptions and considerations associated with estimating the non-municipal well counts, treatment methods, and treatment costs for the non-municipal wells. For the communities that do not have municipal wells (i.e., Afton, Denmark, and Grey Cloud Island), it was assumed that they would remain on POET systems under this scenario and the number of non-municipal wells requiring treatment was the same as those determined under the treatment scenarios.

E.1.1.2 Conceptual projects – Afton

E.1.1.2.1 Project summary

The conceptual project considered for Afton under this scenario would include installing GAC POET systems on PFAS impacted non-municipal wells. A summary of the project is provided below.

GAC POET systems

This scenario would provide GAC POET systems for PFAS impacted non-municipal wells under both 2020 and 2040 conditions. As of October 2019 sample data, Afton has an estimated 708 existing non-municipal wells, of which 124 have been sampled. Of these sampled wells, 11 currently have GAC POET systems installed. Based on current sampling trends, it was estimated that by 2020 another 17 non-municipal wells (in addition to the 11 that have GAC POET systems) would have HI values greater than or equal to 0.5 and would receive treatment through new GAC POET systems. The groundwater model flow path analysis estimated that by 2040 a total of 85 non-municipal wells would be impacted and receive treatment through existing or proposed GAC POET systems.

E.1.1.2.2 LGU water supplies and infrastructure

A drinking water distribution model was not created for this community as there is no municipal water system within Afton.

E.1.1.2.3 Hydrogeologic impacts

The non-municipal wells in Afton draw water primarily from the St. Peter/Jordan/Prairie du Chien aquifers. However, there are a number of wells that also draw water from the Quaternary and Tunnel City aquifers, and wells that draw water from unknown depths and therefore unknown aquifers. Within Afton, groundwater in the Jordan, Prairie du Chien, and Tunnel City aquifers generally moves west to east across the city under the normal and wet climate conditions (which is expected to be the climate conditions over the next 10-20 years). Under the dry condition, the groundwater contours appear to be very similar when compared to the wet condition. There are very small differences between the groundwater contours when superimposed. The apparent concurrence of the groundwater contours between the wet and dry conditions is most likely because there is not a municipal water system present in Afton withdrawing groundwater. Currently, there are a number of non-municipal wells that indicate PFAS impacts are less than the HI of 0.5. Under the current groundwater flow patterns, the groundwater model indicates that PFAS contamination in the northern area of Afton may migrate along groundwater flow paths and impact an additional 67 non-municipal wells (85 total) by the year 2040.

E.1.1.2.4 Cost estimate breakdown

Capital and O&M costs are summarized in Table E.2 for the year 2020 and Table E.3 for the year 2040. Capital and operation and maintenance (O&M) costs were included in the cost estimate for the non-municipal wells requiring the installation of a new POET system. Only O&M costs were included for the non-municipal wells that currently have a POET system.

Table E.2. Year 2020 costs for conceptual projects included in the Community-Specific Scenario 1 for Afton.

Item	Quantity	Units	Description	Total cost
Capital cost				
GAC POET systems[1]	17	Each	Standard household systems, $2,500 per well	$42,500
			Subtotal	$42,500
			Contingency (20%)	$8,500
			Professional services (15%)	$6,400
			Total capital	**$57,400**
Annual O&M cost				
GAC POET systems	28	Each	$1,000/year	$28,000
20 years of annual O&M				$560,000
20 year costs (capital + O&M)				**$617,400**
Capital and operating cost per 1,000 gal[2]				**$7.41**
Operating only cost per 1,000 gallons[2]				**$6.72**

Notes:

1. GAC POET system cost is estimated for non-municipal wells with HI ≥ 0.50.
2. Annual water usage was determined using a 2020 population of 3,070, an average daily demand of 94 gallons per capita per day, and 708 non-municipal wells. Equating water demand to an average population of 4.34 people per well, results in an average daily demand of 408 gallons per day per well, or 83.3 million gallons in 20 years for 28 wells.

Table E.3. Year 2040 costs for conceptual projects included in the Community Scenario 1 for Afton.

Item	Quantity	Units	Description	Total cost
Capital cost				
GAC POET systems[1]	74	Each	Standard household systems, $2,500 per well	$185,000
			Subtotal	$185,000
			Contingency (20%)	$37,000
			Professional services (15%)	$28,000
			Total capital	$250,000
Annual O&M cost				
GAC POET systems	85	Each	$1,000/year	$85,000
			20 years of annual O&M	$1,900,000
			20 year costs (capital + O&M)	**$2,184,000**
			Capital and operating cost per 1,000 gallons[2]	**$7.55**
			Operating only cost per 1,000 gallons[2]	**$6.57**

Notes:

1. GAC POET system cost is estimated for non-municipal wells within the groundwater model 20 year flow paths.
2. Annual water usage was determined using a 2040 population of 3,140, an average daily demand of 94 gallons per capita per day, and 708 non-municipal wells. Equating water demand to an average population of 4.44 people per well, results in an average daily demand of 417 gallons per day per well, or 289 million gallons in 20 years for 85 wells.

E.1.1.3 Conceptual projects – Cottage Grove

E.1.1.3.1 Project summary

The conceptual projects considered for Cottage Grove under this scenario would include the installation of centralized WTPs and extending water mains to nearby neighborhoods that currently have PFAS impacted non-municipal wells. In addition, GAC POET systems would be installed for the rest of the impacted non-municipal wells that were not proposed to be connected to the municipal water system in this scenario based on cost or constructability constraints, primarily in the neighborhoods in the southeast and southwest corners of the city. A summary of the projects is provided below.

WTPs

All municipal supply wells in Cottage Grove would be treated through a combination of centralized groundwater WTPs under both 2020 and 2040 conditions. The proposed project would consist of two WTPs including a centralized WTP (WTP1) to serve the high and intermediate pressure zones and a second WTP (WTP2) to serve the low pressure zone. A dedicated raw water main would convey water from Wells 11 and 12 in the high pressure zone to WTP1 in the intermediate pressure zone. The WTP1 would be located near the existing booster pump station at 80th Street in Pine Tree Pond Park and would serve a combination of Wells 3-9, 11, and 12. Another analysis was performed to determine if it was more cost-effective to treat Wells 11 and 12 with a separate WTP (WTP4) in the high zone from WTP1.

The second WTP (WTP2), located near Jamaica Avenue and 100th Street, would serve the low-pressure zone and would have the capacity to treat water from Wells 1, 2, and 10. Due to the low capacity and distance from other municipal supply wells, an additional analysis was performed to determine if it is more cost effective to connect Wells 1 and 2 to WTP2 or treat the wells with a dedicated WTP (WTP3).

Currently, Well 2 exceeds the HI of 1 and is not in operation, and Well 1 is under the HI of 1. The option of replacing these wells with one new well closer to the proposed WTP2 and future industrial development was also evaluated as part of a long-term solution.

For drinking water distribution modeling purposes, the above options were grouped into three alternatives as outlined below for years 2020 and 2040. Under the following alternatives, municipal supply wells were routed to WTPs to provide operational flexibility while WTPs were sized to meet the maximum daily demands for the 2020 and 2040 conditions for cost purposes.

Alternative 1 – 2020

Under this alternative, WTP1 would be installed in the intermediate zone to serve Wells 3-9. In the low pressure zone, WTP3 would be located at Well 2 and serve Wells 1 and 2, as summarized below.

- WTP1 – 7,800 gallons per minute (gpm) for Wells 3-9
- WTP3 – 1,200 gpm for Wells 1 and 2.

Because Cottage Grove's maximum daily demand in 2020 is only 8,000 gpm, the proposed WTPs for Well 10 (2,000 gpm) and Wells 11 and 12 (3,000 gpm) were not included in this alternative.

Alternative 1 – 2040

The 2040 Alternative 1 is similar to the 2020 Alternative 1 but would include the WTPs for Well 10 (2,000 gpm) and Wells 11 and 12 (3,000 gpm), as summarized below.

- WTP1 – 7,800 gpm for Wells 3-9
- WTP2 – 2,000 gpm for Well 10
- WTP3 – 1,200 gpm for Wells 1 and 2
- WTP4 – 3,000 gpm for Wells 11 and 12.

Alternative 2 - 2020

Under this alternative, WTPs would be consolidated such that Wells 11 and 12 would be routed to WTP1 in the intermediate zone and the WTP for Wells 1 and 2 would be removed, as summarized below.

- WTP1 – 10,800 gpm in the intermediate pressure zone for Wells 3-9, 11, and 12.

Alternative 2 - 2040

The 2040 Alternative 2 is similar to the 2020 Alternative 2 but would include WTP2 to serve Well 1, 2, and 10, as summarized below.

- WTP1 – 10,800 gpm in the intermediate pressure zone for Wells 3-9, 11, and 12
- WTP2 – 3,200 gpm in the low pressure zone for Wells 1, 2, and 10.

Alternative 3 - 2040

The 2040 Alternative 3 is similar to the 2020 Alternative 2 and would maintain the same WTP configuration. However, in 2040, the capacity needed for the WTP in the intermediate zone would need to increase to accommodate the additional demand, as summarized below.

- WTP1 – 10,800 gpm in the intermediate pressure zone for Wells 3-9, 11, and 12

- WTP2 – 3,200 gpm in the low pressure zone for Well 10 and a new 1,200 gpm well to replace Wells 1 and 2.

Additional improvements common to each alternative

GAC POET systems

This scenario would provide GAC POET systems for PFAS impacted non-municipal wells under both 2020 and 2040 conditions that were not connected to the municipal water system. As of October 2019 sample data, Cottage Grove has an estimated 820 existing non-municipal wells, of which 672 have been sampled. Of those sampled wells, 44 currently have GAC POET systems installed. Based on current sampling trends, it was estimated that by 2020 another 47 non-municipal wells (in addition to the 44 that have GAC POET systems) would have HI values greater than or equal to 0.5 and would receive treatment through new GAC POET systems. The groundwater model flow path analysis estimated that by 2040 a total of 140 non-municipal wells would be impacted and receive treatment through existing or proposed GAC POET systems. These counts exclude any wells that would be connected to the city's municipal water system through expedited projects, proposed water lines, or connections to existing water lines.

Water supply

Cottage Grove has a municipal water system consisting of 12 wells with a total design capacity of 14,000 gpm or 20.16 million gallons per day (mgd) with all wells running. If all municipal supply wells were treated and in operation, the city would have a calculated firm capacity of 10,500 gpm (15.12 mgd) with the two largest wells out of service. Assuming the well field is able to support these sustained pumping rates and their proximity to each other does not impact pumping capacities (see Section E.1.1.3.3), this firm capacity would meet their current 2020 maximum daily demand of 8,000 gpm (11.5 mgd) and anticipated 2040 maximum daily demand of 9,792 gpm (14.1 mgd) without the addition of new wells. However, no pumping tests have been performed for this well field.

Water storage

Under 2040 conditions, the city would need to add another storage facility with a minimum storage volume of 0.7 million gallons based on their average daily demand and required fire flow. However, this storage facility was not included in the cost estimates.

Water transmission and distribution infrastructure

In addition to the WTPs outlined above, additional infrastructure modifications would need to be implemented to accommodate the proposed projects under all alternatives. The modifications listed below do not include any approved expedited projects.

1. <u>Raw water transmission lines</u>
    a. New raw water transmission lines would be required to convey flows from municipal supply wells to the proposed WTPs.
2. <u>Distribution lines</u>
    a. New distribution lines would be installed in the neighborhoods near the intersection of Goodview Avenue/Goodview Court and 70th Street to serve 41 connections.
    b. A new 2,307 linear feet, 8" distribution line would be installed along Harkness Avenue to serve 4 connections and complete the loop along Hardwood Avenue.

c. A new 3,762 linear feet, 6” distribution line would be installed along Keats Avenue from 82nd Street to Joliet Avenue to serve 4 connections and loop the system.

d. A distribution loop would be added to provide water to the Old Cottage Grove neighborhood. The loop would include approximately 20,920 linear feet of 12” distribution lines along 70th Street, Lamar Avenue, Kimbro Avenue, and 80th Street. An additional 14,323 linear feet, 8” distribution line would be required to service the residences off Lamar Avenue.

3. Pressure reducing valves

a. Two 8” pressure reducing valve would be necessary to serve the connections in the neighborhoods along Goodview Avenue/Goodview Court and 70th Street as the topography in this area rapidly slopes downward towards I-61.

b. Two 8” pressure reducing valve would be needed in the Granada Avenue neighborhood that was proposed to be connected under an expedited project but was not included in the cost estimate. This region has the same topography challenges as the Goodview Avenue neighborhood.

c. One 8” pressure reducing valve would be needed in the River Acres neighborhood that was proposed to be connected under an expedited project but was not included in the cost estimate. This neighborhood is located much further south and has lower elevations lending to higher pressures.

E.1.1.3.2 LGU water supplies and infrastructure

Table E.4 below provides the results of the drinking water distribution model runs for each alternative under 2040 maximum daily demands and includes the infrastructure modifications listed in the previous section. Pressures were found to be consistent with data provided by the city.

Table.E.4. Pressure results (psi) from the drinking water distribution model for Cottage Grove under 2040 conditions.

	Alternative 1		Alternative 2		Alternative 3	
Pressure zone	Low	High	Low	High	Low	High
High zone pressure range	30	113	31	114	31	114
Intermediate zone pressure range	40	93	40	101	40	101
Low zone pressure range	45	75	46	76	47	76

Under Alternative 2, it is recommended that the pumps in Wells 1 and 2 be modified or replaced to convey flow to the proposed low pressure zone WTP. In addition, it is recommended that the existing intermediate booster pump station be evaluated to determine the best solution for conveying flow from the proposed, intermediate pressure zone WTP. Due to the age of the existing pumps and the amount of flow, it is likely that these pumps would need to be upgraded.

Operations

Under this scenario, all of Cottage Grove’s municipal supply wells would be routed to their respective WTPs prior to distribution to the public. The city would not need to blend water from wells containing low levels of PFAS, otherwise operations would be similar to existing operating procedures with the city optimizing well operations.

E.1.1.3.3 Hydrogeologic impacts

In Cottage Grove, groundwater generally flows from northeast to southwest towards the Mississippi River. The proposed 1,200 gpm well under Alternative 3 was modeled under wet climate conditions and results indicate that the aquifer can sustain its required pumping rate. The aquifer can sustain a higher pumping capacity of 1,566 gpm maximum daily demand needed under drought conditions. Particle tracking, both forward and reverse, indicates that the new municipal supply well may require treatment under normal and wet climate conditions as well as drought conditions. These treatment costs were included in the cost estimates.

Non-municipal wells in Cottage Grove draw water from both the Quaternary and Prairie du Chien aquifers. However, there are a number of wells (approximately half) that draw water from unknown depths and therefore unknown aquifers. Of the wells that draw water from known aquifers, most draw water from the Prairie du Chien aquifer. Groundwater in the Prairie du Chien aquifer moves northeast to southwest under both wet and dry conditions across the City. The groundwater contours are very similar for the Prairie du Chien. In the Jordan aquifer, the dry condition groundwater contours are shifted slightly when compared to the wet condition. However, the general shape of the contours and the pattern of groundwater flow is preserved. The contours in the Tunnel City aquifer are also very similar, and there are no shifts of the groundwater contours between the wet and dry conditions. The groundwater model indicates that PFAS contamination may continue to follow this flow path and potentially impact another 35 non-municipal wells (140 total) by the year 2040.

E.1.1.3.4 Cost estimate breakdown

Three alternatives were analyzed to provide treatment for Cottage Grove's municipal supply wells. Under each alternative, GAC and ion exchange (IX) WTPs were considered. The proposed raw water transmission lines and proposed distribution lines installed in 2020 would be sized for 2040 maximum daily demands, and therefore the costs would be the same. However, costs would be different for the WTPs that would be sized for the maximum daily demand for each year. In addition, the number of non-municipal wells and resulting treatment or connection costs would differ from 2020 to 2040. Capital and O&M costs are summarized for Alternatives 1 and 2 in Tables E.5 and E.6 for the year 2020 and for Alternatives 1, 2, and 3 in Tables E.7, E.8, and E.9 for the year 2040.

2020 cost estimates

Due to lower maximum daily demands in 2020, the dedicated WTPs for Well 10 (2,000 gpm) and Wells 11 and 12 (3,000 gpm) and the over 14,000 linear feet of 8", 16", and 18" water mains were not included in the cost estimates for the 2020 Alternative 1 as opposed to the 2040 Alternative 1. Similarly, for the 2020 Alternative 2, the proposed lower zone WTP for Wells 1, 2, and 10 at 3,200 gpm and the nearly 22,000 linear feet of 8", 12", and 18" water mains were not included in the cost estimates as opposed to the 2040 Alternative 2.

2040 cost estimates

Cottage Grove's maximum daily water demand in 2040 is approximately 9,800 gpm and as such the additional WTPs to serve Wells 11 and 12 (3,000 gpm) in the high zone and Wells 1 and 2 (1,200 gpm) and 10 (2,000 gpm) in the low zone were included in the 2040 Alternative 1 as opposed to the 2020

Alternative 1. Similarly, for the 2040 Alternative 2, the proposed WTP to serve Wells 1, 2, and 10 (3,200 gpm) in the low zone were included in this alternative as opposed to the 2020 Alternative 2.

Table E.5. Year 2020 costs for conceptual projects included in the Community-Specific Scenario 1 for Cottage Grove - Alternative 1.

Item	Quantity	Units	Description	Total cost (GAC)	Total cost (IX)
Capital cost					
WTPs	2	Lump sum	9,000 gpm total capacity	$16,240,000	$11,586,000
8" pressure reducing valves	2	Lump sum	Installed within right-of-way	$250,000	
Water distribution mains	9.57	Miles	Water mains from wells to WTPs and neighborhoods	$21,372,000	
Land acquisition (WTP sites + transmission lines)	24.20	Acres	1/2 acre per WTP, 20 feet wide easements	$3,163,000	
GAC POET systems[1]	47	Each	Standard household systems, $2,500 per well	$117,500	
			Subtotal	$41,142,500	$36,488,500
			Contingency (20%)	$8,229,000	$7,298,000
			Professional services (15%)	$6,172,000	$5,474,000
			Total capital	**$55,544,000**	**$49,261,000**
Annual O&M cost					
WTPs	2	Lump Sum	9,000 gpm total capacity	$2,634,000	$763,000
8" pressure reducing valves	2	Lump Sum	Installed within right-of-way	$17,000	
Water distribution mains	9.57	Miles		$749,000	
GAC POET systems	91	Each	$1,000/year	$91,000	
			Subtotal	$3,491,000	$1,620,000
			20 years of annual O&M	$69,820,000	$32,400,000
			20 year costs (capital + O&M)	**$125,364,000**	**$81,661,000**
			Capital and operating cost per 1,000 gal[2]	**$1.31**	**$0.86**
			Operating only cost per 1,000 gallons[2]	**$0.73**	**$0.34**

Notes:

1. GAC POET system cost is estimated for non-municipal wells with HI ≥ 0.50. 35 wells currently have GAC POET systems installed.
2. Based on 13.1 mgd for 20 years, including 91 POET systems and 246 non-municipal wells connected to the municipal water system.

Table E.6. Year 2020 costs for conceptual projects included in the Community-Specific Scenario 1 for Cottage Grove - Alternative 2.

<table>
<tr><th>Item</th><th>Quantity</th><th>Units</th><th>Description</th><th>Total cost (GAC)</th><th>Total cost (IX)</th></tr>
<tr><td colspan="6">Capital cost</td></tr>
<tr><td>WTPs</td><td>1</td><td>Lump sum</td><td>10,800 gpm total capacity</td><td>$14,897,000</td><td>$10,627,000</td></tr>
<tr><td>8" pressure reducing valves</td><td>2</td><td>Lump sum</td><td>Installed within right-of-way</td><td colspan="2">$250,000</td></tr>
<tr><td>Water distribution mains</td><td>11.43</td><td>Miles</td><td>Installed within right-of-way</td><td colspan="2">$25,827,000</td></tr>
<tr><td>Land acquisition (WTP sites + transmission lines)</td><td>28.2</td><td>Acres</td><td>1/2 acre per WTP, 20 feet wide easements</td><td colspan="2">$3,686,000</td></tr>
<tr><td>GAC POET systems[1]</td><td>47</td><td>Each</td><td>Standard household systems, $2,500 per well</td><td colspan="2">$117,500</td></tr>
<tr><td colspan="4">Subtotal</td><td>$44,777,500</td><td>$40,507,500</td></tr>
<tr><td colspan="4">Contingency (20%)</td><td>$8,956,000</td><td>$8,102,000</td></tr>
<tr><td colspan="4">Professional services (15%)</td><td>$6,717,000</td><td>$6,077,000</td></tr>
<tr><td colspan="4">Total capital</td><td>$60,451,000</td><td>$54,687,000</td></tr>
<tr><td colspan="6">Annual O&M cost</td></tr>
<tr><td>WTPs</td><td>1</td><td>Lump sum</td><td>10,800 gpm total capacity</td><td>$2,931,000</td><td>$752,000</td></tr>
<tr><td>8" pressure reducing valves</td><td>2</td><td>Lump sum</td><td>Installed within right-of-way</td><td colspan="2">$17,000</td></tr>
<tr><td>Water distribution mains</td><td>11.43</td><td>Miles</td><td>Installed within right-of-way</td><td colspan="2">$904,000</td></tr>
<tr><td>GAC POET systems</td><td>91</td><td>Each</td><td>$1,000/year</td><td colspan="2">$91,000</td></tr>
<tr><td colspan="4">Subtotal</td><td>$3,943,000</td><td>$1,764,000</td></tr>
<tr><td colspan="4">20 years of annual O&M</td><td>$78,860,000</td><td>$35,280,000</td></tr>
<tr><td colspan="4">20 year costs (capital + O&M)</td><td>$139,311,000</td><td>$89,967,000</td></tr>
<tr><td colspan="4">Capital and operating cost per 1,000 gal[2]</td><td>$1.22</td><td>$0.79</td></tr>
<tr><td colspan="4">Operating only cost per 1,000 gallons[2]</td><td>$0.69</td><td>$0.31</td></tr>
</table>

Notes:

1. GAC POET system cost is estimated for non-municipal wells with HI ≥ 0.50. 35 wells currently have GAC POET systems installed.
2. Based on 15.7 mgd for 20 years, including 91 POET systems and 246 non-municipal wells connected to the municipal water system.

Table E.7. Year 2040 costs for conceptual projects included in the Community-Specific Scenario 1 for Cottage Grove - Alternative 1.

<table>
<tr><th>Item</th><th>Quantity</th><th>Units</th><th>Description</th><th>Total cost (GAC)</th><th>Total cost (IX)</th></tr>
<tr><td colspan="6">Capital cost</td></tr>
<tr><td>WTPs</td><td>4</td><td>Lump sum</td><td>14,000 gpm total capacity</td><td>$28,563,000</td><td>$20,376,000</td></tr>
<tr><td>8" pressure reducing valves</td><td>2</td><td>Lump sum</td><td>Installed within right-of-way</td><td colspan="2">$250,000</td></tr>
<tr><td>Water distribution mains</td><td>12.65</td><td>Miles</td><td>Water mains from wells to WTPs and neighborhoods</td><td colspan="2">$28,519,000</td></tr>
<tr><td>Land acquisition (WTP sites + transmission lines)</td><td>32.67</td><td>Acres</td><td>1/2 acre per WTP, 20 feet wide easements</td><td colspan="2">$4,269,000</td></tr>
<tr><td>GAC POET systems[1]</td><td>82</td><td>Each</td><td>Standard household systems, $2,500 per well</td><td colspan="2">$205,000</td></tr>
<tr><td colspan="4">Subtotal</td><td>$61,806,000</td><td>$53,619,000</td></tr>
<tr><td colspan="4">Contingency (20%)</td><td>$12,362,000</td><td>$10,724,000</td></tr>
<tr><td colspan="4">Professional services (15%)</td><td>$9,271,000</td><td>$8,043,000</td></tr>
<tr><td colspan="4">Total capital</td><td>$83,439,000</td><td>$72,386,000</td></tr>
<tr><td colspan="6">Annual O&M cost</td></tr>
<tr><td>WTPs</td><td>4</td><td>Lump sum</td><td>14,000 gpm total capacity</td><td>$4,262,000</td><td>$1,304,000</td></tr>
<tr><td>8" pressure reducing valves</td><td>2</td><td>Lump sum</td><td>Installed within right-of-way</td><td colspan="2">$17,000</td></tr>
<tr><td>Water distribution mains</td><td>12.65</td><td>Miles</td><td>Raw water mains from wells to WTPs</td><td colspan="2">$999,000</td></tr>
<tr><td>GAC POET systems</td><td>140</td><td>Each</td><td>$1,000/year</td><td colspan="2">$140,000</td></tr>
<tr><td colspan="4">Subtotal</td><td>$5,418,000</td><td>$2,460,000</td></tr>
<tr><td colspan="4">20 years of annual O&M</td><td>$108,360,000</td><td>$49,200,000</td></tr>
<tr><td colspan="4">20 year costs (capital + O&M)</td><td>$191,799,000</td><td>$121,586,000</td></tr>
<tr><td colspan="4">Capital and operating cost per 1,000 gal[2]</td><td>$1.29</td><td>$0.82</td></tr>
<tr><td colspan="4">Operating only cost per 1,000 gallons[2]</td><td>$0.73</td><td>$0.33</td></tr>
</table>

Notes:

1. GAC POET system cost is estimated for non-municipal wells within the groundwater model 20 year flow paths.
2. Based on 20.3 mgd for 20 years.

Table E.8. Year 2040 costs for conceptual projects included in the Community-Specific Scenario 1 for Cottage Grove - Alternative 2.

Item	Quantity	Units	Description	Total cost (GAC)	Total cost (IX)

Capital cost					
WTPs	2	Lump sum	14,000 gpm total capacity	$22,076,000	$15,749,000
8" pressure reducing valves	2	Lump sum	Installed within right-of-way	$250,000	
Water distribution mains	15.59	Miles	Installed within right-of-way	$35,440,000	
Land acquisition (WTP sites + transmission lines)	38.8	Acres	1/2 acre per WTP, 20 feet wide easements	$5,070,000	
GAC POET systems[1]	82	Each	Standard household systems, $2,500 per well	$205,000	
			Subtotal	$63,041,000	$56,714,000
			Contingency (20%)	$12,609,000	$11,343,000
			Professional services (15%)	$9,457,000	$8,508,000
			Total capital	**$85,107,000**	**$76,565,000**
Annual O&M cost					
WTPs	2	Lump sum	14,000 gpm total capacity	$3,937,000	$1,073,000
8" pressure reducing valves	2	Lump sum	Installed within right-of-way	$17,000	
Water distribution mains	15.59	Miles	Installed within right-of-way	$1,241,000	
GAC POET systems	140	Each	$1,000/year	$140,000	
			Subtotal	$5,335,000	$2,471,000
			20 years of annual O&M	$106,700,000	$49,420,000
			20 year costs (capital + O&M)	**$191,807,000**	**$125,985,000**
			Capital and operating cost per 1,000 gal[2]	**$1.30**	**$0.85**
			Operating only cost per 1,000 gallons[2]	**$0.72**	**$0.33**

Notes:

1. GAC POET system cost is estimated for non-municipal wells within the groundwater model 20 year flow paths.
2. Based on 20.3 mgd for 20 years.

Table E.9. Year 2040 costs for conceptual projects included in the Community-Specific Scenario 1 for Cottage Grove - Alternative 3.

Item	Quantity	Units	Description	Total cost (GAC)	Total cost (IX)
Capital cost					
WTPs	2	Lump sum	14,000 gpm total capacity	$22,076,000	$15,749,000
Well	1	Lump sum	1,200 gpm	$2,178,000	

8" pressure reducing valves	2	Lump sum	Installed within right-of-way	$250,000	
Water distribution mains	12.95	Miles	Water mains from wells to WTPs and neighborhoods	$29,441,000	
Land acquisition (WTP sites + transmission lines)	32.4	Acres	1/2 acre per WTP, 20 feet wide easements	$4,232,000	
GAC POET systems[1]	82	Each	Standard household systems, $2,500 per well	$205,000	
			Subtotal	$58,382,000	$52,055,000
			Contingency (20%)	$11,677,000	$10,411,000
			Professional services (15%)	$8,758,000	$7,809,000
			Total capital	**$78,817,000**	**$70,275,000**
Annual O&M cost					
WTPs	2	Lump sum	14,000 gpm total capacity	$3,937,000	$1,073,000
Well	1	Lump sum	1,200 gpm	$83,000	
8" pressure reducing valves	5	Lump sum	Installed within right-of-way	$43,000	
Water distribution mains	12.33	Miles	Raw water mains from wells to WTPs	$1,031,000	
GAC POET systems	140	Each	$1,000/year	$140,000	
			Subtotal	$5,208,000	$2,344,000
			20 years of annual O&M	$104,160,000	$46,880,000
			20 year costs (capital + O&M)	**$182,977,000**	**$117,155,000**
			Capital and operating cost per 1,000 gal[2]	**$1.24**	**$0.79**
			Operating only cost per 1,000 gallons[2]	**$0.70**	**$0.32**

Notes:

1. GAC POET system cost is estimated for non-municipal wells within the groundwater model 20 year flow paths.
2. Based on 20.3 mgd for 20 years.

E.1.1.4 Conceptual projects – Denmark

E.1.1.4.1 Project summary

The conceptual project considered for Denmark under this scenario would include installing GAC POET systems on PFAS impacted non-municipal wells. A summary of the project is provided below.

GAC POET systems

This scenario would provide GAC POET systems for PFAS impacted non-municipal wells under both 2020 and 2040 conditions. As of October 2019 sample data, Denmark has an estimated 487 existing non-municipal wells, of which 103 wells have been sampled. All sampled wells have a HI value less than 0.5, and thus, no GAC POET systems have been installed. Based on current sampling trends, it was estimated that by 2020 a total of 3 non-municipal wells would have HI values greater than or equal to 0.5 and would receive treatment through GAC POET systems. The groundwater model flow path analysis estimated that by 2040 no additional GAC POET systems would be needed.

E.1.1.4.2 LGU water supplies and infrastructure

A drinking water distribution model was not created for this community as there is no municipal water system within Denmark.

E.1.1.4.3 Hydrogeologic impacts

The non-municipal wells in Denmark draw water from the Prairie du Chien and Tunnel City aquifers. Groundwater in these aquifers moves primarily west to east across the Township. The groundwater model indicates that PFAS contamination may not migrate into Denmark and may not impact non-municipal wells by 2040.

E.1.1.4.4 Cost estimate breakdown

Capital and O&M costs are summarized in Table E.10 for the Years 2020 and 2040, as they are the same.

Table E.10. Year 2020 and 2040 costs for conceptual projects included in the Community-Specific Scenario 1 for Denmark.

Item	Quantity	Units	Description	Total cost
Capital cost				
GAC POET systems[1]	3	Each	Standard household systems, $2,500 per well	$7,500
			Subtotal	$7,500
			Contingency (20%)	$1,500
			Professional services (15%)	$1,200
			Total capital	**$10,200**
Annual O&M cost				
GAC POET systems	3	Each	$1,000/year	$3,000
			20 years of annual O&M	$60,000
			20 year costs (capital + O&M)	**$70,200**
			Capital and operating cost per 1,000 gal[2]	**$8.65**
			Operating only cost per 1,000 gallons[2]	**$7.39**

Notes:

1. GAC POET system cost is estimated for non-municipal wells with HI ≥ 0.50.
2. Annual water usage was determined using a 2020 population of 1,920, an average daily demand of 94 gallons per capita per day, and 487 non-municipal wells. Equating water demand to an average population of 3.94 people per well, results in an average daily demand of 371 gallons per day per well, or 8.12 million gallons in 20 years for 3 wells.

E.1.1.5 Conceptual projects – Grey Cloud Island

E.1.1.5.1 Project summary

The conceptual project considered for Grey Cloud Island under this scenario would include installing GAC POET systems on PFAS impacted non-municipal wells. A summary of the project is provided below.

While some residents prefer to remain on non-municipal wells with treatment, others support connecting to a neighboring community with a municipal water system. This second option was evaluated under the integrated scenario (Section E.4).

GAC POET systems

This scenario would provide GAC POET systems for PFAS impacted non-municipal wells under both 2020 and 2040 conditions. Based on October 2019 sample data, Grey Cloud Island has an estimated 121 existing non-municipal wells, of which 109 wells have been sampled. Of these sampled wells, 52 currently have GAC POET systems installed. Based on current sampling trends, it was estimated that by 2020 another 27 non-municipal wells (in addition to the 52 that have GAC POET systems) would have HI values greater than or equal to 0.5 and would receive treatment through new GAC POET systems. The groundwater model flow path analysis estimated that by 2040 a total of 116 non-municipal would be impacted and require treatment through existing or proposed GAC POET systems.

E.1.1.5.2 LGU water supplies and infrastructure

A drinking water distribution model was not created for this community as there is no municipal water system within Grey Cloud Island.

E.1.1.5.3 Hydrogeologic impacts

The non-municipal wells in Grey Cloud Island draw water from the Prairie du Chien aquifer. However, the majority of wells in Grey Cloud Island are of unknown depth and therefore unknown aquifers. Groundwater in the Prairie du Chien aquifer generally moves northeast to southwest across the Township and the groundwater model indicates that PFAS contamination may follow this established flow path and potentially impact another 37 wells (116 total) by 2040.

E.1.1.5.4 Cost estimate breakdown

Capital and O&M costs are summarized in Table E.11 for the year 2020 and Table E.12 for the year 2040. Capital and O&M costs were included in the cost estimate for the non-municipal wells requiring the installation of a new POET system. Only O&M costs were included for the non-municipal wells that currently have a POET system.

Table E.11. Year 2020 costs for conceptual projects included in the Community-Specific Scenario 1 for Grey Cloud Island.

Item	Quantity	Units	Description	Total cost
Capital cost				
GAC POET systems[1]	27	Each	Standard household systems, $2,500 per well	$67,500
			Subtotal	$67,500
			Contingency (20%)	$13,500
			Professional services (15%)	$10,200
			Total capital	**$91,200**
Annual O&M cost				
GAC POET systems[3]	79	Each	$1,000/year	$79,000
			20 years of annual O&M	$1,580,000
			20 year costs (capital + O&M)	**$1,672,000**

Capital and operating cost per 1,000 gal²	**$12.44**
Operating only cost per 1,000 gallons²	**$11.76**

Notes:

1. GAC POET system cost is estimated for non-municipal wells with HI ≥ 0.50.
2. Annual water usage was determined using a 2020 population of 300, an average daily demand of 94 gallons per capita per day, and 121 non-municipal wells. Equating water demand to an average population of 2.48 people per well, results in an average daily demand of 233 gallons per day per well, or 134 million gallons in 20 years for 79 wells.
3. Annual O&M cost includes the 52 POETS that are currently installed.

Table E.12. Year 2040 costs for conceptual projects included in the Community-Specific Scenario 1 for Grey Cloud Island.

Item	Quantity	Units	Description	Total Cost
Capital cost				
GAC POET systems[1]	64	Each	Standard household systems, $5,500 per well	$160,000
			Subtotal	$160,000
			Contingency (20%)	$32,000
			Professional services (15%)	$24,000
			Total capital	**$216,000**
Annual O&M cost				
GAC POET systems	116	Each	$1,000/year	$116,000
			20 years of annual O&M	$2,320,000
			20 year costs (capital + O&M)	$2,**536**,000
			Capital and operating cost per 1,000 gallons²	$14.**28**
			Operating only cost per 1,000 gallons²	$13.06

Notes:

1. GAC POET system cost is estimated for non-municipal wells within the groundwater model 20 year flow paths.
2. Annual water usage was determined using a 2020 population of 270, an average daily demand of 94 gallons per capital per day, and 121 non-municipal wells. Equating water demand to an average population of 2.23 people per well, results in an average daily demand of 210 gallons per day per well, or 196 million gallons in 20 years for 116 wells.

E.1.1.6 Conceptual projects – Lake Elmo

E.1.1.6.1 Project summary

The conceptual projects considered for Lake Elmo under this scenario would include the installation of two new municipal supply wells and extending water mains to nearby neighborhoods currently on PFAS impacted non-municipal wells. GAC POET systems would be installed for the rest of the impacted non-municipal wells that were not proposed to be connected to the municipal water system in this scenario based on cost or constructability constraints. A summary of the projects is provided below.

Water supply

Lake Elmo has a municipal water system consisting of two wells (Wells 2 and 4) with a total design capacity of 2,250 gpm with all wells running. If all municipal supply wells were in operation, the city would have a calculated firm capacity of 1,000 gpm with the largest well out of service. The city is currently installing a third well, Well 5, which is expected to have a 1,250 gpm pumping capacity and would increase the firm capacity to 2,250 gpm. With all three wells, this firm capacity of 2,250 gpm would meet their current 2020 maximum daily demand of 1,400 gpm, but would be less than the anticipated 2040 maximum daily demand of 3,750 gpm.

New municipal supply wells

To meet 2040 maximum daily demands and firm capacity requirements, two additional municipal supply wells would be required. These wells would be constructed to pump water from the Jordan aquifer and be located in the northern portion of the community where PFAS levels are relatively low and treatment is not required. It was assumed that these wells could be implemented without negatively impacting the levels in White Bear Lake. However, if these wells were to be installed, additional analysis would likely be required to show that there are no negative impacts (see Hydrogeologic Impacts Section below).

Another alternative that was considered under the integrated scenario includes installing additional wells in the southern portion of the city to mitigate the effects on White Bear Lake.

Water main extension to existing neighborhoods

Under this scenario, all existing neighborhoods within the Special Well and Boring Construction Area would be connected to the city's municipal water system. Table E.13 lists these neighborhoods and areas provided by the city that are proposed to be connected, with the exception of the expedited projects that have been approved (see Appendix A).

Table E.13. Proposed neighborhoods and areas that would be connected to Lake Elmo's municipal water system under this scenario.

Name	Listed no. of properties	Connections accounted for in well counts	Discrepancy	City's estimated cost
Whistling Valley Neighborhood	46	32	5 missing from Minnesota Well Index (MWI) & 9 not built yet	$4,927,000
Parkview Estates/Cardinal Ridge/Cardinal View Neighborhood	62	66	Added 4 in for nursery	$6,870,000
Torre Pines Neighborhood	23	22	1 is sealed	$2,504,000
The Forest Neighborhood	18	18		$1,268,000
Tartan Meadows Neighborhood	39	36	3 missing from CWI	$1,884,000
The Homestead Neighborhood	18	18		$1,512,000
20th Street Circle	4	3	1 missing from CWI	$196,000
Packard Park Neighborhood	21	20	1 missing from CWI	$5,600,000
Eden Park Neighborhood	44	28	13 missing from CWI & 3 not built	
Downs Lake Estates Neighborhood	16	13	3 missing from CWI	$2,128,000
Klondike Avenue	11	11		$1,736,000
Stillwater Lane/Stillwater Blvd	14	14		$405,000

31st Street Area	7	7		$508,000
38th & 39th Street	49	25	24 missing from CWI	$3,197,000
Tapestry Neighborhood	4	3	1 missing from CWI	$470,800
Sunfish Ponds Neighborhood	16	16		$952,000
Total	**392**	**314**		**$33,205,800**

GAC POET systems

This scenario would provide GAC POET systems for PFAS impacted non-municipal wells under both 2020 and 2040 conditions that were not connected to the municipal water system. Based on October 2019 sample data, Lake Elmo has an estimated 1,309 existing non-municipal wells, of which 503 have been sampled. Under 2020 conditions, it was assumed that all residences with existing GAC POET systems would be connected to the city's municipal water system. In addition, based on current sampling trends, it was estimated that by 2020, 30 non-municipal wells would have an HI value greater than or equal to 0.5 and would receive treatment through a new GAC POET system. The groundwater model flow path analysis estimated that by 2040 a total of 131 non-municipal wells would be impacted and require treatment through proposed GAC POET systems.

E.1.1.6.2 LGU water supplies and infrastructure

As Lake Elmo's Well 5 and two proposed new wells have yet to be installed, a single point system curve was created for each well pump to maintain system pressures currently observed in the system. Under 2040 conditions, the southern high zone and the low zone would be hydraulically connected by the proposed trunk lines. There are currently four existing pressure reducing valves in the system and an additional pressure reducing valve would be required on the proposed 12" trunk line along 10th Street to maintain adequate pressures throughout the system. However, pressures along the far eastern edge of the community could still see some relatively higher pressures at 80 to 90 pounds per square inch (psi); particularly in the northeastern area where the four municipal supply wells are located. In this region, having four high capacity wells in close proximity presents some hydraulic challenges to ensure that each pump is meeting its design flow rate while minimizing the pressures in the area. To help regulate pressures, the discharge lines from the two new municipal supply wells would be conveyed via a single large diameter pipe to the 16" line along Stillwater Boulevard. Additionally, several lines along Stillwater Boulevard would need to be paralleled to facilitate the conveyance of flow to the other regions within the community. While this helps alleviate some of the pressure in the northeastern area, high pressures ranging from 100-115 psi are occurring and modifying the existing pumps may help. It is recommended that a system wide assessment and model calibration be performed to determine the best course of action to regulate pressures across the community such that each zone would be hydraulically connected. In the remaining areas, pressures in the high zone ranged from 45 to 90 psi, in the low zone from 65 to 90 psi, and in the intermediate north (with the exclusion of the northeastern well field area) from 40 psi near the high zone booster pump station to 100 psi.

E.1.1.6.3 Hydrogeologic impacts

Two new municipal supply wells have been proposed for Lake Elmo and each of these wells would extract groundwater at a rate of 333 gpm average daily demand (1,000 gpm maximum daily demand) from the Jordan aquifer. Using the groundwater model, it can be shown that the aquifer could sustain this pumping rate without excessive drawdown. However, it is acknowledged that despite drawdown being within a normal range, there still may be impacts to White Bear Lake levels as a result of these wells. This is a factor that will need additional analysis using information specific to White Bear Lake, which was not a focus of this analysis. Based on particle tracking/flow path analysis for PFAS, it was projected that these wells would not require treatment for PFAS now or in the future. Particle tracking/flow path analysis was not completed for other contaminants such as TCE.

Non-municipal wells in Lake Elmo draw water from the Quaternary, Jordan, and Prairie du Chien aquifers. The majority of residential wells draw water from the Jordan and Prairie du Chien aquifers. However, there are a number of residential wells that are of unspecified depth, and therefore it is unknown from which aquifer these wells draw water. Groundwater in the Prairie du Chien aquifer(s) migrates northeast to southwest across the City in the western portion of the community, and northwest to southeast on the eastern side of the community. The groundwater model indicates that PFAS contamination may follow these flow paths and potentially impact another 101 non-municipal wells (131 total) by 2040.

E.1.1.6.4 Cost estimate breakdown

The projects included in this scenario for Lake Elmo includes two new municipal supply wells, water main extensions to PFAS impacted neighborhoods, and the installation of 131 GAC POET systems for residences that cannot be reasonably connected to the municipal water system by 2040. Capital and O&M costs are summarized in Table E.14 for the year 2020 and Table E.15 for the year 2040.

With Well 5 nearing completion and starting operation soon, sufficient well capacity is available to meet the 2020 maximum daily demands of 2.0 mgd. New wells are not required for 2020 and were not included in the 2020 cost estimate. The 2020 projects include water main extensions to the same neighborhoods included in the 2040 cost estimate.

Table E.14. Year 2020 costs for conceptual projects included in Community-Specific Scenario 1 for - Lake Elmo.

Item	Quantity	Units	Description	Total cost
Capital cost				
Water distribution mains	21.71	Miles	Extensions to neighborhoods	$41,982,000
12” pressure reducing valves	1	Lump sum	Installed within right-of-way	$125,000
Land acquisition (sites + water mains)	53.1	Acres	1/2 acre per well, 20 feet wide easements	$6,944,000
GAC POET systems[1]	30	Each	Standard household systems, $2,500 per well	$75,000
			Subtotal	$49,126,000
			Contingency (20%)	$9,826,000
			Professional services (15%)	$7,369,000
			Total capital	**$66,321,000**
Annual O&M cost				

Water distribution mains	18.01	Miles	Installed within right-of-way	$1,470,000
12” pressure reducing valves	1	Lump sum	Installed within right-of-way	$9,000
GAC POET systems	30	Each	$1,000/year	$30,000
			Subtotal	$1,509,000
			20 years of annual O&M	$30,180,000
			20 year costs (capital + O&M)	**$96,501,000**
			Capital and operating cost per 1,000 gal[2]	**$119.90**
			Operating only cost per 1,000 gallons[2]	**$37.50**

Notes:

1. GAC POET system cost is estimated for non-municipal wells with HI ≥ 0.50.
2. Based on estimated water demands of the 362 non-municipal wells connected to the municipal water system and the 30 installed POET systems. $/1000 gallons is based on 40.2 million gallons per year.

Table E.15. Year 2040 costs for conceptual projects included in Community-Specific Scenario 1 for - Lake Elmo.

Item	Quantity	Units	Description	Total cost
Capital cost				
Wells 6 & 7	2	Lump sum	2,000 gpm total capacity	$4,356,000
12” pressure reducing valves	1	Lump sum	Installed in right-of-way	$125,000
Water distribution mains	21.71	Miles	Extensions to neighborhoods	$41,982,000
Land acquisition (sites + water mains)	53.6	Acres	1/2 acre per well, 20 feet wide easements	$7,009,000
GAC POET systems[1]	131	Each	Standard household systems, $2,500 per well	$327,500
			Subtotal	$53,799,500
			Contingency (20%)	$10,760,000
			Professional services (15%)	$8,070,000
			Total capital	**$72,629,500**
Annual O&M cost				
Wells 6 & 7	2	Lump sum	2,000 gpm total capacity	$132,000
12” pressure reducing valves	1	Lump sum	Installed within right-of-way	$9,000
Water distribution mains	21.71	Miles	Installed within right-of-way	$1,470,000
GAC POET systems	131	Each	$1,000/year	$120,000
			Subtotal	$1,742,000
			20 years of annual O&M	$34,840,000
			20 year costs (capital + O&M)	**$107,469,500**
			Capital and operating cost per 1,000 gal[2]	**$4.89**

Operating only cost per 1,000 gallons[2]	**$1.59**

Notes:

1. GAC POET system cost is estimated for non-municipal wells within the groundwater model 20 year flow paths.
2. Based on 2,000 gpm for the two proposed municipal supply wells plus estimated water demands of the 362 non-municipal wells connected to the municipal water system and the 131 installed POET systems. $/1000 gallons is based on 1,098 million gallons per year.

E.1.1.7 Conceptual projects – Lakeland, Lakeland Shores, and Lake St. Croix Beach

E.1.1.7.1 Project summary

The conceptual projects considered for Lakeland (and included communities of Lakeland Shores and Lake St. Croix Beach) under this scenario would include extending water mains to nearby neighborhoods such as St. Mary's Point by 2040 and connecting all non-municipal wells to the municipal water system. A summary of the projects is provided below.

Water main extension to existing neighborhoods

The City of Lakeland has indicated that they plan to continue connecting residents and businesses to their municipal water system. This includes residents and businesses that may already be connected but have a non-municipal well for irrigation purposes. Under this scenario, the irrigation wells would be sealed. The existing municipal water system is almost completely built out for the communities of Lakeland, Lakeland Shores, and Lake St. Croix Beach. However, the City has reserved capacity of their municipal supply wells that would enable them to extend water lines to St. Mary's Point. The cost of these new distribution lines for St. Mary's Point was not included in the cost estimate.

GAC POET systems

This scenario would provide GAC POET systems for PFAS impacted non-municipal wells until they were connected to the municipal water system. As of October 2019 sample data, Lakeland and Lakeland Shores have an estimated 337 existing non-municipal wells, of which 70 have been sampled. Of those sampled wells, 3 currently have GAC POET systems installed. Based on current sampling trends, it was estimated that by 2020 a total of 171 non-municipal wells would have HI values greater than or equal to 0.5 and would receive treatment through GAC POET systems. By 2040, it is assumed that all non-municipal wells would be connected to the city's municipal water system through connections to existing water lines. However, until all residences could be connected to the municipal water system, GAC POET systems would be an interim solution. Existing non-municipal wells proposed to receive GAC POET systems were included in the 2020 cost estimate.

E.1.1.7.2 LGU water supplies and infrastructure

System operations for Lakeland would not change under this scenario. The municipal supply wells would continue to operate as they are currently across one pressure zone. Under 2040 conditions, the range of pressures seen in the system ranged from 40 to 90 psi. No modifications to the municipal water system are recommended at this time to meet 2040 demands. If the city decides to serve St. Mary's Point further analysis would be required to expand the existing distribution system, however, the city has enough water supply to meet the additional demand.

E.1.1.7.3 Hydrogeologic impacts

Groundwater in the Lakeland, Lakeland Shores, and Lake St. Croix Beach communities flows from west to east. Sampling data indicate there is significant PFAS contamination to the west of these communities and there is a concern that this will migrate further into this area. The non-municipal wells appear to mostly be located in the Quaternary, Eau Claire, and Mt. Simon aquifers. Based on MDH PFAS sampling data, approximately 50% of the residential wells in these communities draw water from unknown depths and therefore unknown aquifers. In addition, the data show that approximately 25% of the residential wells may already be contaminated with PFAS compounds. Groundwater modeling of this region has indicated that it is likely that PFAS contamination may continue to migrate into these communities within the next 20 years. However, modeling results have also indicated that the Mt. Simon aquifer, from which both municipal supply wells are drawing, will remain unimpacted over the next 20 years. Therefore, neither municipal supply well would require treatment by 2040.

E.1.1.7.4 Cost estimate breakdown

Capital and O&M costs are summarized in Table E.16 for the year 2020 and Table E.17 for the year 2040. All non-municipal wells would be connected to the city's municipal water system and/or be sealed by 2040.

Table E.16. Year 2020 costs for conceptual projects included in Community-Specific Scenario 1 for Lakeland, Lakeland Shores, and Lake St. Croix Beach.

Item	Quantity	Units	Description	Total cost
Capital cost				
GAC POET systems[1]	168	Each	Standard household systems, $2,500 per well	$420,000
			Subtotal	$420,000
			Contingency (20%)	$84,000
			Professional services (15%)	$63,000
			Total capital	**$987,000**
Annual O&M cost				
GAC POET systems	171	Each	$1,000/year	$171,000
			20 years of annual O&M	$3,420,000
			20 year costs (capital + O&M)	**$4,407,000**
			Capital and operating cost per 1,000 gal[2]	**$15.65**
			Operating only cost per 1,000 gallons[2]	**$12.14**

Notes:

1. GAC POET system cost is estimated for non-municipal wells with HI ≥ 0.50.
2. Annual water usage was determined using 2.4 people per household and 94 gallons per person per day. Equating water demand to an estimated average daily demand, results in 256 gallons per day per well or 281 million gallons in 20 years for 171 wells.

Table E.17. Year 2040 costs for conceptual projects included in Community-Specific Scenario 1 for Lakeland and Lakeland Shores.

Item	Quantity	Units	Description	Total cost
Capital cost				
Well sealing	171	Each	$300 per well	$52,000
Install service laterals	171	Each	$2,500 per well	$428,000
			Subtotal	$480,000
			Contingency (20%)	$96,000

			Professional services (15%)	$72,000
			Total capital	**$648,000**
Annual O&M cost				
Well sealing & laterals	No on-going maintenance or O&M, both would become responsibility of well owner			0
			20 years of annual O&M	0
			20 year costs (capital + O&M)	**$648,000**
			Capital and operating cost per 1,000 gallons	**$14.08**
			Operating only cost per 1,000 gallons	**$0**

E.1.1.8 Conceptual projects – Maplewood

E.1.1.8.1 Project summary

The conceptual project considered for Maplewood under this scenario would include connecting the majority of residences on PFAS impacted non-municipal wells to the existing St. Paul Regional Water Services (SPRWS) system for both the 2020 and 2040 conditions.

Within the southern region of Maplewood, four residences have GAC POET systems installed and one residence does not but has a HI value greater than or equal to 0.5. These wells and the other remaining wells in the area would be connected to SPRWS's existing distribution system by extending the water lines. Other non-municipal wells would remain active in the area, but do not have HI values greater than or equal to 0.5 and therefore do not require treatment or connecting to SPRWS' system.

E.1.1.8.2 LGU water supplies and infrastructure

No drinking water distribution model was created for Maplewood as SPRWS owns, operates, and maintains their system-wide distribution model that includes various other communities. All new lines were assumed to be 8" for cost estimating purposes and to meet the minimum size requirement.

E.1.1.8.3 Hydrogeologic impacts

The City of Maplewood has approximately 50 non-municipal wells. These wells draw water from the Prairie du Chien aquifer. In Maplewood, the Prairie du Chien aquifer flows northeast to southwest. Five wells in southern Maplewood have shown PFAS impacts in the past. However, flow path analysis using the groundwater model does not show additional wells in Maplewood as being affected in the future.

E.1.1.8.4 Cost estimate breakdown

Capital and O&M costs are summarized in Table E.18 for the **year 2040.**

Table E.18. Year 2040 costs for conceptual projects included in the Community-Specific Scenario 1 for Maplewood.

Item	Quantity	Units	Description	Total cost
Capital cost				
Water distribution mains	1.44	Miles	Extensions to neighborhoods	$3,164,000

Land acquisition (sites + water mains)	3.5	Acres	1/2 acre per well, 20 feet wide easements	$456,000
GAC POET systems[1]	0	Each	Standard household systems, $2,500 per well	$0
Subtotal				$3,620,000
Contingency (20%)				$724,000
Professional services (15%)				$543,000
Total capital				**$4,887,000**
Annual O&M cost				
Water distribution mains	1.44	Miles	Installed within right-of-way	$111,000
GAC POET systems	0	Each	$1,000/year	$0
Subtotal				$111,000
20 years of annual O&M				$2,220,000
20 year costs (capital + O&M)				**$7,107,000**
Capital and operating cost per 1,000 gal[2]				**$58.65**
Operating only cost per 1,000 gallons[2]				**$18.32**

Notes:

1. There are zero non-municipal wells with HI ≥ 0.50 that are expected to require a GAC POET. All PFAS contaminated wells are being tied into SPRWS with water main extensions.
2. Based on estimated water demands of the 62 non-municipal wells connected to the municipal water system. $/1000 gallons is based on 6.01 million gallons per year using an average population per household of 3.15 (from Oakland due to lack of data), and a gallons per capita per day water demand of 90 (from Oakdale).

E.1.1.9 Conceptual projects – Newport

E.1.1.9.1 Project summary

The conceptual project considered for Newport under this scenario would include installing GAC POET systems on PFAS impacted non-municipal wells. While there are no municipal or non-municipal wells in 2020 with HI values greater than or equal to 0.5, POET systems are anticipated to be necessary by the year 2040 in the southeast corner of the city. A summary of the project is provided below.

The option of Newport to hydraulically interconnect with neighboring communities was evaluated in the integrated scenario.

GAC POET systems

This scenario would provide GAC POET systems for PFAS impacted non-municipal wells under 2040 conditions. As of October 2019 sample data, Newport has an estimated 113 existing non-municipal wells, of which 25 have been sampled. Of these sampled wells, none currently have GAC POET systems installed. Based on current sampling trends, it was estimated that by 2020 no municipal wells would have HI values greater than or equal to 0.5. The groundwater model flow path analysis estimated that by 2040 a total of 15 non-municipal wells would be impacted and receive treatment through proposed GAC POET systems.

E.1.1.9.2 LGU water supplies and infrastructure

A drinking water distribution model was created and calibrated based on the data provided by the City of Newport. Pressures in the system are consistent with those recently observed during hydrant testing. The model was used in the integrated scenario to evaluate interconnects with neighboring communities as opposed to providing treatment at the municipal supply wells in the event that these wells become contaminated in the future.

E.1.1.9.3 Hydrogeologic impacts

Groundwater in Newport flows from northeast to southwest. Currently, sampling data has indicated that there have been very low levels of PFAS contamination across the city and groundwater modeling has indicated that Newport's municipal supply wells will remain uncontaminated over the next 20 years. However, 15 non-municipal wells are expected to be impacted by PFAS by the year 2040.

E.1.1.9.4 Cost estimate breakdown

Capital and O&M costs are summarized in Table E.19 for the year 2040.

Table E.19. Year 2040 costs for conceptual projects included in Community-Specific Scenario 1 for Newport.

Item	Quantity	Units	Description	Total cost
Capital Cost				
GAC POET systems[1]	15	Each	Standard household systems, $2,500 per well	$38,000
			Subtotal	$38,000
			Contingency (20%)	$8,000
			Professional services (15%)	$6,000
			Total Capital	**$52,000**
Annual O&M Cost				
GAC POET systems	15	Each	$1,000/year	$15,000
			20 years of annual O&M	$300,000
			20 year costs (capital + O&M)	**$352,000**
			Capital and operating cost per 1,000 gallons[2]	**$12.45**
			Operating only cost per 1,000 gallons[2]	**$10.61**

Notes:

1. GAC POET system cost is estimated for non-municipal wells within the groundwater model 20 year flow paths.
2. Based on an average population per well of 3.15 and an average gallons per capita per day of 82, results in 258 gallons per day per well, or 28.3 million gallons in 20 years.

E.1.1.10 Conceptual projects – Oakdale

E.1.1.10.1 Project summary

The conceptual projects considered for Oakdale under this scenario would include the expansion of the City of Oakdale's centralized WTP and the installation of a new municipal supply well. GAC POET systems would be installed for PFAS impacted non-municipal wells. A summary of the projects is provided below.

WTPs

Under this scenario, two alternatives were considered to expand the city's centralized WTP. This analysis was only conducted for 2040 conditions, since the 2020 maximum daily demand was only 700 gpm less than the 2040 maximum daily demand and does not have a significant impact on the two 2040 alternatives.

Alternative 1 – 2040

This alternative would route all flows from Wells 1, 2, 7, and 8 to the existing centralized WTP. The WTP would be expanded by 3,900 gpm to a total treatment capacity of 6,300 gpm to be able to treat flows from all six wells (Wells 1, 2, 5, 7, 8, and 9).

PFAS impacted Wells 3 and 10 were not included in this alternative.

Alternative 2 – 2040

This alternative would relocate one new municipal supply well close to the existing WTP to replace Well 8, which has a capacity of 1,000 gpm. The existing WTP would be expanded by 3,900 gpm to a capacity of 6,300 gpm to be able to treat all six wells in the area (Wells 1, 2, 5, 7, 9, and the new well).

Under this alternative, it was more cost effective to abandon and seal Well 8; drill a new well near the treatment site; and treat at the centralized WTP as opposed to installing 8,900 linear feet of 10" pipe to convey flow from Well 8 to the centralized WTP or install treatment at the well site.

Due to the proximity of Well 2 to Well 1, the most cost-effective option was to pipe Well 2 to Well 1 and convey flow from both wells to the expanded, central WTP.

PFAS impacted Wells 3 and 10 were not included in this alternative.

GAC POET systems

This scenario would provide GAC POET systems for PFAS impacted non-municipal wells under both 2020 and 2040 conditions. As of October 2019 sample data, Oakdale has an estimated 124 existing non-municipal wells, of which 39 have been sampled. Of those sampled wells, none currently have GAC POET systems installed. Based on current sampling trends, it was estimated that by 2020 15 non-municipal wells would have HI values greater than or equal to 0.5 and would receive treatment through GAC POET systems. The groundwater model flow path analysis estimated that by 2040 a total of 28 non-municipal wells would be impacted and require treatment through proposed GAC POET systems. These counts exclude any wells that would be connected to the Oakdale municipal water system through expedited projects, proposed water lines, or connections to existing water lines.

E.1.1.10.2 LGU water supplies and infrastructure

The results from the hydraulic model indicate that the pressures were very similar for both alternatives. The range of system pressures resulting from running the model under 2040 conditions is listed in Table E.20.

Table E.20 Pressure results from the drinking water distribution model for Oakdale under 2040 conditions.

Pressure zones	Alternative 1	
	Low	High
North zone pressure range	53	95

Central zone pressure range	53	110
South zone pressure range	30	95

In the southern zone, the majority of the pressures ranged between 60 and 90 psi. However, the south eastern corner experiences pressures between 90 to 100 psi resulting from lower elevations. Areas of low pressure were more centrally located near Hale Avenue and places with higher surface or ground elevations such as those areas near Tank 4.

In the central zone, pressures were slightly higher with pressures along the western half ranging from 75 to 90 psi and pressures on the eastern side ranging from 60 to 90 psi. The highest pressures were found to be more centrally located and on the far east side.

In the northern zone, the majority of the pressures were in the 60 to 70 psi range with pressures increasing along the northern boundary. The lowest pressures in the northern region were more centrally located as well.

E.1.1.10.3 Hydrogeologic impacts

Generally, groundwater in the Quaternary and St. Peter aquifers flows from northeast to southwest in Oakdale on the western side of Oakdale, and northwest to southeast on the eastern side of Oakdale. In the Prairie du Chien aquifer, groundwater flows northeast to southwest. Under Alternative 2, an additional municipal supply well would be installed in southwest Oakdale near Granite Avenue. This well would extract groundwater at a rate of approximately 1,000 gpm maximum daily demand for the wet climate condition and 1,265 gpm maximum daily demand for the drought climate condition. Using the groundwater model, it can be shown that the aquifer can sustain these pumping rates without excessive drawdown. However, both forward and reverse particle tracking under wet and drought climate conditions show that treatment may be required within the next 20 years.

Within Oakdale, six of the community's municipal supply wells are currently impacted by PFAS with HI values greater than 1.0. East and north of the municipal supply wells, significant PFAS impacted areas exist. These areas would continue to serve as source areas of PFAS to the Oakdale municipal supply wells. These wells would require treatment through the year 2040.

The majority of residential wells in Oakdale are located within the Quaternary and Prairie du Chien aquifers with a few residential wells located in the Platteville Formation or are of unknown depth, and therefore are drawing water from an unspecified aquifer. Particle tracking and flow path analysis indicate that a total of 28 non-municipal wells could be impacted by the year 2040.

E.1.1.10.4 Cost estimate breakdown

Capital and O&M costs are summarized in Table E.21 and Table E.22 for the two alternatives considered for the Year 2040.

Table E.21. Year 2040 costs for conceptual projects included in Community-Specific Scenario 1 for Oakdale - Alternative 1.

Item	Quantity	Units	Description	Total cost (GAC)	Total cost (IX)
Capital cost					
WTPs	1	Lump sum	Expand WTP to 6,300 gpm	$8,085,000	$5,768,000

Water distribution mains	4.32	Miles	Raw water mains to centralized WTP	$10,339,000	
Land acquisition (sites + water mains)	11.0	Acres	1/2 acre per well, 20 feet wide easements	$1,434,000	
GAC POET systems[1]	28	Each	Standard household systems, $2,500 per well	$70,000	
			Subtotal	$19,928,000	$17,611,000
			Contingency (20%)	$3,986,000	$3,523,000
			Professional services (15%)	$2,990,000	$2,642,000
			Total capital	**$26,904,000**	**$23,776,000**
Annual O&M cost					
WTPs	1	Lump sum	Expand WTP to 6,300 gpm	$1,194,000	$368,000
Water distribution mains	4.32	Miles	Installed within right-of-way	$362,000	
GAC POET systems	28	Each	$1,000/year	$28,000	
			Subtotal	$1,584,000	$758,000
			20 years of annual O&M	$31,680,000	$15,160,000
			20 year costs (capital + O&M)	**$58,584,000**	**$38,936,000**
			Capital and operating cost per 1,000 gal[2]	**$1.43**	**$0.95**
			Operating only cost per 1,000 gallons[2]	**$0.77**	**$0.37**

Notes:

1. GAC POET system cost is estimated for non-municipal wells within the groundwater model 20 year flow paths.
2. Based on 3,900 gpm for the WTP plus the water demands for the 28 non-municipal wells that would receive POET systems. $/1000 gallons is based on 2,052 million gallons per year.

Table E.22. Year 2040 costs for conceptual projects included in Community-Specific Scenario 1 for Oakdale - Alternative 2.

Item	Quantity	Units	Description	Total cost (GAC)	Total cost (IX)
Capital cost					
WTPs	1	Lump sum	Expand WTP to 6,300 gpm	$8,085,000	$5,768,000
New Well 8	1	Lump sum	Drill new Well 8 near WTP	$2,178,000	
Water distribution mains	2.64	Miles	Raw water mains to centralized WTP	$6,525,000	
Land acquisition (sites + water mains)	11.0	Acres	1/2 acre per well, 20 feet wide easements	$903,000	

GAC POET systems[1]	28	Each	Standard household systems, $2,500 per well	$70,000	
			Subtotal	$17,761,000	$15,444,000
			Contingency (20%)	$3,553,000	$3,089,000
			Professional services (15%)	$2,665,000	$2,317,000
			Total capital	**$23,979,000**	**$20,850,000**
Annual O&M cost					
WTPs	1	Lump sum	Expand WTP to 6,300 gpm	$1,194,000	$368,000
New Well 8	1	Lump sum	Drill near WTP	$48,000	
Water distribution mains	2.64	Miles	Installed within right-of-way	$229,000	
GAC POET systems	28	Each	$1,000/year	$28,000	
			Subtotal	$1,499,000	$673,000
			20 years of annual O&M	$29,980,000	$13,460,000
			20 year costs (capital + O&M)	**$53,959,000**	**$34,310,000**
			Capital and operating cost per 1,000 gal[2]	**$1.31**	**$0.84**
			Operating only cost per 1,000 gallons[2]	**$0.73**	**$0.33**

Notes:

1. GAC POET system cost is estimated for non-municipal wells within the groundwater model 20 year flow paths.
2. Based on 3,900 gpm for the expanded WTP capacity, plus the water demands for the 28 non-municipal wells that would receive POET systems. $/1000 gallons is based on 2,052 million gallons per year.

E.1.1.11 Conceptual projects – Prairie Island Indian Community

E.1.1.11.1 Project summary

The conceptual project considered for Prairie Island Indian Community under this scenario would include the installation of a WTP at the existing well to provide water service to the property. The existing well is assumed to be capable of providing 600 gpm based on the information provided. However, the well would need to be modified to meet the code for a potable drinking water supply well. Thus, a WTP would be installed at the existing 600 gpm well to serve its future residents for the foreseeable future.

E.1.1.11.2 LGU water supplies and infrastructure

A drinking water distribution model was not created for this community as there is no municipal water system within Prairie Island Indian Community at this time.

E.1.1.11.3 Hydrogeologic impacts

Groundwater in Prairie Island Indian Community flows from west to east and significant PFAS contamination exists to the north and west of this community. Using the groundwater model, it can be shown that the aquifer can sustain the required pumping rate of 600 gpm without excessive drawdown of the aquifer. However, it is anticipated that the 600 gpm well would require treatment.

E.1.1.11.4 Cost estimate breakdown

Capital and O&M costs are summarized in Table E.23 for the year 2040.

Table E.23. Year 2040 costs for conceptual projects included in the Community-Specific Scenario 1 for Prairie Island Indian Community.

Item	Quantity	Units	Description	Total cost (GAC)	Total cost (IX)
Capital cost					
WTPs	1	Lump sum	600 gpm	$2,630,000	$1,876,000
			Subtotal	$2,630,000	$1,876,000
			Contingency (20%)	$526,000	$376,000
			Professional services (15%)	$395,000	$282,000
			Total capital	**$3,551,000**	**$2,534,000**
Annual O&M cost					
WTPs	1	Lump sum	600 gpm total capacity	$253,000	$107,000
			Subtotal	$253,000	$107,000
			20 years of annual O&M	$5,060,000	$2,140,000
			20 year costs (capital + O&M)	**$8,611,000**	**$4,674,000**
			Capital and operating cost per 1,000 gal[1]	**$1.38**	**$0.75**
			Operating only cost per 1,000 gallons[1]	**$0.81**	**$0.34**

Notes:

1. Based on 1,000 gpm for the WTP. $/1000 gallons is based on 312 million gallons per year.

E.1.1.12 Conceptual projects – St. Paul Park

E.1.1.12.1 Project summary

The conceptual projects considered for St. Paul Park under this scenario would include installing a centralized WTP to treat the existing municipal supply wells and extending water mains to nearby neighborhoods currently on PFAS impacted non-municipal wells. GAC POET systems would be installed for the rest of the impacted non-municipal wells that were not proposed to be connected to the municipal water system in this scenario based on cost or constructability constraints. A summary of the projects is provided below.

WTPs

The city is in the process of constructing a temporary WTP to treat groundwater supplied by Wells 3 and 4. Eventually, the city plans to connect Well 2 to the temporary WTP and upgrade it to meet 2040 maximum daily demands and what the city considers to be its ultimate buildout capacity. Under this scenario, the WTP would be made permanent and all municipal supply wells (including Well 2) would be routed to the WTP for both 2020 and 2040 conditions.

Water main extension to existing neighborhoods

Wherever possible, any residences on PFAS impacted non-municipal wells would be connected to the city’s municipal water system.

GAC POET systems

This scenario would provide GAC POET systems for PFAS impacted non-municipal wells under both 2020 and 2040 conditions that were not connected to the municipal water system. As of October 2019 sample data, St. Paul Park has an estimated 49 existing non-municipal wells, of which 16 have been sampled. Of those sampled wells, 4 currently have GAC POET systems installed. Based on current sampling trends, it was estimated that by 2020 a total of 22 non-municipal wells would have HI values greater than or equal to 0.5 and receive treatment through GAC POET systems. The existing 4 non-municipal wells with GAC POET systems would be connected to the existing municipal water system. The groundwater model flow path analysis estimated that by 2040 a total of 34 non-municipal wells would require treatment through proposed GAC POET systems.

E.1.1.12.2 LGU water supplies and infrastructure

Results from the drinking water distribution model found that pressures across the one pressure zone ranged from approximately 60 to 100 psi. No pump curves were available to use in the model, therefore it is recommended that a more detailed hydraulic evaluation and pump assessment be performed to determine if any equipment upgrades are required. The city had mentioned that there was an issue filling the two storage towers with the proposed WTP as one tower is located next to the WTP and fills at a faster rate. To address this, it is recommended that an altitude valve be installed at the Lincoln Tower to allow flow to be conveyed to the Broadway Tower. However, the city had reported that the closing of the altitude valve would cause pressure spikes around 30 psi and would be unfavorable among residents. While the hydraulic model performed under this project was not an extended period analysis, the steady state results could not duplicate the 30 psi pressure spike although there was an increase in pressures across the system. Changes in the system such as closing valves would impact system pressures as well as pump operations. It is recommended that an evaluation of the existing well pumps be performed to develop pump curves that can be used in the hydraulic model.

E.1.1.12.3 Hydrogeologic impacts

Groundwater in St. Paul Park flows from north/northeast to south/southwest. Residential wells in St. Paul Park draw water from the Prairie du Chien aquifer. However, there are a number of non-municipal wells in St. Paul Park that are of unspecified depth, and it is not known which aquifers these wells draw water from. PFAS contamination exists in this community. A number of the residential wells in St. Paul Park are already impacted by PFAS, and the three municipal supply wells in St. Paul Park are also impacted by PFAS. The municipal supply wells and the 36 non-municipal wells impacted by PFAS (HI>0.5) in St. Paul Park would require treatment within the next 20 years (2040).

E.1.1.12.4 Cost estimate breakdown

Capital and O&M costs are summarized in Tables E.24 and E.25 for the year 2020 and 2040.

Table E.24. Year 2020 costs for conceptual projects included in Community-Specific Scenario 1 for St. Paul Park.

Item	Quantity	Units	Description	Total cost (GAC)	Total cost (IX)
Capital Cost					
WTPs	1	Lump sum	2,200 gpm	$5,707,000	$4,072,000
Water distribution mains	0.61	Miles	Extensions to neighborhoods and WTP	$1,343,000	
Land acquisition (sites + water mains)	2.0	Acres	1/2 acre per well, 20 feet wide easements	$259,000	

Service laterals	4	Each	$2,500 to connect private wells to existing water mains	$10,000	
GAC POET systems[1]	22	Each	Standard household systems, $2,500 per well	$55,000	
			Subtotal	$7,374,000	$5,480,000
			Contingency (20%)	$1,475,000	$1,096,000
			Professional services (15%)	$1,107,000	$822,000
			Total Capital	**$9,956,000**	**$7,398,000**
Annual O&M Cost					
WTPs	1	Lump Sum	2,200 gpm total capacity	$727,000	$248,000
Water distribution mains	0.61	Miles	Raw water mains from wells to WTPs	$48,000	
GAC POET systems	22	Each	$1,000/year	$22,000	
			Subtotal	$797,000	$318,000
			20 years of annual O&M	$15,940,000	$6,360,000
			20 year costs (capital + O&M)	**$25,896,000**	**$13,758,000**
			Capital and operating cost per 1,000 gal[2]	**$1.12**	**$0.59**
			Operating only cost per 1,000 gallons[2]	**$0.69**	**$0.27**

Notes:

1. GAC POET system cost is estimated for non-municipal wells with HI ≥ 0.50.
2. Based on 2,200 gpm for the WTP plus the water demands for the 22 non-municipal wells that would receive POET systems and the 4 non-municipal wells that would be connected to the municipal water system. $/1000 gallons is based on 3.17 mgd and 1,158 million gallons per year.

Table E.25 Year 2040 costs for conceptual projects included in the Community-Specific Scenario 1 for St. Paul Park.

Item	Quantity	Units	Description	Total cost (GAC)	Total cost (IX)
Capital cost					
WTPs	1	Lump sum	2,200 gpm	$5,707,000	$4,072,000
Water distribution mains	0.61	Miles	Extensions to neighborhoods and WTP	$1,343,000	
Land acquisition (sites + water mains)	2.0	Acres	1/2 acre per well, 20 feet wide easements	$259,000	
Service laterals	4	Each	$2,500 to connect private wells to existing water mains	$10,000	

GAC POET systems[1]	34	Each	Standard household systems, $2,500 per well	$85,000	
Subtotal				$7,404,000	$5,769,000
Contingency (20%)				$1,481,000	$1,154,000
Professional services (15%)				$1,111,000	$866,000
Total capital				**$9,996,000**	**$7,789,000**
Annual O&M cost					
WTPs	1	Lump sum	2,200 gpm total capacity	$727,000	$248,000
Water distribution mains	0.61	Miles	Installed within right-of-way	$48,000	
GAC POET systems	34	Each	$1,000/year	$34,000	
Subtotal				$809,000	$330,000
20 years of annual O&M				$16,180,000	$6,600,000
20 year costs (capital + O&M)				**$26,176,000**	**$14,389,000**
Capital and operating cost per 1,000 gal[2]				**$1.13**	**$0.62**
Operating only cost per 1,000 gallons[2]				**$0.70**	**$0.28**

Notes:

1. GAC POET system cost is estimated for non-municipal wells within the groundwater model 20 year flow paths.
2. Based on 2,200 gpm for the WTP plus the water demands for the 34 non-municipal wells that would receive POET systems and the 4 non-municipal wells that would be connected to the municipal water system. $/1000 gallons is based on 3.18 mgd and 1,159 million gallons per year.

E.1.1.13 Conceptual projects – West Lakeland

E.1.1.13.1 Project summary

The conceptual projects considered for West Lakeland under this scenario would include the installation of a new municipal water system to supply treated water to residences on PFAS impacted non-municipal wells under 2020 and 2040 conditions. A summary of the project is provided below.

The option for all non-municipal wells in West Lakeland to remain on GAC POET systems was included under the treatment scenarios (Section E.3).

New municipal water system

Under this scenario, a new municipal water system would be installed for West Lakeland. This new municipal water system would require the implementation of two municipal supply wells, a WTP, and a water distribution system with storage facilities and any necessary booster pump stations and pressure reducing valves to control system pressures. Since the water demand decreases slightly for West Lakeland from 2020 to 2040 (see Appendix A), the proposed system would be sized for 2020 conditions and would remain the same for 2040 conditions.

It was assumed that all impacted non-municipal wells would be connected to the municipal water system by the year 2040. Thus, it was assumed that no GAC POET systems would be necessary.

E.1.1.13.2 LGU water supplies and infrastructure

West Lakeland has varying topography with ground elevations ranging from 805 to 1,115 feet. The nature of its landscape presents hydraulic challenges for regulating system pressures. In order to maintain adequate pressures, a series of pressure reducing valves would be required to provide water to the lower lying areas. However, to deliver flow to the storage tanks that would be placed at locations with higher elevations, additional booster pump stations would be required at the storage tanks for filling. Across the community, pressures can range from approximately 35 psi to 100 psi near the well pumps. At least five pressure reducing valves and two booster pump stations to feed the storage tanks would be required.

E.1.1.13.3 Hydrogeologic impacts

Generally, groundwater flows from west to east towards the river within West Lakeland. Residential wells in West Lakeland primarily draw water from the Jordan with some wells drawing water from the Quaternary, Prairie du Chien, St. Peter, and Tunnel City/Wonewoc aquifer. However, there are a number of residential wells in West Lakeland that are of unspecified depth, and it is not known from which aquifer these wells draw water. Areas of known PFAS contamination exist to the west and northwest of West Lakeland and a large percentage of existing wells (in the Prairie du Chien, Jordan and unspecified aquifers) are already impacted by PFAS. Groundwater modeling results indicate that the two proposed municipal supply wells would require treatment for the next 20 years (2040).

E.1.1.13.4 Cost estimate breakdown

The cost estimates for West Lakeland under 2020 conditions do not include the installation of GAC POET systems as an interim solution, as this option is covered under the treatment scenario. The new municipal water system for West Lakeland would be sized to meet 2040 conditions and serve 742 existing non-municipal wells, including wells that currently have POET systems installed as of 2020.

In addition, the municipal water system would require one 800 gpm municipal supply well to meet 2040 water demands, but two municipal supply wells were included in the cost estimates for redundancy and firm capacity requirements.

Capital and O&M costs are summarized in Table E.26 for the year 2020 and Table E.27 for the year 2040.

Table E.26. Year 2020 costs for conceptual projects included in the Community-Specific Scenario 1 for West Lakeland.

Item	Quantity	Units	Description	Total cost (GAC)	Total cost (IX)
Capital cost					
WTPs	1	Lump sum	800 gpm	$3,111,000	$2,219,000
Wells	2	Lump sum	2-800 gpm wells	$4,356,000	
8" pressure reducing valves	5	Lump sum		$625,000	
Storage tanks	2	Lump sum	2-200,000 gallon tanks	$1,405,000	
Booster pumps	2	Lump sum		$1,199,000	
Water distribution mains	40.93	Miles	Extensions to neighborhoods and WTP	$89,957,000	

Land acquisition (sites + water mains)	100.7	Acres	1/2 acre per well, 20 feet wide easements	$13,162,000	
GAC POET systems[1]	0	Each	Standard household systems, $2,500 per well	$0	
			Subtotal	$113,815,000	$112,923,000
			Contingency (20%)	$22,763,000	$22,585,000
			Professional services (15%)	$17,073,000	$16,939,000
			Total Capital	**$153,651,000**	**$152,447,000**
Annual O&M cost					
WTPs	1	Lump sum	800 gpm total capacity	$317,000	$128,000
Wells	2	Lump sum	2-800 gpm	$140,000	
8" pressure reducing valves	5	Lump sum	Installed within right-of-way	$43,000	
Storage tanks	2	Lump sum	2-200,000 gallon tanks	$53,000	
Booster pumps	2	Lump sum		$75,000	
Water distribution mains	10.93	Miles	Installed within right-of-way	$3,149,000	
GAC POET systems	0	Each	$1,000/year	$0	
			Subtotal	$3,777,000	$3,588,000
			20 years of annual O&M	$75,540,000	$71,760,000
			20 year costs (capital + O&M)	**$229,191,000**	**$224,207,000**
			Capital and operating cost per 1,000 gal[2]	**$13.63**	**$13.33**
			Operating only cost per 1,000 gallons[2]	**$4.49**	**$4.27**

Notes:

1. All existing non-municipal wells with PFAS contamination would be connected to the new municipal water system. Connection costs were included in the water distribution main costs.
2. Based on 1,600 gpm for the two municipal supply wells. $/1000 gallons is based on 2.3 mgd and 840 million gallons per year.

Table E.27. Year 2040 costs for conceptual projects included in the Community-Specific Scenario 1 for West Lakeland.

Item	Quantity	Units	Description	Total cost (GAC)	Total cost (IX)
Capital cost					
WTPs	1	Lump sum	800 gpm	$3,111,000	$2,219,000
Wells	2	Lump sum	2-650 gpm wells	$3,016,000	
8" pressure reducing valves	5	Lump sum		$625,000	
Storage tanks	2	Lump sum	2-200,000 gallon tanks	$1,405,000	
Booster pump stations	2	Lump sum		$1,199,000	

Water distribution mains	40.93	Miles	Extensions to neighborhoods and WTP	$104,300,000	
Land acquisition (sites + water mains)	100.7	Acres	1/2 acre per well, 20 feet wide easements	$15,240,000	
GAC POET systems[1]	0	Each	Standard household systems, $2,500 per well	$0	
Subtotal				$128,545,000	$127,754,000
Contingency (20%)				$25,709,000	$25,551,000
Professional services (15%)				$19,282,000	$19,164,000
Total capital				**$173,536,000**	**$172,469,000**
Annual O&M cost					
WTPs	1	Lump sum	800 gpm total capacity	$270,000	$112,000
Wells	2	Lump sum	2-800 gpm	$132,000	
8" pressure reducing valves	5	Lump sum	Installed within right-of-way	$43,000	
Storage tanks	2	Lump sum	2-200,000 gallon tanks	$53,000	
Booster pump stations	2	Lump sum		$75,000	
Water distribution mains	10.93	Miles	Installed within right-of-way	$3,651,000	
GAC POET systems	0	Each	$1,000/year	$0	
Subtotal				$4,224,000	$4,066,000
20 years of annual O&M				$84,480,000	$81,320,000
20 year costs (capital + O&M)				**$258,016,000**	**$253,789,000**
Capital and operating cost per 1,000 gal[2]				**$18.88**	**$18.57**
Operating only cost per 1,000 gallons[2]				**$6.18**	**$5.95**

Notes:

1. All existing non-municipal wells with PFAS contamination would be connected to the new municipal water system. Connection costs were included in the water distribution main costs.
2. Based on 1,300 gpm for the two municipal supply wells. $/1000 gallons is based on 1.8 mgd and 683 million gallons per year.

E.1.1.14 Conceptual projects – Woodbury

E.1.1.14.1 Project summary

The conceptual projects considered for Woodbury under this scenario would include the installation of centralized WTPs in various configurations and extending water mains to nearby neighborhoods included in the expedited projects that currently have PFAS impacted non-municipal wells. No additional water mains were included in this scenario other than what was necessary for the wells and WTPs. In addition, GAC POET systems would be installed for the rest of the PFAS impacted non-municipal wells that have a HI greater than zero. A summary of the projects is provided below.

WTPs

Under this scenario, municipal supply wells in Woodbury would be treated with either one, two, or three centralized WTPs under both 2020 and 2040 conditions. All municipal supply wells would be treated with the exception of Well 1, which would be taken off-line. The originally submitted 2040 maximum daily demand of 19.5 mgd was used for analysis purposes. The modified 2040 maximum daily demand of 28.2 mgd in the Local Water Supply Plan approved by the Metropolitan Council and DNR in January 2020 will be evaluated at a later date. Since Woodbury's 2020 maximum daily demand is only approximately 200 gpm less that the 2040 maximum daily demand, this scenario was evaluated under 2040 conditions and the provided 2040 cost estimates apply to the 2020 conditions as well.

In order to meet the original 2040 maximum daily demand, not all wells would be required. However, all wells would be connected to a WTP so the city could optimize well operations to meet demands. The intent under this scenario was to maximize the flow from the eastern and southern well fields and supply the remaining demand from the Tamarack Well Field.

Three alternatives were developed to analyze the number and location of centralized WTPs.

Alternative 1 - 2040

Under this alternative, a centralized WTP would be located in each well field. Due to pumping restrictions in the East Well Field, only two pumps could be operated at a time for a maximum flow of 3,980 gpm. For this analysis, Wells 18 and 16 would operate simultaneously with a new 4,000 gpm East WTP. To reduce the overall demand on the Tamarack Well Field, one well in the South Well Field would operate continuously. To achieve this, a second redundant well with the same capacity of 2,000 gpm, or two wells at 1,000 gpm each, would be installed and both wells routed to the new 4,000 gpm South WTP. The WTP would be sized to meet a potential maximum capacity of 4,000 gpm which would allow the city to operate both wells as needed to reduce the demand on the Tamarack Well Field. The Tamarack WTP would then be sized for the remaining 2040 maximum daily demand at 7,600 gpm, which is the necessary flow rate if one of the southern wells were off-line. In summary, the following WTPs and wells are provided in this alternative:

- 4,000 gpm East WTP
- 4,000 gpm South WTP
- 2,000 gpm well in the South Well Field
- 7,600 gpm Tamarack WTP.

Alternative 2 - 2040

Under this alternative, two centralized WTPs would be located in the Tamarack and East Well Fields, and flow from the South Well Field would be routed to the WTP in the Tamarack Well Field. Similar to Alternative 1, in the East Well Field, Wells 18 and 16 would operate simultaneously for treatment at a new 4,000 gpm WTP. However, the Tamarack WTP would treat flows from the South Well Field with a capacity of 9,600 gpm. Again, this alternative would provide the city with the flexibility to optimize well operations as the raw water transmission lines conveying flow from the South Well Field to the Tamarack WTP would be sized to accommodate flow from all wells in the South Well Field. In summary, the following centralized WTPs are provided in this alternative:

- 4,000 gpm East WTP

- 9,600 gpm Tamarack WTP.

Alternative 3 - 2040

Under this alternative, one centralized WTP would be located in the Tamarack Well Field and transmission lines would convey flow from all wells in both the East and South Well Fields providing the city with operational flexibility and the potential to minimize the demand on the Tamarack Well Field. However, as the number of WTPs decrease to a single centralized location, additional water distribution lines would need to be installed to convey higher flow rates back out into the system (discussed in the following section). The following centralized WTP is provided in this alternative:

- 13,600 gpm Tamarack WTP.

Additional improvements common to each alternative

GAC POET systems

This scenario would provide GAC POET systems for sampled, non-municipal wells that have detectable levels of PFAS or are located within anticipated areas of future PFAS contamination. As of October 2019 sample data, Woodbury has an estimated 632 existing non-municipal wells, of which 215 have been sampled. Of those sampled wells, 1 currently has a GAC POET system installed. Based on current sampling trends, it was estimated that by 2020 a total of 5 non-municipal wells would have HI values greater than or equal to 0.5 and require treatment through new GAC POET systems. The groundwater model flow path analysis estimated that by 2040 a total of 181 non-municipal wells would be impacted and require treatment through the proposed GAC POET systems.

E.1.1.14.2 LGU water supplies and infrastructure

Woodbury currently operates across one pressure zone so the hydraulic impacts from the infrastructure modifications would focus on additional distribution lines that would be required as the WTPs become more centralized. As mentioned, for the purposes of this Conceptual Plan, parallel lines would be installed rather than upsizing existing lines for cost-saving purposes.

The drinking water distribution model was run using set points provided by the city with the corresponding tank levels and pumps running. Pressures resulting from all three alternatives were similar to higher pressures observed in the central low lying areas near lakes and on the eastern side of the city. The observed pressures ranged from approximately 30 to 120 psi. While no addition modifications would be required in Alternative 1, Alternative 2 would require the Well 19 pump to be upsized to convey flow to the Tamarack Well Field and Alternative 3 would require a booster pump station. Likewise, under Alternatives 2 and 3, the flow from Well 18 would be greatly reduced and would need to be upsized.

E.1.1.14.3 Hydrogeologic impacts

Generally, groundwater flows from east/northeast to west/southwest in Woodbury. However, in southeastern Woodbury, there appears to be a component of groundwater flow to the south/southeast. Under Alternative 2, two additional municipal supply wells would be installed and operated in the South Well Field (near Well 19). Both of these wells would extract groundwater at a rate of approximately 1,000 gpm maximum daily demand for the wet climate condition and 1,285 gpm maximum daily demand for the drought climate condition. Both proposed municipal supply wells would extract groundwater from the Prairie du Chien/Jordan aquifer and the groundwater model indicates that the aquifer can sustain these pumping rates without excessive drawdown. The groundwater flow direction around these wells appears to be west/southwest and the effect of the pumping wells appears to be localized. Reverse particle tracking under wet and drought climate conditions show that treatment for these two new wells should not be required within the next 20 years. Because Well 19 has shown PFAS impacts, the two additional wells would receive treatment.

In Woodbury, the majority of residential wells are located within the Prairie du Chien aquifer. There are also a number of wells of unknown depth, and therefore are drawing water from an unspecified aquifer. Particle tracking and flow path analysis indicate that 181 residential wells could be impacted by the year 2040 and would receive GAC POET systems.

E.1.1.14.4 Cost estimate breakdown

Year 2040 cost estimates for installation and O&M are shown in Tables E.28, E.29, and E.30 below for Alternatives 1, 2, and 3, respectively. Woodbury's 2020 maximum daily demands are only 200 gpm less than the year 2040 maximum daily demands, which has a negligible impact, so the infrastructure requirements for each alternative are the same.

Table E.28. Year 2040 costs for conceptual projects included in the Community-Specific Scenario 1 for Woodbury - Alternative 1.

Item	Quantity	Units	Description	Total cost (GAC)	Total cost (IX)
Capital cost					
WTPs	3	Lump sum	15,600 gpm total capacity	$28,481,000	$20,378,000
Wells	1	Lump sum	2,000 gpm well in South Well Field	$2,960,000	
Water mains	5.91	Miles	Raw water mains to WTPs	$14,634,000	
Land acquisition (sites + water mains)	15.8	Acres	1/2 acre per well or WTP, 20 feet wide easements	$2,069,000	
GAC POET systems[1]	180	Each	Standard household systems, $2,500 per well	$450,000	
			Subtotal	$51,554,000	$43,451,000
			Contingency (20%)	$10,311,000	$8,691,000
			Professional services (15%)	$7,734,000	$6,518,000
			Total capital	**$69,599,000**	**$58,660,000**
Annual O&M cost					
WTPs	3	Lump sum	15,600 gpm total capacity	$4,854,000	$1,334,000
Wells	1	Lump sum	2,000 gpm	$68,000	
Water mains	5.91	Miles	Installed within right-of-way	$513,000	
GAC POET systems	181	Each	$1,000/year	$181,000	
			Subtotal	$5,616,000	$2,096,000

20 years of annual O&M	$112,320,000	$41,920,000
20 year costs (capital + O&M)	**$181,919,000**	**$100,580,000**
Capital and operating cost per 1,000 gal[2]	**$1.11**	**$0.61**
Operating only cost per 1,000 gallons[2]	**$0.68**	**$0.26**

Notes:

1. GAC POET system cost is estimated for non-municipal wells within the groundwater model 20 year flow paths that are outside the municipal water system. 180 POET systems would be new installations with one existing POET included for the annual O&M estimate.
2. Based on 15,600 gpm for the WTPs plus the water demands for the 181 non-municipal wells on POET systems and the three non-municipal wells that would be connected to the existing municipal water system. $/1000 gallons is based on 22.5 mgd and 8,218 million gallons per year.

Table E.29. Year 2040 costs for conceptual projects included in the Community-Specific Scenario 1 for Woodbury - Alternative 2.

Item	Quantity	Units	Description	Total cost (GAC)	Total cost (IX)
Capital cost					
WTPs	2	Lump sum	13,600 gpm total capacity	$22,088,000	$15,757,000
Wells	0	Lump sum			
Water mains	8.33	Miles	Raw water mains to WTPs	$20,187,000	
Land acquisition (sites + water mains)	21.2	Acres	1/2 acre per well or WTP, 20 feet wide easements	$2,769,000	
GAC POET systems[1]	180	Each	Standard household systems, $2,500 per well	$450,000	
Subtotal				$45,494,000	$39,163,000
Contingency (20%)				$9,099,000	$7,833,000
Professional services (15%)				$6,825,000	$5,875,000
Total capital				**$61,418,000**	**$52,871,000**
Annual O&M cost					
WTPs	2	Lump sum	13,600 gpm total capacity	$3,857,000	$1,065,000
Wells	0	Lump sum	2,000 gpm		
Water mains	8.33	Miles	Installed within right-of-way	$707,000	
GAC POET systems	181	Each	$1,000/year	$181,000	
Subtotal				$4,745,000	$1,953,000
20 years of annual O&M				$94,900,000	$39,060,000
20 year costs (capital + O&M)				**$156,318,000**	**$91,931,000**
Capital and operating cost per 1,000 gal[2]				**$1.09**	**$0.64**
Operating only cost per 1,000 gallons[2]				**$0.66**	**$0.27**

Notes:

1. GAC POET system cost is estimated for non-municipal wells within the groundwater model 20 year flow paths that are outside the municipal water system.
2. Based on 13,600 gpm for the WTPs plus the water demands for the 181 non-municipal wells on POET systems and the three non-municipal wells that would be connected to the existing municipal water system. $/1000 gallons is based on 19.6 mgd and 7,167 million gallons per year.

Table E.30. Year 2040 costs for conceptual projects included in the Community-Specific Scenario 1 for Woodbury - Alternative 3.

Item	Quantity	Units	Description	Total cost (GAC)	Total cost (IX)
Capital cost					
WTPs	1	Lump sum	13,600 gpm total capacity	$17,106,000	$12,203,000
Booster pump stations	1	Lump sum	2,000 gpm	$1,421,000	
Water mains	10.28	Miles	Raw water mains to WTPs	$27,476,000	
Land acquisition (sites + water mains)	25.9	Acres	1/2 acre per well or WTP, 20 feet wide easements	$3,388,000	
GAC POET systems[1]	180	Each	Standard household systems, $2,500 per well	$450,000	
			Subtotal	$49,841,000	$44,938,000
			Contingency (20%)	$9,969,000	$8,988,000
			Professional services (15%)	$7,477,000	$6,741,000
			Total capital	**$67,287,000**	**$60,667,000**
Annual O&M cost					
WTPs	1	Lump sum	13,600 gpm total capacity	$3,608,000	$887,000
Booster pump stations	1	Lump sum	2,000 gpm	$170,000	
Water mains	10.28	Miles	Installed within right-of-way	$962,000	
GAC POET systems	181	EACH	$1,000/year	$181,000	
			Subtotal	$4,921,000	$2,200,000
			20 years of annual O&M	$98,420,000	$44,000,000
			20 year costs (capital + O&M)	**$165,707,000**	**$104,667,000**
			Capital and operating cost per 1,000 gal[2]	**$1.16**	**$0.73**
			Operating only cost per 1,000 gallons[2]	**$0.69**	**$0.31**

Notes:

1. GAC POET system cost is estimated for non-municipal wells within the groundwater model 20 year flow paths that are outside the municipal water system. 180 POET systems would be new installations with one existing POET included for the annual O&M estimate.
2. Based on 13,600 gpm for the WTPs plus the water demands for the 181 non-municipal wells on POET systems and the three non-municipal wells that would be connected to the existing municipal water system. $/1000 gallons is based on 19.6 mgd and 7,167 million gallons per year.

E.1.1.15 Community scenarios summary

A summary of the costs by each community for the various alternatives is shown in Table E.31 below. Costs are shown for GAC systems only and are reflective of infrastructure and treatment necessary for the year 2040 water demands. Cost estimates for the year 2020 and the costs for IX treatment systems are shown in the individual community sections.

Table E.31. Year 2040 costs for conceptual projects included in the Community-Specific Scenario 1.

Option	Community served	Components	Water provided (mgd)	Capital cost (1,000s)	Annual O&M cost (1,000s)	Total 20 year costs (1000s)	O&M cost per 1,000 gallons	Total 20 year cost per 1,000 gallons
1A	Afton	74 new POETS, 85 total	.04	$250	$85	$1,950	$6.57	$7.54
1B-Alt 1	Cottage Grove	4 WTPs (14,000 gpm)	20.3	$83,439	$5,418	$191,800	$0.73	$1.29
1B-Alt 2	Cottage Grove	2 WTPs (14,000 gpm)	20.3	$85,107	$5,335	$191,807	$0.72	$1.30
1B-Alt 3	Cottage Grove	2 WTPs (14,000 gpm), 1 new well	20.3	$78,817	$5,208	$182,977	$0.70	$1.24
1C	Denmark	3 new POETS, 3 total	.0011	$10	$3	$70	$7.33	$8.58
1D	Grey Cloud Island	64 new POETS, 116 total	.03	$216	$116	$2,536	$13.06	$14.28
1E	Lake Elmo	Extend to neighborhoods , 2 wells, 131 POETS	3.01	$72,629	$1,742	$107,470	$1.59	$4.89
1F	Lakeland	171 sealed wells	0.04	$648	$0	$648	$0	$14.08
1G	Maplewood	62 non-municipal wells tied into SPRWS	0.02	$4,887	$111	$7,107	$18.32	$58.65
1H	Newport	15 POETS	0.004	$52	$15	$352	$10.61	$12.45
1I – Alt 1	Oakdale	Treat Wells 1,2,7,8 at Central WTP, 28 POETS	5.62	$26,904	$1,584	$58,584	$0.77	$1.43
1I – Alt 2	Oakdale	Relocated Well 8, treat Wells 1,2,7,8 at Central WTP, 28 POETS	5.62	$23,979	$1,499	$53,959	$0.73	$1.31
1J	PIIC	WTP	0.85	$3,551	$253	$8,611	$0.81	$1.38
1K	St. Paul Park	WTP, 34 POETS	3.18	$9,996	$809	$26,176	$0.70	$1.13
1L	W. Lakeland	New public water system,	2.37	$173,536	$4,224	$258,016	$6.18	$18.88

		2 wells and 1 WTP						
1M-Alt 1	Woodbury	3 WTPs (15,600 gpm), 1 well, 181 POETS	22.52	$69,599	$5,616	$181,919	$0.68	$1.11
1M–Alt 2	Woodbury	2 WTPs (13,600 gpm), 181 POETS	19.6	$61,418	$4,745	$156,318	$0.66	$1.09
1M-Alt 3	Woodbury	1 WTP (13,600 gpm), 1 pump station, 181 POETS	19.6	$67,287	$4,921	$165,707	$0.69	$1.16
Sum of Most Cost-Effective Options (shaded rows)			**55**	**$430,329**	**$18,823**	**$809,949**		

Note:
Alternatives that were selected for this scenario are shown in blue.

E.1.2 Regional scenarios

E.1.2.1 Regional scenarios overview

These scenarios would provide clean drinking water to the whole East Metropolitan Area via a shared public water system supplied by either surface water or groundwater. Potential surface water sources evaluated include the Mississippi River, the St. Croix River, and extending St. Paul Regional Water Services' distribution system. The option to serve all 14 communities via one large surface water treatment plant (SWTP) on the St. Croix River was not considered due to the extended implementation timeframe that would likely be needed as a result of the required environmental regulations and permitting, and stakeholders involved as this river is a federally protected National Scenic Riverway (see Section 3.1.5.2 of this Conceptual Plan). Therefore, two of the surface water scenarios include a smaller SWTP on the St. Croix River, which would serve a subset of the communities. All scenarios were based on an estimated maximum daily demand of 52 mgd for the East Metropolitan Area. The following regional scenarios were identified:

A. Regional Scenario 2A – This scenario consists of one large SWTP on the Mississippi River, with distribution throughout the East Metropolitan Area.

B. Regional Scenario 2B – This scenario consists of one SWTP on the Mississippi River and one SWTP on the St. Croix River, with distribution throughout the East Metropolitan Area. Two variations of this scenario were evaluated to determine the impacts of supplying Woodbury (the largest water user) from either plant.

C. Regional Scenario 2C – This scenario consists of extending SPRWS throughout the East Metropolitan Area.

D. Regional Scenario 2D – This scenario consists of one groundwater well field in an optimized location, likely with treatment (as needed), with distribution throughout the East Metropolitan Area. Two locations of this scenario were evaluated. One well field was located in western Denmark, and the second well field was located in central Denmark. The pumping rates of each of these well fields were simulated in the groundwater model at approximately 14,679 gpm average daily demands.

E. Regional Scenario 2E – This scenario consists of multiple groundwater well fields in optimized locations, with or without treatment (as needed), with distribution throughout the East Metropolitan Area. The three well fields were located in southwestern Cottage Grove, southwest Woodbury, and southwest Afton. These well fields were simulated in the groundwater model with all three well fields operating simultaneously to achieve a pumping rate of approximately 15,240 gpm.

E.1.2.1.1 Assumptions/considerations

The following are assumptions and considerations that were used for the regional scenarios.

Time frame for implementation: Due to the scale of infrastructure required for implementing a regional water treatment and supply system for the East Metropolitan Area, the potential scenarios would not be available for use in 2020. Until projects are implemented, East Metropolitan Area communities would need to implement interim, temporary solutions to address PFAS contamination and clean drinking water supply. Specifically, it was assumed that communities would implement approved expedited projects; the extension of existing water distribution lines to serve nearby residences with PFAS impacted wells; temporary WTPs at existing municipal supply wells; and GAC POET systems for any non-municipal well. Implementation time is not as much of a concern in the eastern region for the communities of Afton, Denmark, Lakeland, and West Lakeland, as Lakeland's municipal supply wells are currently not impacted with PFAS above the HI of 1 and the rural areas are currently receiving individual GAC POET systems for non-municipal wells through the MPCA as needed.

While projects may be implemented prior to 2040, 2040 conditions were used for all design aspects including sizing and hydraulic analysis of both WTPs and municipal water systems.

Communities served: For the regional scenarios it was assumed that all affected communities in the East Metropolitan Area with an existing municipal water system (i.e., Cottage Grove, Lake Elmo, Lakeland, Lakeland Shores, Newport, Oakdale, St. Paul Park, and Woodbury) would receive treated water from the new regional system and all existing municipal supply wells would be taken off-line.

For communities without a municipal water system (i.e., Afton, Denmark, Grey Cloud Island, Prairie Island Indian Community, and West Lakeland), these communities would receive treatment for PFAS by the installation of GAC POET systems. Water transmission mains from the SWTP(s) would be extended to each community, with the exception of Denmark. PFAS contamination is not expected to be a significant concern in Denmark that would justify a new water supply. Water distribution main extensions from existing municipal water systems to provide water service to areas currently on non-municipal wells was not included in this analysis. For 2020 and 2040 conditions, it was assumed that Denmark would remain on non-municipal wells which would receive individual treatment as needed. Any impacted residents on non-municipal wells in Maplewood would be connected to SPRWS' existing water distribution system.

Municipal and non-municipal water supply wells: Under the regional and sub-regional scenarios, it was assumed that all municipal supply wells would be taken off-line. This includes the communities of Cottage Grove, Lake Elmo, Lakeland, Newport, Oakdale, Prairie Island Indian Community, St. Paul Park, and Woodbury. These wells would be shut down and utilized only during emergency conditions such as in the event of a temporary outage at the WTP or a failure of the associated raw water or treated water supply infrastructure. Furthermore, it was assumed that when use of the existing municipal supply wells is discontinued, the containment wells at the 3M disposal sites would continue to operate to control the migration of PFAS impacted groundwater from the sites. On-going monitoring will be necessary to ensure continued source area containment. For the given communities, the remaining non-municipal wells that could not be connected to the municipal water system due to limitations such as technical feasibility or cost would receive GAC POET systems as needed due to contamination. If these wells were connected to the municipal water system, they would be sealed, unless MPCA prefers to keep the well as a monitoring well.

For communities without an existing municipal water system, any non-municipal wells that could not be connected to the regional supply system would also receive individual treatment. These communities would include Denmark and the majority of Afton.

Distribution infrastructure: Under the surface water regional scenarios, cost estimates include only the WTPs, transmission lines, storage tanks, and pumping stations necessary to deliver the treated surface water to the existing water distribution systems. Extending water systems to new areas that are currently unserved was not included. Again, it was assumed that any non-municipal wells in these communities that are currently on POET systems, would remain on POET systems. The non-municipal wells in Denmark and Afton would be treated by POET systems. All new infrastructure for the proposed systems would be sized to provide the necessary 2040 maximum daily demands to replace these non-municipal wells if they were to become contaminated.

Under all regional and sub-regional scenarios, the water supply systems from the various WTPs were hydraulically modeled in order to determine the appropriate size for transmission lines and any modified or proposed distribution lines; the locations of pressure reducing stations and booster pump stations; and the appropriate size for high service pumps. Transmission lines were assumed to be ductile iron pipe and sized to maintain a velocity of 2 to 7 feet per second and booster pumps were sized to maintain system line pressures between 20 to 200 psi and 20 to 40 psi at storage tanks or towers. As these transmission lines would be acting only as supply lines, the pressures can be significantly higher than what would be used for typical distribution lines since no customers would be served off the transmission lines. Individual pumps were not selected for this Conceptual Plan as pump selection would take place at the detailed design level if implemented. Pressure reducing valves were incorporated in the system to maintain a pressure of less than 200 psi. In most cases, pressure reducing valves were not required in the water supply system; however, drinking water distribution modeling indicated significantly high pressures at some of the storage tanks and lower elevation areas. Storage tanks or towers were assumed to have a pressure reducing valve included in their cost; however, an additional pressure reducing valve may be needed if the pressure differential is greater than 80 psi. In general, it was assumed that treated water would be conveyed via the new transmission lines to existing or new water storage tanks or towers. From the water storage tanks or towers, treated water would be distributed to customers through the existing or new water distribution system.

Transmission and distribution line alignments: The alignments of new transmission and distribution lines would follow major roads in many cases, but secondary roads would be utilized as much as possible to reduce pavement work, jack and bore lengths at major arterial road crossings, and construction impacts on neighborhoods and commercial areas. There would be some locations, however, where the use of jack and bore or horizontal directional drilling would be necessary in order to distribute water throughout the entire East Metropolitan Area.

Redundancy: The surface water regional supply systems for each scenario were hydraulically modeled using one transmission line, which is reflected in the cost estimates. However, dual water transmission lines could be installed for redundancy to prevent a loss of water supply in the event of a temporary failure of the single water transmission line. If dual water transmission lines were installed, they would be designed with isolation valves and interconnects and sized such that a single water transmission line can carry the average daily demands and the dual water transmission lines would have the capacity to convey the maximum daily demands and be designed with isolation valves and interconnects. If there was a water transmission line break in this dual water transmission line configuration, there would be sufficient water storage in the water distribution systems and the single water transmission line to meet the short-term morning and evening high demand period that may occur during the summer. For instance, when a single 60” transmission line is necessary to meet maximum daily demands, this may be installed as two, parallel 42” transmission lines. The cost for the smaller diameter, dual water transmission lines was not reflected in the cost estimates, which include only the cost for the one larger water transmission line. A cost comparison indicated that there is a 20-25% cost increase if dual transmission lines were installed.

For the regional and sub-regional groundwater scenarios, it was assumed that the existing infrastructure would be utilized as well as any new infrastructure. The existing and proposed water storage tanks would be used in the event of an emergency as well as any unimpacted municipal supply wells.

Water demands: As previously mentioned, the water treatment and supply system elements were conceptually designed and sized for 2040 conditions. The 2040 maximum daily demands were calculated for all East Metropolitan Area communities. Demands for the communities with municipal water systems were based on their projected population and demands provided in the community’s most recent Water Supply Plan and/or Comprehensive Plan approved by the Metropolitan Council, as of October 2019. Water demands for rural communities that do not have a municipal water system were determined by using the 2040 projected populations, an average use of 94 gallons per capita per day (gpcd), and a peak ratio of 2.4. Based on these values and assumptions, the maximum total regional demand for all East Metropolitan Area communities is approximately 52 mgd.

New WTP siting: To visually identify potential locations for the new WTPs, property parcel data were obtained for the East Metropolitan Area from Washington County to determine land that is currently owned by the City or County. Ideal locations for the SWTPs were defined as parcels of sufficiently sized (approximately 3 to 6 acres), undeveloped land. Essential features include river access suitable for an intake structure and river character where the water levels allow the ability to supply water during high and low water level periods. Other factors of concern when locating the SWTP would be proximity to existing and future neighborhoods, current zoning, and road accessibility suitable for heavy machinery. For the groundwater regional and sub-regional scenarios, ideal locations were also those parcels currently owned by the city or county that were located near the proposed well fields and existing infrastructure.

Surface Water Quality and Treatment Parameters: Surface water quality was reviewed and used to define the treatment parameters for this scenario. Essential parameters to be controlled by the treatment process included: sediment, hardness, taste and odor compounds as well as disinfection and corrosion control. To advance the flow sheet development and cost estimation activities, Wood assumed that surface water represented PFAS HI <1. The treatment process includes capability to control taste and odor using GAC, which would also provide the ability to control low concentration of PFAS that could be present in the surface water. If warranted, the location of the intake structure and collection of site specific data about the surface water quality at the location of the intake structure represents an opportunity for future development studies.

E.1.2.2 Regional Scenario 2A – Mississippi River SWTP

This scenario would replace existing groundwater supplies with a single 52 mgd SWTP on the Mississippi River. Under this scenario, the plant would be large enough to supply the maximum daily demands for the East Metropolitan Area up to the year 2040. The exception is the southern end of Maplewood where residents would be served by extending the existing SPRWS distribution lines.

The location used for the potential Mississippi SWTP consists of two adjacent parcels with a total of 13.5 acres located along the Mississippi River in St. Paul Park**.**

E.1.2.2.1 SWTP and infrastructure components

A 52 mgd SWTP located on the Mississippi River would include the following components:

- Intake piping, intake structure, and screening
- Clarifiers – remove suspended solids
- Gravity filtration (GAC) – taste and odor control
- Lime softening – water softening
- Chlorination – disinfection
- Fluoridation – increase fluoride level in the water
- Corrosion control – prevents pipe corrosion within the distribution system
- Finished water pump station and finished water storage
- Rechlorination – disinfection
- Solids dewatering – reduce the volume of solids sent to landfill
- Administration and operations building.

Cost estimates for the SWTP include all items identified above and cover all components between the river and the SWTP, as well as components within the plant property.

The infrastructure requirements for the regional water supply system would include the following components that would deliver treated surface water to existing and potential future water storage facilities within each community:

- Water transmission lines
- Booster pump stations
- Water storage facilities
- Pressure reducing stations.

E.1.2.2.2 LGU water supplies and infrastructure

The following is a summary of the water supply infrastructure necessary to deliver surface water to the existing municipal water systems.

Transmission line alignment and sizes

Regional Scenario 2A would include the new SWTP and would require extensive infrastructure to supply treated water across the East Metropolitan Area. Two transmission lines would convey treated water from the SWTP to two separate regions based on topography and pressure requirements. One 18” transmission line would carry approximately 5 mgd to serve south of the SWTP including a portion of St. Paul Park, the southern portion of Cottage Grove, and Grey Cloud Island and one 54” transmission line would carry 47 mgd to serve the remaining north and east area.

The two primary roads that would contain the main transmission lines would be Century Avenue/Geneva Avenue and 10th Street North. The total length of pipe that would be needed to supply the East Metropolitan Area in this scenario would be just under 66 miles. Table E.32 shows the lengths per size of the pipe.

Table E.32. Size and length of transmission lines for Regional Scenario 2A.

Transmission line diameter (inches)	Miles of transmission line
8”	9.5
10”	4.6
12”	4.4
14”	11.3
16”	2.9
18”	10.9
20”	2.6
24”	5.6
30”	3.0
36”	2.5
42”	4.6
48”	1.7
54”	1.9
Total	**65.5**

Distribution system requirements

The topography of the region is the main consideration when designing a new water supply system of this size. Drinking water distribution modeling of this scenario helped identify locations where pressures would need to be boosted and areas that would require pressure reducing valves. Areas with large variations in elevation would require either a booster pump or pressure reducing valve to maintain water system pressures between 20 and 200 psi. As these transmission lines would be acting only as supply lines, the pressures can be significantly higher than what would normally be used for distribution lines. Pressures in a typical distribution system would be between 40 to 100 psi.

Booster pump stations: Results from the drinking water distribution model indicate that booster pump stations would be needed at various locations in the new water supply system. The following booster pump stations would be necessary to provide water to the existing municipal water systems:

- 31,800 gpm booster pump station at the SWTP site for the high-pressure zone
- 3,500 gpm booster pump station at the SWTP site for the low-pressure zone
- 31,200 gpm booster pump station in St. Paul Park
- 2,800 gpm booster pump station in Cottage Grove
- 4,600 gpm booster pump station in the south area of Woodbury
- 2,300 gpm booster pump station at Woodbury Tank 6
- 6,800 gpm booster pump station in the north area of Woodbury

- 8,900 gpm booster pump station in the south area of Oakdale
- 3,700 gpm booster pump station in the north area of Oakdale.

Water storage tanks: Existing water storage tanks would continue to provide water storage for emergencies, including fire flow, and to provide water during the peak demands. Additional storage tanks that would be necessary to meet the demands and water storage requirements include:

- Cottage Grove – two 350,000 gallon elevated storage tanks
- Lake Elmo – one 700,000 gallon elevated storage tank
- Grey Could Island – one 30,000 gallon elevated storage tank
- Prairie Island – one 20,000 gallon elevated storage tank
- Afton – one 50,000 gallon elevated storage tank
- West Lakeland – two 200,000 gallon elevated storage tanks.

Pressure reducing valve stations: One pressure reducing valve station would be needed to reduce pressures along the 10” diameter transmission line that extends through West Lakeland. The pressure drop required at this station would be approximately 75 psi, therefore more than one valve may be necessary at this station.

E.1.2.2.5 Hydrogeologic impacts

For this scenario, all municipal supply wells were turned off for Cottage Grove, Lake Elmo, Lakeland, Lakeland Shores, Newport, Oakdale, St. Paul Park, and Woodbury. Based on the results of the groundwater model, the groundwater flow patterns (contours) appear to be comparable to the current day flow patterns where municipal supply wells are pumping groundwater. Side by side comparisons of the model simulation to the interpolated regional scale contours from 2009 are generally similar, and they indicate that the contour spacing orientation is slightly different because of differing pumping and recharge conditions. Generally, the flow patterns generated by the model are consistent with the interpolated regional scale contours from 2009. Based on the flow path analysis, it was estimated that a total of 1,457 new POET systems would be needed by the year 2040.

E.1.2.2.6 Cost estimate breakdown

Tables E.33 and E.34 provide a screening level cost estimate breakdown for the initial installation costs, annual O&M costs, and the total costs for a 20-year period up to the year 2040 for the Regional Scenario 2A. Costs include the SWTP, land acquisition, transmission line easements, and the water system infrastructure (e.g., transmission lines, storage tanks, pump stations, pressure reducing valves) that would be necessary to deliver the water to the existing municipal water systems and potential future water systems. Land acquisition costs were included in the total capital cost for the water system infrastructure. Costs to extend SPRWS’s distribution lines to Maplewood residents were not included in the distribution mains capital costs. Costs to provide POET systems for non-municipal wells across the East Metropolitan Area were included based on 2040 groundwater projections.

Capital costs for this scenario are shown in Table E.33. Annual O&M costs for this scenario are shown in Table E.34.

Table E.33. Capital costs of the Regional Scenario 2A.

Item	Quantity	Units	Description	Total cost
52 mgd SWTP	1	Each	Lump sum	$53,692,000

Land acquisition (SWTP + transmission lines)	177.5	Acres	Two adjacent parcels	$23,199,000
Booster pump stations	9	Each	138 mgd total	$30,954,000
Pressure reducing valve station in West Lakeland	1	Each	900 gpm	$377,000
Water storage tanks	8	Each	1.9 million gallons total	$5,917,000
Water distribution mains	65.4	Miles	8” to 54” diameter	$165,773,000
GAC POET systems[1]	1,457	Each	Standard household systems, $2,500 per well	$3,643,000
			Subtotal	$283,555,000
			Contingency (20%)	$56,711,000
			Professional services (15%)	$51,040,000
			Total	**$391,306,000**

Notes:

1. GAC POET system cost is estimated for non-municipal wells with HI > 0.75 using the same method as was used for the 2020 treatment scenarios in lieu of results from the groundwater model for 2040.

Table E.34. Annual O&M costs for the Regional Scenario 2A.

Item	Cost basis	Total
52 mgd SWTP	Each	$7,206,000
Booster pump stations	138 mgd total	$2,685,000
Pressure reducing valve station in West Lakeland	900 gpm	$14,800
Water storage tanks	1.9 million gallons total	$222,000
Water distribution mains	8” to 54” diameter	5,803,000
GAC POET systems	2,070 @$1,000/year	$2,070,000
	Total annual O&M	$18,001,000
	20 years of annual O&M	$360,020,000
	Total 20 year costs (capital + O&M)	**$751,326,000**
	Capital and operating cost per 1,000 gallons	**$1.98**
	Operating only cost per 1,000 gallons	**$0.95**

E.1.2.3 Regional Scenario 2B.1 – Mississippi and St. Croix River SWTPs

This scenario would replace existing groundwater supplies with two SWTPs. The first SWTP would be a 43.5 mgd plant on the Mississippi River to serve Cottage Grove, Grey Cloud Island, Newport, Oakdale, St. Paul Park, and Woodbury. The second SWTP would be an 8.5 mgd plant on the St. Croix River, which would be able to serve the remaining communities including Afton, Denmark, Lake Elmo, Lakeland, Lakeland Shores, Prairie Island Indian Community, and West Lakeland. Although Denmark is not currently experiencing PFAS contamination, the drinking water demands used to size this SWTP incorporates the drinking water demand for all of these communities, including Denmark. The exception is the southern end of Maplewood where residents would be served by extending the existing SPRWS distribution lines.

The Mississippi SWTP would be located on the two adjacent parcels with a total of 13.5 acres along the Mississippi River as described in the Regional Scenario 2A. A 15.7-acre parcel along the St. Croix River north of highway 94 in Lakeland has been identified for the St. Croix SWTP.

E.1.2.3.1 SWTP and infrastructure components

Each SWTP would include the following components:

- Intake piping, intake structure, and screening
- Clarifiers – remove suspended solids
- Gravity filtration (GAC) – taste and odor control
- Lime softening – water softening
- Chlorination – disinfection
- Fluoridation – increase fluoride level in the water
- Corrosion control – prevents pipe corrosion within the distribution system
- Finished water pump station and finished water storage
- Rechlorination – disinfection
- Solids dewatering – reduce the volume of solids sent to landfill
- Administration and operations building.

Cost estimates for the SWTP include all items identified above and cover all components between the river and the SWTP, as well as components within the plant property.

The infrastructure requirements for the regional water supply system from each SWTP would include the following components that would deliver treated surface water to existing and potential future water storage facilities within each community:

- Water transmission lines
- Booster pump stations
- Water storage facilities
- Pressure reducing stations.

E.1.2.3.2 LGU water supplies and infrastructure

The following is a summary of the water supply infrastructure that would be necessary to deliver surface water to the existing municipal water systems.

Transmission line alignment and sizes

Similar to the Regional Scenario 2A, two transmission lines would convey treated water from the Mississippi SWTP to two separate regions based on topography and pressure requirements. One 18” transmission line would carry approximately 5.0 mgd to serve south of the SWTP and one 48” transmission line would carry approximately 38.5 mgd to serve the northwestern communities including Woodbury. The St. Croix SWTP would convey approximately 8.5 mgd to the eastern communities via a 24” transmission line. By implementing two WTPs, overall pipe diameters and pump sizes could be decreased as the flow would be provided from both the East and West side of the region.

The total length of pipe that would be needed to supply the East Metropolitan Area in this scenario would be just over 70 miles. Table E.35 shows the lengths per size of the pipe.

Table E.35. Size and length of transmission lines for the Regional Scenario 2B.1.

Transmission line diameter (inches)	Miles of transmission line
10”	7.8
12”	4.6
14”	16.5
16”	5.4
18”	4.5
20”	6.0
24”	7.1
30”	0.6
36”	4.6
42”	1.7
48”	1.9
Total	**70.31**

Distribution system requirements

The topography of the region is the main consideration when designing a new water supply system of this size. Drinking water distribution modeling of this scenario helped identify locations where pressures would need to be boosted and areas that would require pressure reducing valves. Areas with large variations in elevation would require either a booster pump or pressure reducing valve to maintain water system pressures between 20 and 200 psi. As these transmission lines would be acting only as supply lines, the pressures can be significantly higher than what would normally be used for distribution lines. Pressures in a typical distribution system would be between 40 and 100 psi.

Booster pump stations: Results from the drinking water distribution model indicate that booster pump stations would be needed at various locations in the new water supply systems. The following booster pump stations would be necessary to provide water to the existing municipal water systems:

- 26,400 gpm booster pump station at the Mississippi SWTP site for the high-pressure zone
- 3,500 gpm booster pump station at the Mississippi SWTP site for the low-pressure zone
- 5,400 gpm booster pump station at the St. Croix SWTP site
- 25,800 gpm booster pump station in St. Paul Park
- 2,800 gpm booster pump station in Southern Cottage Grove
- 4,500 gpm booster pump station in the south area of Woodbury
- 2,250 gpm booster pump station at Woodbury Tank 6
- 6,800 gpm booster pump station in the northwestern area of Woodbury
- 2,500 gpm booster pump station in the south area of Oakdale
- 2,500 gpm booster pump station in the north area of Oakdale
- 1,200 gpm booster pump station at Oakdale Tank 2
- 1,250 gpm booster pump station at Lake Elmo Tank 3

- 2,500 gpm booster pump station in the central area of Lake Elmo.

Water storage tanks: Existing water storage tanks would continue to provide water storage for emergencies, including fire flow, and to provide water during the peak demands. Additional storage tanks that would be necessary to meet the demands and water storage requirements include:

- Cottage Grove – two 350,000 gallon elevated storage tanks
- Lake Elmo – one 700,000 gallon elevated storage tank
- Grey Could Island – one 30,000 gallon elevated storage tank
- Prairie Island – one 20,000 gallon elevated storage tank
- Afton – one 50,000 gallon elevated storage tank
- West Lakeland – two 200,000 gallon elevated storage tanks.

Pressure reducing valve stations: No pressure reducing valve stations would be needed under this scenario.

E.1.2.3.5 Hydrogeologic impacts

For this scenario, all municipal supply wells were turned off for Cottage Grove, Lake Elmo, Lakeland, Lakeland Shores, Newport, Oakdale, St. Paul Park, and Woodbury. Based on the results of the groundwater model, the groundwater flow patterns (contours) appear to be comparable to the current day flow patterns where municipal supply wells are pumping groundwater. Side by side comparisons of the model simulation to the interpolated regional scale contours from 2009 are generally similar, and they indicate that the contour spacing orientation is slightly different because of differing pumping and recharge conditions. Generally, the flow patterns generated by the model are consistent with the interpolated regional scale contours from 2009. Based on the flow path analysis, it was estimated that a total of 1,457 new POET systems would be needed by the year 2040.

E.1.2.3.6 Cost estimate breakdown

Tables E.36 and E.37 below provide a screening level cost estimate breakdown for the initial installation costs, annual O&M costs, and the total costs for a 20-year period up to the year 2040 for the Regional Scenario 2B.1. Costs include the SWTPs, land acquisition, transmission line easements, and the water system infrastructure (e.g., transmission lines, storage tanks, pump stations, pressure reducing valves) that would be necessary to deliver the water to the existing municipal water systems and potential future water systems. Land acquisition costs were included in the total capital cost for the water system infrastructure. Costs to extend SPRWS's distribution lines to Maplewood residents were not included in the distribution mains capital costs. Costs to provide POET systems for non-municipal wells across the East Metropolitan Area were included based on 2040 groundwater projections.

Capital costs for this scenario are shown in Table E.36. Annual O&M costs for this scenario are shown in Table E.37.

Table E.36. Capital costs of the Regional Scenario 2B.1.

Item	Quantity	Units	Description	Total cost
43 mgd SWTP	1	Each	Lump sum	$47,906,000
8 mgd SWTP	1	Each	Lump sum	$17,465,000
Land acquisition	206	Acres	SWTPs and mains	$26,836,000
Booster pump stations	13	Each	126 mgd total	$33,273,000

Water storage tanks	8	Each	1.9 million gallons total	$5,917,000
Water distribution mains	70.3	Miles	8" to 48" diameter	$165,699,000
GAC POET systems[1]	1,457	Each	Standard household systems, $2,500 per well	$3,643,000
			Subtotal	$300,739,000
			Contingency (20%)	$60,148,000
			Professional services (15%)	$54,134,000
			Total	**$415,021,000**

Notes:

1. GAC POET system cost is estimated for non-municipal wells with HI > 0.75.

Table E.37. Annual O&M costs for the Regional Scenario 2B.1.

Item	Cost basis	Total
43 mgd SWTP	Each	$6,429,000
8 mgd SWTP	Each	$2,344,000
Booster pump stations	126 mgd total	$2,803,000
Water storage tanks	1.9 million gallons total	$222,000
Water distribution mains	8" to 48" diameter	$5,800,000
GAC POET systems	2,070 @$1,000/year	$2,070,000
	Total annual O&M	$19,668,000
	20 years of annual O&M	$393,360,000
	Total 20 year costs (capital + O&M)	**$808,381,000**
	Capital and operating cost per 1,000 gallons (18,980 million gallons per year)	**$2.13**
	Operating only cost per 1,000 gallons	**$1.04**

E.1.2.4 Regional Scenario 2B.2 – Mississippi and St. Croix River SWTPs

This scenario would replace existing groundwater supplies with two SWTPs. The first SWTP would be a 24 mgd plant on the Mississippi River to serve Cottage Grove, Grey Cloud Island, Newport, Oakdale, and St. Paul Park. The second SWTP would be a 28 mgd plant on the St. Croix River, which would serve the remaining communities including Afton, Denmark, Lake Elmo, Lakeland, Lakeland Shores, Prairie Island Indian Community, West Lakeland, and Woodbury. The notable difference between Scenarios 2B.1 and 2B.2 is the supply of Woodbury. Woodbury has the largest drinking water demands in the project area and has the greatest impact on the infrastructure and associated costs. In this scenario, Woodbury would receive drinking water from the St. Croix SWTP, while in Scenario 2B.1 Woodbury would be served by the Mississippi River SWTP. Maplewood residents would not be served by the new SWTP, and instead be served by extending SPRWS.

The locations of the Mississippi and St. Croix River SWTPs would be the same as the Regional Scenario 2B.1.

E.1.2.4.1 SWTP and infrastructure components

Each SWTP would include the following components:

- Intake piping, intake structure, and screening
- Clarifiers – remove suspended solids
- Gravity filtration (GAC) – taste and odor control
- Lime softening – water softening
- Chlorination – disinfection
- Fluoridation – increase fluoride level in the water
- Corrosion control – prevents pipe corrosion within the distribution system
- Finished water pump station and finished water storage
- Rechlorination – disinfection
- Solids dewatering – reduce the volume of solids sent to landfill
- Administration and operations building.

Cost estimates for the SWTP include all items identified above and cover all components between the river and the SWTP, as well as components within the plant property.

The infrastructure requirements for the regional water supply system from each SWTP would include the following components that would deliver treated surface water to existing and potential future water storage facilities within each community:

- Water transmission lines
- Booster pump stations
- Water storage facilities
- Pressure reducing stations.

E.1.2.4.2 LGU water supplies and infrastructure

The following is a summary of the water supply infrastructure that would be necessary to deliver surface water to the existing municipal water systems.

Transmission line alignment and sizes

Similar to the Regional Scenario 2B.1, two transmission lines would convey treated water from the Mississippi SWTP to two separate regions based on topography and pressure requirements. One 18" transmission line would carry approximately 5.0 mgd to serve south of the SWTP and one 36" transmission line would carry approximately 19 mgd to serve the northwestern communities excluding Woodbury. The St. Croix SWTP would convey approximately 28 mgd to the eastern communities and Woodbury via a 48" transmission line. By implementing two SWTPs of similar capacities, this would allow smaller diameter pipes and smaller pumps to be used.

The total length of pipe that would be needed to supply the East Metropolitan Area in this scenario would be just over 69 miles. Table E.38 shows the lengths per size of the pipe.

Table E.38. Size and length of transmission lines for the Regional Scenario 2B.2.

Transmission line diameter (inches)	Miles of transmission line
8"	8.5
10"	6.8

12”	4.9
14”	10.2
16”	6.6
18”	3.3
20”	3.8
24”	11.2
30”	3.1
36”	8.7
48”	2.1
Total	**69.12**

Distribution system requirements

The topography of the region is the main consideration when designing a new water supply system of this size. Drinking water distribution modeling of this scenario helped identify locations where pressures would need to be boosted and areas that would require pressure reducing valves. Areas with large variations in elevation would require either a booster pump or pressure reducing valve to maintain water system pressures between 20 and to 200 psi. As these transmission lines would be acting only as supply lines, the pressures can be significantly higher than what would normally be used for distribution lines. Pressures in a typical distribution system would be between 40 and 100 psi.

Booster pump stations: Results from the drinking water distribution model indicate that booster pump stations would be needed at various locations in the new water supply systems. The following booster pump stations would be necessary to provide water to the existing municipal water systems:

- 12,850 gpm booster pump station at the Mississippi SWTP site for the high-pressure zone
- 3,500 gpm booster pump station at the Mississippi SWTP site for the low-pressure zone
- 18,950 gpm booster pump station at the St. Croix SWTP site
- 12,250 gpm booster pump station in St. Paul Park
- 2,800 gpm booster pump station in Southern Cottage Grove
- 4,500 gpm booster pump station at Woodbury Tanks 1 and 2
- 2,250 gpm booster pump station at Woodbury Tank 6
- 4,500 gpm booster pump station at Woodbury Tanks 3 and 4
- 2,400 gpm booster pump station in the south area of Oakdale
- 2,400 gpm booster pump station in the north area of Oakdale
- 1,200 gpm booster pump station at Oakdale Tank 2
- 2,500 gpm booster pump station in the central area of Lake Elmo.

Water storage tanks: Existing water storage tanks would continue to provide water storage for emergencies, including fire flow, and to provide water during the peak demands. Additional storage tanks that would be necessary to meet the demands and water storage requirements include:

- Cottage Grove – two 350,000 gallon elevated storage tanks
- Lake Elmo – one 700,000 gallon elevated storage tank
- Grey Could Island – one 30,000 gallon elevated storage tank
- Prairie Island – one 20,000 gallon elevated storage tank

- Afton – one 50,000 gallon elevated storage tank
- West Lakeland – two 200,000 gallon elevated storage tanks.

Pressure reducing valve stations: No pressure reducing valve stations would be needed under this scenario.

E.1.2.4.5 Hydrogeologic impacts

For this scenario, all municipal supply wells were turned off for Cottage Grove, Lake Elmo, Lakeland, Lakeland Shores, Newport, Oakdale, St. Paul Park, and Woodbury. Based on the results of the groundwater model, the groundwater flow patterns (contours) appear to be comparable to the current day flow patterns where municipal supply wells are pumping groundwater. Side by side comparisons of the model simulation to the interpolated regional scale contours from 2009 are generally similar, and they indicate that the contour spacing orientation is slightly different because of differing pumping and recharge conditions. Generally, the flow patterns generated by the model are consistent with the interpolated regional scale contours from 2009. Based on the flow path analysis, it was estimated that a total of 1,457 new POET systems would be needed by the year 2040.

E.1.2.4.6 Cost estimate breakdown

Table E.39 and E.40 below provide a screening level cost estimate breakdown for the initial installation costs, annual O&M costs, and the total costs for a 20-year period up to the year 2040 for the Regional Scenario 2B.2. Costs include the SWTPs, land acquisition, transmission line easements, and the water system infrastructure (e.g., transmission lines, storage tanks, pump stations, pressure reducing valves) that would be necessary to deliver the water to the existing municipal water systems and potential future water systems. Land acquisition costs were included in the total capital cost for the water system infrastructure. Costs to extend SPRWS's distribution lines to Maplewood residents were not included in the distribution mains capital costs. Costs to provide POET systems for non-municipal wells across the East Metropolitan Area were included based on 2040 groundwater projections.

Capital costs for this scenario are shown in Table E.39. Annual O&M costs for this scenario are shown in Table E.40.

Table E.39. Capital costs of the Regional Scenario 2B.2.

Item	Quantity	Units	Description	Total cost
24 mgd SWTP	1	Each	Lump sum	$33,763,000
28 mgd SWTP	1	Each	Lump sum	$37,034,000
Land acquisition	202.5	Acres	SWTP & mains	$26,462,000
Booster pump stations	12	Each	101 mgd total	$29,731,000
Water storage tanks	8	Each	1.9 million gallons total	$5,917,000
Water distribution mains	69	Miles	8” to 48” diameter	$169,853,000
GAC POET systems[1]	1,457	Each	Standard household systems, $2,500 per well	$3,643,000
			Subtotal	$306,403,000

Contingency (20%)	$61,281,000
Professional services (15%)	$55,153,000
Total	$422,837,000

Notes:

1. GAC POET system cost is estimated for non-municipal wells with HI > 0.75.

Table E.40. Annual O&M costs for the Regional Scenario 2B.2.

Item	Cost basis	Total
24 mgd SWTP	Each	$4,531,000
28 mgd SWTP	Each	$4,970,000
Booster pump stations	101 mgd total	$2,526,000
Water storage tanks	1.9 million gallons total	$222,000
Water distribution mains	8” to 48” diameter	$5,945,000
GAC POET systems	2,070 @$1,000/year	$2,070,000
Total annual O&M		$19,668,000
20 years of annual O&M		$393,360,000
Total 20 year costs (capital + O&M)		**$828,117,000**
Capital and operating		**$2.18**
Cost per 1,000 gallons (18,980 million gallons per year)		**$1.07**

E.1.2.5 Regional Scenario 2C – St. Paul Regional Water Services

This scenario would replace existing groundwater supplies by using water from SPRWS’ existing WTP. The McCarron’s WTP currently has 30 mgd of extra water treatment capacity. Additional studies would be necessary to determine the necessary improvements to the raw water supply system and the existing WTP that would be required to meet the 2020 and 2040 maximum daily demands of 43 mgd and 52 mgd, respectively.

The existing McCarron’s WTP is located in Maplewood between Roselawn Avenue and Larpenteur Avenue just West of Highway 35.

E.1.2.5.1 SWTP and infrastructure components

New SWTPs were not included in this scenario since all water would be provided by SPRWS from their existing McCarron’s WTP. As part of their treatment process, SPRWS softens the water before pumping it into the distribution system. SPRWS charges a bulk water rate of $2.05 per 100 cubic feet ($2.74 per 1000 gallons) that should cover all costs associated with water supply improvements, WTP capacity expansion, or booster pump station upgrades at the plant and as such these were not addressed further in this estimate. If this is the preferred option to provide clean drinking water to the project area, further studies and a rate study may be necessary to further define the necessary upgrades, the cost of the upgrades, and a suitable bulk water rate.

E.1.2.5.2 LGU water supplies and infrastructure

The following is a summary of the water supply infrastructure necessary to deliver surface water from the existing WTP to the project area.

Transmission line alignment and sizes

The existing McCarron's WTP would distribute water to all of the affected communities in the East Metropolitan Area. There would be one 60" to convey the water from the WTP to the project area and transmission lines to carry the water to each community that currently has a municipal water system.

The total length of pipe that would be needed to supply the East Metropolitan Area in this scenario would be just under 75 miles. Table E.41 shows the lengths per size of the pipe.

Table E.41. Size and length of transmission lines for the Regional Scenario 2C.

Transmission line diameter (inches)	Miles of transmission line
8"	12.7
10"	6.0
12"	7.4
14"	8.1
16"	6.3
18"	3.6
20"	4.7
24"	5.3
30"	7.9
36"	2.8
48"	2.1
54"	2.2
60"	5.6
Total	**74.7**

Distribution system requirements

The topography of the region is the main concern when designing a water supply system of this size. Drinking water distribution modeling of this scenario helped determine locations where pressures would need to be boosted and areas that would require pressure reducing valves. Areas with large changes in elevations would require either a booster pump or pressure release valves to maintain water system pressures between 20 to 200 psi. This scenario was dependent on using the existing McCarron's WTP information and modelling the regional supply from the given facility specifications.

Booster pump stations: Results from the drinking water distribution model indicate that booster pump stations would be needed at various locations in the new water supply system. The following booster pump stations would be necessary to provide water to the existing municipal water systems:

- One 7,000 gpm booster pump station in the south area of Cottage Grove
- One 35,250 gpm booster pump station on the 60" transmission line from SPRWS
- One 2,300 gpm booster pump station at Woodbury's Tank 6
- Two 400 gpm booster pump stations in West Lakeland at each proposed tower.

Water storage tanks: Existing water storage tanks would continue to provide water storage for emergencies, including fire flow, and to provide water during the peak demands. Additional storage tanks that would be necessary to meet the demands and water storage requirements include:

- Cottage Grove – two 350,000 gallon elevated storage tanks
- Lake Elmo – one 700,000 gallon elevated storage tank
- Grey Could Island – one 30,000 gallon elevated storage tank
- Prairie Island – one 20,000 gallon elevated storage tank
- Afton – one 50,000 gallon elevated storage tank
- West Lakeland – two 200,000 gallon elevated storage tanks.

Pressure reducing valve stations: One 30” pressure reducing valve station would be necessary to reduce pressures along the 30” diameter transmission line that would extend through Maplewood to reduce the pipeline pressure from 198 to 90 psi.

E.1.2.5.5 Hydrogeologic impacts

For this scenario, all municipal supply wells were turned off for Cottage Grove, Lake Elmo, Lakeland, Lakeland Shores, Newport, Oakdale, St. Paul Park, and Woodbury. Based on the results of the groundwater model, the groundwater flow patterns (contours) appear to be comparable to the current day flow patterns where municipal supply wells are pumping groundwater. Side by side comparisons of the two model simulations indicate that the contour spacing and intervals are slightly different. Based on the flow path analysis, it was estimated that a total of 1,457 new POET systems would be needed by the year 2040.

E.1.2.5.6 Cost estimate breakdown

Tables E.42 and E.43 below provide a screening level cost estimate breakdown for the initial installation costs, annual O&M costs, and the total costs for a 20-year period up to the year 2040 for the Regional Scenario 2C. Costs include the bulk water rate, land acquisition, transmission line easements, and the water system infrastructure (e.g., transmission lines, storage tanks, pump stations, pressure reducing valves) that would be necessary to deliver the water to the existing municipal water systems and potential future systems. Land acquisition costs were included in the total capital cost for the water system infrastructure. Costs to provide GAC POET systems for non-municipal wells across the East Metropolitan Area were included. Costs associated with the bulk water rate of $2.05 per 100 cubic feet are reflected in the SWTP operation and maintenance costs.

Capital costs for this scenario are shown in Table E.42. Annual O&M costs for this scenario are shown in Table E.43.

Table E.42. Capital costs of the Regional Scenario 2C.

Item	Quantity	Units	Description	Total cost
Land acquisition	187	Acres	Pipeline easements and lots for facilities	$24,388,000
Booster pump stations	5	Each	45,350 gpm total	$13,582,000
Pressure reducing valve station in Maplewood	1	Each	11,500 gpm, 30” pressure reducing valve	$1,500,000
Water storage tanks	8	Each	1.9 million gallons total	$5,971,000
Water distribution mains	75	Miles	8” to 60” diameter	$202,726,000

GAC POET systems[1]	1,457	Each	Standard household systems, $2,500 per well	$3,643,000
			Subtotal	$251,756,000
			Contingency (20%)	$50,352,000
			Professional services (15%)	$45,317,000
			Total	**$347,425,000**

Notes:

1. GAC POET estimates are based on 2040 projections of groundwater flow.

Table E.43. Annual O&M costs for Regional Scenario 2C.

Item	Cost basis	Total
52 mgd SWTP	$2.05/100 cubic feet for 20 mgd	$20,005,300
Booster pump stations	45,350 gpm total	$1,651,000
Pressure reducing valve station in Maplewood	11,500 gpm	$36,500
Water storage tanks	1.9 million gallons total	$220,000
Water distribution mains	8” to 60” diameter	7,096,000
GAC POET systems	2,070 @$1,000/year	$2,070,000
	Total annual O&M	$31,081,000
	20 years of annual O&M	$621,620,000
	Total 20 year costs (capital + O&M)	**$969,045,000**
	Capital and operating cost per 1,000 gallons (18,980 million gallons per year)	**$2.55**
	Operating only cost per 1,000 gallons	**$1.64**

E.1.2.6 Regional Scenario 2D – regional groundwater

This scenario would replace existing municipal groundwater supply wells by providing water from a new groundwater well field located in Denmark to meet the 2040 maximum daily demand of 52 mgd. The potential well field would be placed in the northwest corner of Denmark and would consist of 30 wells, each with an equal well production rate. These wells would draw water from the Jordan and Prairie du Chien aquifers. A transient model (time varying) has not been developed for the East Metropolitan Area. The transient demand cannot be tested with the current model. This location is on the east side of the groundwater divide and mostly unaffected by PFAS contamination.

Results of the steady state groundwater modeling indicate the well field would be unable to produce enough water to meet the necessary pumping rates. Initial results showed that only about 80-85% of the required demand would be available in this area. As a result, no further analysis was conducted, as smaller well fields were further analyzed in the sub-regional groundwater scenario (Regional Scenario 2E).

E.1.2.7 Regional Scenario 2E – Sub-Regional Groundwater

The proposed sub-regional wells fields under this scenario would replace existing municipal groundwater supply wells by providing water from three separate groundwater well fields to meet the 2040 maximum daily demand of 52 mgd. Each well field would have a total pumping capacity of up to 18 mgd and would consist of 9 wells drawing water from the Jordan and Prairie du Chien aquifers. The groundwater model indicated that the aquifers could sustain the required demand based on the hydraulic parameters. The three proposed well fields include the following:

1. Southwest Well Field – Located in the southwest corner of Cottage Grove and east of Grey Cloud Island. This well field would be well positioned to provide water to Grey Cloud Island, St. Paul Park, and Cottage Grove.

2. Northwest Well Field - Located in the southwest corner of Woodbury. Appears to be an area of limited PFAS contamination and could provide water to Newport (if necessary), Woodbury, and areas north of Woodbury.

3. Northeast Well Field - Located in the southwest corner of Afton, which is largely unaffected by PFAS contamination. A well field here could be used to supply water to Afton, Lake Elmo, Lakeland (and associated communities), Oakdale, West Lakeland, and Woodbury.

E.1.2.7.1 LGU water supplies and infrastructure

The following is a summary of the water supply infrastructure necessary to deliver groundwater from the existing WTPs to the project area and the existing municipal water systems. Given the location of the proposed well fields, the Southwest Well Field would serve the communities of Cottage Grove, Grey Cloud Island, and St. Paul Park and the two centrally located well fields (i.e., Northwest Well Field and Northeast Well Field) would collectively serve the remaining communities of Lake Elmo, Lakeland, Lakeland Shores, Newport, Oakdale, Prairie Island Indian Community, West Lakeland, Woodbury, and the very northern border region of Afton. Table E.44 shows the communities served by the different treatment facility locations and the community 2040 mgd. Table E.45 shows the lengths per size of the pipe.

Table E.44. Summary of Sub-Regional treatment facilities.

Treatment facility location	Communities served	Community 2040 maximum daily demand (mgd)
Southwest Well Field and WTP (16 mgd)	Cottage Grove	14.1
	St. Paul Park	1.7
Two centralized well fields (Northwest Well Field and Northeast Well Field) and WTPs (18 mgd and 17 mgd)	Lake Elmo	5.4
	Lakeland, Lakeland Shore=s, Lake St. Croix Beach	1.1
	Newport	0.6
	Oakdale	7.0
	Prairie Island Indian Community	.03
	Woodbury	19.5

Table E.45. Size and length of transmission lines for the Regional Scenario 2E.

Transmission line diameter (inches)	Miles of transmission line
6”	0.64
8”	5.27
10”	2.64
12”	5.79
14”	0.18
18”	0.59
24”	0.88

36”	8.94
Total	**48.91**

E.1.2.7.2 Southwest Well Field to southern communities (Cottage Grove, Grey Cloud Island, and St. Paul Park)

The following is a summary of the water supply infrastructure that would be necessary to deliver groundwater water to the existing municipal water systems.

Transmission line alignment and sizes

The proposed WTP would be located in Cottage Grove’s southern low pressure zone near Well 10. One 36” line from the WTP would convey flow to two 24” transmission lines that would be required to route flow to an existing 12” line to the west along Hadley Avenue and 24” line to the northeast just west of Hemingway Avenue. From there the flows would be conveyed to the west through a series of proposed interconnects to St. Paul Park; and to the northeast to the intermediate pressure zone where it would be boosted at the existing booster pump station to the high pressure zone. According to the provided pump curves, Pumps 3 and 4 would need to be replaced with Pumps 1 and 2, requiring some modifications. Further analysis of the booster pump station and existing conditions is recommended in order to size the proposed pumps.

Table E.46 provides the total length of pipeline required for the proposed interconnects, transmission lines, and proposed distribution lines.

Table E.46. Size and length of all pipelines for the Southwest Well Field.

Pipeline diameter (inches)	Miles of pipeline
6”	0.64
10”	2.64
12”	1.46
24”	0.88
Total	**5.61**

Distribution system requirements

The topography of the region is the main consideration when designing a water supply system of this size. Because Cottage Grove operates their distribution system across three pressures zones and the natural topography slopes rapidly near the river, managing pressures would be the greatest challenge. Drinking water distribution modeling helped determine locations where pressures would need to be boosted and areas that would require pressure reducing valves.

Water storage tanks: Existing water storage tanks would continue to provide water storage for emergencies, including fire flow, and to provide water during the peak demands. Additional storage tanks that would be necessary to meet the demands and water storage requirements include:

- Cottage Grove – two 350,000 gallon elevated storage tanks

Pressure reducing valve stations: Once flow from the WTP is conveyed to the intermediate zone booster pump station in Cottage Grove, Cottage Grove’s existing pressure reducing valves would be operated as normal. Additional pressure reducing valves would be located at the northern interconnect between St.

Paul Park and Cottage Grove, and at the entrances to the neighborhoods on Goodview Avenue and Granada Avenue.

E.1.2.7.3 Northwest and Northeast Well Field to northern communities (Lake Elmo, Lakeland, Newport, Oakdale, Prairie Island Indian Community, West Lakeland, Woodbury, and Afton)

The following is a summary of the water supply infrastructure that would be necessary to deliver groundwater water to the existing municipal water systems.

Distribution system requirements

The Northwest Well Field would convey water towards Woodbury via a 30" water main that would be routed north along Radio Drive and tie into the existing water system at Lake Road. From here, it would connect to the existing 16" line running east-west and the 24" line running north-south. A 30" water transmission main would convey water north along Manning Avenue where it would then be routed west along Brookview Road and connect with the existing 20" line.

Additional distribution mains would be required at the Lake Elmo – Woodbury interconnects on the eastern and western boundaries of Lake Elmo. The eastern interconnect would extend a 12" line north along Settlers Ridge Parkway/Lake Elmo Avenue conveying approximately 1,800 gpm. The western interconnect would extend an 18" line north along Radio Drive to the Lake Elmo-Oakdale boundary and would require a booster pump station sized at approximately 1,000 gpm at 90 feet. The existing interconnect between Oakdale and Woodbury is a 12" line sized to convey 2,000 gpm. This interconnect should be evaluated to determine its current condition and if any improvements are needed. In addition, this interconnect would also require a booster pump station sized at approximately 2,500 gpm at 140 feet and located south of Ashwood Road. At this rate, velocities would be higher, around 7 feet per second, and a pressure reducing valve would be necessary on the distribution system in Ashwood Road.

For Woodbury to provide water to Newport, approximately 6,165 linear feet of 8" lines would be required to connect to the existing 8" line in Military Road near the new subdivision. While Newport would need to adjust their pressure reducing valve settings; allow flow to run back through their northern booster pump station; and take their southern booster pump station off-line, no additional infrastructure changes would be required.

For water to be conveyed through Lake Elmo through West Lakeland to Lakeland an additional interconnect and booster pump station would be required. Approximately 1,300 linear feet of 12" line and a booster pump station with a capacity of 1,500 gpm at 100 feet would be needed and would be located on 10th Street between Manning Avenue and Palmer Drive. A 12" water transmission main would cross West Lakeland to deliver water to Lakeland's northern water storage tank.

Water storage tanks: Existing water storage tanks would continue to provide water storage for emergencies, including fire flow, and to provide water during the peak demands. Additional storage tanks that would be necessary to meet the demands and water storage requirements include:

- Lake Elmo – one 700,000 gallon elevated storage tank.

E.1.2.7.4 Hydrogeologic impacts

Results from the groundwater model indicate that the required water supply was available from all three well fields. Under the current "wet" climate condition, particles from areas with HI values greater than 0.5 were not captured by the Northeast nor the Northwest Well Fields and the Northwest Well Field currently shows very low PFAS levels. The groundwater model does not simulate PFAS transport. If flow path analysis indicated PFAS impacts in wells, then it was assumed that the HI>0, and treatment potentially would be required. However, the Southwest Well Field is expected to have continued PFAS contamination for the next 20 years and PFAS treatment would be required. Further analysis showed that under the “drought” condition, all of the well fields in Cottage Grove (Southwest Well Field) and southwest Woodbury (Northwest Well Field) are potentially expected to have PFAS contamination with HI values exceeding 0.5. As a result, it was assumed that these two well fields would require treatment by the year 2040 and treatment costs were included in the cost estimates based on WTP capacities of 16 mgd for the Southern Well Field and 18 mgd for the Northwest Well Field. No treatment was included in the cost estimates for the 17 mgd Northeast Well Field in Afton. Under the drought conditions, the sub-regional well field in southwest Woodbury would affect the flowfield, and groundwater in the Prairie du Chien would be drawn toward the Woodbury well field. It was estimated that approximately, 285 non-municipal wells would require GAC POET systems under the drought condition. This is a conservative number and includes those POET systems that would be affected under drought conditions. The potential for negative impacts to Valley Creek and Trout Brook due to pumping from the Northeast Well Field is a concern and would require further evaluation.

E.1.2.7.5 Cost estimate breakdown

Tables E.47 and E.48 below provide a screening level cost estimate breakdown for the initial installation costs, annual O&M costs, and the total costs for a 20-year period up to the year 2040 for the Regional Scenario 2E. Land acquisition costs were included in the total capital cost for the water system infrastructure. Costs to provide POET systems for non-municipal wells across the East Metropolitan Area were included. A summary of the Regional Scenario 2E costs is provided in Table E.49.

Table E.47. Capital and O&M costs of the Regional Scenario 2E – southern communities.

Item	Quantity	Units	Description	Total cost (GAC)	Total cost (IX)
Southwest Well Fields and southern communities					
Capital costs					
18 mgd WTP (Southwest Well Field)	1	Lump sum		$16,262,000	$11,601,000
Wells	9	Each	1,400 gpm each	$22,402,000	
Land acquisition	20	Acres	Pipeline easements and lots for facilities	$2,652,000	
Booster pump stations	3	Each	19,550 gpm total capacity	$12,646,000	
Pressure reducing valve station	1	Each	10” pressure reducing valve	$125,000	
Water storage tanks	4	Each	2.73 million gallons total storage volume	$6,686,000	
Water distribution mains	5.61	Miles	8” to 36” diameter	$13,386,000	
GAC POET systems[1]	175	Each	Standard household systems, $2,500 per well	$438,000	

(including Denmark)					
			Subtotal	$74,597,000	$69,936,000
			Contingency (20%)	$14,920,000	$13,988,000
			Professional services (15%)	$11,190,000	$10,491,000
			Total	**$100,707,000**	**$94,415,000**
Annual O&M costs					
Item	**Cost basis**			**GAC**	**IX**
18 mgd WTP (Southwest Well Field)	GAC media for treatment			$3,343,000	$835,000
Wells	9 wells			$590,000	
Booster pump stations	19,550 gpm total			$951,000	
8” pressure reducing valves	Installed in right-of-way			$10,000	
Water storage tanks	2.73 million gallons			$217,000	
Water distribution mains	8” to 36” diameter			$469,000	
GAC POET systems[1] (including Denmark)	285 at $1,000/year			$285,000	
			Total annual O&M	$5,865,000	$3,357,000
			20 years of annual O&M	$117,300,000	$67,140,000
			Total 20 year costs (capital + O&M)	**$218,007,000**	**$161,555,000**
			Capital and operating cost per 1,000 gallons (18,980 million gallons per year)	**$1.66**	**$1.23**
			Operating only cost per 1,000 gallons	**$0.89**	**$0.51**

Notes:

1. GAC POET estimates are based on projections from the 2040 groundwater model. It was estimated that Denmark would have three non-municipal wells that would require treatment.

Table E.48. Capital and O&M costs of the Regional Scenario 2E – northern communities.

Item	Quantity	Units	Description	Total cost (GAC)	Total cost (IX)
Northwest and Northeast Well Fields and northern communities					
Capital costs					
18 mgd WTP (Northwest Well Field)	1	Lump sum		$16,262,000	$11,601,000
Wells	18	Each	1,400 gpm each	$44,803,000	
Land acquisition	93	Acres	Pipeline easements and lots for facilities	$11,967,000	

Booster pump stations	7	Each	35,420 gpm total capacity	$15,355,000	
Pressure reducing valve stations	3	Each	8” pressure reducing valves	$375,000	
Water storage tanks	2	Each	4.0 million gallon total storage volume	$8,638,000	
Water distribution mains	19.32	Miles	8” to 36” diameter	$47,352,000	
GAC POET systems[1]	1025	Each	Standard household systems, $2,500 per well	$2,563,000	
			Subtotal	$142,747,000	$138,086,000
			Contingency (20%)	$28,550,000	$27,618,000
			Professional services (15%)	$21,413,000	$20,713,000
			Total	**$192,710,000**	**$186,417,000**
Annual O&M costs					
Item	**Cost basis**			**GAC**	**IX**
18 mgd WTP (Northwest Well Field)	GAC media for treatment			$3,343,000	$835,000
Wells	9 wells			$1,180,000	
Booster pump stations	35,420 gpm total			$1,261,000	
8” pressure reducing valves	Installed in right-of-way			$30,000	
Water storage tanks	2 million gallons at each WTP			$262,000	
Water distribution mains	8” to 36” diameter			$1,658,000	
GAC POET systems	1403 at $1,000/year			$1,403,000	
			Total annual O&M	$9,137,000	$6,629,000
			20 years of annual O&M	$182,740,000	$132,580,000
			Total 20 year costs (capital + O&M)	**$375,450,000**	**$318,997,000**
			Capital and operating cost per 1,000 gallons (18,980 million gallons per year)	**$1.43**	**$1.21**
			Operating only cost per 1,000 gallons	**$0.70**	**$0.50**

Table E.49. Regional Scenario 2E cost summary.

Item	Capital costs (GAC) ($1000s)	Capital costs (IX) ($1000s)	O&M costs (GAC) ($1000s)	O&M costs (IX) ($1000s)	20 Year costs (Capital + O&M) (GAC) ($1000s)	20 Year costs (Capital + O&M) (IX) ($1000s)	$/1000 gal (capital + O&M	$/1000 gal (capital +	$/1000 gal (operating only)	$/1000 gal (operating only) (IX)

							)(GA C)	O&M)(IX)	(GAC)	
Northern Communities (supplied by 2 well fields)	$192,710	$186,417	$9,137	$6,629	$375,450	$318,997	$1.43	$1.21	$0.70	$0.50
Southern Communities (supplied by 1 well field)	$100,707	$94,415	$5,865	$3,357	$218,007	$161,555	$1.66	$1.23	$0.89	$0.51
Total	**$293,417**	**$280,832**	**$15,002**	**$9,986**	**$593,457**	**$480,552**	**$1.54**	**$1.22**	**$0.79**	**$0.51**

E.1.2.8 Regional scenarios summary

The summary of the regional scenario results are presented in Table E.50. Regional scenario results show that, although Scenario 2C requires the least upfront capital costs, the water rate charges might be difficult to overcome or may require subsidization in comparison to other regional options. Overall the regional scenario with the lowest cost is Scenario 2A where one SWTP is constructed on the Mississippi River to supply all of the East Metropolitan Area.

Table E.50. Cost estimate summary for the regional scenarios.

Option	Community served	Components	Water provided	Capital cost (1000s)	Annual O&M cost (1000s)	Total 20 year costs (1000s)	Cost per 1,000 gallons
2A – Mississippi SWTP	All	WTP and transmission mains only, distribution to new areas not included, 2,591 POETS	52 mgd	$391,306	$18,001	$751,326	$1.98
2B.1 – Mississippi SWTP + St. Croix SWTP	All	2 WTPs and transmission mains only, distribution to new areas not included, 2,591 POETS	52 mgd total (43 mgd Miss. SWTP, 8 mgd St. Croix SWTP)	$415,021	$19,668	$808,381	$2.13
2B.2 – Mississippi SWTP + St. Croix SWTP	All	2 WTPs and transmission mains only, distribution to new areas not included, 2,591 POETS	52 mgd (24 mgd Miss. SWTP, 28 mgd St. Croix SWTP)	$422,837	$20,264	$828,117	$2.18

2C –SPRWS	All	Transmission mains only, distribution to new areas not included, 2,591 POETS	20-52 mgd (range between average and maximum daily demands)	$347,425	$31,081	$969,045	$2.55
2D – regional groundwater	Not a feasible solution due to lack of water supply for a single 52 mgd well field in Denmark						
2E – sub-regional groundwater	All	3 well fields, 2 WTPs, and distribution for Grey Cloud Island, Lake Elmo, and West Lakeland neighborhoods	52 mgd	$293,417	$15,002	$593,457	$1.54

E.1.3 Treatment scenarios

E.1.3.1 Treatment scenarios overview

These scenarios would provide treatment for existing drinking water wells, both municipal and non-municipal, at the individual well sites for both 2020 and 2040 population demands. Two treatment technologies were evaluated under these scenarios – GAC and IX. An assessment of these and other PFAS treatment technologies is provided in Appendix F.

Relative costs associated with the levels of contamination described below (Treatment Scenarios 3A-3D) are provided as a desktop exercise, but do not reflect efficiencies that may be realized upon additional analysis (for example, via centralized WTPs as opposed to treating each well individually). Those efficiencies are explored in the other scenarios.

The determination of providing treatment to impacted wells is based on the MDH HI calculation. The HI is calculated as the sum of the PFAS concentrations divided by their respective (most conservative) Health Based Value (HBV) or Health Risk Limit (HRL), as described in Chapter 7.

The following treatment scenarios were identified:

A. Treatment Scenario 3A – This scenario would provide treatment at each well (both municipal and non-municipal drinking water wells) with PFAS detections of HI(PFAS) > 1.

B. Treatment Scenario 3B – This scenario would provide treatment at each well (both municipal and non-municipal drinking water wells) with PFAS detections of HI(PFAS) > 0.5.

C. Treatment Scenario 3C – This scenario would provide treatment at each well (both municipal and non-municipal drinking water wells) with the detection of perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and/or perfluorohexane sulfonate (PFHxS). Perfluorobutanoic acid (PFBA) has been detected in groundwater and other media across not only the Twin Cities Metropolitan Area, but across the world. Providing treatment of drinking water based on a PFBA and/or perfluorobutane sulfonate (PFBS) detection alone (i.e., no other PFAS are detected), which is potentially the case in Treatment Scenario 3D, has cost implications as well as implications for communities outside the East Metropolitan Area.

D. Treatment Scenario 3D – This scenario would provide treatment at each well (both municipal and non-municipal drinking water wells) with PFAS detections of HI(PFAS) > 0.

E.1.3.1.1 Assumptions/considerations

The following records were obtained for the East Metropolitan Area and used to estimate the total number of non-municipal wells receiving treatment per community:

- Minnesota Well Index (a.k.a. County Well Index) records
- Water Supply Plans from each community
- Correspondence and first-hand knowledge from city staff
- Well sampling data from MDH as of 10/24/2019
- Correspondence and first-hand knowledge from MDH staff
- In-home GAC installation records from MPCA as of 10/24/2019

Non-municipal well treatment systems: Quantities and costs for treatment of non-municipal wells were determined by the following approach and assumptions:

- The total number of non-municipal wells requiring treatment for the year 2020 was estimated by summing all non-municipal wells that have been sampled and have PFAS results at the respective scenario concentrations (HI > 1.0; HI > 0.5; PFOS, PFOA, PFHxS > 0; and HI > 0); adding the number of wells that were determined to have a high likelihood of PFAS results at the respective scenario concentrations within the next year, using first-hand knowledge from MDH staff; and subtracting the non-municipal wells that already have GAC installed as well as wells that have been sealed or are used solely for monitoring, testing, or industrial purposes.
- The total number of non-municipal wells requiring treatment for the year 2040 was estimated using the groundwater model.
- The treatment system would be GAC POET equipment for each household served by non-municipal wells.
- Based on MPCA's current POET contract pricing and Wood's prior experience, the capital cost to supply and install a POET system is estimated to be $2,500 for an indoor GAC unit.
- The annual cost to service and replace the carbon in a POET system is estimated to be $1,000 per unit.
- It is assumed that the existing infrastructure would be utilized for non-municipal wells.

Municipal water treatment systems: Quantities and costs for the treatment of municipal supply wells were estimated by the following approach and assumptions:

- Records suggest that the municipal supply wells are currently or would be routed to the water distribution system rather than routed to centralized WTPs which have not been implemented at this time in the East Metro. As a result, for the basis of this estimate, it was assumed that each municipal supply well would receive an independent treatment system, for a maximum of 47 independent municipal supply installations under Scenario 3D (HI > 0).
- Cost estimates were prepared for both GAC and IX treatment systems. GAC and IX are similar media in column style treatment systems. GAC treatment generally requires a slightly longer

contact time compared to an IX treatment system. The difference generally leads to slightly larger equipment, buildings, and higher overall capital costs for GAC as compared to IX.

- In both GAC and IX drinking water treatment systems the media used for treatment would be single use and replaced and discarded after use. The consumption of media for both GAC and IX can be influenced by the water composition, as well as the concentration of individual PFAS that require treatment. Where available, site-specific operating or pilot test data can provide the most reliable estimates.
  - The consumption of GAC media was estimated based on published information from the City of Oakdale PFAS treatment plant which consumes 140 to 230 pounds of GAC per million gallons treated,[1] with an estimated delivered cost of $2.75 per pound.
  - The consumption of IX media was estimated based on Wood's prior experience to range from 0.030 to 0.086 cubic feet per million gallons treated, with an estimated delivered cost of $450 per cubic foot.
- Other operating and maintenance costs were estimated as an industry standard 5% of the capital cost.
- Drinking water distribution modeling was not conducted for these scenarios. Infrastructure costs were included in the costs for municipal well treatment systems, which are assumed to be installed at or near each individual municipal supply well or in an existing building.

E.1.3.2 Treatment Scenarios 3A.1-3D.1 for year 2020

The following sections describe the treatment scenarios for the year 2020.

E.1.3.2.1 LGU water supplies and infrastructure

Table E.51 provides a summary of the number of drinking water wells that would be treated under the different scenarios for the year 2020. Wells that already have PFAS treatment were excluded from the cost estimate.

Table E.51. Number of municipal and non-municipal drinking water wells that would be treated under each 2020 scenario.

	Municipal supply wells				Non-municipal wells			
Scenario	3A.1	3B.1	3C.1	3D.1	3A.1	3B.1	3C.1	3D.1
Community	HI > 1.0	HI > 0.5	PFOS, PFOA, PFHxS > 0	HI > 0	HI > 1.0	HI > 0.5	PFOS, PFOA, PFHxS > 0	HI > 0
Afton					15	17	25	102
Cottage Grove	8	12	12	12	45	87	124	453
Denmark					3	3	9	68
Grey Cloud Island					20	27	35	61
Lake Elmo	2	2	2	4	48	66	121	338
Lakeland	0	0	0	2	130	143	173	295
Lakeland Shores					21	25	29	44

[1] G. Hohenstein, B. Bachmeier, 3M Poster – Granular Activated Carbon Treatment of Groundwater, presented at Fluoros Conference, 2015.

Maplewood					0	1	2	29
Newport	0	0	0	2	0	0	4	20
Oakdale	4	6	6	7	15	15	15	16
Prairie Island Indian Community[1]	1	1	1	1	0	0	0	0
St. Paul Park	3	3	3	3	20	22	27	53
West Lakeland					182	205	267	513
Woodbury	6	11	12	19	2	7	29	177
Total (region)	**24**	**35**	**36**	**50**	**501**	**618**	**860**	**2169**

Notes:

1. Well types include: commercial, domestic, irrigation, municipal, other, community supply, public supply/non-comm.-transient, public supply/non-community-non-transient, public supply/non-community, and unknown.
2. HI categories are not exclusive of each other and have overlap from one HI category to the next.
3. Counts for Oakdale do include 2 municipal wells that are already receiving treatment. These wells were not included in the counts used to calculate costs to install new treatment systems.
4. The GAC counts exclude those residences that would be connected to a municipal system as a result of the approved expedited projects.

E.1.3.2.2 Hydrogeologic impacts

The groundwater model was not used for the 2020 cost analysis. Pumping conditions for existing wells in the area were analyzed using the groundwater model in order to establish baseline conditions for the area. More information can be found in the groundwater model report in Appendix C.

E.1.3.2.3 Cost estimate breakdown

The tables below (Tables E.52-E.59) provide a screening level cost estimate breakdown for the initial installation costs, annual O&M costs, and the total costs for a 20-year period up to the year 2040 for Treatment Scenarios 3A.1-3D.1. These 2020 scenario costs assume that only those impacted through the year 2020 would be provided treatment depending on the HI value found based on groundwater sampling. Costs include land acquisition and water treatment costs applied to wells for the different scenarios while utilizing existing municipal water systems. Cost to extend SPRWS distribution lines to Maplewood residents is not included as those residents with impacted wells currently have individual POET systems.

Table E.52. Capital costs for the 2020 Treatment Scenario 3A.1 (HI > 1.0).

Item	Quantity	Units	Description	Total cost (IX)	Total cost (GAC)
Land acquisition	11.89	Acres	150x150 feet lots for facilities	$1,553,000	
Municipal supply well treatment systems	23	Each	23,725 gpm total capacity	$56,135,000	$78,690,000
GAC POET systems	498	Each	Standard household systems, $2,500 per well	$1,245,000	
			Subtotal	$58,933,000	$81,488,000
			Contingency (20%)	$11,787,000	$16,298,000
			Professional services (15%)	$10,608,000	$14,668,000
			Total	**$81,328,000**	**$112,454,000**

Table E.53. Annual O&M costs for the 2020 Treatment Scenario 3A.1 (HI > 1.0).

Item	Cost basis	Total cost (IX)	Total cost (GAC)
Municipal supply well treatment annual media cost	Media consumption: IX: 0.086 ft^3/million gallons at $450/$ft^3$ GAC: 140 lb/million gallons at $2.75/lb	$3,264,000	$8,483,000
Municipal supply well treatment annual operating cost	5% of capital costs		
GAC POET systems	$1,000/year	$1,120,000	
	Total annual O&M	$4,384,000	$9,603,000
	20 years of annual O&M	$87,680,000	$192,060,000
	Total 20 year costs (capital + O&M)	**$169,008,000**	**$304,514,000**
	Capital and operating cost per 1,000 gallons	**$0.68**	**$1.22**
	Operating only cost per 1,000 gallons	**$0.35**	**$0.77**

Table E.54. Capital costs for the 2020 Treatment Scenario 3B.1 (HI > 0.5).

Item	Quantity	Units	Description	Total cost (IX)	Total cost (GAC)
Land acquisition	17.57	Acres	150x150 feet lots for facilities	$2,295,000	
Municipal supply well treatment	34	Each	38,325 gpm total capacity	$88,936,000	$124,669,000
GAC POET systems	604	Each	Standard household systems, $2,500 per well	$1,510,000	
			Subtotal	$92,741,000	$128,474,000
			Contingency (20%)	$18,549,000	$25,695,000
			Professional services (15%)	$16,694,000	$23,126,000
			Total	**$127,984,000**	**$177,295,000**

Table E.55. Annual O&M costs for the 2020 Treatment Scenario 3B.1 (HI > 0.5).

Item	Cost basis	Total cost (IX)	Total cost (GAC)
Municipal supply well treatment annual media cost	Media consumption: IX: 0.086 ft^3/million gallons at $450/$ft^3$ GAC: 140 lb/million gallons at $2.75/lb	$5,201,000	$13,736,000
Municipal supply well treatment annual operating cost	5% of capital costs		
GAC POET systems	$1,000/year	$1,226,000	
	Total annual O&M	$6,427,000	$14,962,000
	20 years of annual O&M	$128,540,000	$299,240,000
	Total 20 year costs (Capital + O&M)	**$256,524,000**	**$476,535,000**
	Capital and operating cost per 1,000 gallons	**$0.63**	**$1.18**
	Operating only cost per 1,000 gallons	**$0.32**	**$0.74**

Table E.56. Capital costs for the 2020 Treatment Scenario 3C.1 (PFOS, PFOA, and PFHxS > 0).

Item	Quantity	Units	Description	Total cost (IX)	Total cost (GAC)

Land acquisition	18.08	Acres	150x150 feet lots for facilities	$2,363,000	
Municipal supply well treatment	35	Each	39,325 gpm total capacity	$91,485,000	$128,242,000
GAC POET systems	840	Each	Standard household systems, $2,500 per well	$2,100,000	
			Subtotal	$95,948,000	$132,705,000
			Contingency (20%)	$19,190,000	$26,541,000
			Professional services (15%)	$17,271,000	$23,887,000
			Total	**$132,409,000**	**$183,133,000**

Table E.57. Annual O&M costs for the 2020 Treatment Scenario 3C.1 (PFOS, PFOA, and PFHxS > 0).

Item	Cost basis	Total cost (IX)	Total cost (GAC)
Municipal supply well treatment annual media cost	Media consumption: IX: 0.086 ft^3/million gallons at $450/$ft^3$ GAC: 140 lb/million gallons at $2.75/lb	$5,349,000	$14,117,000
Municipal supply well treatment annual operating cost	5% of capital costs		
GAC POET systems	$1,000/year	$1,462,000	
	Total annual O&M	$6,811,000	$15,579,000
	20 years of annual O&M	$136,220,000	$311,580,000
	Total 20 year costs (capital + O&M)	**$268,629,000**	**$494,713,000**
	Capital and operating cost per 1,000 gallons	**$0.65**	**$1.19**
	Operating only cost per 1,000 gallons	**$0.33**	**$0.75**

Table E.58. Capital costs for the 2020 Treatment Scenario 3D.1 (HI > 0).

Item	Quantity	Units	Description	Total cost (IX)	Total cost (GAC)
Land acquisition	25.31	Acres	150x150 feet lots for facilities	$3,308,000	
Municipal supply well treatment	49	Each	55,075 gpm total capacity	$130,119,000	$182,398,000
GAC POET systems	2,082	Each	Standard household systems, $2,500 per well	$5,205,000	
			Subtotal	$138,632,000	$190,911,000
			Contingency (20%)	$27,727,000	$38,183,000
			Professional services (15%)	$24,954,000	$34,364,000
			Total	**$191,313,000**	**$263,458,000**

Table E.59. Annual O&M costs for the 2020 Treatment Scenario 3D.1 (HI > 0).

Item	Cost basis	Total cost (IX)	Total cost (GAC)
Municipal supply well treatment annual media cost	Media consumption: IX: 0.086 ft^3/million gallons at $450/$ft^3$ GAC: 140 lb/million gallons at $2.75/lb	$7,629,000	$20,293,000

Municipal supply well treatment annual operating cost	5% of capital costs		
GAC POET systems	$1,000/year	$2,704,000	
Total annual O&M		$10,333,000	$22,997,000
20 years of annual O&M		$206,660,000	$459,940,000
Total 20 year costs (capital + O&M)		**$397,973,000**	**$723,398,000**
Capital and operating cost per 1,000 gallons		**$0.68**	**$1.24**
Operating only cost per 1,000 gallons (27,601 million gallons per year)		**$0.35**	**$0.79**

E.1.3.3 Treatment Scenarios 3A.2-3D.2 for the year 2040

The following sections describe the treatment scenarios for the year 2040.

E.1.3.3.1 LGU water supplies and infrastructure

Table E.60 provides a summary of the number of drinking water wells that would be treated under the different scenarios for the year 2040. Wells that already have permanent PFAS treatment were excluded from the cost estimate.

Table E.60. Number of municipal and non-municipal drinking water wells that would be treated under each 2040 scenario.

	Municipal supply wells				Non-municipal wells			
Scenario	**3A.2**	**3B.2**	**3C.2**	**3D.2**	**3A.2**	**3B.2**	**3C.2**	**3D.2**
Community	**HI > 1.0**	**HI > 0.5**	**PFOS, PFOA, PFHxS > 0**	**HI > 0**	**HI > 1.0**	**HI > 0.5**	**PFOS, PFOA, PFHxS > 0**	**HI > 0**
Afton					74	74	78	115
Cottage Grove	8	12	12	12	99	117	138	382
Denmark					0	0	6	62
Grey Cloud Island					60	62	62	65
Lake Elmo	4	4	4	6	419	420	425	454
Lakeland	0	0	0	2	238	238	238	236
Lakeland Shores					29	29	29	29
Maplewood					0	0	1	27
Newport	0	0	0	2	15	15	19	32
Oakdale	6	8	8	8	41	41	41	42
Prairie Island Indian Community[1]	1	1	1	1	0	0	0	0
St. Paul Park	3	3	3	3	34	34	34	35
West Lakeland					593	593	595	602
Woodbury	8	13	14	21	21	24	46	191
Total (region)	**28**	**39**	**40**	**54**	**1,623**	**1,647**	**1,712**	**2,272**

Notes:

1. Well types include: commercial, domestic, irrigation, municipal, other, community supply, public supply/non-comm.-transient, public supply/non-community-non-transient, public supply/non-community, and unknown.
2. HI categories are not exclusive of each other and have overlap from one HI category to the next.
3. Counts for Oakdale do include 2 municipal wells that are already receiving treatment. These wells were not included in the counts used to calculate costs to install new treatment systems.

4. The GAC counts exclude those residences that would be connected to a municipal system as a result of the approved expedited projects.

E.1.3.3.2 Hydrogeologic impacts

The groundwater model was used to simulate current pumping conditions (existing municipal supply wells, irrigation wells, etc.) for each of the communities. Particles were placed in the groundwater model in areas of known residential well PFAS impacts above a HI of 0.5 (HI>0.5). Forward tracking flow paths were established through the year 2040. Based on the flow path analysis, it was estimated a total of between 1,112 and 2,279 new POET systems would be impacted by PFAS and potentially require treatment by the year 2040.

E.1.3.3.3 Cost estimate breakdown

Tables E.61-E.68 below provide a screening level cost estimate breakdown for the initial installation costs, annual O&M costs, and the total costs for a 20-year period up to the year 2040 for Treatment Scenarios 3A.2-3D.2. Costs include land acquisition and water treatment costs applied to wells for the different scenarios while utilizing existing municipal water systems. Cost to extend SPRWS distribution lines to Maplewood residents is not included as those residents with impacted wells currently have individual POET systems.

Table E.61. Capital costs for the 2040 Treatment Scenario 3A.2 (HI > 1.0).

Item	Quantity	Units	Description	Total cost (IX)	Total cost (GAC)
Land acquisition	14.47	Acres	150x150 feet lots for facilities	$1,890,000	
Municipal well treatment	28	Each	24,513 gpm total capacity	$61,591,000	$86,338,000
GAC POET systems	1,623	Each	Standard household systems, $2,500 per well	$4,058,000	
			Subtotal	$67,539,000	$92,286,000
			Contingency (20%)	$13,508,000	$18,458,000
			Professional services (15%)	$12,158,000	$16,612,000
			Total	**$93,205,000**	**$127,356,000**

Table E.62. Annual O&M costs for the 2040 Treatment Scenario 3A.2 (HI > 1.0).

Item	Cost basis	Total cost (IX)	Total cost (GAC)
Municipal supply well treatment annual media cost	Media consumption: IX: 0.086 ft^3/million gallons at $450/$ft^3$ GAC: 140 lb/million gallons at $2.75/lb	$3,579,000	$9,278,000
Municipal supply well treatment annual operating cost	5% of capital costs		
GAC POET systems	$1,000/year	$2,245,000	
	Total annual O&M	$5,824,000	$11,523,000
	20 years of annual O&M	$116,480,000	$230,460,000
	Total 20 year costs (capital + O&M)	$209,685,000	$357,816,000
	Capital and operating cost per 1,000 gallons	**$0.80**	**$1.37**
	Operating only cost per 1,000 gallons	**$0.45**	**$0.88**

Table E.63. Capital costs for the 2040 Treatment Scenario 3B.2 (HI > 0.5).

Item	Quantity	Units	Description	Total cost (IX)	Total cost (GAC)
Land acquisition	20.15	Acres	150x150 feet lots for facilities	$2,633,000	
Municipal well treatment	39	Each	43,113 gpm total capacity	$102,119,000	$143,148,000
GAC POET systems	1,647	Each	Standard household systems, $2,500 per well	$4,118,000	
			Subtotal	$108,870,000	$149,899,000
			Contingency (20%)	$21,774,000	$29,980,000
			Professional services (15%)	$19,597,000	$26,982,000
			Total	**$150,241,000**	**$206,861,000**

Table E.64. Annual O&M costs for the 2040 Treatment Scenario 3B.2 (HI > 0.5).

Item	Cost basis	Total cost (IX)	Total cost (GAC)
Municipal supply well treatment annual media cost	Media consumption: IX: 0.086 ft^3/million gallons at $450/$ft^3$ GAC: 140 lb/million gallons at $2.75/lb	$5,983,000	$15,882,000
Municipal supply well treatment annual operating cost	5% of capital costs		
GAC POET systems	$1,000/year	$2,269,000	
	Total annual O&M	$8,252,000	$18,151,000
	20 years of annual O&M	$165,040,000	$363,020,000
	Total 20 year costs (Capital + O&M)	**$315,281,000**	**$569,881,000**
	Capital and operating cost per 1,000 gallons	**$0.69**	**$1.25**
	Operating only cost per 1,000 gallons	**$0.36**	**$0.80**

Table E.65. Capital costs for the 2040 Treatment Scenario 3C.2 (PFOS, PFOA, and PFHxS > 0).

Item	Quantity	Units	Description	Total cost (IX)	Total cost (GAC)
Land acquisition	20.67	Acres	150x150 feet lots for facilities	$2,700,000	
Municipal supply well treatment	40	Each	44,113 gpm total capacity	$104,667,000	$146,721,000
GAC POET systems	1,712	Each	Standard household systems, $2,500 per well	$4,280,000	
			Subtotal	$111,647,000	$153,701,000
			Contingency (20%)	$22,330,000	$30,741,000
			Professional services (15%)	$20,097,000	$27,667,000
			Total	**$154,074,000**	**$212,109,000**

Table E.66. Annual O&M costs for the 2040 Treatment Scenario 3C.2 (PFOS, PFOA, and PFHxS > 0).

Item	Cost basis	Total cost (IX)	Total cost (GAC)
Municipal supply well treatment annual media cost	Media consumption: IX: 0.086 ft^3/million gallons at $450/$ft^3$	$6,131,000	$16,263,000

	GAC: 140 lb/million gallons at $2.75/lb		
Municipal supply well treatment annual operating cost	5% of capital costs		
GAC POET systems	$1,000/year	$2,334,000	
	Total annual O&M	$8,465,000	$18,597,000
	20 Years of annual O&M	$169,300,000	$371,940,000
	Total 20 year costs (capital + O&M)	**$323,374,000**	**$584,049,000**
	Capital and operating cost per 1,000 gallons	**$0.69**	**$1.25**
	Operating only cost per 1,000 gallons	**$0.36**	**$0.80**

Table E.67. Capital costs for the 2040 Treatment Scenario 3D.2 (HI > 0).

Item	Quantity	Units	Description	Total cost (IX)	Total cost (GAC)
Land acquisition	27.9	Acres	150x150 feet lots for facilities	$3,645,000	
Municipal supply well treatment	54	Each	61,113 gpm total capacity	$146,215,000	$204,962,000
GAC POET systems	2,272	Each	Standard household systems, $2,500 per well	$5,680,000	
			Subtotal	$155,540,000	$214,287,000
			Contingency (20%)	$31,108,000	$42,858,000
			Professional services (15%)	$27,998,000	$38,572,000
			Total	**$214,646,000**	**$295,717,000**

Table E.68. Annual O&M costs for the 2040 Treatment Scenario 3D.2 (HI > 0).

Item	Cost basis	Total cost (IX)	Total cost (GAC)
Municipal supply well treatment annual media cost	Media consumption: IX: 0.086 ft^3/million gallons at $450/$ft^3$ GAC: 140 lb/million gallons at $2.75/lb	$8,583,000	$22,896,000
Municipal supply well treatment annual operating cost	5% of capital costs		
GAC POET systems	$1,000/year	$2,894,000	
	Total annual O&M	$11,477,000	$25,790,000
	20 years of annual O&M	$229,540,000	$515,800,000
	Total 20 year costs (capital + O&M)	**$444,186,000**	**$811,517,000**
	Capital and operating cost per 1,000 gallons	**$0.69**	**$1.25**
	Operating only cost per 1,000 gallons (27,601 million gallons per year)	**$0.35**	**$0.80**

E.1.3.4 Treatment scenarios summary

These scenarios provide raw costs associated with an individual well treatment approach. As expected, the scenario with the lowest HI tolerance (HI > 0) and the highest number of wells to be treated is the most expensive, ranging from over $400 million for IX to over $800 million for GAC treatment systems across the East Metropolitan Area for 2040 conditions. A summary of the cost estimates for the treatment scenarios is provided in Table E.69 below.

Table E.69. Cost estimate summary for the treatment scenarios.

Option	Community served	Components	Water provided (mgd)	Capital cost (1,000s)		Annual O&M cost (1,000s)		Total 20 year costs (1,000s)		Capital and operating cost per 1,000 gallons		Operating only cost per 1,000 gallons	
				IX	GAC	IX	GAC	IX	GAC	IX	GAC	IX	GAC
3A.1 year 2020 HI > 1.0	All except Maplewood, Newport, and PIIC	Treatment at 24 municipal supply and 501 non-municipal wells	35	$81,328	$112,454	$4,384	$9,603	$169,008	$304,514	$0.68	$1.22	$0.35	$0.77
3B.1 year 2020 HI > 0.5	All except Newport and PIIC	Treatment at 35 municipal supply and 618 non-municipal wells	56	$127,984	$177,295	$6,427	$14,962	$256,524	$476,535	$0.63	$1.18	$0.32	$0.74
3C.1 year 2020 PFOS, PFOA and PFHxS > 0	All except PIIC	Treatment at 36 municipal supply and 860 non-municipal wells	57	$132,409	$183,133	$6,811	$15,579	$268,629	$494,713	$0.65	$1.19	$0.33	$0.75
3D.1 year 2020 HI > 0	All except PIIC	Treatment at 50 municipal supply and 2,169 non-municipal wells	80	$191,313	$263,458	$10,333	$22,997	$397,973	$723,398	$0.68	$1.24	$0.35	$0.79
3A.2 year 2040 HI > 1.0	All except Maplewood and Newport	Treatment at 28 municipal and 1,623 non-municipal wells	36	$93,205	$127,356	$5,824	$11,523	$209,685	$357,816	$0.80	$1.37	$0.45	$0.88
3B.2 year 2040 HI > 0.5	All except Newport	Treatment at 39 municipal and 1,647	63	$150,241	$206,861	$8,252	$18,151	$315,281	$569,881	$0.69	$1.25	$0.36	$0.80

		non-municipal wells											
3C.2 year 2040 PFOS, PFOA and PFHxS > 0	All	Treatment at 40 municipal and 1,712 non-municipal wells	64	$154,074	$212,109	$8,465	$18,597	$323,374	$584,049	$0.69	$1.25	$0.36	$0.80
3D.2 year 2040 HI > 0	All	Treatment at 54 municipal and 2,272 non-municipal wells	89	$214,646	$295,717	$11,477	$25,790	$444,186	$811,517	$0.69	$1.25	$0.35	$0.80

E.1.4 Integrated scenario

E.1.4.1 Integrated scenario overview

This scenario consists of a combination of conceptual projects included in the community-specific, regional, and treatment scenarios that were bundled to address PFAS-related drinking water quality and quantity issues for the 14 affected communities in the East Metropolitan Area. Interconnections between communities and new groundwater well fields with centralized treatment that serve multiple communities were considered. Conceptual projects are presented by the following groups of communities:

- Northeast communities: Afton, Lakeland, Lakeland Shores, Prairie Island Indian Community, and West Lakeland (Section E.1.4.2)
- Northwest and western communities: Lake Elmo, Maplewood, Newport, Oakdale, and Woodbury (Section E.1.4.3)
- Southwestern communities: Cottage Grove, Grey Cloud Island, and St. Paul Park (Section E.1.4.4)
- Denmark is not included, as they have lower PFAS drinking water contamination issues with HI values significantly less than 0.5. It is assumed that any future contaminated non-municipal wells found within Denmark would receive GAC POET systems.

Multiple conceptual project alternatives were considered for the given communities and groups of communities as indicated above. Relative costs were determined for each alternative and projects that were found to be the most cost effective were used in the final scenario assessment. The following sections identify the assumptions, considerations, and costs for each alternative and the final selected projects are summarized in Table E.70.

Table E.70. Integrated Scenario alternatives summary.

	Scenario alternatives		
Community	**Selected alternative**	**Alternative 1**	**Alternative 2**
Afton, West Lakeland, PIIC, & Lakeland/Lakeland Shores (Section E)	• PIIC to supply West Lakeland • West Lakeland would install new distribution system as proposed for the Community-Specific Scenario • Afton and remaining impacted wells to receive POET systems		
Afton, West Lakeland, and Lakeland/Lakeland Shores (Section E.)		• PIIC to update existing well and install new well to serve West Lakeland and potentially northern Afton • Remaining impacted wells to receive POET systems	• West Lakeland to implement new treatment and distribution system to serve PIIC and potentially northern Afton • Remaining impacted wells to receive POET systems

Cottage Grove (Section E.)	• Intermediate zone WTP to serve Wells 3, 4, 5, 6, 7, 8, 9, 11, and 12 • Low zone WTP to serve Wells 10 and a new Well 11 • Connect neighborhoods to the municipal water system • GAC POET systems • New water tower	• Interconnect with St. Paul Park	
Denmark (Section E.1.1.4)	• GAC POET systems		
Grey Cloud Island (Section E.1.1.5)	• GAC POET systems	• Interconnect with Cottage Grove to receive treated water	• Interconnect with St. Paul Park to receive treated water
Lake Elmo (Section E.1.1.6)	• Interconnect with Oakdale to receive treated water • Water Tower #3 • Connect neighborhoods to municipal water system • GAC POET systems	• Equip and treat water from existing Well 3 and drill new well with treatment in southern region	
Maplewood (Section E.1.1.8)	• Connect residences to SPRWS	• Extend Woodbury's system to serve Maplewood residents	
Newport (Section E.1.1.9)	• GAC POET systems as needed	• Interconnect with Woodbury to receive treated water	• Interconnect with Cottage Grove to receive treated water
Oakdale (Section E.1.1.10)	• Expand existing WTP at Public Works Facility • Route Wells 1, 2, 7 & 8 to WTP • Treat Wells 3 and 10 and send treated water to Lake Elmo • GAC POET systems	• Wells 3 and 10 to remain untreated and out-of-service	• Interconnect with SPRWS for new water supply
St. Paul Park (Section E.1.1.12)	• Treated water supplied by Cottage Grove through interconnect • Connecting nearby, impacted wells to existing municipal water system	• Same as existing temporary treatment system to provide centralized treatment to all 3 wells	
Woodbury (Section E.1.1.14)	• Construct two WTPs • Drill two new wells in southern well field	• Interconnect with Oakdale to receive treated water	

	• Connect neighborhoods to municipal water system • GAC POET systems		

E.1.4.1.1 Assumptions/considerations

The following are assumptions and considerations that were used for the integrated scenario.

- Each evaluation was performed under 2040 conditions with the understanding that any given project could be implemented prior to the year 2040.
- Expedited projects were considered during the drinking water distribution modeling, but their associated costs were not included in the final cost estimates.
- Infrastructure required for population growth that does not address PFAS contamination was included in the cost estimates. This could include storage facilities and distribution infrastructure such as water lines, booster pump stations, pressure reducing valves, etc. needed to serve unimpacted areas of development.
- Communities would need to adhere to local, tribal, state and/or federal standards and regulations as applicable in the event that a new water system was implemented, or an interconnect was installed that enabled one community to supply water to another.

Chapter 2 includes assumptions regarding the development and calibration of the drinking water distribution and groundwater models including information regarding each community and their water demands.

Section E.3.1.1 includes assumptions and considerations associated with estimating the non-municipal well counts, treatment methods, and treatment costs for the non-municipal wells. Installing GAC POET systems for non-municipal wells was included in this integrated scenario for any wells with HI values greater than or equal to 0.5 (HI ≥ 0.5).

E.1.4.2 Conceptual projects – Northeast communities (Afton, Lakeland, Lakeland Shores, Lake St. Croix Beach, Prairie Island Indian Community, and West Lakeland)

E.1.4.2.1 Project summary

The conceptual projects considered for the northeast communities under this scenario included creating interconnects between communities and creating a municipal water system for West Lakeland (as proposed in the Community Scenario). For any impacted, non-municipal wells that could not be connected to the proposed municipal water system, GAC POET systems would be installed. An overview of the projects is presented below. The selected projects and associated cost estimates are provided in Section E.4.1.2.2.

Improvements common to each option

Improvements that are common to each option include:

- Lakeland (including Lakeland Shores and Lake St. Croix Beach) – Municipal supply wells would continue to be utilized as they are not anticipated to become contaminated with PFAS by 2040. Under current operations, the City expects that all non-municipal wells (a combination of domestic and irrigation use) would be connected to the municipal water system by the year 2040. All wells would be sealed.

- West Lakeland – A municipal water system would be installed for the PFAS contaminated areas that would connect approximately 971 non-municipal wells. The remaining homes in West Lakeland would continue to be supplied by their existing non-municipal wells, mostly in the northern half of the community. The water distribution system was designed to provide water to the majority of wells projected to be contaminated by PFAS in the year 2040. Refer to the community-specific scenario (Section E.1) for a description of the necessary infrastructure.
- Prairie Island Indian Community and West Lakeland – For all interconnect options it was assumed that Prairie Island Indian Community and West Lakeland would be connected to the same water treatment and distribution system. The cost analysis of either community supplying the other is discussed below. 800 gpm of water supply would be necessary to serve both communities.

Interconnect options

Multiple options to interconnect communities were examined, including:

- Prairie Island Indian Community providing water to West Lakeland
- West Lakeland/Prairie Island Indian Community providing water to Afton
- Woodbury providing water to West Lakeland and Prairie Island Indian Community
- Lakeland providing water to West Lakeland and Prairie Island Indian Community

Interconnect between West Lakeland and Prairie Island Indian Community

There are advantages for these two communities to provide water to each other, as each has a relatively small water demand. By the year 2040, West Lakeland's demand will be 650 gpm for the portion of the Community that would be served by the new municipal water system and Prairie Island Indian Community's demand will be approximately 100 gpm based on the information provided regarding the planned land use. The combined maximum daily demands of the two communities is approximately 750 gpm which could be provided by a single 800 gpm. The capacity of the existing Prairie Island Indian Community well is 600 gpm and would have to be redrilled. The advantages of using the Prairie Island Indian Community well is that land acquisition for the new wells and water treatment plant is not required as the PIIC owns the entire parcel. Easements are required for the water main between the two communities. Similarly to PIIC, to become a municipal supplier of drinking water, West Lakeland would need to drill two new wells. Connecting these two communities would eliminate the costs associated with the additional land acquisition. In addition, the communities are relatively close to each other and 1,800 LF of 8" water main would be required to connect the two communities. Groundwater results indicate that all wells are likely to be contaminated for the next 20 years and thus WTPs were included in the incremental cost estimates of the two alternatives as shown in Table E.71. According to the cost difference of the two alternatives, it is more cost-effective for the Prairie Island Indian Community to deliver water to the proposed municipal water system for West Lakeland (Option 1) than vice versa (Option 2). Option 1 is carried forward into the final costs for the integrated scenario to save the $15,618,000 in costs of W. Lakeland installing the two wells and a PFAS treatment plant.

Table E.71. Incremental Cost Estimate to create an interconnect between West Lakeland and Prairie Island Indian Community.

Option	Description	20 year costs (capital + O&M)	Option	Description	20 year costs (capital + O&M)

1	**Prairie Island Indian Community supplying West Lakeland**		**2**	**West Lakeland supplying Prairie Island Indian Community**	
	New 800 gpm well to replace existing well	$3,018,000		800 gpm well	$3,018,000
	800 gpm well	$3,018,000		800 gpm well	$3,018,000
	800 gpm WTP (GAC)	$9,451,000		800 gpm WTP (GAC)	$9,451,000
	Transmission main (1,810 linear feet 8")	$1,280,000		Transmission main (1,810 linear feet 8")	$1,280,000
	Easements + land acquisition	$109,000		Easements + land acquisition	$239,000
	Sum	**$16,877,000**		**Sum**	**$17,008,000**

Prairie Island Indian Community providing water to West Lakeland and Afton

Small pockets of homes in the northern area of Afton, along the boundary with West Lakeland, are affected by PFAS contamination. One option that could provide Afton with clean drinking water could be to install an interconnect to the proposed West Lakeland municipal water system that under this alternative would be supplied by Prairie Island Indian Community. This interconnect would require over 9,900 linear feet of 8” water mains. Another option, would be to provide GAC POET systems on the individual PFAS impacted, non-municipal wells within the impacted area of Afton. There are 85 residences in Afton that are estimated to need POET systems for the long-term. As shown in Table E.72, the incremental cost differences of the interconnect (Option 1) that connects 35 private wells with another 50 on POETS, is more expensive than the cost of 85 POET systems over a 20-year period (Option 2). Thus, Option 2 was used for the scenario and PFAS impacted non-municipal wells in Afton would continue to receive POET systems. It should be noted that these are incremental costs and would be in addition to the cost of Prairie Island Indian Community supplying West Lakeland at $16,877,000.

Table E.72. Incremental cost estimate to create an interconnect between Prairie Island Indian Community/West Lakeland and Afton and provide Afton residents with POET systems.

Option	Description	20 year costs (capital + O&M)	Option	Description	20 year costs (capital + O&M)
1	**Prairie Island Indian Community supplying West Lakeland and Afton**		**2**	**GAC POET systems for Afton Residents**	
	Interconnect Afton with West Lakeland/Prairie Island Indian Community	$7,740,000		74 new POET systems	$250,000
	50 new POET systems with O&M	$1,000,000		85 total POET systems O&M	$1,700,000
	Sum	**$8,740,000**		**Sum**	**$1,950,000**

Woodbury or Lakeland providing water to West Lakeland and Prairie Island Indian Community

Two options were considered for providing water to the combined municipal water system of West Lakeland and Prairie Island Indian Community. The first option evaluated Woodbury and the second option evaluated Lakeland as being the water supplier. Although Woodbury is farther away, it has cost advantages over Lakeland due to centralized WTPs that take advantage of economies of scale and additional municipal supply wells that are already operational. Conversely, Lakeland would require an additional municipal supply well to provide the necessary 2040 MDD of 800 gpm to these two communities. Woodbury is the most cost-effective solution to provide water to West Lakeland and Prairie Island Indian Community. However, there are known issues of well interference and associated reduced pumping rates at Woodbury's Tamarack Well Field that need to be considered. For the long-term sustainability of the Tamarack Well Field, it is recommended that Woodbury not take on any additional unnecessary demand including providing West Lakeland and Prairie Island Indian Community.

Therefore, despite the additional cost, this integrated scenario will consider a new well municipal well within Lakeland and the associated infrastructure to supply water to West Lakeland and Prairie Island Indian Community. One cost consideration for Lakeland being a water supplier would be whether the new municipal supply well could be drilled into the Mt. Simon Aquifer. If the new supply well could be drilled into the Mt. Simon Aquifer, groundwater modeling results have indicated that the aquifer will not require PFAS treatment by the year 2040. Under this assumption the cost of Lakeland supplying West Lakeland and Prairie Island Indian Community would be less expensive than Prairie Island Indian Community supplying West Lakeland. However, it should be noted that there is the potential for treatment to be required depending on the concentration of other contaminants as well as iron and manganese. Or treatment may be required if it is decided that the well cannot be drilled into the Mt. Simon Aquifer and the well would need to be drilled into other aquifers that are currently contaminated and will remain contaminated. Due to the unknowns associated with potential contaminants in the new 800 gpm well in Lakeland, costs associated with PFAS treatment is provided in the cost estimate.

All comparable, incremental costs are summarized in Table E.73 below. It should be noted that the previous cost estimates in this section are separate from the estimates below.

Table E.73. Incremental cost estimate to connect West Lakeland and Prairie Island Indian Community to Woodbury (Option 3) or Lakeland (Option 4).

Option	Description	20 year costs (capital + O&M)	Option	Description	20 year costs (capital + O&M)
3	**Woodbury to West Lakeland and Prairie Island Indian Community**		4	**Lakeland to West Lakeland and Prairie Island Indian Community**	
	+800 gpm incremental WTP capacity at centralized WTP (GAC)	$5,230,000		800 gpm well	$3,018,000
	800 gpm booster pump station	$1,813,000		800 gpm WTP (GAC), if needed	$9,451,000
	Transmission main (9,032 linear feet 8")	$6,389,000		800 gpm booster pump station	$1,813,000
	Easements and land acquisition	$608,000		Transmission main (6,170 linear feet 8")	$4,365,000
				Easements + land acquisition	$436,000
	Sum	**$14,040,000**		**Sum**	**$ 19,083,000**

E.1.4.2.2 Treatment Options for Lakeland

Lakeland's existing municipal supply wells have very low detectable levels of PFAS as indicated by their low HI values and because these wells are drilled into the Mt. Simon aquifer. While the groundwater model does not project that the existing wells or the proposed third well in the Mt. Simon aquifer would require treatment for PFAS, for planning purposes the cost of treating all three wells with a 1,500 gpm centralized treatment facility was determined to address the potential of future contamination as shown below in Table E.74.

Table E.74. Cost estimate to provide centralized treatment for a Lakeland, West Lakeland and Prairie Island Indian Community interconnect (variation of Option 4).

Item	Quantity	Units	Description	Total cost (GAC)	Total cost (IX)
Capital Cost					
WTPs	1	Lump sum	1,500 gpm	$4,557,000	$3,251,000
Water distribution mains	0.92	Miles	8" and 12" raw water mains between wells	$2,039,000	
Land acquisition (sites + water mains)	2.7	Acres	1/2 acre for WTP, 20 feet wide easements	$358,000	
			Subtotal	$6,954,000	$5,648,000
			Contingency (20%)	$1,391,000	$1,130,000
			Professional services (15%)	$1,044,000	$848,000
			Total Capital	**$9,389,000**	**$7,626,000**
Annual O&M Cost					
WTPs	1	Lump sum	1500 gpm total capacity	$532,000	$194,000
Water distribution mains	0.92	Miles	Installed within right-of-way	$72,000	
			Subtotal	$604,000	$266,000
			20 years of annual O&M	$12,080,000	$5,320,000
			20 year costs (capital + O&M)	**$21,469,000**	**$12,946,000**
			Capital and operating cost per 1,000 gal[2]	**$1.36**	**$0.82**
			Operating only cost per 1,000 gallons[2]	**$0.77**	**$0.34**

E.1.4.2.3 Cost estimate breakdown

Based on the incremental cost analysis of the options presented in the previous sections, Table E.75 shows the estimated cost for the selected alternatives for Prairie Island Indian Community, West Lakeland, Lakeland, and Afton including all infrastructure, POET systems, and municipal WTPs necessary. Under this scenario, West Lakeland would install a new municipal water system and interconnect with Prairie Island Indian Community. Prairie Island would drill two new wells, add PFAS treatment, and supply water to W. Lakeland's proposed water system. All remaining PFAS impacted non-municipal wells not connected to a municipal water system would receive POET systems including those wells within

Afton. Costs include connecting 171 non-municipal wells (domestic and irrigation) in Lakeland to the existing municipal water system.

Table E.75. Integrated scenario costs for the northeast communities (Afton, Lakeland, Lakeland Shores, Lake St. Croix Beach, Prairie Island Indian Community, West Lakeland).

Community	Description	20 year costs (capital + O&M)
Lakeland, Lakeland Shores, Lake St. Croix Beach	Connect 171 non-municipal wells to municipal water system @ $2,500 per connection, seal 171 wells	$648,000
Prairie Island Indian Community	8" water main for interconnection with W. Lakeland	$1,281,000
	New 800 gpm well	$3,018,000
	New 800 gpm well	$3,018,000
	800 gpm WTP (GAC)	$9,451,000
	Easements + Land Acquisition	$109,000
West Lakeland	Water mains, tanks, pumps, pressure reducing valves	$242,179,000
Afton	GAC POET systems (74 new, 85 total)	$1,950,000
	Total	**$261,654,000**

Notes:

1. GAC POET system cost is estimated for non-municipal wells with HI > 0.50.

E.1.4.3 Conceptual projects – Northwest and western communities (Lake Elmo, Maplewood, Newport, Oakdale, and Woodbury)

E.1.4.3.1 Project summary

The conceptual projects considered for the northwest and western communities under this scenario included the installation of centralized WTPs, the installation of new municipal supply wells, extending water mains to nearby neighborhoods as proposed by the LGUs, and creating interconnects between communities (multiple options analyzed). Treatment was added for all wells (municipal and non-municipal) within the projected year 2040 PFAS impact area and all wells outside the impact area received treatment if the HI > 0.5. An overview of the projects is presented below. The selected projects and associated cost estimates are provided in Section E.4.1.3.3.

Improvements common to each option

Improvements that are common to each option include:

- Maplewood – Extend SPRWS to create a 1.4 mile loop that extends east along Carver Avenue East and north on Century Avenue South to connect 24 non-municipal wells. The option to connect these wells to Woodbury's municipal water system was also evaluated, however, a high-level cost comparison indicated that this was the least cost-effective solution. For the purposes of this integrated scenario, Maplewood residents would continue to be serviced by SPRWS as there are no advantages to switching water providers for these residents.
- Oakdale – Since Oakdale has excess capacity under 2040 MDD conditions, multiple options evaluated the City being a water supplier to neighboring communities. However, to serve its own residents, Alternative 2 from the community-specific scenario would be implemented in

this integrated scenario. Under this alternative, the existing treatment facility would be expanded to meet a treatment capacity of 5,300 gpm; Well 8 would be abandoned and re-drilled near the centralized WTP; and Wells 1, 2, 5, 7, and 9 would be piped to the centralized WTP. The expanded WTP would be sufficiently sized to meet 2040 water demands with one well out of service and the well piping would allow for operational flexibility. In addition, 28 non-municipal wells were estimated to require POET systems.

Interconnect options and community alternatives

Multiple options to interconnect communities were examined, including:

- SPRWS providing water to Oakdale
- Oakdale supplying Lake Elmo
- Lake Elmo drilling new wells with treatment
- Oakdale supplying Woodbury
- Newport interconnecting with Woodbury or Cottage Grove
- Interconnecting Woodbury and Cottage Grove

SPRWS providing water to Oakdale

Oakdale requires 7 mgd of water supply to meet a 2040 maximum daily demand. Per the Washington County Municipal Water Coalition Supply Feasibility Assessment (SEH, 2016), this is possible with the installation of a 13,000 linear foot 16" water transmission main, a booster pump station, and a blending station. Purchasing water from SPRWS was considered at their bulk water rate of $2.74/1000 gallons at 3.14 mgd (average daily demand). The cost estimate in Table E.75 accounts for the installation and O&M of the pipeline, booster pump station, and blending station. If SPRWS supplied water to Oakdale, Oakdale would have less annual operation and maintenance costs as the existing wells and treatment plant would not be utilized. Oakdale's operation and maintenance cost savings are not reflected in the table below.

As shown in Table E.76, it is $30 million less over 20 years for Oakdale to continue to utilize their own wells than purchasing water from SPRWS. For this integrated scenario, Oakdale would implement the Community-Specific Scenario Alternative 2 for a centralized WTP.

Table E.76. Cost estimate of connecting Oakdale to SPRWS Compared to Community Specific Alternative 2

Option	Description	20 year costs (capital + O&M)
SPRWS providing water to Oakdale	13,000 linear feet 16" water main	$15,500,000
	Booster pump station	$4,674,000
	Easements + land acquisition	$780,000
	Bulk water rate	$62,806,000
	Total costs	**$83,759,000**
Option	**Description**	**20 year costs (capital + O&M)**

Oakdale Community Scenario (Alternative 2)	**Total costs**	**$53,959,000**

Oakdale and Lake Elmo interconnect

Lake Elmo does not currently have enough municipal wells to meet their own 2040 MDD and as such the City would have to drill new municipal supply wells and install treatment to be able to supply excess water to any neighboring communities. However, Oakdale currently has excess capacity and has sufficient, existing well capacity to meet their 2040 maximum daily demands with one well out of service. As a result, Oakdale could treat their municipal Wells 3 and 10 and supply its neighboring communities with treated water.

Under this alternative, Oakdale could supply up to 2,000 gpm of treated water to Lake Elmo so that Lake Elmo does not have to build and treat additional municipal supply wells. To convey water from Oakdale to Lake Elmo, the communities would not be able to use the existing 6” interconnect because it would have to be upsized to 12” and about 9,300 linear feet of 12” water main would be necessary to convey water through the interconnect to Lake Elmo’s nearest trunk line.

However, Oakdale and Lake Elmo could interconnect their systems that are in close proximity near Stillwater Boulevard and Ideal Avenue. The cost for this 12” interconnection that would supply 2,000 gpm from Oakdale to Lake Elmo, is shown as Option 1 in Table E.77 below.

Lake Elmo new supply wells with treatment

The above alternative was compared to the option of Lake Elmo remaining autonomous and drilling two new 1,000 gpm municipal wells within the City to supply the additional demand required to meet 2040 MDD. As opposed to the community-specific, the two new municipal supply wells were relocated to the southern region due to concerns with the proximity to White Bear Lake and TCE contamination. Lake Elmo had previously drilled Well 3 located in the southwestern corner of the City, however, it was never equipped or put into service because of PFAS contamination. Under this alternative, Well 3 would be equipped and treated for PFAS and a new 1,000 gpm municipal supply well would be installed with treatment in the southeast corner of the City outside of the Special Well and Boring Construction Area. Both alternatives include water main extensions to the 16 neighborhoods to connect 392 homes and providing POET systems for 131 impacted, non-municipal wells.

Table E.77 shows the incremental cost difference of the two options described above, and it is more cost-effective for Oakdale to supply Lake Elmo 2,000 gpm. This interconnect was included in the integrated scenario for Oakdale to supply Lake Elmo with 2,000 gpm.

Table E.77 Cost estimate of interconnect between Oakdale and Lake Elmo (Option 1). Also shown is the cost for Lake Elmo to bring online two new municipal supply wells.

Option	Description	20 year costs (capital + O&M)	Option	Description	20 year costs (capital + O&M)
1	**Oakdale to supply 2,000 gpm to Lake Elmo**		2	**Lake Elmo to bring online 2 wells**	
	2000 gpm WTP (GAC)	$18,925,000		Equip Well 3 (1,000 gpm)	$2,837,000
	3,300 linear feet 12” Water Main (Well 3 to Well 10)	$2,418,000		Well 3 WTP (GAC)	$11,193,000

	12" interconnect	$260,000		New 1,000 gpm well	$3,137,000
	Easements + land acquisition	$264,000		Treat 1,000 gpm well (GAC)	$11,193,000
				Easements + land acquisition	$131,000
	Sum	**$21,867,000**		**Sum**	**$28,491,000**

<u>Oakdale and Woodbury interconnect</u>

Oakdale and Woodbury have an existing 2,000 gpm interconnect that could be utilized to convey water from Oakdale to Woodbury, which would help offset potential demand increases in the Tamarack Well Field. Cost savings for Woodbury would include 2,000 gpm of reduced treatment capacity at the Tamarack WTP and the two new municipal supply wells planned for the South Well Field that would be necessary for Woodbury to meet their 2040 maximum daily demands. Table E.78 shows the costs to implement this interconnect option and the cost savings that Woodbury would achieve from using this interconnect.

Table E.78. Cost estimate of interconnect between Oakdale and Woodbury (Option 3). Also shown are the cost savings for Woodbury to utilize this interconnect (Option 4).

Option	Description	20 year costs (capital + O&M)	Option	Description	20 year costs (capital + O&M)
3	**Oakdale to supply 2,000 gpm to Woodbury**		4	**Woodbury cost savings (-2,000 gpm)**	
	2,000 gpm WTP for Well 3 and Well 10 (GAC)	$18,925,000		-2,000 gpm WTP capacity at Tamarack WTP (GAC)	$11,725,000
	3,300 linear feet 12" water main (Well 3 to Well 10)	$2,418,000		New 1,000 gpm well	$3,137,000
	12" interconnect	$260,000		New 1,000 gpm well	$3,137,000
	Easements + land acquisition	$264,000		3,200 linear feet of 12" raw water main from new wells	$2,345,000
				Land acquisition	$323,000
	Sum	**$21,867,000**		**Sum**	**$ 20,667,000**

As shown in Table E.78, there is no cost advantage for Oakdale to supply 2,000 gpm to Woodbury. Thus, this interconnect was not included in the integrated scenario. Rather, the Community-Specific Scenario Alternative 2 for Woodbury would be implemented in this scenario that utilizes two centralized WTPs in the East and Tamarack Well Fields to treat wells that have HI values greater than or equal to 0.5. Under this alternative, Woodbury would drill two new municipal supply wells (1,000 gpm) located in the South Well Field near Well 19. Flow from these wells would be routed to the treatment facility located near the Tamarack Well Field. In addition, Well 1 would be abandoned as it has PFAS contamination and it would not be cost-effective to route flow from this well to the proposed Tamarack Well Field treatment facility. In addition, 20 non-municipal wells would require POET systems, for a total of 21 POETS required for the long-term.

<u>Woodbury to Newport interconnect</u>

Newport's two municipal supply wells currently very low detectable levels of PFAS contamination as indicated by their low HI values and groundwater modeling expects this trend to continue. However, three options were considered if this situation were to change in the future and Newport's wells required treatment. The first two options considered interconnecting Newport to either Woodbury or Cottage Grove. Based on incremental costs, more linear footage of pipe and a booster pump station would be required to connect Newport to Cottage Grove rather than Woodbury and the option was not further evaluated. The third option compared the incremental cost of connecting Newport to Woodbury as opposed to implementing a 420 gpm centralized treatment for Newport's existing municipal supply wells. Table E.79 outlines the costs associated with each option.

Table E.79. Cost estimate of interconnect between Woodbury and Newport (Option 1). Also shown are the treatment costs for Newport (Option 2).

Option	Description	20 year costs (capital + O&M)	Option	Description	20 year costs (capital + O&M)
1	**Woodbury to supply 420 gpm to Newport**		2	**Newport treatment costs**	
	+420 gpm at centralized WTP (GAC)	$3,671,000		420 gpm WTP (GAC)	$5,946,000
	6,165 linear feet 8" water main	$4,360,000		Interconnect wells (3,250 linear feet 8")	$2,298,000
	Easements + land acquisition	$370,000		Land acquisition + easements	$260,000
	8" interconnect	$260,000			
	Sum	**$8,661,000**		**Sum**	**$ 8,505,000**

Over a 20-year period, installation and O&M costs for an interconnect are nearly identical to Newport's treatment costs. However, as Newport currently does not need treatment, this interconnect was not considered further in this integrated scenario. However, it does remain a viable future option for Newport if PFAS contamination levels increase.

<u>Woodbury and Cottage Grove interconnect</u>

Under this alternative, an interconnect between Woodbury and Cottage Grove would be limited to an emergency interconnect only. Groundwater modeling from the sub-regional groundwater scenario (Regional Scenario 2E) indicates that neither City would have the available water supply to fully meet the other city's water demands. Thus, this interconnect was not considered further in this integrated scenario.

E.1.4.3.2 Cost estimate breakdown

Table E.80 shows the estimated cost for the infrastructure, POETS, and WTPs necessary to install the proposed improvements for these five communities. The costs are for GAC WTPs, which is the more expensive of the two treatment technologies (GAC and IX) considered in this analysis.

Table E.80. Integrated scenario costs for the northwest and western communities (Lake Elmo, Maplewood, Newport, Oakdale, Woodbury).

Community	Description	20 Year costs (capital + O&M)
Woodbury	8,600 gpm WTP in Tamarack, 4,000 gpm WTP in East, 2 new wells in South (treatment at Tamarack), plus raw water mains, 21 POETS (HI>0.5)	$144,586,000
Oakdale	Expand WTP to 5,300 gpm, drill new Well 8, plus raw water mains, 28 POETS	$46,908,000
Oakdale – Lake Elmo interconnect	Using Wells 3 and 10, Oakdale to supply 2,000 gpm to Lake Elmo with new 12" interconnect, centralized treatment near Well 10, 3,300 linear feet of 12" raw water mains between wells	$21,867,000
Lake Elmo	12" pressure reducing valve, water main extensions to neighborhoods, 131 POETS	$98,773,000
Maplewood	Extend SPRWS to neighborhood	$7,107,000
Newport	15 POETS	$352,000
	Total	**$319,593,000**

Notes:

1. GAC POET system cost is estimated for non-municipal wells with HI > 0.50.
2. Capital and O&M costs are shown for GAC WTPs.

E.1.4.4 Conceptual projects - Southwestern communities (Cottage Grove, Grey Cloud Island, and St. Paul Park)

E.1.4.4.1 Project summary

The conceptual projects considered for the southwestern communities under this scenario included the installation of centralized WTPs, extending water mains to nearby neighborhoods, and creating interconnects between communities (multiple options analyzed). The remaining impacted non-municipal wells would receive GAC POET systems. The selected projects and associated cost estimates are provided in Section E.4.1.4.3.

Improvements common to each option

Improvements that are common to each option include:

- Cottage Grove – In addition to the alternatives evaluated under this scenario, Cottage Grove would implement the most cost-effective alternative under the Community-Specific Scenario which was Alternative 3. Alternative 3 provided two WTPs that were sized at 10,800 gpm for the Central Well Field and 3,200 gpm for the wells on the south side of the City. To balance water pumping within the City and limit potential well interference in the Central Well Field from excessive pumping, it was assumed that the City would maximize flow from wells in the high- and low-pressure zones. Wells 11 and 12 would be piped to the intermediate pressure zone WTP, and a new well near Well 10 would be drilled and piped to the low pressure zone WTP. However, the WTPs do not need the capacity that was assumed in the community-specific scenario and could be reduced to 6,600 gpm for the Central Well Field along with the 3,200 gpm WTP in the southern area.

Interconnect options

Multiple options to interconnect communities were examined, including:

- Cottage Grove providing water to Grey Cloud Island
- St. Paul Park providing water to Grey Cloud Island
- Cottage Grove providing water to St. Paul Park
- Cottage Grove providing water to East Cottage Grove

<u>Cottage Grove providing water to Grey Cloud Island</u>

Cottage Grove has the well capacity to provide water to the current residents and businesses of Grey Cloud Island as well as residences on PFAS impacted non-municipal wells in Cottage Grove along Grey Cloud Island Trail South. This area is currently contaminated with PFAS and is expected to be contaminated for the next 20 years and beyond. Grey Cloud Island has 79 non-municipal wells that would require POET systems and there are 33 non-municipal wells in Cottage Grove along Grey Cloud Island Trail South that would also be connected. Over 52,600 linear feet of 8" water mains would be necessary to provide a looped connection with Cottage Grove's municipal water system.

A cost comparison was performed to determine if it was more cost effective to connect the southwestern Cottage Grove residents and Grey Cloud Island or provide GAC POET systems. As shown in Table E.81, over a 20-year period, it will cost $47 million more to connect the proposed non-municipal wells to Cottage Grove's municipal water system rather than install POET systems. Under this scenario, these areas would remain on POET systems.

Table E.81. Cost estimate to create an interconnect between Cottage Grove and Grey Cloud Island (Option 1). The cost to provide GAC POET systems on the individual residences is also provided (Option 2).

Option	Description	20 year costs (capital + O&M)
1- Install water mains to Grey Cloud Island and Grey Cloud Island Trail South Neighborhoods	52,600 linear feet 8" Water Main	$49,162,000
2- Remain on POETS	GCI - Install 27 POETS, O&M for 79 POETS CG – Install 12 POETS, O&M for 33 POETS	$2,373,000

<u>St. Paul Park providing water to Grey Cloud Island</u>

Similar to Cottage Grove, St. Paul Park is also relatively close to Grey Cloud Island and could extend their existing infrastructure to provide a looped water system to Grey Cloud provide Island. However, St. Paul Park has does not have the excess water supply that Cottage Grove has nor does the City have much of a buffer between their firm well capacity of 1,200 gpm and the projected 2040 maximum daily demands of 1,181 gpm. Do to the lack of excess water supply; the costs associated with drilling, equipping, and treating a new well; and the infrastructure cost of extending lines to Grey Cloud Island, this option was not considered further in this scenario.

<u>Cottage Grove providing water to St. Paul Park</u>

St. Paul Park requires 1,200 gpm of water to meet their 2040 maximum daily demands. Under this alternative, Cottage Grove would be expected to provide enough treated water to meet St. Paul Park's demand of 1,200 gpm. However, if Cottage Grove were to treat all their municipal supply wells, they would only have 700 gpm of excess supply available to provide to neighboring communities. As such they would need to drill an additional well to be routed to a centralized treatment facility prior to distributing to neighboring communities.

Due to the small water main sizes in the area, three 6" interconnects would have to be installed to move 1,200 gpm from Cottage Grove to St. Paul Park. The cost comparison is shown in Table E.82.

As shown in the cost comparison, it is $2.5 million less for Cottage Grove to supply St. Paul Park than for St. Paul Park to install their own treatment. This interconnect is included in the final integrated scenario.

Table E.82. Cost estimate of Cottage Grove to provide water to St. Paul Park (Option 1). Also shown are the treatment costs for St. Paul Park (Option 2).

Option	Description	20 year costs (capital + O&M)	Option	Description	20 year costs (capital + O&M)
1	**Cottage Grove to supply 1200 gpm to St. Paul Park**		**2**	**St. Paul Park treatment costs**	
	+1,200 gpm at centralized WTP (GAC)	$7,209 ,000		1,500 gpm WTP (GAC)	$10,644,000
	1,200 gpm well	$3,378,000		3,000 feet of 8" water mains	$2,121,600
	860 linear feet 6" water mains	$611,000		Land acquisition + easements	$245,000
	3-6" interconnects	$375,000			
	Easements + land acquisition	$52,000			
	Sum	**$11,625,000**		***Sum***	**$ 13,010,000**

Note: Costs used in the above table do not include a contingency or professional services, which are included in the cost summary tables below.

<u>Cottage Grove providing water to East Cottage Grove</u>

Under the Community-Specific Scenario, it was assumed for all alternatives, new water lines would be extended to provide water to East Cottage Grove where a number of municipal wells have experienced PFAS contamination. For Cottage Grove to service East Cottage Grove and 163 non-municipal wells, where 33 are expected to require PFAS treatment by year 2040, a distribution loop would have to be added. The loop would include approximately 20,920 linear feet of 12" distribution lines along 70th Street, Lamar Avenue, Kimbro Avenue, and 80th Street. An additional 14,323 linear feet of 8" distribution line would be required to service the residents off Lamar Avenue. The cost comparison is shown in Table E.83.

Over a 20-year period, it is over $32 million more for installation and operation and maintenance costs than to install POETS for all 33 non-municipal wells expected to need PFAS treatment by year 2040. East Cottage Grove versus connecting to Cottage Grove's municipal water system. In the integrated scenario, this area would remain on POET systems.

Table E.83. Cost estimate to connect East Cottage Grove to Cottage Grove's municipal water system (Option 1). The cost to provide GAC POET systems on the individual residences is also provided (Option 2).

Option	Description	20 year costs (capital + O&M)
1- Install water mains to East Cottage Grove	20,920 linear feet 12" water main, 14,300 linear feet 8" water main	$33,572,000
2- Remain on POETS	Install 19 POETS, O&M for 33 POETS[1]	$708,000

E.1.4.4.2 Cost estimate breakdown

Table E.84 shows the estimated cost for the infrastructure, POET systems, and WTPs necessary to install the proposed improvements for these three communities. The costs are for GAC WTPs, which is the more expensive of the two treatment technologies (GAC and IX) considered in this analysis. A 20% contingency and 15% for professional services is included in the costs below.

Table E.84. Integrated scenario costs for the southwestern communities (Cottage Grove, Grey Cloud Island, St. Paul Park)

Community	Description	20 year costs (capital + O&M)
Cottage Grove	6,600 gpm WTP in Central Well Field and interconnect Wells 3-9, 11 and 12, 3,200 gpm WTP in the south part of City, tie in Wells 1,2 and new 1,200 gpm well to 3,200 gpm WTP, 82 POETS install, 140 POETS total	$154,267,000
Grey Cloud Island	Install 64 POETS and O&M for 116 POETS	$2,536,000
St. Paul Park	Install 34 POETS, 34 POETS total	$795,000
Cottage Grove to supply St. Paul Park	+1,200 gpm at central well field, new 1,200 gpm well, water mains, 3 interconnects	$13,069,000
	Total	**$178,342,000**

Notes:

1. GAC POET system cost is estimated for non-municipal wells expected to need treatment in 2040.
2. Capital and O&M costs are shown for GAC WTPs.

E.1.4.5 Integrated scenario summary

Overall, the integrated scenario analysis was able to reduce the overall costs of the community-specific scenario ($786 million) by $34 million over a 20-year period to $752 million for the integrated scenario over a 20-year period. Costs for both granular activated carbon (GAC) and ion exchange (IX) is shown below for the 20 years costs (capital and operations and maintenance), capital only, and annual operation and maintenance costs for each community. A summary of all costs for the integrated scenario are provided in Table E.85.

Table E.85. Cost estimate summary for the Integrated Scenario 1.

Community	Description	20 year costs (capital + O&M) for GAC	20 year costs (capital + O&M) for IX
Lakeland, Lakeland Shores, Lake St. Croix Beach	Connect 171 non-municipal wells to water system @ $2,500 per connection	$648,000 (capital only, no annual O&M)	
Prairie Island Indian Community	Water main for interconnection to West Lakeland, 2-800 gpm wells, 800 gpm WTP	$16,877,000 ($7,535,000 capital, $467,000 annual O&M)	$12,379,000 ($6,639,000 capital, $287,000 annual O&M)
West Lakeland	Water mains, tanks, pumps, pressure reducing valves	$242,179,000 ($165,739,000 capital, $3,822,000 annual O&M)	
Afton	GAC POET systems (74 new, 85 total)	$1,950,000 ($250,000 capital, $85,000 annual O&M)	
Woodbury	8,600 gpm WTP in Tamarack, 4,000 gpm WTP in East, 2 new wells in South, plus raw water mains, 21 POET systems	$144,586,000 ($72,326,000 capital, $3,613,000 annual O&M)	$101,342,000 ($64,122,000 capital, $1,861,000 annual O&M)
Oakdale	Expand WTP to 5,300 gpm, drill new Well 8, plus raw water mains, 28 POET systems	$46,908,000 ($22,288,000 capital, $1,231,000 annual O&M)	$31,790,000 ($19,670,000 capital, $606,000 annual O&M)
Oakdale – Lake Elmo Interconnect	Using Wells 3 and 10, Oakdale to supply Lake Elmo 2,000 gpm with new 12" interconnect, treatment included	$21,867,000 ($7,494,000 capital, $726,000 annual O&M)	$11,622,000 ($5,942,000 capital, $284,000 annual O&M)
Lake Elmo	12" pressure reducing valve, water main extensions to neighborhoods, 131 POET systems	$98,773,000 ($66,573,000 capital, $1,610,000 annual O&M)	
Maplewood	Extend SPRWS to neighborhood	$7,107,000 ($4,887,000 capital, $111,000 annual O&M)	
Newport	15 POET systems	$352,000 ($52,000 capital, $15,000 annual O&M)	
Cottage Grove	6,600 gpm WTP in Central Well Field and interconnect Wells 3-9, 11 and 12, 3,200 gpm	$154,267,000 ($70,907,000 capital, $4,168,000 annual O&M)	$106,280,000 ($63,840,000 capital, $2,122,000 annual O&M)

Community	Description	20 year costs (capital + O&M) for GAC	20 year costs (capital + O&M) for IX
	WTP in the south part of City, tie in Wells 1,2 and new 1,200 gpm well to 3,200 gpm WTP, 82 POET systems install, 140 POET systems total		
Grey Cloud Island	Install 64 POET systems and O&M for 116 POET systems	$2,536,000 ($216,000 capital, $116,000 annual O&M)	
St. Paul Park	Install 34 POET systems, 34 POET systems total	$795,000 ($115,000 capital, $34,000 annual O&M)	
Cottage Grove to supply St. Paul Park	+1,200 gpm at central WTP, new 1,200 gpm well, water mains, 3-6” interconnects	$13,069,000 ($5,569,000 capital, $375,000 annual O&M)	$7,917,000 ($5,117,000 capital, $140,000 annual O&M)
	Capital costs	$424,599,000	$403,810,000
	Annual O&M costs	$16,373,000	$11,093,000
	20 year O&M costs	$327,460,000	$221,860,000
	Total	**$752,059,000**	**$625,670,000**

E.2 Revised Community Scenario Evaluation Results

This section provides the detailed modeling and costing results for the revised Community Scenario. After feedback was received regarding the scenario results presented in the previous section, modifications were made that resulted in four (4) new community scenarios. Section E.2.2 presents the Community-Specific Scenario A, Section E.2.3 presents the Community-Specific Scenarios B and C, and Section E.2.4 presents the Community-Specific Scenario D. Each scenario will be further explained in the following sections.

E.2.1 Revised Community-specific scenario introduction

Similar to the community scenario in the previous section, this scenario would provide clean drinking water on a community by community basis across the East Metropolitan Area. The original community scenario alternatives consisted of conceptual projects submitted by the local government units (LGUs) through the conceptual project submittal process and/or communicated in discussions with Wood. With a few exceptions, these conceptual projects were consistent with the community's existing long-term water supply plans and current efforts regarding the Conceptual Drinking Water Supply Plan (CDWSP). The alternatives represented the different options explored within each community. After the initial evaluation described in Section E.1.1, feedback and additional information submitted by the LGUs required modifications to some of the community alternatives while the selected alternatives for the remaining communities remained the same. A summary of the previously selected and additional alternatives analyzed for this Community Scenario A is included in Table E.86. Each alternative was assessed based on economic and operational feasibility, and cost estimates were developed to compare each alternative.

For the year 2040, alternatives were developed under two conditions used to identify impacted wells that would receive treatment – those with a health index (HI) value greater than zero (> 0) and those with an HI value greater than or equal to one (≥ 1). As defined in Chapter 3, the HI value takes into account the five PFAS constituents – PFBS, PFBA, PFHxS, PFOS, and PFOA. For the purposes of this scenario, "HI > 0" implies a health index where PFBS, PFBA, PFHxS, PFOS, and/or PFOA have been detected above their respective laboratory detection limits. Treatment for municipal and non-municipal wells is applied as determined by these conditions.

Under the Community-specific scenario, each community would remain autonomous with the exception of Newport which, under the HI>0 condition, includes the evaluation of interconnects with Woodbury and Cottage Grove. Residents and businesses would be served by their local municipal water system where feasible and those on non-municipal wells that could not be connected to a municipal water system would continue to be served by their groundwater wells with treatment as necessary. This scenario would eliminate the establishment of new regional water systems and work within the existing political boundaries and structure of the East Metropolitan Area.

Base cost estimates for each of the scenarios were also developed to include capital costs and operations and maintenance (O&M) costs for each alternative. During this second round of scenario analysis, additional cost estimates were developed for the revised Community Scenario A and C as described in the following sections. Under this evaluation, initial cost estimates were developed that included all costs relative to the improvement projects and were considered "All Inclusive Costs". These base costs included every aspect associated with each alternative including new water lines, treatment facilities, POETS, water storage tanks, etc. as seen in the previous evaluation. However, for various reasons, some costs may not be covered by settlement funds. For the most part, if the costs did not directly address PFAS contamination those costs would not be covered. The following guidelines were used to determine which aspects of the projects would be eligible for Settlement funding. It is important to note that while the guidelines below were used for general Settlement funding determination, case-by-case considerations were also taken into account.

- Additional treatment beyond treatment threshold selected
- Line upsizing due to growth beyond 2040
- Installation of wells needed due to growth alone (as opposed to replacing a well that fell out of service due to PFAS contamination)
- Treatment required for chemicals other than PFAS (with the exception of pretreatment required for PFAS treatment technologies)
- Storage tanks needed for growth only
- Infrastructure recapitalization costs
- Certain neighborhood/home connections and water main extensions to those neighborhoods
- O&M outside treatment plants and POETS (e.g. O&M for water storage tanks, distribution or raw water lines, booster pump stations, etc.)

Costs that were considered to not be covered were removed from the all-inclusive costs to develop what was termed as “PFAS Eligible Costs”. These PFAS eligible costs also excluded any neighborhoods or individual homes that had originally been evaluated and proposed to be connected to the distribution system but were determined to either not be connected or require additional sampling/evaluation before connecting them.

A third set of cost estimates termed “particle tracking costs” was developed that further reduced the PFAS eligible costs by removing costs identified by particle tracking in the groundwater model. The particle tracking costs include those costs associated with treating or connecting wells that are located within the projected areas of future PFAS contamination. As discussed in previous sections and chapters of the CDWSP, particle tracking was used to develop potential areas of PFAS contamination over the next 20 years. Since a true fate and transport analysis has not been performed at this time, it is unknown what the concentration of PFAS contamination could be and in which aquifers it may be present during that time period. As such, to be conservative, it was assumed that all wells designated for potable use including those well types considered under this conceptual plan that fell within these projected areas would be treated for PFAS contamination as if their HI value was equal to or greater than 1. However, this added considerable costs in some areas and to evaluate the cost implications of the particle tracking these costs were removed. In addition, the same neighborhood costs that were removed under the PFAS Eligible Costs were also removed for the Particle Tracking Costs. Lastly, to help show the cost savings of providing a partial distribution system for West Lakeland as opposed to a distribution that served the entire community, Alternative 4 (which proposed implementing a partial distribution system) was used for the total cost estimate. It should be noted that these additional cost estimates were only performed for the revised Community Scenarios A and C. The specific cost implications as they related to each community are further discussed in the following sections.

E.2.1.1 Revised Community Scenario Overview

As mentioned, the community scenario alternatives presented in Section E.1 were the basis of the community scenarios presented in this section with modifications being made for those communities that provided additional information with regards to 2040 demands or other related infrastructure modifications. The following list summarizes the revised community scenarios covered under this section:

- Scenario A – independent community alternatives as outlined below in Table E.86
- Scenario B – same as Scenario A except Oakdale is supplied by SPRWS
- Scenario C – same as Scenario A except Oakdale and Lake Elmo are supplied by SPRWS
- Scenario D – same as Scenario A except West Lakeland Township is supplied by PIIC

Table E.86. Overview of Community-specific Scenario A alternatives[1].

	Scenario alternatives		
Community	**1**	**2**	**3-6**
Afton (Section E.2.2.1)	• Granular activated carbon (GAC) point of entry treatment (POET) systems for HI>0 and HI≥1		
Cottage Grove (Section E.2.2.2)	• HI>0 – 9800 gpm WTP and 3200 gpm WTP for 11 wells, a new well, 89 connections by extending water mains, GAC POETS • HI≥1 – 9300 gpm WTP and 3200 gpm WTP for 10 wells, one new well, 89 connections by extending water mains, GAC POETS		
Denmark (Section E.2.2.3)	• GAC POET systems for HI>0 and HI≥1		
Grey Cloud Island (Section E.2.2.4)	• GAC POET systems for HI>0 and HI≥1		
Lake Elmo (Section E.2.2.5)	• HI>0 – Two new wells in northeast Lake Elmo, 4,500 gpm WTP, 609 connections by extending water mains, 609 service laterals, GAC POETS • HI≥1 – Two new wells in northeast Lake Elmo, 1,250 gpm WTP for Well 5, 609 connections by extending water mains, 609 service laterals, GAC POETS	• HI>0 – Two new wells in north Lake Elmo, 3,500 gpm WTP and 2,000 gpm WTP, 609 connections by extending water mains, 609 service laterals, GAC POETS • HI≥1 – Two new wells in north Lake Elmo, 1,250 gpm WTP for Well 5, 609 connections by extending water mains, 609 service laterals, GAC POETS	• HI>0 – Two new wells in southeast Lake Elmo, 3,500 gpm WTP and 2,000 gpm WTP, 609 connections by extending water mains, 609 service laterals, GAC POETS • HI≥1 – Two new wells in southeast Lake Elmo, 2,000 gpm WTP for new wells, 1,250 gpm WTP for Well 5, 609 connections by extending water mains, 609 service laterals, GAC POETS

Lakeland/Lakeland Shores (Section E.2.2.6)	• HI>0 – WTPs for both wells, 453 service laterals, GAC POETS • HI≥1 – 453 service laterals and GAC POETS		
Maplewood (Section E.2.2.7)	• Extend SPRWS water mains for 35 homes, 35 service laterals, GAC POETS for both HI>0 and HI≥1		
Newport (Section E.2.2.8)	• HI>0 – WTP for existing wells, 9 service laterals, GAC POETS • HI>1 – 9 service laterals, GAC POETS	• HI>0 – Interconnect with Woodbury, 9 service laterals, GAC POETS	• HI>0 – Interconnect with Cottage Grove, 9 service laterals, GAC POETS
Oakdale (Section E.2.2.9)	• HI>0 – expand existing WTP to 4275 gpm, new 1000 gpm WTP at Well 7, new 1850 gpm WTP for Wells 3 and 10, 58 service laterals, GAC POETS • HI≥1 – expand existing WTP to 4275 gpm, new 1000 gpm WTP at Well 7. 58 service laterals, GAC POETS	• HI>0 – expand existing WTP to 4925 gpm, new 1850 gpm WTP for Wells 3 and 10, redrill Well 7 closer to WTP, 58 service laterals, GAC POETS • HI≥1 – expand existing WTP to 4925 gpm, redrill Well 7 closer to WTP, 58 service laterals, GAC POETS	• HI>0 – expand existing WTP to 4150 gpm, new 1850 gpm WTP for Wells 3 and 10, two new wells to replace Wells 1,2,7, 58 service laterals, GAC POETS • HI≥1 – expand existing WTP to 4150 gpm two new wells to replace Wells 1,2,7, 58 service laterals, GAC POETS • Alt 4, HI>0 – expand existing WTP to 4900 gpm, 4 new wells to replace Wells 1,2,3,7,10, 58 service laterals, GAC POETS
Prairie Island Indian Community (Section E.2.2.10)	• Construct WTP to treat the existing well		
St. Paul Park (Section E.2.2.11)	• HI>0 and HI≥1 – Make temporary WTP permanent to provide centralized treatment for all 3 wells, 28 service laterals, GAC POETS		
West Lakeland (Section E.2.2.12)	• Alternatives 1-4 are variations of a new water system to service 1190 connections	• Alternatives 5-6 are variations of a new larger water system to service 1340 connections	• Alternative 7 is a POET only solution

Woodbury (Section E.2.2.13)	• HI>0 – 19,600 WTP in south well field, 5 new wells, 516 connections by extending water mains, GAC POETS	• HI>0 – 15,600 gpm WTP in south well field, 4,000 gpm in east well field, 5 new wells, 516 connections by extending water mains, GAC POETS	• HI>1 – 9600 gpm WTP in south well field, 5 wells, 18 service laterals

Notes:

1. These alternatives include those neighborhoods and homes that were decided to either not be connected or required additional sampling/evaluation.

Under the revised community scenario, Scenarios B, C, and D were also developed to look at various alternatives using the alternatives outlined for Scenario A above as the basis. Scenario B and C both examined the possibility of St. Paul Regional Water Services (SPRWS) serving Oakdale (Scenario B) or Oakdale and Lake Elmo (Scenario C). Under these two scenarios, the alternatives for the remaining communities remained the same as outlined above. Similarly, Scenario D used all the same alternatives as outlined above for Scenario A but considered Prairie Island Indian Community (PIIC) serving West Lakeland Township.

Conceptual projects included in each scenario are provided for each community in Sections E.2.2.1-E.2.2.13. A summary of the scenario is provided in Section E.2.2.14. Additional assumptions and considerations are provided in Section E.2.1.1.

E.2.1.2 Assumptions/considerations

The following are assumptions and considerations that were used for the community-specific scenario:

- Each community evaluation was simulated with 2040 projected demands with the understanding that any given project could be implemented prior to the year 2040.
- Expedited projects were simulated with the drinking water distribution modeling, but the costs of the expedited projects (i.e., installation of the proposed distribution lines and other associated project costs) were not included in the scenario cost estimates.
- Infrastructure required for population growth that does not address PFAS contamination was included in the cost estimates. This could include storage facilities, wells, and distribution infrastructure such as water lines, booster pump stations, pressure reducing valves, etc. needed to serve unimpacted areas of development and/or future population demand. As previously mentioned, subsequent cost estimates evaluated the cost implications of having these removed.

Installing GAC POET systems for non-municipal wells was included in this community-specific scenario for any wells with a Minnesota Department of Health (MDH) Health Index (HI) value greater than zero (HI>0) or greater than or equal to one (HI ≥ 1) for those wells that have been sampled as of October 2019. This was applied to all communities to evaluate the required costs under the two opposing conditions. Under 2040 conditions, the groundwater model flow path analysis was used to simulate the movement of PFAS from areas of known contamination to projected areas that would be impacted by PFAS contamination in future years. Particles were inserted into the model and allowed to follow predicted groundwater flow patterns for 20 years into the future beginning in 2020. The areal extent of future impacts predicted by these flow paths was used to estimate the number of additional non-municipal wells that would require treatment (i.e., POET systems) under both HI conditions. To be conservative, it was assumed that all wells within the predicted PFAS-impacted areas would receive either treatment or be connected to a municipal water system. Those wells outside of the areas of impact would receive GAC POET systems based on the HI constraints mentioned above, excluding those wells that would be sealed and replaced with a connection to the municipal water system.

Existing sample data was used to determine the number of wells that would require treatment under the condition of HI≥1 for wells outside of the predicted PFAS-impacted areas. However, to determine which wells would require treatment for the condition of HI>0 was slightly different as not all wells have been sampled, and it is known that most wells have some, if not very low, detectible levels of PFAS. First, the percentage of sampled wells outside the predicted PFAS-impacted areas, with an HI>0 or detectible levels of PFAS, that were not being connected to the municipal distribution system or already have a GAC POET system was calculated based on existing sampling data. This percentage was then multiplied by the total number of wells outside the predicted PFAS-impacted areas as provided by the Minnesota Well Index (MWI), or manual counts if MWI was not representative of actual well counts, to get a representative number of wells that had detectible levels of PFAS as opposed to those wells that may have non-detectible levels of PFAS. A summary table of the existing and proposed GAC POETS can be found in Section E.2.2.14.

Groundwater Modeling Details

Model simulations of forward particle tracking for the next 20 years to 2040 was conducted under wet, normal, and drought climate conditions from known PFAS sources and areas of potential secondary transport. The results of the particle tracking under each condition for Scenarios A, B, and C are shown in Figures E.2.1.2.1-3 for Scenario A, Figures E.2.1.2.4-6 for Scenario B, and Figures E.2.1.2.7-9 for Scenario C. Particle tracking enabled the groundwater team to develop anticipated areas of PFAS impact by the year 2040. Figure E.2.1.2.10 shows the comparison of the areas developed under each scenario. Additionally, water supply wells were evaluated for drawdown under a drier setting that approaches drought conditions (worst case and herein referred to as drought) to determine whether drawdown exceeds the regulatory guidance threshold provided by the DNR and used as an indication of the aquifer sustainability under the projected demands. This drawdown analysis was performed for Scenarios A, B, and C under both drought and wet conditions for the Jordan aquifer. The results are shown in Figures Figure E.2.1.2.11 and 12 for Scenario A, Figure E.2.1.2.13 and 14 for Scenario B, and Figure E.2.1.2.15 and 16 for Scenario C.

The currently calibrated model is based on a wet climate condition that is observed for the state of Minnesota and is represented by higher precipitation rates and warmer temperatures[2]. The currently modeled wet climate condition observed for the state of Minnesota is predicted to continue over the next century with intervening dry periods. Given the current time period is reported by MDH[3] as wet and predicted to remain so though 2040, simulated model recharge for what is being referred to as "normal" in these scenarios was reduced to 87% of the current condition recharge rate based on modeling by the DNR using the Soil Water Balance model over a time period of 1989 to 2018. However, pumping rates for the normal condition did not change from those used under wet conditions. Model recharge for drier time periods approaching drought conditions was reduced to 66% of the current condition recharge rate based on modeling by the DNR using the Soil Water Balance model over a drier

[2] MDH, 2015. Minnesota Climate & Health Profile Report. Minnesota Department of Health. St. Paul, MN. February 2015. https://www.health.state.mn.us/communities/environment/climate/docs/mnprofile2015.pdf Accessed June 2, 2020.
[3] MDH, 2015. Minnesota Climate & Health Profile Report. Minnesota Department of Health.

time period of 2006 to 2009 that approaches drought like conditions. Additionally, average daily demand rates for the water supply wells were increased for the drought condition by multiplying the current condition rates by a factor based on the ratio of maximum per capita demand for the water supply wells over average per capita demand from years 2005-2015. Pumping rates at irrigation wells were also increased for the drought condition simulations by taking the maximum annual volume reported over a 20-year period (1988- 2018).

To ensure the aquifer does not become unconfined, the DNR has provided written guidance on assessing the risk for exceeding groundwater head thresholds. A 50% available head threshold was designated as a warning check that drawdown needs to be assessed further. If the simulated drawdown exceeds the 50% threshold, a transient simulation applying the MDD production rate to the well of interest over a short duration of pumping would then be necessary to evaluate whether simulated drawdown does not exceed 75% of the available head. The 75% available head threshold allows for a buffer to ensure the aquifer does not become unconfined. The available head is the difference between the “static” groundwater elevation (in this case the average 2016-2018 simulated head from the calibrated steady-state groundwater flow model) and the top elevation of the aquifer. The threshold is applied to the aquifer in which the assessed well produces from and overlying aquifers (e.g. a well producing from the Jordan Sandstone aquifer requires a threshold assessment for the Jordan Sandstone and the overlying Prairie du Chien if present).

Using the guidance provided by the DNR, simulated head at the existing and proposed water supply well locations were evaluated under the drought conditions (worst case) to determine whether drawdown exceeds the 50% threshold and whether a scenario was deemed acceptable from a water availability (quantity) perspective. The available head reported in the community specific sections is the difference between the average 2016-2018 simulated head and the elevation of the top of the aquifer. The percent of available head reported in the following community specific sections is the amount of available head that is taken up by drawdown under drought conditions.

Particle tracking was used to determine if in the next 20 years (out to 2040) treatment for PFAS may be required for a new or existing water supply well and to determine domestic water wells that may require a point of entry treatment system (POETS). Particle tracking results, PFAS HI values, and groundwater contours for the wet, normal, and dry simulations are provided in Figures E.2.1.2.1 through E.2.1.2.9. Particles were initiated at source areas (e.g. 3M Woodbury, Oakdale disposal site, etc.), and at secondary areas of potential transport: areas of existing groundwater with HI>1, along project 1007, and along Raleigh Creek. The particles were tracked for a 20-year time period to help identify areas of potential PFAS impacts by 2040 and wells that may require treatment for PFAS.

Drawdown for the drought and wet simulations associated with the particle tracking scenarios, based on long term annual average pumping rates for all communities with new and existing wells, are shown in Figures E.2.1.2.11 through E.2.1.2.16. The drawdown shown under wet conditions is relative to the average 2016-2018 simulated groundwater elevations under wet conditions (calibrated solution). The drawdown for the normal condition was very similar to the wet condition and is not provided. Drawdown under drought conditions is relative to 2016-2018 simulated groundwater elevations under drought conditions (calibrated model with reduced recharge and increased pumping).

E.2.2 Community Scenario A

E.2.2.1 Conceptual projects – Afton

E.2.2.1.1 Project summary

The conceptual project considered for Afton under this scenario would include installing GAC POET systems on PFAS impacted non-municipal wells under 2040 conditions. A summary of the project is provided below and is shown in Figures E.2.2.1.1 and E.2.2.1.2 for both HI conditions. These two figures are regional maps illustrating the impact on private and non-municipal wells and which wells will receive GAC POETS or be connected to the distribution system as necessary and depending on HI condition.

E.2.2.1.2 Project improvements

Afton does not have a municipal supply system and does not have impacts to the extent that may warrant a new system. Therefore, no new municipal supply improvements were identified.

GAC POETS

This scenario would provide GAC POET systems for PFAS impacted non-municipal wells under 2040 conditions. As of October 2019 sample data, 124 of the estimated total of 1,195 existing non-municipal wells have been sampled. The total number of existing wells was estimated based on county parcel data; Minnesota Well Index (MWI) only provided a total of 708 wells, which was underestimated as identified by the City of Afton.

Of the 124 sampled wells, 11 currently have GAC POET systems installed. Based on sampling data as of October 2019 and trends currently observed in the community, it is estimated that by 2040 another 810 non-municipal wells (in addition to the 11 that have GAC POET systems) would potentially have detections of PFAS, with HI values greater than or equal to 0.0, and would receive treatment through new GAC POET systems. Under the HI>1 alternative, groundwater modeling and flow path analysis indicate that another 221 POETS (in addition to the 11 that currently have GAC POET systems), would be necessary for a total of 232 POETS.

E.2.2.1.3 Hydraulic modeling analysis

A drinking water distribution model was not created for this community as there is no municipal water system within Afton.

E.2.2.1.4 Groundwater modeling analysis

Forward particle tracking to 2040 was conducted under wet, normal, and drought climate conditions from known PFAS sources and areas where HI>1, as shown in Figures E.2.2c, E.2.2d, and E.2.2e, respectively. Particle movement simulated in the model travel in the direction of groundwater flow. In Afton, groundwater in the uppermost bedrock aquifers generally flows toward the St. Croix River. The eastern region of Afton is located within the Hudson-Afton Horst (HAH). The uppermost bedrock aquifers within the HAH are primarily the Prairie Du Chien and Jordan Sandstone; however, the Tunnel City Group and Wonewoc Sandstone are the uppermost bedrock in the northeast corner of Afton. West of the HAH, the uppermost bedrock is either St. Peter Sandstone or Prairie Du Chien.

A small cluster of groundwater samples with HI>1 is located on the northeast corner of Afton. The samples were collected from wells drilled into the Tunnel City Group and/or Wonewoc Sandstone. Particles originating around this cluster of wells travel east towards the St. Croix River. A larger cluster of wells with HI>1 is located north of Afton in West Lakeland. The samples from this cluster were collected from wells drilled into the Prairie Du Chien and/or Jordan Sandstone. Particles originating around this cluster of wells also travel east towards the St. Croix River.

Within Afton, groundwater in the Jordan, Prairie du Chien, and Tunnel City aquifers generally moves west to east across the city under the normal and wet climate conditions. Under the dry condition, the groundwater flow direction simulated by the calibrated model is very similar to the wet condition. The results indicate that the primary groundwater flow direction is relatively stable and significant volumes of water would need to be pumped to alter the simulated paths. Under the current groundwater flow patterns, the groundwater model indicates that PFAS contamination in the northern area of Afton may migrate along groundwater flow paths and impact additional non-municipal wells by the year 2040, as described above.

Note that a drawdown analysis was not performed for Afton since no new wells were proposed.

E.2.2.1.5 Project alternatives

A summary of each alternative is provided below, and costs are provided in E.2.2.1.6. Refer to Figures E.2.2.1.1 and E.2.2.1.2 for a map of Afton with the projected PFAS impacted area in 2040.

Alternative 1a – 2040 HI > 0

In this alternative, only the installation of POETS is considered due to the low density of the residences and because there is not an existing potable water system. A total of 821 POET systems are projected to be needed by 2040.

Alternative 1b – 2040 HI ≥ 1

This alternative is identical to Alternative 1a, but the total number of POET systems required is reduced to 232.

E.2.2.1.6 Cost estimate breakdown

Capital and O&M costs are summarized in Tables E.87 and E.88 for the year 2040. Capital and operation and maintenance (O&M) costs were included in the cost estimate for the non-municipal wells requiring the installation of a new POET system. Only O&M costs were included for the non-municipal wells that currently have a POET system.

Table E.87. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for Afton-Alternative 1a.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
GAC POETS	810	POETS	Standard household systems, $2,500 per well	$2,025,000	
			Subtotal	$2,025,000	$2,025,000
			Contingency (25%)	$507,000	$507,000
			Professional services (15%)	$304,000	$304,000
			Total Capital	**$2,836,000**	**$2,836,000**
Annual O&M Cost					

GAC POETS	821	POETS	Standard household systems, $1,000 per well	$821,000	
			Subtotal	$821,000	$821,000
			20 years of annual O&M	$16,420,000	$16,420,000
			20 years of annual O&M future value[1]	$22,061,000	$22,061,000
			20-year costs (capital + O&M)	**$19,256,000**	**$19,256,000**
			20-year future value costs (capital + O&M)	**$24,897,000**	**$24,897,000**
			Capital and operating cost per 1,000 gal	$10.16	$10.16
			Operating only cost per 1,000 gallons	$9.00	$9.00

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.88. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for Afton-Alternative 1b.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
GAC POETS	221	POETS	Standard household systems, $2,500 per well	$553,000	
			Subtotal	$553,000	$553,000
			Contingency (25%)	$139,000	$139,000
			Professional services (15%)	$83,000	$83,000
			Total Capital	**$775,000**	**$775,000**
Annual O&M Cost					
GAC POETS	232	POETS	Standard household systems, $1,000 per well	$232,000	
			Subtotal	$232,000	$232,000
			20 years of annual O&M	$4,640,000	$4,640,000
			20 years of annual O&M future value[1]	$6,234,000	$6,234,000
			20 year costs (capital + O&M)	**$5,415,000**	**$5,415,000**
			20 year future value costs (capital + O&M)	**$7,009,000**	**$7,009,000**
			Capital and operating cost per 1,000 gal	$10.12	$10.12
			Operating only cost per 1,000 gallons	$9.00	$9.00

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

A summary of the costs for the two alternatives along with capital and operating costs per 1000 gallons is shown in Table E.89 below.

Table E.89. Summary of Year 2040 costs with 3% inflation included for the Community-Specific Scenario A for Afton.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)		Capital and operating cost per 1000 gal		Operating Cost per 1000 gal	
					IX	GAC	IX	GAC	IX	GAC	IX	GAC	IX	GAC
Alt 1a	>0	POETS only	821	0.34	N/A	$2.84	N/A	$0.82	N/A	$24.9	N/A	$10.2	N/A	$9.0
Alt 1b	>1	POETS only	232	0.09	N/A	$0.78	N/A	$0.23	N/A	$7.0	N/A	$10.1	N/A	$9.0

Notes:

1. Recapitalization and inflation costs (3% inflation rate) are included in Total 20 year costs and are not included in the Capital and Annual O&M costs.

E.2.2.1.7 PFAS eligible cost summary

The cost estimates presented above include all related costs for each given alternative to meet Year 2040 water demands. However, for various reasons, some costs may not be covered by settlement funds. The guidelines used to determine project components that would be eligible for settlement funding were presenting in the Appendix E.2 Introduction. Afton does not have any ineligible costs and as such the PFAS Eligible costs will be the same as above and shown below in Table E.90.

Table E.90. Summary of PFAS Eligible Costs Community-Specific Scenario A for Afton.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1a	**>0**	POETS only	821	0.34	N/A	$2.84	N/A	$0.82	N/A	$24.9
Alt 1b	**>1**	POETS only	232	0.09	N/A	$0.78	N/A	$0.23	N/A	$7.0

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.1.8 Cost summary with particle tracking costs removed

As discussed in previous sections and chapters of the CDWSP, particle tracking was used to develop potential areas of PFAS contamination over the next 20 years. Since a true fate and transport analysis has not been performed at this time, it is unknown what the concentration of PFAS contamination could be and in which aquifers it may be present during that time period. As such, to be conservative, it was assumed that all wells designated for potable use, including those well types considered under this conceptual plan that fell within these projected areas would be treated for PFAS contamination as if their HI value was equal to or greater than 1. To evaluate the cost implications of particle tracking and the projection of future potential areas of PFAS impact, these costs were removed from the PFAS eligible cost estimate. Costs presented in this section are reflective of the currently known areas of PFAS contamination and do not consider future costs associated with the potential migration of the groundwater contamination noted by the particle tracking exercise. These costs also take into account only those cost considered to be eligible for funding as noted in the previous section. For Afton this impacted the total number of GAC POETS that would be required as shown below in Table E.91.

Table E.91. Summary of Costs Community-Specific Scenario A for Afton with particle tracking costs removed.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1a	**>0**	POETS only	780	0.32	N/A	$2.69	N/A	$0.78	N/A	$23.65
Alt 1b	**>1**	POETS only	16	0.01	N/A	$0.02	N/A	$0.02	N/A	$0.45

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.2 Conceptual projects – Cottage Grove

E.2.2.2.1 Project summary

The conceptual projects considered for Cottage Grove under this scenario would include the installation of centralized water treatment plants (WTPs) and extending water mains to nearby neighborhoods that currently have PFAS impacted non-municipal wells. In addition, GAC POET systems would be installed for the rest of the impacted non-municipal wells that were not proposed to be connected to the municipal water system in this scenario based on cost or constructability constraints, primarily in the neighborhoods in the southeast and southwest corners of the city. A summary of the project is provided below and the infrastructure modifications are shown in Figures E.2.2.2.1 and E.2.2.2.2 for both HI conditions. The implications on Cottage Grove's private and non-municipal wells are shown in Figures E.2.2.1.1 and E.2.2.1.2 for both HI conditions. These two figures are regional maps illustrating the impact on private and non-municipal wells and which wells will receive GAC POETS or be connected to the distribution system as necessary.

Water supply

Cottage Grove currently has a municipal water system consisting of 12 existing municipal wells. Due to PFAS contamination as shown in Table E.92 below, not all wells are currently in service. However, if all wells received treatment based on the selection criteria, the wells would have a total combined design capacity of 14,000 gpm and a firm capacity with the two largest wells out of service of 10,500 gpm as shown below.

Table E.92. Cottage Grove municipal well HI values and Pumping rates

Well No.	Design Pumping Rate (gpm)	HI Value
1	600	0.545
2	600	2.342
3	800	2.49

4	1,000	3.047
5	1,000	1.204
6[1]	1,000	1.970
7	1,000	1.064
8	1,500	1.404
9	1,500	0.905
10	2,000	2.913
11	1,500	0.249
12	1,500	0.010
Total	14,000	

Notes:

1. The 4-quarter rolling average HI for well 6 was 0.568 as of the date of this publication; however, this well was already issued a well advisory due to previous exceedances of HI>1.0. Therefore, the most recent sample result with HI>1.0 of 1.970 is shown here and was used in this analysis.

Assuming the intermediate pressure zone well field is able to support these sustained pumping rates and their proximity to each other does not impact pumping capacities (see Section E.2.2.2.3), this firm capacity would meet their current 2020 maximum daily demand of 8,000 gpm (11.5 mgd) and anticipated 2040 maximum daily demand of 9,792 gpm (14.1 mgd) without the addition of new wells. However, no pumping tests have been performed for this well field.

E.2.2.2.2 Project improvements

New municipal supply wells

Cottage Grove does not need any additional wells to meet their 2040 MDD. However, Wells 1 and 2 are the City's lowest producing wells that have been contaminated by PFAS as shown in the table above and are the farthest away from the other municipal supply wells. A previous analysis examined whether it was more cost effective to treat the two wells or replace them with a new well closer to Well 10 and the proposed low pressure zone water treatment plant (WTP). The results indicated that it was more cost effective to seal the two existing wells and drill a new replacement well. In an effort to not eliminate water supply from the City, the new well would have a pumping capacity equal to that of the two existing wells at 1,200 gpm.

Water treatment plants (WTPs)

All municipal supply wells in Cottage Grove would be treated through a combination of centralized groundwater WTPs under 2040 conditions. As mentioned above, wells would be selected for treatment based on their current HI values. Under the previous evaluation, the more cost-effective solution was to include two WTPs. One centralized WTP (WTP1) would serve the high and intermediate pressure zone wells and a second WTP (WTP2) to serve the low-pressure zone wells. A dedicated raw water main would convey water from Wells 11 and 12 in the high-pressure zone to WTP1 in the intermediate pressure zone under the condition of HI>0 but not under the HI≥1 condition. For the HI≥1 condition, Well 11 would be routed to WTP1. All intermediate zone wells (i.e. Wells 3-9) would be routed to WTP1 under both HI conditions. The WTP1 would be located near the existing booster pump station at 80th Street in Pine Tree Pond Park. Under the HI>0 condition this WTP would have a capacity of 9,800 gpm, and under the HI≥1 condition this WTP would have a capacity of 9,300 gpm.

The second WTP (WTP2), located near Jamaica Avenue and 100th Street, would serve the low-pressure zone and would have the capacity to treat water from Well 10 and the new replacement well for Wells 1 and 2. This plant under both HI conditions would be sized to meet the flow from both wells, or 3,200 gpm.

For drinking water distribution modeling purposes, the above options were grouped into two alternatives to represent the two HI conditions. Under the alternatives described below, municipal supply wells were routed to WTPs to provide operational flexibility while the treatment facilities were sized to meet the 2040 maximum daily demands for cost purposes.

Water storage

Under 2040 conditions, the city would need to add another storage facility with a minimum storage volume of 0.7 million gallons based on their average daily demand and required fire flow. For cost estimating purposes, the cost for the tank was included as a separate line item.

Water main extensions and distribution lines

In addition to the WTPs outlined above, additional infrastructure modifications would need to be implemented to accommodate the proposed projects under all alternatives and HI conditions with the exception of Options D and E listed below under “Distribution Lines”. Extending lines east to Old Cottage Grove and southwest to serve homes along Grey Cloud Trail South was found to be less cost effective than POETS. The modifications listed below do not include any approved expedited projects. Table E.93 provides costs of neighborhood connections as compared to costs of providing POETS to residents.

4. Raw water transmission lines
    a. New raw water transmission lines would be required to convey flows from municipal supply wells to the proposed WTPs.
5. Distribution lines
    a. New distribution lines would be installed in the neighborhoods near the intersection of Goodview Avenue/Goodview Court and 70th Street to serve 43 connections.
    b. A new 2,307 linear feet, 8” distribution line would be installed along Harkness Avenue to serve 9 connections and complete the loop along Hardwood Avenue.
    c. A new 5,280 linear feet, 8” distribution line would be installed along Keats Avenue from 90th to 80th Street to serve 17 connections and loop the system.
    d. The option to install a distribution loop to provide water to the Old Cottage Grove neighborhood was also examined. The loop would include approximately 20,920 linear feet of 12” distribution lines along 70th Street, Lamar Avenue, Kimbro Avenue, and 80th Street. An additional 14,323 linear feet, 8” distribution line would be required to service the residences off Lamar Avenue. In the table below this is referred to as “East Cottage Grove” in the Neighborhood column.
    e. The option to install a distribution loop to provide water to the southwest corner of Cottage Grove to serve homes along Grey Cloud Trail South was also examined. This

would require approximately 21,000 LF of 12” water main to convey water to the area and approximately 28,650 LF of 8” distribution line to create a loop through the neighborhood. In the table below this is referred to as “SW Cottage Grove” in the Neighborhood column.

Table E.93. Proposed neighborhoods and areas that could be connected to Cottage Grove’s water system under this scenario.

Neighborhood	No. of Existing Homes	POETS ($K)			Extend Water Distribution Mains ($K)			No. of Years for POETS to Exceed Mains	No. of Years for POETS to Exceed Mains (PFAS Eligible)[1]
		Capital	O&M	20 Year Total	Capital	O&M[1]	20 Year Total		
East Cottage Grove[2]	163	522	163	3,782	26,498	93	27,787	371	159
SW Cottage Grove[2]	32	42	32	682	5,053	18	5,290	358	157
Goodview Ave[2,3]	43	140	43	1,000	1,335	5	1,319	31	28
Harkness Ave[2,3]	9	25	9	205	680	3	703	109	73
Point Douglas Rd[2,3]	15	14	15	314	1,446	5	1,492	143	95
Keats Ave[2]	17	56	17	396	1,200	5	1,258	95	67
Total	280	798	279	6,378	36,212	129	38,792		

Notes:
1. Operation and maintenance costs for water distribution mains are not eligible for funding under the settlement. This column represents the number of years for the costs of POETS for the entire neighborhood to exceed the costs of installing distribution mains.
2. These neighborhoods are not included in the cost estimates presented in this section.
3. Highlighted neighborhoods listed in this table are included in the recommended options presented in Section E.4.
4. Cost estimates do not include inflation or recapitalization of assets.
5. Well sealing of $2,000 per non-municipal well is included in the distribution line estimates.
6. No consideration to the potential generation of revenue through water sales or service associated with similar type public water systems have been applied to this analysis.

6. <u>Pressure reducing valves</u>
    a. Two 8” pressure reducing valves would be necessary to serve the connections in the neighborhoods along Goodview Avenue/Goodview Court and 70th Street as the topography in this area rapidly slopes downward towards I-61.
    b. Two 8” pressure reducing valves would be needed in the Granada Avenue neighborhood that was proposed to be connected under an expedited project but was not included in the cost estimate. This region has the same topography challenges as the Goodview Avenue neighborhood.
    c. One 8” pressure reducing valve would be needed in the River Acres neighborhood that was proposed to be connected under an expedited project but was not included in the

cost estimate. This neighborhood is located much further south and has lower elevations lending to higher pressures.

GAC POET systems

Under this scenario, non-municipal wells would be selected for treatment using the same HI categories as previously described. Current or anticipated PFAS impacted non-municipal wells would be provided with GAC POET systems that were not proposed to be connected to the municipal water system. According to PFAS sampling data from October 2019 and Minnesota Well Index (MWI) data, Cottage Grove has an estimated 820 existing non-municipal wells, of which 672 have been sampled. The groundwater model flow path analysis estimated that by 2040 345 non-municipal wells have potential to be impacted by PFAS contamination as indicated by the particle flow tracking analysis (see E.2.2.2.4). Wells identified as potentially impacted are included to receive treatment through existing or proposed GAC POET systems or be connected to the existing distribution system. Also included to a lesser extent are wells that fall outside the projected impact areas.

Under 2040 conditions with an HI>0, 58 wells with GAC POETS would remain on POETS while 402 wells would need to have GAC POETS installed for a total of 460 wells on POETS. Under the HI ≥ 1 condition, the same 58 wells would remain on their existing GAC POETS and 75 wells would receive GAC POET systems for a total of 133 wells on POETS. These counts exclude any wells that would be connected to the city's municipal water system through expedited projects, proposed water lines, or connections to existing water lines. Under both HI conditions, a total of approximately 89 homes would be connected to either the existing distribution system or proposed distribution line extensions.

E.2.2.2.3 Hydraulic modeling analysis

Once all the infrastructure improvements discussed above were included, the hydraulic model was run under 2040 MDD conditions. Modifications to pump operating points were made as necessary to regulate pressures and achieve a pressure range that is consistent with observed pressure data provided by the City. It was found that the intermediate zone booster pump station would need to be modified and upgraded to accommodate the higher flows and maintain pressures. Since there is the potential for more flow to be coming from the higher-pressure zones, the PRV settings to the low-pressure zone may need to be adjusted. By increasing the pressure setting slightly, the PRV near the intersection of 80th Street and Hadley Ave the valve would be open during certain periods, allowing flow to enter the low zone. Flow would also enter the low zone through the line on Belden Blvd even though this is a 6-inch line. It is recommended, and was modeled as such, that the 8-inch lines to the tower be increased in size to 12-inch diameter pipe to increase capacity needed for 2040 conditions.

Under this scenario, all of Cottage Grove's municipal supply wells would be routed to their respective WTPs prior to distribution to the public. The city would not need to blend water from wells containing low levels of PFAS, otherwise operations would be similar to existing operating procedures with the city optimizing well operations.

E.2.2.2.4 Groundwater modeling analysis

Drawdown at existing and proposed municipal wells was evaluated with the Cottage Grove well field operating at average rates based on the 2040 average daily demand (ADD). Under this scenario, the new proposed well is extracting groundwater from the Jordan Sandstone aquifer at an annual average daily demand rate of 400 gpm and Wells 1 and 2 are out of service. Table E.94 provides a summary of pumping rates used in the groundwater model for existing and proposed wells.

Table E.94. Summary of maximum daily demands and average daily demands for the existing and proposed municipal wells in Cottage Grove.

Well	Unique Well Number	Average Daily Demand (gpm)
1	208808	Off
2	208809	Off
3	208807	187
4	208805	233
5	208806	233
6	201238	233
7	201227	233
8	110464	350
9	165602	350
10	191904	466
11	655944	350
12	830682	350
Proposed Well		400

Using the guidance provided by the DNR, drawdown at the existing wells and proposed locations was evaluated under a drier setting that approaches drought like conditions (worst case and herein referred to as drought) to determine whether drawdown exceeds the 50% threshold. For scenarios run under drought conditions, average daily demand rates for the Cottage Grove water supply wells were increased by multiplying the current condition (i.e. average 2016-2018) rates by a factor of 1.18 (the ratio of maximum per capita demand over average per capita demand from Years 2005-2015). Pumping rates at irrigation wells were also increased by taking the maximum annual volume reported over a 20-year period (1988-2018). Drawdown for Scenario A under wet and dry conditions are shown on Figures E.2.2a and E.2.2b, respectively.

Under drought conditions, drawdown does not exceed the 50% available head in the Jordan Sandstone. The Prairie Du Chien aquifer is currently unconfined at the Cottage Grove existing and proposed water supply well locations; therefore, head thresholds could not be applied to the Prairie Du Chien. Table E.95 provides a summary of drawdown in the Jordan Sandstone aquifer under wet and drought conditions. The reported drawdown is relative to average 2016-2018 simulated groundwater elevations, which is considered a wet period. The available head is the difference between the average 2016-2018 simulated head and the elevation of the top of the aquifer. The percent of available head is the amount of available head that is taken up by drawdown under drought conditions.

Table E.95. Summary of drawdown in the Jordan Sandstone aquifer under wet, normal, and drought conditions.

Well	Jordan Sandstone Aquifer			
	Drawdown (m)		Available Head (m)	Percent of Available Head (drought)
	Wet	Drought		
1	Off			
2	Off			
3	3	7	45	16

4	7	12	45	27
5	5	9	45	20
6	7	10	46	22
7	3	5	45	11
8	8	12	45	27
9	2	4	45	9
10	<1	<1	38	0
11	<1	3	44	7
12	9	15	58	26
Proposed Well	6	8	42	19

Forward particle tracking to 2040 was conducted under wet, normal, and drought climate conditions from known PFAS sources and areas where HI>1, as shown in Figures E.2.2c, E.2.2d, and E.2.2e, respectively. Model recharge for normal conditions was reduced to 87% of the current condition recharge rate based on modeling by the DNR using the Soil Water Balance model over a drier time period of 1989 to 2018. Wells 3 through 12, along with the new proposed well, were operating at the average daily rates used for the drawdown analysis discussed above. Under each climate condition, the general groundwater flow direction in Cottage Grove is from northeast to southwest in the uppermost bedrock aquifers (Prairie Du Chien and Jordan Sandstone aquifers). Particles originating from, but not captured by pollution control wells, at 3M Woodbury disposal site were captured by the downgradient municipal well cluster located in the central region (Wells 3 through 9), as well as Well 11 to the north. Particles originating at the 3M Cottage Grove site travel towards the Mississippi River and are not intercepted by the Cottage Grove municipal wells. No particles were captured by the proposed well.

E.2.2.2.5 Project alternatives

A summary of each alternative including WTP sizing is provided below and costs are provided in E.2.2.2.6. Water supply configurations for these alternatives are shown on Figures E.2.2.2.1 and E.2.2.2.2.

Alternative 1a – 2040 Two Centralized WTPs HI>0

Under this alternative, all municipal wells and non-municipal wells with detectable levels of PFAS contamination would be treated. Flow from municipal wells would be routed to two WTPs. One WTP would be in the intermediate pressure zone to treat Wells 3-9 and Wells 11 and 12 configuration and one would be in the low pressure zone to treat Well 10 and the new well as described above. The distribution lines, storage tanks, and GAC POETS as discussed above and selected for treatment under this condition would also be included. The capacity of the two treatment facilities is listed below.

- WTP1 – 9,800 gpm in the intermediate pressure zone for Wells 3-9, 11, and 12
- WTP2 – 3,200 gpm in the low pressure zone for Well 10 and a new 1,200 gpm well to replace Wells 1 and 2.

Alternative 1b – 2040 Two Centralized WTPs HI≥1

This alternative is very similar to Alternative 1a above, however, wells would be selected for treatment only if their HI value was greater than or equal to 1. Under this alternative Well 12 would not require treatment. Well 11 would require treatment due to the particle tracking analysis described above and is routed to the intermediate zone treatment facility. The distribution lines, storage tanks, and GAC POETS as discussed above and selected for treatment under this condition would also be included. The capacity of the two treatment facilities is listed below.

- WTP1 – 9,300 gpm in the intermediate pressure zone for Wells 3-9 and 11.
- WTP2 – 3,200 gpm in the low pressure zone for Well 10 and a new 1,200 gpm well to replace Wells 1 and 2.

E.2.2.2.6 Cost estimate breakdown

Under the alternatives discussed above, GAC and ion exchange (IX) WTPs were considered to treat the City's municipal wells as well as iron and manganese pretreatment. In addition to the treatment facilities, the proposed raw water transmission lines and proposed distribution lines would be sized for 2040 maximum daily demands. A breakdown of capital and O&M costs for each alternative discussed above are provided in Tables E.96, E.97, and E.98 below for projected 2040 conditions.

Table E.96. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for Cottage Grove - Alternative 1a.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	2	WTPs	9800 gpm WTP (intermediate zone), 3200 gpm WTP (low zone)	$21,240,000	$15,150,000
Pretreatment at WTP	2	Lump Sum	Iron/Manganese	$6,740,000	$6,740,000
New Well	1	Well	1200 gpm	$2,180,000	
Well Modifications	10	Wells	Well & SCADA upgrades	$1,200,000	
Pressure Reducing Valves	5	Stations	8" PRVs	$630,000	
Storage tanks	1	Tank	0.7 MG (28kgpd new connections)	$2,090,000	
Raw water transmission mains	4.4	Miles	from wells to WTPs	$9,520,000	
Neighborhood mains	3.4	Miles	connect 84 homes	$3,040,000	
Well Sealing	91	Each	$2,000 per well + W1,W2	$182,000	
Service Laterals	89	Each	Connect homes to existing mains ($2500 ea)	$222,500	
Land acquisition (site + water mains)	14.4	Acres	1/2 acre per well/tank, 2 acre at WTPs, 20 ft easements (50%)	$1,960,000	
GAC POETS	402	POETS	Standard household systems, $2,500 per well	$1,005,000	
			Subtotal	$50,010,000	$43,920,000
			Contingency (25%)	$12,510,000	$10,980,000
			Professional services (15%)	$7,510,000	$6,590,000

			Total Capital	**$70,030,000**	**$61,490,000**
Annual O&M Cost					
PFAS WTPs	2	WTP	Media Cost	$120,000	$73,000
PFAS WTPs	2	WTP	Maint. and Operations	$1,270,000	$970,000
Wells	1	Well	1200 gpm	$60,000	
Pressure Reducing Valves	5	Stations	Installed within right-of-way	$43,000	
Storage Tanks	1	Tank	0.7 MG (28kgpd new connections)	$45,000	
Raw water transmission mains	4.4	Miles	from wells to WTPs	$48,000	
Neighborhood mains	3.4	Miles	connect 84 homes	$129,000	
GAC POETS	460	POETS	Standard household systems, $1,000 per well	$460,000	
			Subtotal	$2,180,000	$1,830,000
			20 years of annual O&M	$43,600,000	$36,600,000
			20 years of annual O&M future value[1]	$58,580,000	$49,180,000
			20 year costs (capital + O&M)	**$113,630,000**	**$98,090,000**
			20 year future value costs (capital + O&M)	**$128,610,000**	**$110,670,000**
			Capital and operating cost per 1,000 gal	$0.93	$0.80
			Operating only cost per 1,000 gallons	$0.42	$0.36
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$560,000	$440,000
Wells		2%	of Capital	$44,000	
Storage Tanks			Rehab every 20 Years	$39,000	
Water Mains		1.67%	of Capital	$210,000	
			Subtotal	$860,000	$740,000
			20 years of recapitalization	**$17,200,000**	**$14,800,000**
			20 years of recapitalization future value[1]	**$23,110,000**	**$19,890,000**
			20 year future value costs (capital + O&M + recapitalization)	**$151,720,000**	**$130,560,000**

[1]The 20-year future value costs were calculated using a 3% inflation rate

Table E.97. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for Cottage Grove - Alternative 1b.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)

Capital Cost					
PFAS Water Treatment Plants	2	WTPs	9300 gpm WTP (intermediate zone), 3200 gpm WTP (low zone)	$20,860,000	$14,840,000
Pretreatment at WTP	2	Lump Sum	Iron/Manganese	$5,700,000	$5,700,000
New Well	1	Well	1200 gpm	$2,180,000	
Well Modifications	9	Well	Well & SCADA upgrades	$1,080,000	
Pressure Reducing Valves	3	Stations	8" PRVs	$630,000	
Storage tanks	1	Tank	0.7 MG (28kgpd new connections)	$2,090,000	
Booster Pump Station	0	Stations		$0	
Raw water transmission mains	3.3	Miles	from wells to WTPs	$7,070,000	
Neighborhood mains	3.4	Miles	connect 84 homes	$3,040,000	
Service Laterals	89	Each	Connect homes to existing mains ($2500 ea)	$222,500	
Well Sealing	91	Each	$2,000 per well + W1,W2	$182,000	
Land acquisition (site + water mains)	13.1	Acres	1/2 acre per well/tank, 2 acre at WTPs, 20 ft easements (50%)	$1,780,000	
GAC POETS (TBD)	75	POETS	Standard household systems, $2,500 per well	$188,000	
			Subtotal	$45,030,000	$39,010,000
			Contingency (25%)	$11,260,000	$9,760,000
			Professional services (15%)	$6,760,000	$5,860,000
			Total Capital	**$63,050,000**	**$54,630,000**
Annual O&M Cost					
PFAS WTPs	2	WTP	Media Cost	$114,000	$69,000
PFAS WTPs	2	WTP	Maint. and Operations	$1,260,000	$950,000
Wells	1	Well	1200 gpm	$60,000	
Pressure Reducing Valves	5	Stations	Installed within right-of-way	$43,000	
Storage Tanks	1	Tank	0.7 MG (28kgpd new connections)	$45,000	
Raw water transmission mains	3.3	Miles	from wells to WTPs	$36,000	
Neighborhood mains	3.4	Miles	connect 84 homes	$129,000	
GAC POETS (TBD)	133	POETS	Standard household systems, $1,000 per well	$133,000	

Subtotal			$1,820,000	$1,470,000
20 years of annual O&M			$36,400,000	$29,400,000
20 years of annual O&M future value[1]			$48,910,000	$39,500,000
20 year costs (capital + O&M)			**$99,450,000**	**$84,030,000**
20 year future value costs (capital + O&M)			**$111,960,000**	**$94,130,000**
Capital and operating cost per 1,000 gal			$0.96	$0.81
Operating only cost per 1,000 gallons			$0.42	$0.34
Recapitalization Costs Factored Annually				
WTPs	2%	of Capital	$540,000	$420,000
Wells	2%	of Capital	$44,000	
Storage Tanks		Rehab every 20 Years	$39,000	
Water Mains	1.67%	of Capital	$169,000	
Subtotal			$800,000	$680,000
20 years of recapitalization			**$16,000,000**	**$13,600,000**
20 years of recapitalization future value[1]			**$21,500,000**	**$18,280,000**
20 year future value costs (capital + O&M + recapitalization)			**$133,460,000**	**$112,410,000**
[1]The 20-year future value costs were calculated using a 3% inflation rate				

Table E.98. Summary of Year 2040 costs with 3% inflation included for the two alternatives for the Community-Specific Scenario A for Cottage Grove.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)		Capital and operating cost per 1000 gal		Operating Cost per 1000 gal	
					IX	GAC	IX	GAC	IX	GAC	IX	GAC	IX	GAC
Alt 1a	>0	2 WTPs (9800, 3200 gpm), 1 new well	460	18.90	$61	$70	$1.8	$2.2	$131	$152	$0.8	$0.9	$0.4	$0.4
Alt 1b	>1	2 WTPs (9300, 3200 gpm), 1 new well	133	15.91	$55	$63	$1.5	$1.8	$112	$133	$0.8	$1.0	$0.3	$0.4

Notes:
1. Recapitalization and inflation costs (3% inflation rate) are included in Total 20 year costs and are not included in the Capital and Annual O&M costs.

Both of these alternatives are carried forward into the final summary table for the Revised Community Specific Scenario.

E.2.2.2.7 PFAS eligible cost summary

The cost estimates presented above include all related costs for each given alternative. However, for various reasons, some costs may not be covered by settlement funds. The guidelines used to determine project components that would be eligible for settlement funding were presenting in the Appendix Section E.2.1.

While Cottage Grove has experienced PFAS contamination, they also require modifications to their current municipal water treatment and distribution system to accommodate future growth. However, these growth related costs for water storage and new wells are not eligible for settlement funding. Additional infrastructure modifications such as pressure reducing valves (PRV's) would not be eligible for settlement funding as they are considered necessary for operational modifications due to growth. Unlike the all-inclusive costs that looked at connecting four of the neighborhoods in Table E.93, the PFAS eligible estimates only incorporated three of these neighborhoods as being connected. This caused the total number of GAC POETS to increase to provide treatment for homes that are not being connected to municipal water. The cost summary is shown in Table E.99. Annual O&M costs would not be covered for any components except for the WTP media.

Table E.99. Summary of PFAS Eligible Costs Community-Specific Scenario A for Cottage Grove.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1a	**>0**	2 WTPs (9800, 3200 gpm), 1 new well	488	18.91	$53.3	$61.9	$1.5	$1.9	$94.7	$112.4
Alt 1b	**>1**	2 WTPs (9300, 3200 gpm), 1 new well	148	15.91	$45.1	$53.5	$1.2	$1.5	$76.5	$94.4

Notes:
1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.2.8 Cost summary with particle tracking costs removed

Costs presented in this section are reflective of the currently known areas of PFAS contamination and do not consider future costs associated with the potential migration of the groundwater contamination noted by the particle tracking exercise. These costs also take into account only those cost considered to be eligible for funding as noted in the previous section. To evaluate the cost implications of particle tracking and the projection of future potential areas of PFAS impact, these costs were removed from the PFAS eligible cost estimate.

For Cottage Grove, 345 non-municipal wells were captured by the potential impact area polygons. Excluding municipal wells; wells within source areas; previously connected wells; and wells being connected through expedited projects, 152 wells remain. Of those remaining wells, 28 wells currently have GAC POETS installed; 30 wells had not been sampled and 96 wells had been sampled.

In addition, under this Scenario, municipal Well No. 11 is anticipated to be impacted by PFAS in the near future and the cost for implementing treatment for this well was excluded in the cost estimate for Alternative 1b, presented in Table E.100. Costs associated with extending new water mains into neighborhoods was also excluded in Table E.100.

Table E.100. Summary of Costs Community-Specific Scenario A for Cottage Grove with particle tracking costs removed.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1a	**>0**	2 WTPs (9800, 3200 gpm), 1 new well	483	18.91	$53	$62	$1.5	$1.9	$94	$112
Alt 1b	**>1**	2 WTPs (7800, 3200 gpm), 1 new well	78	15.90	$39	$47	$1.0	$1.3	$67	$82

Notes:
1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.3 Conceptual projects – Denmark

E.2.2.3.1 Project summary

The conceptual project considered for Denmark under this scenario would include installing GAC POET systems on PFAS impacted non-municipal wells. Denmark does not have an existing municipal water supply and PFAS contamination above the current HI threshold of 1.0 is not anticipated through 2040. A summary of the project is provided below and is shown in Figures E.2.2.1.1 and E.2.2.1.2 for both HI conditions. These two figures are regional maps illustrating the impact on private and non-municipal wells and which wells will receive GAC POETS or be connected to the distribution system as necessary and depending on HI condition.

E.2.2.3.2 Project improvements

Water treatment plants (WTPs), water main extensions and other municipal water supply components were not considered for Denmark under this scenario.

GAC POET systems

This scenario would provide GAC POET systems for PFAS impacted non-municipal wells as projected under 2040 conditions. Based on October 2019 sample data, Denmark has an estimated 761 existing non-municipal wells, of which 111 wells have been sampled. All sampled wells have a HI value less than 1.0, and thus, no GAC POET systems have been installed. Based on current sampling trends, it was estimated that by 2040 a total of 426 non-municipal wells would have detectible concentrations of PFAS and therefore HI values greater than 0 and would receive treatment through GAC POET systems in the HI>0 alternative. No non-municipal wells are anticipated to require treatment by 2040 for the HI≥1 alternative.

E.2.2.3.3 Hydraulic modeling analysis

A drinking water distribution model was not created for this community as there is no municipal water system within Denmark.

E.2.2.3.4 Groundwater modeling analysis

Groundwater in Denmark moves primarily west to east across the Township. Forward particle tracking to 2040 was conducted for the East Metro Area under wet, normal, and drought climate conditions from known PFAS sources and areas where HI>1, as shown on Figures E.2.2c, E.2.2d, and E.2.2e, respectively. Based on this analysis, PFAS contamination is not expected to migrate into Denmark and impact non-municipal wells by 2040. A drawdown analysis was not performed for Denmark since no new wells were proposed.

E.2.2.3.5 Project alternatives

A summary of each alternative is provided below, and costs are provided in E.2.2.3.6. Refer to Figures E.2.2.1.1 and E.2.2.1.2 for maps of Denmark with the projected PFAS impacted area in 2040.

Alternative 1a – 2040 HI > 0

In this alternative, only the installation of POETS is considered due to the low density of the residences and because there is not an existing municipal water system. A total of 426 POET systems are projected to be needed by 2040.

Alternative 1b – 2040 HI ≥ 1

This alternative is identical to Alternative 1a, but the total number of POET systems required is reduced to zero.

E.2.2.3.6 Cost estimate breakdown

Capital and O&M costs are summarized in Tables E.101 and E.102 for the Year 2040.

Table E.101. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for Denmark-Alternative 1a.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
GAC POETS	426	POETS	Standard household systems, $2,500 per well	$1,065,000	
			Subtotal	$1,065,000	$1,065,000
			Contingency (25%)	$267,000	$267,000
			Professional services (15%)	$160,000	$160,000
			Total Capital	**$1,492,000**	**$1,492,000**
Annual O&M Cost					
GAC POETS	426	POETS	Standard household systems, $1,000 per well	$426,000	
			Subtotal	$426,000	$426,000
			20 years of annual O&M	$8,520,000	$8,520,000

20 years of annual O&M future value[1]	$11,447,000	$11,447,000
20 year costs (capital + O&M)	**$10,012,000**	**$10,012,000**
20 year future value costs (capital + O&M)	**$12,939,000**	**$12,939,000**
Capital and operating cost per 1,000 gal	$11.15	$11.15
Operating only cost per 1,000 gallons	$9.86	$9.86
Notes: 1. The 20-year future value costs were calculated using a 3% inflation rate		

Table E.102. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for Denmark-Alternative 1b.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
GAC POETS	0	POETS	Standard household systems, $2,500 per well	$0	
			Subtotal	$0	$0
			Contingency (25%)	$0	$0
			Professional services (15%)	$0	$0
			Total Capital	**$0**	**$0**
Annual O&M Cost					
GAC POETS	0	POETS	Standard household systems, $1,000 per well	$0	
			Subtotal	$0	$0
			20 years of annual O&M	$0	$0
			20 years of annual O&M future value[1]	$0	$0
			20 year costs (capital + O&M)	**$0**	**$0**
			20 year future value costs (capital + O&M)	**$0**	**$0**
			Capital and operating cost per 1,000 gal	$0	$0
			Operating only cost per 1,000 gallons	$0	$0
Notes: 1. The 20-year future value costs were calculated using a 3% inflation rate					

A summary of the costs for the two alternatives along with capital and operating costs per 1000 gallons is shown in Table E.103 below.

Table E.103. Summary of Year 2040 costs with 3% inflation included for the Community-Specific Scenario A for Denmark

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)		Capital and operating cost per 1000 gal		Operating Cost per 1000 gal	
					IX	GAC	IX	GAC	IX	GAC	IX	GAC	IX	GAC
Alt 1a	>0	POETS only	426	0.16	N/A	$1.49	N/A	$0.43	N/A	$12.9	N/A	$11.1	N/A	$9.9

Alt 1b	>1	POETS only	0	0.00	N/A	$0.00	N/A	$0.00	N/A	$0.00	N/A	$0.00	N/A	$0.00

Notes:
1. Recapitalization and inflation costs are included in Total 20 year costs and are not included in the Capital and Annual O&M costs.

E.2.2.3.7 PFAS eligible cost summary

Because Denmark does not have a municipal water system and the entire community relies on private or non-municipal wells, the cost of any GAC POET systems required due to PFAS contamination and dependent on the HI selection criteria would be considered eligible. As such the PFAS Eligible costs will be the same as above and shown below See Table E.104.

Table E.104. Summary of PFAS Eligible Costs Community-Specific Scenario A for Denmark.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1a	**>0**	POETS only	426	0.16	N/A	$1.49	N/A	$0.426	N/A	$12.9
Alt 1b	**>1**	POETS only	0	0.00	N/A	$0.00	N/A	$0.000	N/A	$0.0

Notes:
1. For these estimates; recapitalization costs are not included, O&M is only provided for the water treatment plants, and inflation at 3% is included in the Total 20 year costs.

E.2.2.3.8 Cost summary with particle tracking costs removed

Costs presented in this section are reflective of the currently known areas of PFAS contamination and do not consider future costs associated with the potential migration of the groundwater contamination noted by the particle tracking exercise. These costs also take into account only those cost considered to be eligible for funding as noted in the previous section. To evaluate the cost implications of particle tracking and the projection of future potential areas of PFAS impact, these costs were removed from the PFAS eligible cost estimate. However, none of the particle tracking analyses resulted in future areas of contamination within Denmark. Therefore, the total number of GAC POETS that would be required remained the same as shown below in Table E.105.

Table E.105. Summary of Costs Community-Specific Scenario A for Denmark with particle tracking costs removed.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1a	**>0**	POETS only	426	0.16	N/A	$1.49	N/A	$0.426	N/A	$12.9
Alt 1b	**>1**	POETS only	0	0.00	N/A	$0.00	N/A	$0.000	N/A	$0.0

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.4 Conceptual projects – Grey Cloud Island

E.2.2.4.1 Project summary

The conceptual project considered for Grey Cloud Island under this scenario would include installing GAC POET systems on PFAS impacted non-municipal wells. Grey Cloud Island does not have an existing municipal water supply and PFAS contamination above the current HI threshold of 1.0 exists in the township. A summary of the project is provided below and is shown in Figures E.2.2.1.1 and E.2.2.1.2 for both HI conditions. These two figures are regional maps illustrating the impact on private and non-municipal wells and which wells will receive GAC POETS or be connected to the distribution system as necessary and depending on HI condition.

E.2.2.4.2 Project improvements

GAC POET systems

This scenario would provide GAC POET systems for PFAS impacted non-municipal wells under 2040 conditions. As of October 2019 sample data, Grey Cloud Island has an estimated 121 existing non-municipal wells, of which 109 wells have been sampled. Of these sampled wells, 52 currently have GAC POET systems installed. Based on current sampling trends, it was estimated that by 2040 another 69 non-municipal wells (in addition to the 52 that have GAC POET systems) would have HI values greater than or equal to 0.0 and would receive treatment through new GAC POET systems, for a total of 121 non-municipal wells. The groundwater model flow path analysis estimated that by 2040 an additional 65 wells would be impacted for a total of 117 non-municipal wells that would require treatment through existing or proposed GAC POET systems for the HI>1 alternative.

E.2.2.4.3 Hydraulic modeling analysis

A drinking water distribution model was not created for this community as there is no municipal water system within Grey Cloud Island.

E.2.2.4.4 Groundwater modeling analysis

The non-municipal wells in Grey Cloud Island draw water from the Prairie du Chien aquifer. However, the majority of wells in Grey Cloud Island are of unknown depth and therefore unknown aquifers. Groundwater in the Prairie du Chien aquifer generally moves northeast to southwest across the township. Forward particle tracking to 2040 was conducted under wet, normal, and drought climate conditions from known PFAS sources and areas where HI>1, as shown on Figures E.2.2c, E.2.2d, and E.2.2e, respectively. Based on this analysis, Grey Cloud Island may see further spread of contamination to wells that are not currently impacted. A drawdown analysis was not performed for Grey Cloud Island since no new wells were proposed.

E.2.2.4.5 Project alternatives

A summary of each alternative is provided below and costs are provided in E.2.2.4.6. Refer to Figures E.2.2.1.1 and E.2.2.1.2 for maps of Grey Cloud Island with the projected PFAS impacted area in 2040.

Alternative 1a – 2040 HI > 0

In this alternative, only the installation of POETS is considered due to the low density of the residences and because there is not an existing municipal water system. A total of 121 POET systems are projected to be needed by 2040.

Alternative 1b – 2040 HI ≥ 1

This alternative is identical to Alternative 1a, but the total number of POET systems required is reduced to 117.

E.2.2.4.6 Cost estimate breakdown

A breakdown of capital and O&M costs is provided in Tables E.106 and E.107 for the year 2040. Capital and O&M costs were included in the cost estimate for the non-municipal wells requiring the installation of a new POET system. Only O&M costs were included for the non-municipal wells that currently have a POET system.

Table E.106. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for Grey Cloud Island-Alternative 1a.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
GAC POETS	69	POETS	Standard household systems, $2,500 per well	$173,000	
			Subtotal	$173,000	$173,000
			Contingency (25%)	$44,000	$44,000
			Professional services (15%)	$26,000	$26,000
			Total Capital	**$243,000**	**$243,000**
Annual O&M Cost					
GAC POETS	121	POETS	Standard household systems, $1,000 per well	$121,000	
			Subtotal	$121,000	$121,000
			20 years of annual O&M	$2,420,000	$2,420,000
			20 years of annual O&M future value1	$3,252,000	$3,252,000
			20 year costs (capital + O&M)	**$2,663,000**	**$2,663,000**
			20 year future value costs (capital + O&M)	**$3,495,000**	**$3,495,000**
			Capital and operating cost per 1,000 gal	$18.88	$18.88
			Operating only cost per 1,000 gallons	$17.56	$17.56

Notes:

1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.107. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for Grey Cloud Island-Alternative 1B.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)

Capital Cost					
GAC POETS	65	POETS	Standard household systems, $2,500 per well	$163,000	
			Subtotal	$163,000	$163,000
			Contingency (25%)	$41,000	$41,000
			Professional services (15%)	$25,000	$25,000
			Total Capital	**$229,000**	**$229,000**
Annual O&M Cost					
GAC POETS	117	POETS	Standard household systems, $1,000 per well	$117,000	
			Subtotal	$117,000	$117,000
			20 years of annual O&M	$2,340,000	$2,340,000
			20 years of annual O&M future value[1]	$3,144,000	$3,144,000
			20 year costs (capital + O&M)	**$2,569,000**	**$2,569,000**
			20 year future value costs (capital + O&M)	**$3,373,000**	**$3,373,000**
			Capital and operating cost per 1,000 gal	$18.84	$18.84
			Operating only cost per 1,000 gallons	$17.56	$17.56

Notes:

1. The 20-year future value costs were calculated using a 3% inflation rate

A summary of the costs for the two alternatives along with capital and operating costs per 1000 gallons is shown in Table E.108 below.

Table E.108. Summary of Year 2040 costs with 3% inflation included for the Community-Specific Scenario A for Grey Cloud Island.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)		Capital and operating cost per 1000 gal		Operating Cost per 1000 gal	
					IX	GAC	IX	GAC	IX	GAC	IX	GAC	IX	GAC
Alt 1a	>0	POETS only	121	0.03	N/A	$0.24	N/A	$0.12	N/A	$3.5	N/A	$18.9	N/A	$17.6
Alt 1b	>1	POETS only	117	0.02	N/A	$0.23	N/A	$0.12	N/A	$3.4	N/A	$18.8	N/A	$17.6

Notes:

1. Recapitalization and inflation costs are included in Total 20 year costs and are not included in the Capital and Annual O&M costs.

E.2.2.4.7 PFAS eligible cost summary

Because Grey Cloud Island does not have a municipal water system and the entire community relies on private or non-municipal wells, the cost of any GAC POET systems required due to PFAS contamination and dependent on the HI selection criteria is considered to be eligible. As such the PFAS Eligible costs will be the same as above and shown below in See Table E.109.

Table E.109. Summary of PFAS Eligible Costs Community-Specific Scenario A for Grey Cloud Island.

Option	HI	Components	POETS				

					IX	GAC	IX	GAC	IX	GAC
Alt 1a	**>0**	POETS only	121	0.03	N/A	$0.24	N/A	$0.12	N/A	$3.5
Alt 1b	**>1**	POETS only	117	0.02	N/A	$0.23	N/A	$0.12	N/A	$3.4

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.4.8 Cost summary with particle tracking costs removed

Costs presented in this section are reflective of the currently known areas of PFAS contamination and do not consider future costs associated with the potential migration of the groundwater contamination noted by the particle tracking exercise. These costs also consider only those cost considered to be eligible for funding as noted in the previous section. To evaluate the cost implications of particle tracking and the projection of future potential areas of PFAS impact, these costs were removed from the PFAS eligible cost estimate. For Grey Cloud Island this reduced the total number of GAC POETS that would be required as shown below in See Table E.110.

Table E.110. Summary of Costs Community-Specific Scenario A for Grey Cloud Island with particle tracking costs removed.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1a	**>0**	POETS only	114	0.02	N/A	$0.22	N/A	$0.11	N/A	$3.3
Alt 1b	**>1**	POETS only	69	0.01	N/A	$0.06	N/A	$0.07	N/A	$1.9

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.5 Conceptual projects – Lake Elmo

E.2.2.5.1 Project summary

The conceptual projects considered for Lake Elmo under this scenario would include the installation of two new municipal supply wells and extending water mains to nearby neighborhoods currently on PFAS impacted, non-municipal wells. GAC POET systems would be installed for any remaining PFAS impacted non-municipal wells that could not be connected to the existing municipal water system based on cost or constructability constraints. A summary of the project is provided below and the infrastructure modifications for each alternative are shown in Figures E.2.2.5.1 and E.2.2.5.2 for both HI conditions. The implications on Lake Elmo's private and non-municipal wells are shown in Figures E.2.2.1.1 and E.2.2.1.2 for both HI conditions. These two figures are regional maps illustrating the impact on private and non-municipal wells and which wells will receive GAC POETS or be connected to the distribution system as necessary.

Water supply

Lake Elmo has a municipal water system consisting of two existing wells (Wells 2 and 4) that have a combined design pumping capacity of 2,250 gpm. Previously, there were two additional wells, Wells 1 and 3. However, sample data from Well 3 indicated the well was contaminated with PFAS and was never equipped or placed into service, and Well 1 was a PFAS contaminated, multi-aquifer Well that DNR required be sealed and taken out of service. If both existing municipal supply wells were in operation, the city would have a calculated firm capacity of 1,000 gpm with the largest well out of service. The city is currently installing a third well, Well 5, which is expected to have a 1,250 gpm pumping capacity and would increase the firm capacity to 2,250 gpm. With all three wells, this firm capacity of 2,250 gpm would meet their current 2020 maximum daily demand of approximately 1,600 gpm but would be less than the anticipated 2040 maximum daily demand of 4,235 gpm. Table E.111 below summarizes the City's Well HI values and designed pumping rates.

Table E.111. Lake Elmo municipal well HI values and Pumping rates

Well No.	Design Pumping Rate (gpm)	HI Value
1	TAKEN OUT OF SERVICE	
2	1,000	0.012
3	NEVER PLACED INTO SERVICE	
4	1,250	0.011
5	1,250	N/A

E.2.2.5.2 Project improvements

New municipal supply wells

In order to supply enough clean drinking water to meet 2040 maximum daily demands and firm capacity requirements, two additional municipal supply wells, each with a capacity of 1,000 gpm, would be required. These wells would be constructed to pump water from the Jordan aquifer and three different general regions were analyzed for placement of the wells. The first region was the northeastern part of the City, close to where the existing municipal wells are located. In this area, the two new wells would be located outside a 5-mile radial buffer of White Bear Lake. The second region examined for placement was also located in the north, but inside the 5-mile radius of White Bear Lake, along Keats Avenue and Rockpoint Church. Based on available sampling data, the existing wells to the north have relatively low levels of PFAS and treatment is not currently required. The third and final region analyzed was the very southeastern corner of the City between Lake Elmo Ave and Manning Ave to the west and east and 10th Street North and the I-94 to the north and south. This area is the only approximate square mile in the southern region that is not included in the Special Well and Boring Construction area and lessens the impacts to White Bear Lake water levels. However, there are relatively higher levels of PFAS than in the northern regions, so wells in this area would likely require treatment.

To assist in the location of the new supply wells, the ground water model was used to evaluate well placement through a well interference and drawdown analysis. Proposed well locations were provided to the groundwater modeling team along with the design flow rates to determine if the potential drawdown exceeded the current limits. This process will be discussed in the following groundwater and hydraulic modeling sections.

Water treatment plants (WTPs)

As mentioned, this current round of analyses looked at two conditions used to select wells for treatment based on the two HI values of HI > 0 and HI ≥ 1. Under the first condition analyzed, wells were selected to receive treatment if they had an HI > 0 or if the well falls within an area identified as potentially becoming impacted by PFAS through the groundwater modeling particle tracking and flow path analysis. Under this conditional all existing and proposed municipal wells would receive treatment and different configurations of centralized treatment facilities are explored in the alternatives described below. Furthermore, all non-municipal supply wells will either receive treatment or be replaced with a connection to the existing municipal water supply.

Under the second condition of an HI ≥ 1, any well will be selected to receive treatment if it currently has an HI ≥ 1 or if it falls within an area identified as potentially becoming impacted by PFAS through the groundwater modeling particle tracking and flow path analysis. Under current conditions, the existing wells in the far northeast corner have HI values much lower than 1. However, results from the flow path analysis have indicated that there is the potential for the new Well 5 (currently being installed at the time of this report) to become impacted by PFAS by 2040. Therefore, Well 5 will receive treatment under both HI conditions where as both potential well locations examined in this area fell outside the 2040 PFAS impact polygons and would not require treatment under the HI ≥ 1 condition.

For the new wells in the southeast corner, current sample data from nearby non-municipal wells indicate that HI levels in the region are less than one. However, the flow path analysis indicates that these wells fall within the delineated areas of future PFAS impact and will require treatment.

Water main extension to existing neighborhoods

The available sample data indicates that the majority of non-municipal wells are currently impacted by PFAS and many have had a GAC POET system installed or been connected to the municipal system wherever possible. Under both conditions of HI > 0 and HI ≥ 1, all existing neighborhoods on private wells within the Special Well and Boring Construction Area (SWBCA) would be connected to the city's municipal water system. This SWBCA designation indicates and informs the public of potential health risks due to groundwater contamination in the area and/or provides controls on drilling municipal and non-municipal water supply wells. In addition to the neighborhoods in the SWBCA, results from the flow path analysis revealed that the residents in the Lake Jane Trail neighborhood could see potential PFAS impacts in the future and these line costs will be included in the alternatives for both HI conditions.

Table E.112 lists the neighborhoods and areas provided by the city that are proposed to be connected, with the exception of the expedited projects that have been approved (see Appendix A of the CDWSP). Residents with private wells or other non-municipal wells outside this area that are currently or are anticipated to be impacted by PFAS contamination will be addressed depending on whether it is more cost effective to provide them with GAC POET systems or connect them to the City's distribution system.

Table E.112 Proposed neighborhoods and areas that would be connected to Lake Elmo's municipal water system under this scenario.

Neighborhood		POETS ($K)	Extend Water Distribution Mains ($K)	No. of Years	No. of Years for POETS to

		Capital	O&M	20 Year Total	Capital	O&M[1]	20 Year Total		
Whistling Valley[2]	37	70	37	810	2,856	10	3056	103	75
Parkview Estates[2,3]	62	74	62	1,314	4,177	14	4457	85	66
Torre Pines[2,3]	22	39	22	479	1,269	5	1369	72	56
The Forest	18	63	18	423	568	2	608	32	28
Tartan Meadow	36	123	36	843	2,657	9	2837	94	70
Homestead[2,3]	18	46	18	406	720	3	780	45	37
20th Circle[2,3]	4	4	4	84	117	1	137	38	28
Packard/Eden Park[2,3]	62	189	62	1,429	2,848	9	3028	50	43
Downs Lake Est.	16	56	16	376	922	3	982	67	54
Klondike Ave	10	32	10	232	1,059	4	1139	171	103
Stillwater Ln/Blvd	11	35	10	235	937	4	1017	150	90
38th & 39 St.[2,3]	49	172	49	1,152	2,437	8	2597	55	46
Tapestry[3]	3	11	3	71	654	3	714	N/A	N/A
Sunfish Ponds	16	56	16	376	542	2	582	35	30
Lake Jane Trail	96	336	96	2,256	2,052	6	2172	19	18
Total	460	1,306	459	10,486	23,816	83	25,476		

Notes:

1. Operation and maintenance costs for water distribution mains are not eligible for funding under the settlement. This column represents the number of years for the costs of POETS for the entire neighborhood to exceed the costs of installing distribution mains.
2. Highlighted neighborhoods are included in the recommended options shown in Section E.4.
3. These neighborhoods are included in the PFAS eligible and particle tracking cost estimates presented in this section in Tables E.122 and E.123.
4. All neighborhoods were included in the cost estimates presented in Tables E.115 to E.121.
5. Cost estimates do not include inflation or recapitalization of assets.
6. Well sealing of $2,000 per non-municipal well is included in the distribution line estimates.
7. No consideration was given to the potential generation of revenue through water sales or service associated with similar type public water systems have been applied to this analysis.

In addition to connecting neighborhoods, distribution lines were added during the hydraulic evaluation to complete loops within the system or increase system capacity and conveyance in certain areas where lines may be undersized. The additional or parallel distribution lines are described in the alternative description and the hydraulic modeling sections below.

GAC POET systems

Under this scenario, non-municipal wells would be selected for treatment using the same HI categories as previously described. Current or anticipated PFAS impacted non-municipal wells would be provided with GAC POET systems that were not proposed to be connected to the municipal water system. According to PFAS sampling data from October 2019 and County Well Index (CWI) data, Lake Elmo has an estimated 1,309 existing non-municipal wells, of which 503 have been sampled.

For this scenario, it was assumed that all residences on private wells within the SWBCA would be connected to the city's municipal water system. Under 2040 conditions with an HI>0, none of the wells with existing GAC POETS would remain on POETS as they would be connected to the distribution system.

However, 609 wells would need to have GAC POETS installed; the majority of which are located in the northern region where, even though sample data is limited, wells are still likely to have detectable levels of PFAS contamination. Under the HI ≥ 1 condition, the same is true for all wells with existing GAC POETS and 80 wells would receive GAC POET systems. These counts exclude any wells that would be connected to the city's municipal water system through expedited projects, proposed water lines, or connections to existing water lines. Under both HI conditions, a total of approximately 609 homes would be connected to either the existing distribution system or proposed distribution line extensions.

E.2.2.5.3 Hydraulic modeling analysis

As Lake Elmo's Well 5 and proposed two wells have yet to be installed, a single point system curve was created for each well pump to maintain system pressures currently observed in the system. In addition, the drawdown analysis done by the groundwater modeling team provided the dynamic or pumping water level at each well location to increase the accuracy of the model. Similarly, for evaluating changes to the system, a single point design curve was used for existing Wells 2 and 4 to determine the necessary operating point and if the pumps would need to be modified. Under 2040 conditions, certain modifications to the system were made that were consistent across all alternatives and HI conditions.

First, as mentioned, neighborhoods in the SWBCA were connected to the existing distribution system as wells as the lines required by the approved expedited projects. Second, trunk lines were added to complete loops throughout the system. This includes mains along Hudson Blvd, 10th Street N, and Stillwater Blvd. In addition, a parallel 6-inch line was included to run alongside the existing 6-inch line in Stillwater Blvd starting at Laverne Ave to increase capacity to the proposed, connecting 12-inch trunk line. Additional parallel lines were also added depending on the alternatives to increase capacity and facilitate flow through the system while regulating system pressures. These additional parallel lines were discussed in the description of the alternatives above. The third implementation was a new water storage tower to be located in the southeast corner of the City. This water storage tower was necessary to meet not only the increased 2040 demands but also the demands of those being connected to the system as a result of PFAS contamination. Our estimates indicate that approximately 609 homes will be connected that would require an average of 175,000 gallons per day of storage. The proposed storage facility will have a total volume of 1 million gallons (MG).

Lastly, during the hydraulic modeling it was found that system pressures near the existing wells were quite high once all the wells were turned on. This is in part due to the topography of the region which causes these wells to sit at a lower elevation than its surrounding areas. In order to provide flow at sufficient pressures the head on the pumps would either need to be increased, causing higher than normal pressures in the area, or the head on the pumps could be decreased with the use of small booster pump stations that would essentially create another pressure zone around the existing pumps. Because Wood had received some consistent comments regarding higher than recommended standard pressures, it was decided that in order to reduce the pressures within the vicinity of the existing wells the head on the pumps would be reduced and small booster pump stations would be placed on the trunk lines along Stillwater Blvd, 43rd Street N, and Keats Ave N. The implementation of the booster pumps is specific to each alternative and was discussed in the alternative descriptions above.

Currently, there are four existing pressure reducing valves in the system and an additional pressure reducing valve would be required on the proposed 12-inch trunk line along 10th Street to maintain adequate pressures throughout the system. However, pressures along the far eastern edge of the community could still see some relatively higher pressures at 80 to 90 pounds per square inch (psi) depending on the implementation of the booster pumps described above. In the remaining areas, pressures in the high zone ranged from 45 to 90 psi, in the low zone from 65 to 90 psi.

E.2.2.5.4 Groundwater modeling analysis

A groundwater divide is present in Lake Elmo as shown by Berg (2019) and simulated with the Wood groundwater flow model. Groundwater east of the divide flows toward the St. Croix River and groundwater west of the divide flows toward the Mississippi River. Since the divide is located on the western side of Lake Elmo; groundwater within the city limits generally flows in an easterly direction towards the St. Croix River.

Two new municipal supply wells have been proposed for Lake Elmo that would extract water from the Jordan Sandstone. The rates used for the groundwater model analysis are summarized in Table 113. The proposed wells along with Wells 2, 4, and 5 are operating at average rates based on the 2040 average daily demand (ADD). Wells 1 and 3 are not included in the groundwater model.

Table E.113. Summary of average daily demands for the existing and proposed municipal wells in Lake Elmo.

Well	Unique Well Number	Average Daily Demand (gpm)
1	208448	Off
2	603085	257
3	655910	Off
4	767874	321
5	Not Available	321
Proposed Well 1		257
Proposed Well 2		257

To ensure the aquifer does not become unconfined, the DNR has provided written guidance on assessing the risk for exceeding groundwater head thresholds. A 50% available head threshold was designated as a warning check that drawdown needs to be assessed further. If the simulated drawdown exceeds the 50% threshold, a transient simulation applying the MDD production rate to the well of interest over a short duration of pumping would then be necessary to evaluate whether simulated drawdown does not exceed 75% of the available head. The 75% available head threshold allows for a buffer to ensure the aquifer does not become unconfined. The available head is the difference between the “static” groundwater elevation (in this case the average 2016-2018 simulated head from the calibrated steady-state groundwater flow model) and the top elevation of the aquifer. The threshold is applied to the aquifer in which the assessed well produces from and overlying aquifers (e.g. a well producing from the Jordan Sandstone aquifer requires a threshold assessment for the Jordan Sandstone and the overlying Prairie du Chien if present).

Using the guidance provided by the DNR, simulated head at the existing wells and proposed locations were evaluated under a drier setting that approaches drought conditions (worst case and herein referred to as drought) to determine whether drawdown exceeds the 50% threshold. Model recharge for drought conditions was reduced to 66% of the current condition recharge rate based on modeling by the DNR using the Soil Water Balance model over a drier time period of 2006 to 2009. For model scenarios run under drought conditions, average daily demand rates for the Lake Elmo water supply wells were increased by multiplying the current condition rates by a factor of 1.33. Pumping rates at irrigation wells were also increased by taking the maximum annual volume reported over a 20-year period (1988 – 2018). Drawdown for Scenario A under wet and dry conditions are shown on Figures E.2.2a and E.2.2b, respectively.

Under drought conditions, drawdown does not exceed the 50% available head in either the Jordan Sandstone or Prairie Du Chien aquifers. Additionally, the effect of pumping is localized such that the general groundwater flow direction is not altered. Table E.114 provides a summary of drawdown in the Jordan Sandstone aquifer under wet and drought conditions and drawdown in the Prairie Du Chien under drought conditions. The computed drawdown is relative to average 2016-2018 simulated groundwater elevations, which is considered a wet period. The available head is the difference between the average 2016-2018 simulated head and the elevation of the top of the aquifer. The percent of available head is the amount of available head that is taken up by drawdown under drought conditions.

The drought drawdown computed at existing wells is well below the 50% threshold. Drawdown at proposed wells near existing municipal wells does approach the 50% threshold under drought conditions; however, since the drawdowns do not exceed 50%, a transient analysis was not warranted. Figures showing drawdown for wet and dry conditions in Lake Elmo have been provided separately.

Table E.114. Summary of drawdown in the Jordan Sandstone and Prairie Du Chien aquifers under wet and drought conditions.

Well	Jordan Sandstone Aquifer				Prairie Du Chien Aquifer		
	Drawdown (m)		Available Head (m)	Percent of Available Head (drought)	Drawdown (m)	Available Head (m)	Percent of Available Head (drought)
	Wet	Drought			Drought		
1	Off						
2	2	4	39	10	2	11	18
3	Off						
4	4	7	42	17	2	18	11
5	2	3	38	8	1	20	5
Proposed Well 1	6	9	43	21	3	15	20
Proposed Well 2	5	8	55	15	3	17	18

Forward particle tracking to 2040 was conducted under wet, normal, and drought climate conditions from known PFAS sources and areas where HI>1, as shown on Figures E.2.2c, E.2.2d, and E.2.2e, respectively. Model recharge for normal conditions was reduced to 87% of the current condition recharge rate based on modeling by the DNR using the Soil Water Balance model over a drier time period of 1989 to 2018. Wells 2, 4, and 5 along with the two proposed wells in the northeastern region were operating at the average daily rates used for the drawdown analysis discussed above. Wells 1 and 3 were not pumping during the particle tracking scenarios as the wells were either taken out of service (Well 1) or was never equipped or placed into service (Well 3). In each of the scenarios, particles are captured by Well 5 by 2040. Particles are not captured by Wells 2, 4, and the proposed wells as these wells are located upgradient of PFAS sources and areas where HI>1.

In addition to the GW modeling efforts by Wood, the DNR has also analyzed the impacts of the proposed wells on White Bear Lake using the transient Northeast Metro Lakes Groundwater-flow (NMLG) model including the two Lake Elmo wells within the 5-mile radius along with wells from the other communities.

E.2.2.5.5 Project alternatives

A summary of each alternative including WTP sizing is provided below and costs are provided in E.2.2.5.6 Water supply configurations for these alternatives are shown on Figures E.2.2.5.1 and E.2.2.5.2.

Alternative 1a – 2040 One Centralized WTP HI > 0

Under this alternative, the two new 1,000 gpm wells required to meet the 2040 MDD were placed in the northeastern region near the existing municipal wells. One well was located off 50th Street N and the other off Marquess TR Circle N. The proposed location of these wells places them outside the White Bear Lake 5-mile radius. The new 4,250 gpm capacity WTP was sized with the largest well out of service and would be located on the north side of 50th Street N east of Lily Ave. All municipal supply wells would be hydraulically connected to the treatment facility.

Results from the hydraulic modeling, which will be explained in the following section, indicated that three small booster pumps would be needed and would create a separate pressure zone around the existing wells to prevent pressures from exceeding 110 psi in that area. Line capacity would need to be increased by installing parallel lines in the same area, notably from Well 4 down to 43rd Street N and from 50th Street N to Well 2 along Marquess Trail N and Marquess Lane N. As discussed in the previous section, all proposed neighborhoods were connected to the distribution system by installing new water lines. Additional distribution lines were installed to complete loops within the system as described in section E.2.2.5.3. These lines were included for all alternatives.

Under this alternative, 609 PFAS impacted, non-municipal wells were replaced with connections to the system and 609 wells were given GAC POET systems.

Alternative 1b – 2040 No WTPs HI ≥ 1

Under this alternative, the two new 1,000 gpm wells required to meet the 2040 MDD were placed in the same location as Alternative 1a in the northeastern region near the existing municipal wells. However, under the condition of HI ≥ 1, none of the proposed municipal wells would require treatment based on available sample data. However, particle tracking indicated that there is potential for the recently installed Well 5 may be impacted by PFAS contamination sometime in the future. Therefore, costs for a WTP at Well 5 was included. In addition, three small booster pump station were implemented to regulate pressures in the system as they were in the previous Alternative, however, the parallel line to Well 2 was not required in this alternative. As discussed in the previous section, all proposed neighborhoods were connected to the distribution system by installing new water lines.

Under this alternative, 609 PFAS impacted, non-municipal wells were connected to the system and 80 wells were given GAC POET systems.

Alternative 2a – 2040 Two Centralized WTPs HI > 0

Under this alternative the two new 1,000 gpm wells required to meet the 2040 MDD were placed in the northern region away from the existing municipal wells. One well was located near the parking lot of Rockpoint Church while the other is near Keats Ave south of 53rd Street N. The proposed location of these wells placed them within the White Bear Lake 5-mile radius. Due to the distance between the two new wells and the existing wells, two centralized WTPs were implemented. The 2,000 gpm capacity WTP to serve the two new wells was located near 59th Street N and Keats Ave. The 3,500 gpm capacity WTP to serve the existing Wells 2, 4, and 5 would be in the same location as it was in Alternative 1 - on the north side of 50th Street N east of Lily Ave. Similar to Alternative 1, three small booster pump stations were implemented to regulate pressures in the system. All proposed neighborhoods were connected to the distribution system by installing new water lines. A couple parallel lines would also be required along 50th Street N near the discharge line of the WTP and along the existing 6-inch line in Stillwater Blvd to increase conveyance capacity in the system.

Under this alternative, 609 PFAS impacted, non-municipal wells were connected to the system and 609 wells were given GAC POET systems.

Alternative 2b – 2040 No WTPs HI ≥ 1

Under this alternative, the two new 1,000 gpm wells required to meet the 2040 MDD were placed in the same location as in Alternative 2a in the northern region away from the existing municipal wells. However, under the condition of HI ≥ 1, none of the proposed municipal wells would require treatment based on available sample data. However, particle tracking indicated that there is potential for the recently installed Well 5 may be impacted by PFAS contamination sometime in the future. Therefore, costs for a WTP at Well 5 was included. As discussed in the previous section, all proposed neighborhoods were connected to the distribution system by installing new water lines.

Under this alternative, 609 PFAS impacted, non-municipal wells were connected to the system and 80 wells were given GAC POET systems.

Alternative 3a – 2040 Two Centralized WTPs HI > 0

Under this alternative, the two new 1,000 gpm well wells required to meet the 2040 MDD were placed in the southeastern corner of the City outside the SWBCA. One well was located near the northwest corner of the intersection of Manning Ave and the I-94, while the other was located near the northeast corner of Lake Elmo Ave and the I-94. The Similar to Alternative 2, the large distance between the new and existing wells justified the need for two separate WTPs. The 2,000 gpm WTP to serve the two new wells in the south would be located near the proposed well near the northeast corner of Lake Elmo Ave and the I-94 and the second well would be routed to the facility along Hudson Blvd. The 3,500 gpm capacity WTP to serve the existing Wells 2, 4, and 5 would be in the same location as it was in Alternative 1 and 2 - on the north side of 50th Street N east of Lily Ave. As discussed in the previous section, all proposed neighborhoods were connected to the distribution system by installing new water lines.

Under this alternative, 609 PFAS impacted, non-municipal wells were connected to the system and 609 wells were given GAC POET systems.

Alternative 3b – 2040 One Centralized WTP HI ≥ 1

Under this alternative, the two new 1,000 gpm wells required to meet the 2040 MDD were placed in the same location as in Alternative 3a in the southeastern corner of the City outside the SWBCA. Under the condition of HI ≥ 1, none of the existing municipal wells in the north would require treatment based on available sample data. However, particle tracking indicated that there is potential for the recently installed Well 5 may be impacted by PFAS contamination sometime in the future. Therefore, costs for a WTP at Well 5 was included. In addition, based on the available sampling data and groundwater modeling flow path analysis, the two new wells in the southeast corner would still require treatment and the 2,000 gpm WTP would be in the same location as it was in Alternative 3 as mentioned above. As discussed in the previous section, all proposed neighborhoods were connected to the distribution system by installing new water lines.

Under this alternative, 609 PFAS impacted, non-municipal wells were connected to the system and 80 wells were given GAC POET systems.

Alternative 4 – Interconnect with Woodbury

In this alternative, an interconnect for Woodbury to supply water to Lake Elmo was considered. Due to potential groundwater pumping restrictions to mitigate reduced water levels at White Bear Lake, Woodbury would provide sufficient potable water to accommodate growth in Lake Elmo from Year 2020 to Year 2040, or 2,700 gpm. 2,700 gpm is necessary to meet Lake Elmo's maximum daily water demand in 2040 with Well 5 on-line. Cost estimates associated with this alternative are only interconnect related and do not consider the existing municipal wells, non-municipal wells, or extending water mains to neighborhoods. Two new wells in Woodbury are needed along with expanded capacity at the water treatment plant, the interconnect, pump upgrades to Lake Elmo's booster pump station, and a pump station in Woodbury to send water to Lake Elmo. See Section E.4.2 and Table E.228 for the interconnect cost estimate in Recommended Option 1 at the end of this Appendix.

E.2.2.5.6 Cost estimate

The projects included in this scenario for Lake Elmo include two new municipal supply wells to replace wells impacted by PFAS, water main extensions to PFAS impacted neighborhoods, and the installation of GAC POET systems to account for residences that may not be connected to the municipal water system by 2040 due to feasibility or other unforeseen factors. A breakdown of capital and O&M costs are provided in Tables E.115-E.121 below for projected 2040 conditions.

Table E.115. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for - Lake Elmo – Alternative 1a (HI>0).

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	1	WTPs	4,500 gpm WTP	$8,810,000	$6,290,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$2,340,000	$2,340,000
New Wells	2	Wells	1,000 gpm each (NE Lake Elmo)	$4,360,000	
Well Modifications	3	Wells	Well & SCADA upgrades	$360,000	
Storage tanks	1	Tank	1 MG (growth based, 175kgal for new connections)	$2,620,000	
Booster Pump Station	3	Stations	1100, 1200, 1500 gpm	$3,240,000	
Raw water transmission mains	3.7	Miles	from wells to WTPs	$4,230,000	
Water distribution mains	5.3	Miles	connecting distribution mains	$10,620,000	
Neighborhood mains	14.6	Miles	connect 422 homes	$15,210,000	

Service Laterals	609	Each	Connect homes to existing mains ($2500 ea)	$1,522,500	
Well Sealing	609	Each	$2,000 per well	$1,218,000	
Land acquisition (site + water mains)	30.8	Acres	1 acre WTP, 20 ft easements (50%)	$4,160,000	
GAC POETS	609	POETS	Standard household systems, $2,500 per well	$1,523,000	
			Subtotal	$60,220,000	$57,700,000
			Contingency (25%)	$15,060,000	$14,430,000
			Professional services (15%)	$9,040,000	$8,660,000
			Total Capital	**$84,320,000**	**$80,790,000**
Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost	$930	$570
PFAS WTPs	1	WTP	Maint. and Operations	$550,000	$420,000
Wells	2	Wells	1,000 gpm each (NE Lake Elmo)	$140,000	
Storage Tanks	1	Tank	1 MG (growth based, 175kgal for new connections)	$52,000	
Booster Pump Station	1	Stations	1100, 1200, 1500 gpm	$170,000	
Raw water transmission mains	3.7	Miles	from wells to WTPs	$22,000	
Water distribution mains	5.3	Miles	connecting distribution mains	$54,000	
Neighborhood mains	14.6	Miles	connect 422 homes	$83,000	
GAC POETS	609	POETS	Standard household systems, $1,000 per well	$609,000	
			Subtotal	$1,680,930	$1,560,000
			20 years of annual O&M	$33,618,600	$31,200,000
			20 years of annual O&M future value[1]	$45,170,000	$41,920,000
			20 year costs (capital + O&M)	**$117,940,000**	**$111,990,000**
			20 year future value costs (capital + O&M)	**$129,490,000**	**$122,710,000**
			Capital and operating cost per 1,000 gal	$2.58	$2.45
			Operating only cost per 1,000 gallons	$0.90	$0.84
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$230,000	$180,000
Wells		2%	of Capital	$88,000	
Booster Pump Stations		2%	of Capital	$70,000	
Storage Tanks			Rehab every 20 Years	$61,000	

Water Mains	1.67%	of Capital	$502,000	
Subtotal			$960,000	$910,000
20 years of recapitalization			**$19,200,000**	**$18,200,000**
20 years of recapitalization future value[1]			**$25,800,000**	**$24,460,000**
20 year future value costs (capital + O&M + recapitalization)			**$155,290,000**	**$147,170,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.116. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for - Lake Elmo – Alternative 1b (HI>1).

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	1	WTP	1,250 gpm at Well 5	$4,090,000	$2,920,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$650,000	$650,000
New Wells	2	Wells	1,000 gpm each (NE Lake Elmo)	$4,360,000	
Well Modifications	1	Wells	Well & SCADA upgrades	$120,000	
Storage tanks	1	Tank	1 MG (growth based, 175kgal for new connections)	$2,620,000	
Booster Pump Station	3	Stations	1100, 1200, 1500 gpm	$3,240,000	
Raw water transmission mains	0.0	Miles	from wells to WTPs	$40,000	
Water distribution mains	5.0	Miles	connecting distribution mains	$10,140,000	
Neighborhood mains	14.6	Miles	connect 422 homes	$15,210,000	
Service Laterals	609	Each	Connect homes to existing mains ($2500 ea)	$1,522,500	
Well Sealing	609	Each	$2,000 per well	$1,218,000	
Land acquisition (site + water mains)	24.9	Acres	20 ft easements (50%)	$3,370,000	
GAC POETS	80	POETS	Standard household systems, $2,500 per well	$200,000	
Subtotal				$46,790,000	$45,620,000
Contingency (25%)				$11,700,000	$11,410,000
Professional services (15%)				$7,020,000	$6,850,000
Total Capital				**$65,510,000**	**$63,880,000**
Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost	$2,580	$1,570

PFAS WTPs	1	WTP	Maint. and Operations	$260,000	$200,000
Wells	2	Wells	1,000 gpm each (NE Lake Elmo)	$140,000	
Storage Tanks	1	Tank	1 MG (growth based, 175kgal for new connections)	$52,000	
Booster Pump Station	1	Stations	1100, 1200, 1500 gpm	$170,000	
Raw water transmission mains	0.04	Miles	from wells to WTPs	$1,000	
Water distribution mains	5.0	Miles	connecting distribution mains	$51,000	
Neighborhood mains	14.6	Miles	connect 422 homes	$83,000	
GAC POETS	80	POETS	Standard household systems, $1,000 per well	$80,000	
			Subtotal	$840,000	$780,000
			20 years of annual O&M	$16,800,000	$15,600,000
			20 years of annual O&M future value[1]	$22,580,000	$20,960,000
			20 year costs (capital + O&M)	**$82,310,000**	**$79,480,000**
			20 year future value costs (capital + O&M)	**$88,090,000**	**$84,840,000**
			Capital and operating cost per 1,000 gal[2]	$3.90	$3.75
			Operating only cost per 1,000 gallons[2]	$1.00	$0.93
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$100,000	$80,000
Wells		2%	of Capital	$88,000	
Booster Pump Stations		2%	of Capital	$70,000	
Storage Tanks			Rehab every 20 Years	$61,000	
Water Mains		1.67%	of Capital	$424,000	
			Subtotal	$750,000	$730,000
			20 years of recapitalization	**$15,000,000**	**$14,600,000**
			20 years of recapitalization future value[1]	**$20,160,000**	**$19,620,000**
			20 year future value costs (capital + O&M + recapitalization)	**$108,250,000**	**$104,460,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.117. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for - Lake Elmo – Alternative 2a (HI>0).

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)

Capital Cost					
PFAS Water Treatment Plants	2	WTPs	3,500 gpm WTP, 2,000 gpm WTP	$13,000,000	$9,270,000
Pretreatment at WTP	2	Lump Sum	Iron/Manganese	$2,850,000	$2,850,000
New Wells	2	Wells	1,000 gpm each (North Lake Elmo)	$4,360,000	
Well Modifications	3	Wells	Well & SCADA upgrades	$360,000	
Storage tanks	1	Tank	1 MG (growth based, 175kgal for new connections)	$2,620,000	
Booster Pump Station	3	Stations	2-1500 gpm, 1000 gpm	$3,330,000	
Raw water transmission mains	3.5	Miles	from wells to WTPs	$3,760,000	
Water distribution mains	4.4	Miles	connecting distribution mains	$8,800,000	
Neighborhood mains	14.6	Miles	connect 422 homes	$15,210,000	
Service Laterals	609	Each	Connect homes to existing mains ($2500 ea)	$1,522,500	
Well Sealing	609	Each	$2,000 per well	$1,218,000	
Land acquisition (site + water mains)	30.8	Acres	1 acre WTPs, 20 ft easements (50%)	$4,170,000	
GAC POETS	609	POETS	Standard household systems, $2,500 per well	$1,523,000	
			Subtotal	$62,730,000	$59,000,000
			Contingency (25%)	$15,690,000	$14,750,000
			Professional services (15%)	$9,410,000	$8,850,000
			Total Capital	**$87,830,000**	**$82,600,000**
Annual O&M Cost					
PFAS WTPs	2	WTP	Media Cost	$11,320	$6,870
PFAS WTPs	2	WTP	Maint. and Operations	$760,000	$570,000
Wells	2	Wells	1,000 gpm each (North Lake Elmo)	$140,000	
Storage Tanks	1	Tank	1 MG (growth based, 175kgal for new connections)	$52,000	
Booster Pump Station	3	Stations	2-1500 gpm, 1000 gpm	$170,000	
Raw water transmission mains	3.5	Miles	from wells to WTPs	$20,000	
Water distribution mains	4.4	Miles	connecting distribution mains	$50,000	
Neighborhood mains	14.6	Miles	connect 422 homes	$83,000	

GAC POETS	609	POETS	Standard household systems, $1,000 per well	$609,000	
			Subtotal	$1,895,320	$1,710,000
			20 years of annual O&M	$37,906,400	$34,200,000
			20 years of annual O&M future value[1]	$50,930,000	$45,950,000
			20 year costs (capital + O&M)	**$125,740,000**	**$116,800,000**
			20 year future value costs (capital + O&M)	**$138,760,000**	**$128,550,000**
			Capital and operating cost per 1,000 gal	$2.29	$2.12
			Operating only cost per 1,000 gallons	$0.84	$0.76
Recapitalization Costs Factored Annually					
WTPs	2%		of Capital	$320,000	$250,000
Wells	2%		of Capital	$88,000	
Booster Pump Stations	2%		of Capital	$70,000	
Storage Tanks			Rehab every 20 Years	$61,000	
Water Mains	1.67%		of Capital	$464,000	
			Subtotal	$1,010,000	$940,000
			20 years of recapitalization	**$20,200,000**	**$18,800,000**
			20 years of recapitalization future value[1]	**$27,140,000**	**$25,260,000**
			20 year future value costs (capital + O&M + recapitalization)	**$165,900,000**	**$153,810,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.118. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for - Lake Elmo – Alternative 2b (HI>1).

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	1	WTPs	1250 gpm at Well 5	$4,090,000	$2,920,000
Pretreatment at WTP	1	Lump sum	Well 5	$650,000	$650,000
New Wells	2	Wells	1,000 gpm each (North Lake Elmo)	$4,360,000	
Storage tanks	1	Tank	1 MG (growth based, 175kgal for new connections)	$2,620,000	
Booster Pump Station	3	Stations	1000 gpm, 1100 gpm, 1500 gpm	$3,130,000	

Raw water transmission mains	0.04	Miles	from wells to WTPs	$40,000	
Water distribution mains	4.6	Miles	connecting distribution mains	$9,110,000	
Neighborhood mains	14.6	Miles	connect 422 homes	$15,210,000	
Service Laterals	609	Each	Connect homes to existing mains ($2500 ea)	$1,522,500	
Well Sealing	609	Each	$2,000 per well	$1,218,000	
Land acquisition (site + water mains)	24.9	Acres	sites and 20 ft easements (50%)	$3,360,000	
GAC POETS	80	POETS	Standard household systems, $2,500 per well	$200,000	
			Subtotal	$45,520,000	$44,350,000
			Contingency (25%)	$11,380,000	$11,090,000
			Professional services (15%)	$6,830,000	$6,660,000
			Total Capital	**$63,730,000**	**$62,100,000**
Annual O&M Cost					
PFAS WTPs	0	WTP	Media Cost	$2,580	$1,570
PFAS WTPs	0	WTP	Maint. and Operations	$260,000	$200,000
Wells	2	Wells	1,000 gpm each (North Lake Elmo)	$140,000	
Storage Tanks	1	Tank	1 MG (growth based, 175kgal for new connections)	$52,000	
Booster Pump Station	3	Stations	1000 gpm, 1100 gpm, 1500 gpm	$170,000	
Raw water transmission mains	0.04	Miles	from wells to WTPs	$1,000	
Water distribution mains	4.6	Miles	connecting distribution mains	$46,000	
Neighborhood mains	14.6	Miles	connect 422 homes	$83,000	
GAC POETS	80	POETS	Standard household systems, $1,000 per well	$80,000	
			Subtotal	$834,580	$780,000
			20 years of annual O&M	$16,691,600	$15,600,000
			20 years of annual O&M future value[1]	$22,430,000	$20,960,000
			20 year costs (capital + O&M)	**$80,430,000**	**$77,700,000**
			20 year future value costs (capital + O&M)	**$86,160,000**	**$83,060,000**
			Capital and operating cost per 1,000 gal	$3.81	$3.67
			Operating only cost per 1,000 gallons	$0.99	$0.93

Recapitalization Costs Factored Annually				
WTPs	2%	of Capital	$100,000	$80,000
Wells	2%	of Capital	$88,000	
Booster Pump Stations	2%	of Capital	$70,000	
Storage Tanks		Rehab every 20 Years	$61,000	
Water Mains	1.67%	of Capital	$407,000	
		Subtotal	$730,000	$710,000
		20 years of recapitalization	**$14,600,000**	**$14,200,000**
		20 years of recapitalization future value[1]	**$19,620,000**	**$19,080,000**
		20 year future value costs (capital + O&M + recapitalization)	**$105,780,000**	**$102,140,000**

Notes:

1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.119. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for - Lake Elmo – Alternative 3a (HI>0).

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	2	WTPs	3,500 gpm WTP, 2,000 gpm WTP	$13,000,000	$9,270,000
Pretreatment at WTP	2	Lump Sum	Iron/Manganese	$2,850,000	$2,850,000
New Wells	2	Wells	1,000 gpm each (SE Lake Elmo)	$4,360,000	
Well Modifications	3	Wells	Well & SCADA upgrades	$360,000	
Storage tanks	1	Tank	1 MG (growth based, 175kgal for new connections)	$2,620,000	
Booster Pump Station	2	Stations	1200 gpm, 700 gpm	$1,810,000	
Raw water transmission mains	1.5	Miles	from wells to WTPs	$1,260,000	
Water distribution mains	4.3	Miles	connecting distribution mains	$8,620,000	
Neighborhood mains	14.6	Miles	connect 422 homes	$15,210,000	
Service Laterals	609	Each	Connect homes to existing mains ($2500 ea)	$1,522,500	
Well Sealing	609	Each	$2,000 per well	$1,218,000	
Land acquisition (site + water mains)	28.2	Acres	2 acre WTPs, 20 ft easements (50%)	$3,820,000	

GAC POETS	609	POETS	Standard household systems, $2,500 per well	$1,523,000	
			Subtotal	$58,180,000	$54,450,000
			Contingency (25%)	$14,550,000	$13,620,000
			Professional services (15%)	$8,730,000	$8,170,000
			Total Capital	**$81,460,000**	**$76,240,000**
Annual O&M Cost					
PFAS WTPs	2	WTP	Media Cost	$11,320	$6,870
PFAS WTPs	2	WTP	Maint. and Operations	$760,000	$570,000
Wells	2	Wells	1,000 gpm each (SE Lake Elmo)	$140,000	
Storage Tanks	1	Tank	1 MG (growth based, 175kgal for new connections)	$52,000	
Booster Pump Station	2	Stations	1200 gpm, 700 gpm	$100,000	
Raw water transmission mains	1.5	Miles	from wells to WTPs	$7,000	
Water distribution mains	4.3	Miles	connecting distribution mains	$44,000	
Neighborhood mains	14.6	Miles	connect 422 homes	$83,000	
GAC POETS	609	POETS	Standard household systems, $1,000 per well	$609,000	
			Subtotal	$1,806,320	$1,620,000
			20 years of annual O&M	$36,126,400	$32,400,000
			20 years of annual O&M future value[1]	$48,540,000	$43,540,000
			20 year costs (capital + O&M)	**$117,590,000**	**$108,640,000**
			20 year future value costs (capital + O&M)	**$130,000,000**	**$119,780,000**
			Capital and operating cost per 1,000 gal	$2.14	$1.98
			Operating only cost per 1,000 gallons	$0.80	$0.72
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$320,000	$250,000
Wells		2%	of Capital	$88,000	
Booster Pump Stations		2%	of Capital	$40,000	
Storage Tanks			Rehab every 20 Years	$61,000	
Water Mains		1.67%	of Capital	$419,000	
			Subtotal	$930,000	$860,000
			20 years of recapitalization	**$18,600,000**	**$17,200,000**

20 years of recapitalization future value[1]	**$24,990,000**	**$23,110,000**
20 year future value costs (capital + O&M + recapitalization)	**$154,990,000**	**$142,890,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.120. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for - Lake Elmo – Alternative 3b (HI>1).

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	2	WTPs	2,000 gpm WTP for new wells, 1250 gpm for W5	$9,510,000	$6,780,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$1,690,000	$1,690,000
New Wells	2	Wells	1,000 gpm each (SE Lake Elmo)	$4,360,000	
Well Modifications	1	Well	Well 5	$120,000	
Storage tanks	1	Tank	1 MG (growth based, 175kgal for new connections)	$2,620,000	
Raw water transmission mains	1.0	Miles	from wells to WTPs	$840,000	
Water distribution mains	4.3	Miles	connecting distribution mains	$8,620,000	
Neighborhood mains	14.6	Miles	connect 422 homes	$15,210,000	
Service Laterals	609	Each	Connect homes to existing mains ($2500 ea)	$1,522,500	
Well Sealing	609	Each	$2,000 per well	$1,218,000	
Land acquisition (site + water mains)	26.6	Acres	2 acre WTP, 20 ft easements (50%)	$3,600,000	
GAC POETS	80	POETS	Standard household systems, $2,500 per well	$200,000	
			Subtotal	$49,520,000	$46,790,000
			Contingency (25%)	$12,380,000	$11,700,000
			Professional services (15%)	$7,430,000	$7,020,000
			Total Capital	**$69,330,000**	**$65,510,000**
Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost	$6,690	$4,060
PFAS WTPs	1	WTP	Maint. and Operations	$580,000	$450,000
Wells	2	Wells	1,000 gpm each (SE Lake Elmo)	$140,000	

Storage Tanks	1	Tank	1 MG (growth based, 175kgal for new connections)	$52,000	
Raw water transmission mains	1.0	Miles	from wells to WTPs	$5,000	
Water distribution mains	4.3	Miles	connecting distribution mains	$44,000	
Neighborhood mains	14.6	Miles	connect 422 homes	$83,000	
GAC POETS	80	POETS	Standard household systems, $1,000 per well	$80,000	
			Subtotal	$990,690	$860,000
			20 years of annual O&M	$19,813,800	$17,200,000
			20 years of annual O&M future value[1]	$26,630,000	$23,110,000
			20 year costs (capital + O&M)	**$89,150,000**	**$82,710,000**
			20 year future value costs (capital + O&M)	**$95,960,000**	**$88,620,000**
			Capital and operating cost per 1,000 gal	$4.24	$3.92
			Operating only cost per 1,000 gallons	$1.18	$1.02
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$230,000	$170,000
Wells		2%	of Capital	$88,000	
Storage Tanks			Rehab every 20 Years	$61,000	
Water Mains		1.67%	of Capital	$412,000	
			Subtotal	$800,000	$740,000
			20 years of recapitalization	**$16,000,000**	**$14,800,000**
			20 years of recapitalization future value[1]	**$21,500,000**	**$19,890,000**
			20 year future value costs (capital + O&M + recapitalization)	**$117,460,000**	**$108,510,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.121. Summary of Year 2040 costs with 3% inflation included for the three alternatives for the Community-Specific Scenario A for Lake Elmo in millions of dollars ($Ms).

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)		Capital and operating cost per 1000 gal		Operating Cost per 1000 gal	
					IX	GAC	IX	GAC	IX	GAC	IX	GAC	IX	GAC
Alt 1a	>0	1 WTP (4500 gpm), wells in NE	609	6.86	$81	$84	$1.6	$1.7	$147	$155	$2.4	$2.6	$0.8	$0.9

Alt 1b	>1	2 wells NE, 1 WTP (1250 gpm)	80	3.10	$64	$66	$0.8	$0.8	$104	$108	$3.8	$3.9	$0.9	$1.0
Alt 2a	>0	2 WTPS (3500, 2000 gpm), wells in North	609	8.30	$83	$88	$1.7	$1.9	$154	$166	$2.1	$2.3	$0.8	$0.8
Alt 2b	>1	2 wells North, 1 WTP (1250 gpm)	80	3.10	$62	$64	$0.8	$0.8	$102	$106	$3.7	$3.8	$0.9	$1.0
Alt 3a	>0	2 WTPS (3500, 2000 gpm), 2 wells SE	609	8.30	$76	$81	$1.6	$1.8	$143	$155	$2.0	$2.1	$0.7	$0.8
Alt 3b	>1	2 WTPs (2000 gpm for new wells, 1250 gpm for W5), 2 wells SE	80	3.10	$66	$69	$0.9	$1.0	$109	$117	$3.9	$4.2	$1.0	$1.2

Notes:

1. Recapitalization and inflation costs are included in Total 20 year costs and are not included in the Capital and Annual O&M costs.

While, Alternatives 1a and 1b cost slightly more than Alternative 3, they were carried forward into the final summary table for the Community Scenario A because they had other ancillary benefits such as locating wells that do not require treatment outside the 5-mile radius of White Bear Lake. However, due to issues associated with the new wells' close proximity to White Bear Lake, the option to have water supplied to Lake Elmo from either SPRWS (as discussed in Section E.2.3) or Woodbury (as described in Chapter 7 and Section E.4) was also examined.

E.2.2.5.7 PFAS eligible cost summary

The cost estimates presented above include all related costs for each given alternative to meet Year 2040 water demands. However, for various reasons, some costs may not be covered by settlement funds. The guidelines used to determine project components that would be eligible for settlement funding were presenting in the Appendix E Introduction.

Costs identified as water distribution mains and booster pump stations were considered to be ineligible for funding as they are necessary for growth. Capital costs for raw water mains and 9.3 miles of neighborhood mains to connect 257 homes are included along with the associated service laterals and non-municipal well sealings. New wells and storage tank capital costs were included using a prorated amount of 8% to account for the 257 new connections to the water system. Operation and maintenance costs were excluded for all components except for the treatment plants and POETS. See Table E.122 for a summary of the settlement eligible costs.

Table E.122. Summary of PFAS Eligible Costs Community-Specific Scenario A for Lake Elmo.

Option	HI	Components	POETS	Treated Water	Capital cost ($Ms)	Annual O&M cost ($Ms)	Total 20 year costs ($Ms)

				provided (MGD)	IX	GAC	IX	GAC	IX	GAC
Alt 1a	**>0**	1 WTP (4500 gpm), wells in NE	933	6.85	$41.6	$45.1	$1.4	$1.5	$78.2	$85.0
Alt 1b	**>1**	2 wells NE (no WTPs)	399	3.07	$14.9	$16.5	$0.7	$0.8	$34.0	$37.2

Notes:
1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.5.8 Cost summary with particle tracking costs removed

Costs presented in this section are reflective of the currently known areas of PFAS contamination and do not consider future costs associated with the potential migration of the groundwater contamination noted by the particle tracking exercise. These costs also consider only those cost considered to be eligible for funding as noted in the previous section. To evaluate the cost implications of particle tracking and the projection of future potential areas of PFAS impact, these costs were removed from the PFAS eligible cost estimate. For Lake Elmo the cost of 39 POETS for HI>0 and 380 POETS for HI≥1 were removed from the estimate shown in Table E.123.

Table E.123. Summary of Costs Community-Specific Scenario A for Lake Elmo with particle tracking costs removed

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1a	**>0**	1 WTP (4500 gpm), wells in NE	894	6.83	$41	$45	$1.3	$1.4	$77	$84
Alt 1b	**>1**	2 wells NE (no WTPs)	19	2.97	$19	$19	$0.02	$0.02	$20	$20

Notes:
1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.6 Conceptual projects – Lakeland, Lakeland Shores, and Lake St. Croix Beach

E.2.2.6.1 Project summary

The conceptual projects considered for Lakeland (and included communities of Lakeland Shores and Lake St. Croix Beach) under this scenario would include extending water mains to additional neighborhoods by 2040 and replacing remaining non-municipal wells with connections to the municipal water system. A summary of the projects is provided below and the infrastructure modifications for each alternative are shown in Figures E.2.2.6.1 and E.2.2.6.2 for both HI conditions. The implications on Lakeland's private and non-municipal wells are shown in Figures E.2.2.1.1 and E.2.2.1.2 for both HI conditions. These two figures are regional maps illustrating the impact on private and non-municipal wells and which wells will receive GAC POETS or be connected to the distribution system as necessary.

Water supply

Lakeland currently has a municipal water system consisting of two existing municipal wells (Wells 1 and 2) that have a combined design capacity of 1,500 gpm, as shown in Table E.124. Due to high iron and manganese levels, both wells are receiving treatment for these compounds. Under firm capacity conditions with their largest well out of service, Lakeland's current supply produces 750 gpm which is sufficient to meet their current demand as well as their 2040 maximum daily demand of approximately 750 gpm which includes Lakeland, Lakeland Shores, Lake St. Croix Beach, and St. Mary's Point.

Table E.124. Lakeland's municipal well HI values and Pumping rates

Well No.	Design Pumping Rate (gpm)	HI Value
1	750	0.002
2	750	0.002
Total	1,500	

E.2.2.6.2 Project improvements

Water treatment plants (WTPs)

This scenario included two conditions used to select wells for treatment based on the two HI values of HI > 0 and HI ≥ 1. Under the first condition analyzed, both of Lakeland's municipal supply wells would receive treatment as described in the alternatives described below. Furthermore, all non-municipal supply wells will either receive treatment or be replaced with a connection to the existing municipal water supply and the existing well sealed.

Water main extension to existing neighborhoods

The City of Lakeland has indicated that they plan to continue connecting residents and businesses to their municipal water system. This includes residents and businesses that may already be connected but have a non-municipal well for irrigation purposes. Under this scenario, the irrigation wells would be sealed and the consumer/resident would be connected to the existing municipal water system. The existing municipal water system is almost completely built out for the communities of Lakeland, Lakeland Shores, and Lake St. Croix Beach. However, the City has reserved capacity of their municipal supply wells that would enable them to extend water lines to St. Mary's Point to serve any PFAS impacted residents by 2040 as necessary. The cost of installing new distribution lines to serve St. Mary's Point was not included in the cost estimate.

GAC POET systems

This scenario would include GAC POET systems for PFAS impacted non-municipal wells until they were connected to the municipal water system. Non-municipal wells would be selected for treatment using the same HI categories as previously described. As of October 2019 sample data and Minnesota Well Index (MWI) data, Lakeland, including Lakeland Shores, Lake St. Croix Beach, and St. Mary's Point have an estimated 554 existing non-municipal wells, of which 75 have been sampled as shown in Table E.125 below.

Table E.125. Summary of Non-Municipal Wells

Community	Number of Wells from CWI	Number of Wells Sampled

Lake St. Croix Beach	119	2
Lakeland	296	58
Lakeland Shores	41	12
St. Mary's Point	98	3
LAKELAND TOTAL	554	75

For the purposes of this analysis and based on the groundwater modeling analysis described below, all non-municipal wells were assumed to be replaced by a connection to the existing distribution system as opposed to receiving GAC POETS with the exception of three wells that would receive a POET system and one well that had an existing POET system in place. In addition, while particle tracking indicates about half of Lake St. Croix Beach may be impacted by 2040, the entire community was included for connection to the existing distribution as well since the community is already being served by Lakeland's municipal distribution system. Therefore, with the exception of St. Mary's Point, it was assumed that 453 non-municipal wells would be replaced with connections to Lakeland's municipal water system by 2040. The number of these wells being replaced with connections excludes three wells in Lakeland that will receive GAC POETS due to feasibility concerns with connecting them. It is noted that until all residences could be connected to the municipal water system, GAC POET systems would be an interim solution. Table E.126 below compares the cost of sealing wells and installing lateral water lines, which is an upfront capital cost, to the cost of installing GAC POETS over 20 years. The impact to residences utility bills is not included in the table below, as the residence would have a reoccurring water bill and would see a decrease in electricity usage with the well going off-line.

Table E.126. Cost comparison between sealing and replacing a well with a municipal supply connection and POET systems.

Non-municipal well alternatives	No. of Existing Wells	Costs ($K)		
		Capital	O&M	20 Year Total[2]
Well Sealing and Laterals	453	2,052	See note 1	2,052
GAC POETS	453	1,596	456	10,716

Note:
1. These costs do not include impacts to monthly or quarterly utility bills, such as water bills or electric bills.
2. 20 year total costs do not account for inflation or recapitalization costs.

E.2.2.6.3 Hydraulic modeling analysis

System operations for Lakeland would not change under this scenario for either HI condition with the exception of implementing additional treatment equipment and facilities at each well for the HI>0 condition. The municipal supply wells would continue to operate as they are currently across one pressure zone. Under 2040 conditions, the range of pressures seen in the system ranged from 40 to 90 psi. No modifications to the municipal water system are recommended at this time to meet 2040 demands. However, if the City implements PFAS treatment at each well under the HI>0 condition, the well pumps may need to be modified to operate at a higher head or discharge pressure to move water through the treatment vessels. If the city decides to serve St. Mary's Point, further analysis would be required to expand the existing distribution system; however, the city has enough water supply to meet the additional demand.

E.2.2.6.4 Groundwater modeling analysis

Forward particle tracking to 2040 was conducted under wet, normal, and drought climate conditions from known PFAS sources and areas where HI>1, as shown on Figures E.2.2c, E.2.2d, and E.2.2e, respectively. Particle movement simulated in the model travel in the direction of groundwater flow which in the uppermost bedrock aquifers is east toward the St. Croix River. Lakeland (and included communities of Lakeland Shores and Lake St. Croix Beach), is located within the Hudson-Afton Horst (HAH). The uppermost bedrock aquifer is primarily the Mt. Simon Sandstone; however, Tunnel City Group and Wonewoc Sandstone are also present in the southwest corner of Lakeland and western region of Lake St. Croix Beach. A large cluster of groundwater samples with HI>1 is located in neighboring West Lakeland Township. The samples were collected primarily from wells drilled into the Prairie Du Chien and Jordan Sandstone aquifers. Additionally, a smaller cluster of HI>1 samples were collected from Tunnel City Group and Wonewoc Sandstone aquifers in the northeast corner of the neighboring city of Afton. Particles inserted around those clusters of wells travel east across faults bounding the HAH into Lakeland reaching wells (Well 2 and other non-municipal wells) within the city limits by the year 2040. Well 1 does not appear to capture particles; however, the well is located within close proximity to a small cluster of Quaternary wells with HI>1 along the northern Lakeland boundary.

A drawdown analysis was not performed for Lakeland since no new wells were proposed.

E.2.2.6.5 Project alternatives

A summary of each alternative including WTP sizing is provided below and costs are provided in E.2.2.6.6. Water supply configurations for these alternatives are shown on Figures E.2.2.6.1 and E.2.2.6.2.

Alternative 1a – 2040 Two Centralized WTPs HI > 0

Under this alternative, each well would receive treatment on-site and existing treatment facilities and equipment for iron and manganese would be kept in service. Each treatment facility would be sized to meet the design flow of each well or 750 gpm. As mentioned above, PFAS impacted residents would be connected to the system and their existing well sealed.

Alternative 1b – 2040 No Centralized WTP HI ≥ 1

Under this alternative, the two municipal supply wells would not need PFAS treatment but treatment facilities and equipment for iron and manganese removal would be kept in service. As mentioned in the previous alternative, PFAS impacted residents would be connected to the system and their existing well sealed.

E.2.2.6.6 Cost estimate breakdown

A breakdown of capital and O&M costs for each alternative described above is provided in Tables E.127 and E.128 for the year 2040. All non-municipal wells would be replaced with connections to the city's municipal water system and be sealed by 2040.

Table E.127. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for Lakeland and Lakeland Shores-Alternative 1a.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					

PFAS Water Treatment Plants	2	WTP	750 gpm each	$6,020,000	$4,290,000
Pretreatment at WTP	0	Lump Sum	already installed	$0	$0
Well Modifications	2	Wells	Well & SCADA upgrades	$240,000	
Service Laterals	453	Ea	Connect homes to existing mains ($2500 ea)	$1,132,500	
Well Sealing	453	Ea	$2,000 per well	$906,000	
Land acquisition (site + water mains)	1.0	Acres	0.5 acres at each WTP	$140,000	
GAC POETS	3	POETS	Standard household systems, $2,500 per well	$8,000	
			Subtotal	$8,450,000	$6,720,000
			Contingency (25%)	$2,120,000	$1,680,000
			Professional services (15%)	$1,270,000	$1,010,000
			Total Capital	**$11,840,000**	**$9,410,000**
Annual O&M Cost					
PFAS WTPs	2	WTP	Media is not anticipated to be changed due to low PFAS conc.	$0	
PFAS WTPs	0	WTP	Maint. and Operations	$360,000	$270,000
Well sealing & laterals	No on-going maintenance or O&M, both would become responsibility of well owner			$0	
GAC POETS	4	POETS	Standard household systems, $1,000 per well	$4,000	
			Subtotal	$364,000	$274,000
			20 years of annual O&M	$7,280,000	$5,480,000
			20 years of annual O&M future value[1]	$9,790,000	$7,370,000
			20 year costs (capital + O&M)	**$19,120,000**	**$14,890,000**
			20 year future value costs (capital + O&M)	**$21,630,000**	**$16,780,000**
			Capital and operating cost per 1,000 gal	$1.31	$1.01
			Operating only cost per 1,000 gallons	$0.59	$0.45
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$130,000	$90,000
			Subtotal	$130,000	$90,000
			20 years of recapitalization	**$2,600,000**	**$1,800,000**
			20 years of recapitalization future value[1]	**$3,500,000**	**$2,420,000**
			20 year future value costs (capital + O&M + recapitalization)	**$25,130,000**	**$19,200,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.128. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for Lakeland and Lakeland Shores-Alternative 1b.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
Service Laterals	453	Ea	Connect homes to existing mains ($2500 ea)	$1,132,500	
Well Sealing	453	Ea	$2,000 per well	$906,000	
GAC POETS	3	POETS	Standard household systems, $2,500 per well	$8,000	
			Subtotal	$2,047,000	$2,047,000
			Contingency (25%)	$512,000	$512,000
			Professional services (15%)	$308,000	$308,000
			Total Capital	**$2,867,000**	**$2,867,000**
Annual O&M Cost					
Well sealing & laterals	No on-going maintenance or O&M, both would become responsibility of well owner			$0	
GAC POETS	4	POETS	Standard household systems, $1,000 per well	$4,000	
			Subtotal	$4,000	$4,000
			20 years of annual O&M	$80,000	$80,000
			20 years of annual O&M future value[1]	$110,000	$110,000
			20 year costs (capital + O&M)	**$2,950,000**	**$2,950,000**
			20 year future value costs (capital + O&M)	**$2,980,000**	**$2,980,000**
			Capital and operating cost per 1,000 gal	$3.81	$3.81
			Operating only cost per 1,000 gallons	$0.14	$0.14

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.129. Summary of Year 2040 costs with 3% inflation included for the Community-Specific Scenario A for Lakeland, Lakeland Shores, and St. Croix Beach

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)		Capital and operating cost per 1000 gal		Operating Cost per 1000 gal	
					IX	GAC	IX	GAC	IX	GAC	IX	GAC	IX	GAC
Alt 1a	>0	2 WTPs (750 gpm each)	4	2.27	$9.4	$12	$0.3	$0.4	$17	$22	$1.0	$1.3	$0.4	$0.6

Alt 1b	>1	453 Service connections	4	0.11	$2.9	$3	$0.0	$0.0	$3.0	$3.0	$3.8	$3.8	$0.1	$0.1

Notes:

1. Recapitalization and inflation costs are included in Total 20 year costs and are not included in the Capital and Annual O&M costs.

E.2.2.6.7 PFAS eligible cost summary

The cost estimates presented above include all related costs for each given alternative to meet Year 2040 water demands. However, for various reasons, some costs may not be covered by settlement funds. The guidelines used to determine project components that would be eligible for settlement funding were presenting in the Appendix E Introduction.

All capital costs for Lakeland were considered eligible for settlement funding. Table E.130 below includes the same capital and operation and maintenance costs as Table E.129, but it does not include recapitalization costs.

Table E.130. Summary of PFAS Eligible Costs Community-Specific Scenario A for Lakeland, Lakeland Shores, and St. Croix Beach.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1a	>0	2 WTPs (750 gpm each)	4	2.27	$9.4	$12	$0.3	$0.4	$17	$22
Alt 1b	>1	453 Service connections	4	0.11	$2.9	$3	$0.0	$0.0	$3.0	$3.0

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.6.8 Cost summary with particle tracking costs removed

Costs presented in this section are reflective of the currently known areas of PFAS contamination and do not consider future costs associated with the potential migration of the groundwater contamination noted by the particle tracking exercise. These costs also consider only those cost considered to be eligible for funding as noted in the previous section. To evaluate the cost implications of particle tracking and the projection of future potential areas of PFAS impact, these costs were removed from the PFAS eligible cost estimate. For Lakeland, the area is already impacted by PFAS contamination and no costs were removed due to projected PFAS migration, as shown in Table E.131.

Table E.131. Summary of Costs Community-Specific Scenario A for Lakeland, Lakeland Shores, and St. Croix Beach with Particle Tracking costs removed.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC

Alt 1a	**>0**	2 WTPs (750 gpm each)	4	2.27	$9.4	$12	$0.3	$0.4	$17	$22
Alt 1b	**>1**	456 Service connections	4	0.11	$2.9	$3	$0.0	$0.0	$3.0	$3.0

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.7 Conceptual projects – Maplewood

E.2.2.7.1 Project summary

The conceptual projects considered for Maplewood under this scenario would include connecting residences on PFAS impacted non-municipal wells to the existing St. Paul Regional Water Services (SPRWS) system as well as the installation of POETS for 2040 conditions. A summary of the project is provided below and the infrastructure modifications for each alternative are shown in Figure E.1.1.8.1 for both HI conditions. The implications on Maplewood's private and non-municipal wells are shown in Figures E.2.2.1.1 and E.2.2.1.2 for both HI conditions. These two figures are regional maps illustrating the impact on private and non-municipal wells and which wells will receive GAC POETS or be connected to the distribution system as necessary.

E.2.2.7.2 Project improvements

Water main extension to existing neighborhoods

The SPRWS system could be extended and looped to include a neighborhood that is south of Highway 494, and is bounded on northwest by Highway 494, east by Century Ave, and south by Carver Ave. A 1.4 mile 8-inch diameter line could be extended to connect the 35 existing homes which are within areas expected to be impacted by PFAS by 2040. In this neighborhood, three homes currently have GAC systems installed and all three exceed HI>1. As shown in Table E.132 below, if the entire neighborhood required POET systems, the cost of the POET systems would exceed the cost of installing distribution mains in 75 years. Installing water distribution mains and service connections for the 35 homes in this neighborhood is included in both HI>1 and HI>0 alternatives.

To the south of the Century and Carver Ave. neighborhood is another pocket of 42 homes that could be tied into the SPRWS. This area is south of Carver Ave., east of Highway 494, and ends about 800 feet north of Bailey Road at the city line. The homes are on both sides of Sterling Street and on Haller Lane E. This area is not easily looped with water mains and requires 11,900 feet of 8-inch water mains to serve the area by SPRWS. All homes in this area have existing PFAS concentrations less than HI=0.25, and could be included in the HI>0 alternative. For the purposes of this evaluation and the relatively low cost-benefit of extending water mains, this neighborhood was not included in Alternative 1b cost estimate.

The table below highlights the differences in the long-term operations and maintenance (O&M) costs of POETS versus the lower O&M, but higher initial installation cost of water mains.

Table E.132. Proposed neighborhoods and areas that could be connected to St. Paul Regional Water Services under this scenario.

Neighborhood	No. of Existing Homes	POETS ($K)			Extend Water Distribution Mains ($K)			No. of Years for POETS to Exceed Mains	No. of Years for POETS to Exceed Mains (PFAS Eligible)[1]
		Capital	O&M	20 Year Total	Capital	O&M[1]	20 Year Total		
Carver & Century Av.[2,3]	38	119	38	879	2,273	8	2,433	75	57
Sterling St. & Haller Ln E.[2]	42	147	42	987	3,463	12	3,703	110	79
Total (existing homes)	80	266	76	1,866	5,448	20	6,136		

Notes:

1. Operation and maintenance costs for water distribution mains are not eligible for funding under the settlement. This column represents the number of years for the costs of POETS for the entire neighborhood to exceed the costs of installing distribution mains.
2. These neighborhoods are not included in the recommended options shown in Section E.4.
3. These neighborhoods are included in the cost estimates presented in this section.
4. Cost estimates do not include inflation or recapitalization of assets.
5. Well sealing of $2,000 per non-municipal well is included in the distribution line estimates.
6. No consideration was given to the potential generation of revenue through water sales or service associated with similar type public water systems have been applied to this analysis.

GAC POETS

As of October 2019 sample data, Maplewood has an estimated 602 existing non-municipal wells, of which 38 wells have been sampled. Within the southern region of Maplewood, four residences have GAC POET systems installed and one residence does not but has a HI value greater than or equal to 0.5, but less than HI=1. These wells and the other remaining wells in the area would be connected to SPRWS's existing distribution system by extending the water lines along Century and Carver Ave, as discussed above. Based on current sampling data, it was estimated that by 2040 a total of 388 non-municipal wells would have HI values greater than or equal to 0 and would receive treatment through GAC POET systems. Groundwater flow path analysis indicates that by 2040, there will not be any additional wells impacted in the HI>1 condition. Zero POETS are necessary in 2040 for the HI>1 alternative.

E.2.2.7.3 Hydraulic modeling analysis

No drinking water distribution model was created for Maplewood as SPRWS owns, operates, and maintains their system-wide distribution model that includes various other communities. All new lines were assumed to be 8-inch for cost estimating purposes and to meet the minimum size requirement for the water system.

E.2.2.7.4 Groundwater modeling analysis

Forward particle tracking to 2040 was conducted under wet, normal, and drought climate conditions from known PFAS sources and areas where HI>1, as shown on Figures E.2.2c, E.2.2d, and E.2.2e, respectively. The particles inserted into the model travel in the direction of groundwater flow. In Maplewood, groundwater flow in the Prairie Du Chien and Jordan Sandstone aquifers is generally from northeast to southwest, toward the Mississippi River. Although the southern region of Maplewood is downgradient from known PFAS sources and areas where HI>1, particles originating at those areas do not reach wells located in Maplewood by 2040. A drawdown analysis was not performed for Maplewood since no new wells were proposed.

E.2.2.7.5 Project alternatives

A summary of each alternative is provided below and costs are provided in E.2.2.7.6. Water supply configurations for these alternatives are shown on Figure E.1.1.8.1.

Alternative 1a – 2040 HI > 0

In this alternative, SPRWS water distribution mains are extended along Carver Ave and S. Century Ave. to provide service to 35 homes in the area. The remaining areas of Maplewood currently on non-municipal wells would receive POETS.

Alternative 1b – 2040 HI ≥ 1

This alternative is identical to Alternative 1a, but no POETS are necessary as all non-municipal wells that are impacted are connected to SPRWS.

E.2.2.7.6 Cost estimate breakdown

Capital and O&M costs are summarized in Tables E.133 and E.134 for the year 2040.

Table E.133. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for Maplewood-Alternative 1a.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
Neighborhood mains	1.44	Miles	connect 35 homes (Carter & Century Ave)	$1,480,000	
Service Laterals	35	Each	Connect homes to existing mains ($2500 ea)	$87,500	
Well Sealing	35	Each	$2,000 per well	$70,000	
Land acquisition (water mains)	1.7	Acres	easements for water mains	$240,000	
GAC POETS	388	POETS	Standard household systems, $2,500 per well	$970,000	
			Subtotal	$2,848,000	$2,848,000
			Contingency (25%)	$712,000	$712,000
			Professional services (15%)	$428,000	$428,000
			Total Capital	**$3,988,000**	**$3,988,000**
Annual O&M Cost					
Neighborhood mains	1.44	Miles	connect 35 homes (Carter & Century Ave)	$8,000	
GAC POETS	388	POETS	Standard household systems, $1,000 per well	$388,000	

		Subtotal	$396,000	$396,000
		20 years of annual O&M	$7,920,000	$7,920,000
		20 years of annual O&M future value[1]	$10,650,000	$10,650,000
		20 year costs (capital + O&M)	**$11,910,000**	**$11,910,000**
		20 year future value costs (capital + O&M)	**$14,640,000**	**$14,640,000**
		Capital and operating cost per 1,000 gal	$17.71	$17.72
		Operating only cost per 1,000 gallons	$12.88	$12.88
Recapitalization Costs Factored Annually				
Water Mains	1.67%	of Capital	$25,000	
		Subtotal	$25,000	$25,000
		20 years of recapitalization	**$500,000**	**$500,000**
		20 years of recapitalization future value[1]	**$680,000**	**$680,000**
		20 year future value costs (capital + O&M + recapitalization)	**$15,320,000**	**$15,320,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.134. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for Maplewood-Alternative 1b

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
Neighborhood mains	1.44	Miles	connect 35 homes (Carter & Century Ave)	$1,480,000	
Service Laterals	35	Each	Connect homes to existing mains ($2500 ea)	$87,500	
Well Sealing	35	Each	$2,000 per well	$70,000	
Land acquisition (water mains)	1.7	Acres	easements for water mains	$240,000	
GAC POETS	0	POETS	Standard household systems, $2,500 per well	$0	
			Subtotal	$1,878,000	$1,878,000
			Contingency (25%)	$470,000	$470,000
			Professional services (15%)	$282,000	$282,000
			Total Capital	**$2,630,000**	**$2,630,000**
Annual O&M Cost					
Neighborhood mains	1.44	Miles	connect 35 homes (Carter & Century Ave)	$8,000	
GAC POETS (TBD)	0	POETS	Standard household systems, $1,000 per well	$0	
			Subtotal	$8,000	$8,000
			20 years of annual O&M	$160,000	$160,000

20 years of annual O&M future value[1]			$220,000	$220,000
20 year costs (capital + O&M)			**$2,790,000**	**$2,790,000**
20 year future value costs (capital + O&M)			**$2,850,000**	**$2,850,000**
Capital and operating cost per 1,000 gal			$41.66	$41.66
Operating only cost per 1,000 gallons			$3.22	$3.22
Recapitalization Costs Factored Annually				
Water Mains	1.67%	of Capital	$25,000	
Subtotal			$25,000	$25,000
20 years of recapitalization			**$500,000**	**$500,000**
20 years of recapitalization future value[1]			**$680,000**	**$680,000**
20 year future value costs (capital + O&M + recapitalization)			**$3,530,000**	**$3,530,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

A summary of the costs for the two alternatives along with capital and operating costs per 1000 gallons is shown in Table E.135 below.

Table E.135. Summary of Year 2040 costs with 3% inflation included for the Community-Specific Scenario A for Maplewood.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)		Capital and operating cost per 1000 gal		Operating Cost per 1000 gal	
					IX	GAC	IX	GAC	IX	GAC	IX	GAC	IX	GAC
Alt 1a	>0	water main extension for 35 connections	388	0.11	N/A	$4.0	N/A	$0.40	N/A	$14.6	N/A	$17.7	N/A	$12.9
Alt 1b	>1	water main extension for 35 connections	0	0.01	N/A	$2.6	N/A	$0.01	N/A	$3.5	N/A	$41.7	N/A	$3.2

Notes:
1. Recapitalization and inflation costs are included in Total 20 year costs and are not included in the Capital and Annual O&M costs.

E.2.2.7.7 PFAS eligible cost summary

The cost estimates presented in Alternative 1a and 1b above include all related costs for each given alternative to meet Year 2040 water demands. However, for various reasons, some costs may not be covered by settlement funds. The guidelines used to determine project components that would be eligible for settlement funding were presented in the Appendix E Introduction.

Neighborhood water mains connecting the Century and Carver Ave neighborhood were removed for this estimate along with the associated improvements for well sealing, service laterals, and land acquisition. Removing the neighborhood from the PFAS eligible cost estimate increased the number of POETS to 497 in the HI>0 alternative and increased the number of POETS in HI≥1 to 4. Costs are summarized in Table E.136.

Table E.136. Summary of PFAS Eligible Costs Community-Specific Scenario A for Maplewood.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1a	**>0**	497 POETS, no connections	497	0.13	N/A	$1.7	N/A	$0.50	N/A	$15.1
Alt 1b	**>1**	4 POETS, no connections	4	0.00	N/A	$0.0	N/A	$0.00	N/A	$0.1

Notes:
1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.7.8 Cost summary with particle tracking costs removed

Costs presented in this section are reflective of the currently known areas of PFAS contamination and do not consider future costs associated with the potential migration of the groundwater contamination noted by the particle tracking exercise. These costs also consider only those cost considered to be eligible for funding as noted in the previous section. To evaluate the cost implications of particle tracking and the projection of future potential areas of PFAS impact, these costs were removed from the PFAS eligible cost estimate. There are no cost implications associated with the particle tracking for Maplewood as the projected areas of PFAS impact did not extend into the community. Costs presented in Table E.137 are the same as Table E.136.

Table E.137. Summary of Costs Community-Specific Scenario A for Maplewood with Particle Tracking costs removed.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1a	**>0**	497 POETS, no connections	497	0.13	N/A	$1.7	N/A	$0.50	N/A	$15.1
Alt 1b	**>1**	4 POETS, no connections	4	0.00	N/A	$0.0	N/A	$0.00	N/A	$0.1

Notes:
1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.8 Conceptual projects – Newport

E.2.2.8.1 Project summary

The conceptual projects considered for Newport under this scenario would include centralized treatment, water supply from neighboring communities, connecting residents to the distribution system, and installing GAC POET systems on PFAS impacted non-municipal wells for two conditions of HI>0 and HI≥1. A summary of the projects is provided below and the infrastructure modifications for each alternative are shown in Figure E.2.2.8.1 for both HI conditions. The implications on Newport's private and non-municipal wells are shown in Figures E.2.2.1.1 and E.2.2.1.2 for both HI conditions. These two figures are regional maps illustrating the impact on private and non-municipal wells and which wells will receive GAC POETS or be connected to the distribution system as necessary.

Water supply

The City of Newport currently has a municipal water system consisting of two existing municipal wells (Wells 1 and 2) that have a combined design capacity of 1,800 gpm and a firm capacity with their largest well out of service of 800 gpm, as shown in Table E.138. The City also has three existing water storage tanks with a total capacity of 1.02 MG. Under firm capacity conditions with their largest well out of service, Newport is able to meet their current demand as well as their 2040 maximum daily demand of approximately 400 gpm. The City does not need any additional wells for water supply through year 2040.

Table E.138. Newport municipal well HI values and Pumping rates

Well No.	Design Pumping Rate (gpm)	HI Value
1	1,000	0.033
2	800	0.056
Total	1,800	

E.2.2.8.2 Project improvements

Water treatment plants (WTPs)

While the City's existing municipal supply wells have very low levels of PFAS contamination they would receive treatment under the HI>0 condition. The treatment plant would be sized to meet the flow from its largest well with a capacity of 1,000 gpm and be located next to Well 2.

Water main extensions and distribution lines

In addition to treating the municipal wells under the HI>0 condition, Wood also examined the options of supplying treated water to Newport through the neighboring communities of Woodbury or Cottage Grove. These connections would require the installation of new transmission lines and is discussed in the alternatives below.

While the majority of homes in the City of Newport are connected to the existing municipal distribution system, the City still has residents that are on private wells particularly in the neighborhoods off Kolff Street and Wild Ridge Trail. Under both HI conditions, nine non-municipal wells are connected to existing water distribution mains with service laterals.

GAC POET systems

This scenario would provide GAC POET systems for PFAS impacted non-municipal wells under 2040 conditions. As of October 2019 sample data, Newport has an estimated 113 existing non-municipal wells, of which 25 have been sampled. Of these sampled wells, only one currently has a GAC POET system installed. The groundwater model flow path analysis estimated that by 2040 a total of 93 non-municipal wells may be impacted and would receive treatment through proposed GAC POET systems for the HI>0 condition and 16 wells for the HI≥1 condition.

E.2.2.8.3 Hydraulic modeling analysis

A drinking water distribution model was created and calibrated based on the data provided by the city. Pressures in the system are consistent with those recently observed during hydrant testing. The model was used to evaluate interconnects with neighboring communities as opposed to providing treatment at the municipal supply wells in the event that these wells become contaminated in the future. It was found that no booster pumps or pressure reducing valves were needed for either connection to Woodbury or Cottage Grove as Newport resides at a lower HGL than these two communities. Water from Woodbury would feed the tank in Newport's high pressure zone while water from Cottage Grove would be conveyed to the two ground storage tanks off of Glen Rd in Loveland Park.

E.2.2.8.4 Groundwater modeling analysis

Forward particle tracking to 2040 was conducted under wet, normal, and drought climate conditions from known PFAS sources and areas where HI>1, as shown on Figures E.2.2c, E.2.2d, and E.2.2e, respectively. Particles inserted into the model travel in the direction of groundwater flow. In Newport, groundwater flow in the uppermost bedrock aquifers (Prairie Du Chien and Jordan Sandstone aquifers) is generally from northeast to southwest, towards the Mississippi River. Although there are areas of PFAS contamination in the uppermost bedrock aquifers that are located upgradient from Newport, particles originating at these locations are not shown to reach wells located within the city limits by the year 2040. A drawdown analysis was not performed for Newport since no new wells were proposed.

E.2.2.8.5 Project alternatives

A summary of each alternative is provided below and costs are provided in E.2.2.8.6. Refer to Figure E.2.2.8.1 for a map of Newport with the water system improvements and interconnects with Cottage Grove and Woodbury.

Alternative 1a – 2040 HI > 0

The existing wells in Newport are approximately a ½ mile apart, and a centralized water treatment plant would be more cost-effective than installing two separate WTPs. In this alternative, a 1,000 gpm centralized WTP to treat water from the existing wells, raw water transmission mains from the wells to the WTP and well modifications are included, as well as POETS to address non-municipal wells that cannot be connected to the system.

Alternative 1b – 2040 HI ≥ 1

Newport's existing wells are not expected to be above HI=1 in 2040, so installing treatment is unnecessary. This alternative includes the 9 service laterals to tie in existing non-municipal wells to existing water distribution mains, well sealing, and 15 POETS.

Alternative 2a – 2040 HI > 0

Alternative 1a considered installing a centralized WTP. This alternative will instead consider an interconnect with Woodbury by connecting the two water systems with an 8-inch water transmission main along Bailey Road. PFAS related capital improvements for Woodbury are estimated to have a PFAS capital and operating cost of $0.58 per 1,000 gallons. For the purposes of this analysis, the bulk water rate that Woodbury would charge Newport for water was assumed to be 2.5 times the PFAS capital and operating cost of $0.58/1000 gallons, or $1.45/1000 gallons for an average day demand 261 gpm.

This alternative also includes a flow meter and valves at the 8-inch interconnect, 0.7 miles of water distribution mains to connect the two water systems, new service laterals, well sealing, and 93 new POET systems.

Alternative 3a – 2040 HI > 0

Similarly to Alternative 2a, this alternative will consider an interconnect with Cottage Grove by connecting the two water systems with an 8-inch water transmission main. The water mains would start at the northwest corner of Cottage Grove where a new subdivision is under construction, and would extend north to the water tower in Newport on Glen Road. PFAS related capital improvements for Cottage Grove are estimated to have a PFAS capital and operating cost of $0.86 per 1,000 gallons. For the purposes of this analysis, the bulk water rate that Cottage Grove would charge Newport for water was assumed to be 2.5 times the PFAS capital and operating cost of $0.86/1000 gallons, or $2.15/1000 gallons for an average day demand 261 gpm.

This alternative also includes a flow meter and valves at the 8-inch interconnect, 1.64 miles of 8 to 12 inch water distribution mains to connect the two water systems, new service laterals, well sealing, and 96 new POET systems.

E.2.2.8.6 Cost estimate breakdown

A breakdown of capital and O&M costs is provided in Tables E.139-E.142 for the year 2040.

Table E.139. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for Newport-Alternative 1a (HI>0)

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	1	WTPs	1,000 gpm	$3,580,000	$2,550,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$520,000	$520,000
Well Modifications	2	Wells	Well & SCADA upgrades	$240,000	
Raw water transmission mains	0.64	Miles	from wells to WTP	$1,322,100	
Service Laterals	9	Each	Connect homes to existing mains ($2500 ea)	$22,500	
Well Sealing	9	Each	$2,000 per well	$18,000	
Land acquisition (site + water mains)	1.8	Acres	1 acre at WTP, 20 ft easements (50%)	$250,000	
GAC POETS	93	POETS	Standard household systems, $2,500 per well	$240,000	
			Subtotal	$6,200,000	$5,170,000
			Contingency (25%)	$1,550,000	$1,300,000

			Professional services (15%)	$930,000	$780,000
			Total Capital	**$8,680,000**	**$7,250,000**
Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost (changeout unlikely w/ low concentrations)	$0	$0
PFAS WTPs	1	WTP	Maint. and Operations	$240,000	$180,000
Pressure Reducing Valves	0	Stations	Installed within right-of-way	$0	
Raw water transmission mains	0.64	Miles	from wells to WTP	$7,000	
GAC POETS	93	POETS	Standard household systems, $1,000 per well	$93,000	
			Subtotal	$340,000	$280,000
			20 years of annual O&M	$6,800,000	$5,600,000
			20 years of annual O&M future value[1]	$9,140,000	$7,530,000
			20 year costs (capital + O&M)	**$15,480,000**	**$12,850,000**
			20 year future value costs (capital + O&M)	**$17,820,000**	**$14,780,000**
			Capital and operating cost per 1,000 gal	$1.66	$1.38
			Operating only cost per 1,000 gallons	$0.85	$0.70
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$90,000	$70,000
Water Mains		1.67%	of Capital	$23,000	
			Subtotal	$120,000	$100,000
			20 years of recapitalization	**$2,400,000**	**$2,000,000**
			20 years of recapitalization future value[1]	**$3,230,000**	**$2,690,000**
			20 year future value costs (capital + O&M + recapitalization)	**$21,050,000**	**$17,470,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.140. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for Newport-Alternative 1b (HI≥1)

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
Service Laterals	9	Each	Connect homes to existing mains ($2500 ea)	$22,500	
Well Sealing	9	Each	$2,000 per well	$18,000	
GAC POETS	16	POETS	Standard household systems, $2,500 per well	$40,000	

			Subtotal	$90,000	$90,000
			Contingency (25%)	$30,000	$30,000
			Professional services (15%)	$20,000	$20,000
			Total Capital	**$140,000**	**$140,000**
Annual O&M Cost					
GAC POETS	16	POETS	Standard household systems, $1,000 per well	$16,000	
			Subtotal	$16,000	$16,000
			20 years of annual O&M	$320,000	$320,000
			20 years of annual O&M future value[1]	$430,000	$430,000
			20 year costs (capital + O&M)	**$460,000**	**$460,000**
			20 year future value costs (capital + O&M)	**$570,000**	**$570,000**
			Capital and operating cost per 1,000 gal	$12.09	$12.09
			Operating only cost per 1,000 gallons	$9.12	$9.12

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.141. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for Newport-Alternative 2a (HI>0)

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
Interconnect with Woodbury	1	Stations	8" Interconnect w/ flow meter and PRV	$200,000	
Water distribution mains	0.71	Miles	From Woodbury to Newport, 8" mains	$660,000	
Service Laterals	9	Each	Connect homes to existing mains ($2500 ea)	$22,500	
Well Sealing	9	Each	$2,000 per well	$18,000	
Land acquisition (water mains)	1.9	Acres	20 ft easements (50%)	$260,000	
GAC POETS	93	POETS	Standard household systems, $2,500 per well	$240,000	
			Subtotal	$1,410,000	$1,410,000
			Contingency (25%)	$360,000	$360,000
			Professional services (15%)	$220,000	$220,000
			Total Capital	**$1,990,000**	**$1,990,000**
Annual O&M Cost					
Interconnect with Woodbury	1	Stations	Installed within right-of-way	$9,000	

Bulk Water from Woodbury	137	MG	$1.45/1000 gallons at 261 gpm (ADD), water rate is WDB PFAS capital & operating cost for Alt 2 of $0.58x2.5.	$199,000	
Water distribution mains	0.71	Miles	From Woodbury to Newport, 8" mains	$10,000	
GAC POETS	93	POETS	Standard household systems, $1,000 per well	$93,000	
			Subtotal	$311,000	$311,000
			20 years of annual O&M	$6,220,000	$6,220,000
			20 years of annual O&M future value[1]	$8,360,000	$8,360,000
			20 year costs (capital + O&M)	**$8,210,000**	**$8,210,000**
			20 year future value costs (capital + O&M)	**$10,350,000**	**$10,350,000**
			Capital and operating cost per 1,000 gal	$2.25	$2.25
			Operating only cost per 1,000 gallons	$1.81	$1.81
Recapitalization Costs Factored Annually					
Water Mains		1.67%	of Capital	$12,000	
			Subtotal	$12,000	$12,000
			20 years of recapitalization	**$240,000**	**$240,000**
			20 years of recapitalization future value[1]	**$330,000**	**$330,000**
			20 year future value costs (capital + O&M + recapitalization)	**$10,680,000**	**$10,680,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.142. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for Newport-Alternative 3a (HI>0)

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
Interconnect with Cottage Grove	1	Station	8" Interconnect w/ flow meter and PRV	$200,000	
Water distribution mains	1.64	Miles	From Cottage Grove to Newport (8"-12" mains)	$1,460,000	
Service Laterals	9	Each	Connect homes to existing mains ($2500 ea)	$22,500	
Well Sealing	9	Each	$2,000 per well	$18,000	
Land acquisition (site + water mains)	2.0	Acres	20 ft easements (50%)	$270,000	
GAC POETS	93	POETS	Standard household systems, $2,500 per well	$240,000	
			Subtotal	$2,220,000	$2,220,000

			Contingency (25%)	$560,000	$560,000
			Professional services (15%)	$340,000	$340,000
			Total Capital	**$3,120,000**	**$3,120,000**
Annual O&M Cost					
Interconnect with Cottage Grove	1	Stations	Installed within right-of-way	$9,000	
Bulk Water from Cottage Grove	137	MG	$2.15/1000 gallons at 261 gpm (ADD), water rate is CG PFAS capital & operating cost for Alt 1a of $0.86x2.5.	$295,000	
Water distribution mains	1.6	Miles	From Cottage Grove to Newport (8"-12" mains)	$10,000	
GAC POETS	93	POETS	Standard household systems, $1,000 per well	$93,000	
			Subtotal	$407,000	$407,000
			20 years of annual O&M	$8,140,000	$8,140,000
			20 years of annual O&M future value[1]	$10,940,000	$10,940,000
			20 year costs (capital + O&M)	**$11,260,000**	**$11,260,000**
			20 year future value costs (capital + O&M)	**$14,060,000**	**$14,060,000**
			Capital and operating cost per 1,000 gal	$3.05	$3.05
			Operating only cost per 1,000 gallons	$2.37	$2.37
Recapitalization Costs Factored Annually					
Water Mains		1.67%	of Capital	$25,000	
			Subtotal	$25,000	$25,000
			20 years of recapitalization	**$500,000**	**$500,000**
			20 years of recapitalization future value[1]	**$680,000**	**$680,000**
			20 year future value costs (capital + O&M + recapitalization)	**$14,740,000**	**$14,740,000**

Notes:

1. The 20-year future value costs were calculated using a 3% inflation rate

A summary of the costs for the four alternatives along with capital and operating costs per 1000 gallons is shown in Table E.143 below.

Table E.143. Summary of Year 2040 costs with 3% inflation included for the four alternatives for the Community-Specific Scenario A for Newport

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)		Capital and operating cost per 1000 gal		Operating Cost per 1000 gal	
					IX	GAC	IX	GAC	IX	GAC	IX	GAC	IX	GAC
Alt 1a	>0	New 420 gpm WTP	93	1.47	$7.3	$8.7	$0.28	$0.34	$17	$21	$1.4	$1.7	$0.7	$0.9

Alt 1b	>1	POETS only	16	0.01	N/A	$0.1	N/A	$0.02	N/A	$1	N/A	$12.1	N/A	$9.1
Alt 2a	>0	Interconnect with Woodbury	93	0.63	N/A	$2.0	N/A	$0.31	N/A	$11	N/A	$2.2	N/A	$1.8
Alt 3a	>0	Interconnect with Cottage Grove	93	0.63	N/A	$3.1	N/A	$0.31	N/A	$15	N/A	$3.1	N/A	$2.4

Notes:

1. Recapitalization and inflation costs are included in Total 20 year costs and are not included in the Capital and Annual O&M costs.

Alternative 2a for an interconnect with Woodbury was carried forward into the recommended options for Community Specific Scenario A as it is the most cost-effective of the three alternatives for HI>0. Alternative 1b was carried forward for HI>1.

E.2.2.8.7 PFAS eligible cost summary

The cost estimates presented above include all related costs for each given alternative to meet Year 2040 water demands. However, for various reasons, some costs may not be covered by settlement funds. The guidelines used to determine project components that would be eligible for settlement funding were presenting in the Appendix E Introduction.

For Newport, all capital costs were considered eligible for funding in both Alternatives 2a and 1b. Operation and maintenance costs were excluded for all infrastructure except for the GAC POETS. Recapitalization costs are also excluded in Table E.144.

Table E.144. Summary of PFAS Eligible Costs Community-Specific Scenario A for Newport.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1b	**>1**	POETS only	16	0.01	N/A	$0.1	N/A	$0.02	N/A	$1
Alt 2a	**>0**	Interconnect with Woodbury	93	0.63	N/A	$2.0	N/A	$0..01	N/A	$4.5

Notes:

1. For these estimates; recapitalization costs are not included. O&M does not include the purchase of water from Woodbury, but it does include the annual maintenance costs associated with GAC POETS. Inflation (3%) is included in the Total 20 year costs.

E.2.2.8.8 Cost summary with particle tracking costs removed

Costs presented in this section are reflective of the currently known areas of PFAS contamination and do not consider future costs associated with the potential migration of the groundwater contamination noted by the particle tracking exercise. These costs also consider only those cost considered to be eligible for funding as noted in the previous section. To evaluate the cost implications of particle tracking and the projection of future potential areas of PFAS impact, these costs were removed from the PFAS eligible cost estimate. For Newport, all POETS previously included from particle tracking were removed from Alternative 1b so that only the service laterals and well sealing costs are remaining in the cost estimate. For Alternative 2a, only four POETS were removed due to particle tracking. The cost summary is shown in Table E.145.

Table E.145. Summary of Costs Community-Specific Scenario A for Newport with Particle Tracking costs removed.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1b	**>1**	POETS only	0	0.01	N/A	$0.1	N/A	$0.16	N/A	$0.57
Alt 2a	**>0**	Interconnect with Woodbury	89	0.63	N/A	$2.0	N/A	$0.01	N/A	$4.6

Notes:

1. For these estimates; recapitalization costs are not included. O&M does not include the purchase of water from Woodbury, but it does include the annual maintenance costs associated with GAC POETS. Inflation (3%) is included in the Total 20 year costs.

E.2.2.9 Conceptual projects – Oakdale

E.2.2.9.1 Project summary

The conceptual projects considered for Oakdale under this scenario would include the expansion of the city's centralized WTP to treat the existing municipal supply wells and the option to relocate existing wells closer to the centralized WTP. While the majority of the City is connected to the municipal distribution system, GAC POET systems would be installed for PFAS impacted non-municipal wells that could not be connected to the existing system. A summary of the projects is provided below and the infrastructure modifications for each alternative are shown in Figures E.2.2.9.1 and E.2.2.9.2 for both HI conditions. The implications on Oakdale's private and non-municipal wells are shown in Figures E.2.2.1.1 and E.2.2.1.2 for both HI conditions. These two figures are regional maps illustrating the impact on private and non-municipal wells and which wells will receive GAC POETS or be connected to the distribution system as necessary.

Water supply

Oakdale currently has a municipal water system consisting of seven existing municipal wells (Wells 1, 2, 3, 5, 7, 9, and 10) that have a combined design capacity of 6,675 gpm, as shown in Table E.146. Due to high iron and manganese levels, Well 6 has currently been taken out of service and Well 8 will be taken out of service as it is not needed to meet 2040 MDD. Well 8 is also the farthest well away from the existing treatment facility and utilizing other existing wells or proposed relocated wells has been determined to be more cost effective. Under firm capacity conditions with their largest well out of service, Oakdale's current supply produces 5,575 gpm which is sufficient to meet their current demand as well as their 2040 maximum daily demand of approximately 4,900 gpm. In addition, the City's Current permitted capacity is 1,210 Million gallons per year (MGY) or 3.32 MGD which is also sufficient to cover their ADD of 3.06 MGD. However, they are not currently utilizing Wells 1, 2, and 7, as those wells have HI values above 1 and are not receiving treatment. Their existing water treatment plant has 2,400 gpm of capacity and currently treats Wells 5 and 9. By 2040, additional wells will need treatment in order to meet demands.

Table E.146. Oakdale municipal well HI values and Pumping rates

Well No.	Design Pumping Rate (gpm)	HI Value
1	925	7.95
2	950	7.34
3	1,000	0.014
5	850	57.97
6	TAKEN OUT OF SERVICE	
7	1,000	30.57
8	TAKEN OUT OF SERVICE	
9	1,100	47.48
10	850	.007
Total	6,675	

E.2.2.9.2 Project improvements

New municipal supply wells

New municipal wells are not required from a capacity perspective to meet Oakdale’s 2040 maximum daily demands and firm capacity requirements, given their existing well pumping capacity. However, due to the need for PFAS treatment for wells in addition to Wells 5 and 9 in the future, the alternatives discussed in the following sections include relocating some existing wells closer to the existing treatment facility. This exercise is to determine if there are cost savings in routing new raw water transmission lines from existing wells versus replacing those wells closer to the existing facility. Upon initial review of the results from this analysis, the City of Oakdale provided feedback on potential locations of the replacement wells. While the alternatives analyzed below were not updated to reflect these new locations identified by the City, the difference in locations is considered relatively minor such that it would not pose a significant impact on hydraulic modeling results, groundwater modeling results or costs.

To assist in the location of the replacement supply wells, the ground water model was used to determine well placement through a well interference and drawdown analysis. Proposed well locations were provided to the groundwater modeling team along with the design flow rates to determine if the potential drawdown exceeded the current limits. This process will be discussed in the hydraulic and groundwater modeling sections (E.2.2.9.3 and E.2.2.9.4, respectively).

Water treatment plants (WTPs)

This current round of analyses looked at two conditions used to select wells for treatment based on the two HI values of HI > 0 and HI ≥ 1. Under the first condition analyzed, wells were selected to receive treatment if they had an HI > 0 or if the well falls within an area identified as potentially becoming impacted by PFAS through the groundwater modeling particle tracking and flow path analysis. Under this condition, all existing and proposed municipal wells would receive treatment and different configurations of centralized treatment facilities are explored in the alternatives described below. Furthermore, all non-municipal supply wells will either receive treatment or be replaced with a connection to the existing municipal water supply.

Under the second condition of an HI ≥ 1, any well will be selected to receive treatment if it currently has an HI ≥ 1 or if it falls within an area identified as potentially becoming impacted by PFAS through the groundwater modeling particle tracking and flow path analysis. Under the second condition of an HI ≥ 1, neither of the wells located in the north (i.e. Wells 3 and 10) would be selected for treatment as current sampling data has indicated that existing wells in the region have HI values less than 1 and at this time it is not anticipated that they will be impacted in the future. However, based on existing data and the groundwater flow path analysis, any new well in the southern region near the existing wells will require treatment. In addition all non-municipal supply wells with an HI ≥ 1 or that fall within the projected areas of impact will either receive treatment or be replaced with connection to the existing distribution through the installing of new water lines.

Water main extensions and distribution lines

Currently 96% of the City's population is served by the existing municipal water distribution system. As such, no neighborhoods were proposed to be connected to the existing system and the hydraulic evaluation, as described below, did not indicate the need to install any additional water distribution lines. The only new lines required would be the raw water transmission lines to convey water from the municipal supply wells to the proposed WTPs.

GAC POET systems

Under this scenario, non-municipal wells would be selected for treatment using the same HI categories as previously described. Current or anticipated PFAS impacted non-municipal wells would be provided with GAC POET systems that were not proposed to be connected to the municipal water system. According to PFAS sampling data from October 2019 and County Well Index (CWI) data, Oakdale has an estimated 124 existing non-municipal wells, of which 39 have been sampled. The groundwater model flow path analysis estimated that by 2040, 54 non-municipal wells would be impacted by PFAS contamination as indicated by the projected impact areas and receive treatment through existing or proposed GAC POET systems or be connected to the existing distribution system in addition to those wells that fall outside the projected impact areas. Under 2040 conditions with an HI>0, no wells have existing GAC POETS while 13 wells would need to have GAC POETS installed. Under the HI ≥ 1 condition, 13 wells would receive GAC POET systems. These counts exclude any wells that would be connected to the city's municipal water system through expedited projects, proposed water lines, or connections to existing water lines. Under both HI conditions, a total of approximately 58 wells would be connected to either the existing distribution system or proposed distribution line extensions.

E.2.2.9.3 Hydraulic modeling analysis

The hydraulic analysis focused on the pumping requirements and sizing of the raw water transmission lines related to replacing existing wells with new wells closer to and expanding the existing WTP. Since almost the entire City is connected to the municipal distribution system, no neighborhood distribution line extensions were required. The drawdown analysis using the groundwater model provided the dynamic or pumping water level at each well location to help determine the appropriate operating point of the pump and maintain sufficient system pressures. In order to maintain system pressures, existing well pumps will need to be modified when they are routed to a centralized treatment facility. Well modifications could entail bowl, motor, or impellor modifications or improvements to match the new system curve. Additional improvements may also be needed to local programmable logic controllers, instrumentation, or Supervisory Control and Data Acquisition (SCADA) systems. In addition, as the capacity of the existing WTP is increased and more flow is conveyed to the facility from new replacement wells, a parallel influent and effluent line will be required to increase conveyance capacity.

The results from the hydraulic model indicate that the pressures were similar for all alternatives. In the southern zone, the majority of the pressures ranged between 60 and 90 psi. However, the south eastern corner experiences pressures between 90 to 100 psi resulting from lower elevations. Areas of low pressure were more centrally located near Hale Avenue and places with higher surface or ground elevations such as those areas near Tank 4.

In the central zone, pressures were slightly higher with pressures along the western half ranging from 75 to 90 psi and pressures on the eastern side ranging from 60 to 90 psi. The highest pressures were found to be more centrally located and on the far east side.

In the northern zone, the majority of the pressures were in the 60 to 70 psi range with pressures increasing along the northern boundary up to 90 psi. The lowest pressures in the northern region were more centrally located as well. These pressures in all zones were consistent with those currently observed in the system and pump modifications and design operating points were considered to keep this consistency. As such, no addition pressure reducing valves or booster pump stations to modify the existing pressure zones were required.

E.2.2.9.4 Groundwater modeling analysis

The pumping conditions analyzed using the groundwater flow model are summarized in Table E.147 below and details of the alternatives are provided in Section E.2.2.9.5. Two additional supply wells which would extract water from the Jordan Sandstone were added to replace existing wells that will be taken out of service. The rates assigned to the existing and proposed wells represent long-term averages based on the anticipated 2040 average daily demand (ADD).

Table E.147. Groundwater model well pumping conditions for four water supply alternative scenarios for the city of Oakdale.

Well	Unique Well ID	Average Daily Demand (gpm)
1	208462	Off
2	208463	Off
3	208454	354
4	226607	Off
5	127287	301
6	151575	Off
7	463534	Off
8	572608	Off
9	611059	390
10	773389	301
Proposed Well 1		390
Proposed Well 2		390

The simulated drawdown from each scenario was analyzed to ensure that both the Jordan Sandstone and Prairie du Chien aquifers do not become unconfined. The aquifers were analyzed using written guidance from the DNR.

Using the guidance provided by the DNR, simulated drawdown at the existing wells and proposed locations were analyzed under a drier setting that approaches drought conditions (worst case and herein referred to as drought) to determine whether drawdown exceeds the 50% threshold. Model recharge for drought conditions was reduced to 66% of the current condition recharge rate based on modeling by the DNR using the Soil Water Balance model over a drier time period of 2006 to 2009. For scenarios run under drought conditions, average daily demand rates for the Oakdale water supply wells were increased by multiplying the current condition rates by a factor of 1.25 (the ratio of maximum per capita demand over average per capita demand from Years 2005-2015). Pumping rates at irrigation wells were also increased by taking the maximum annual volume reported over a 20-year period (1988 – 2018). Drawdown for Scenario A under wet and dry conditions are shown on Figures E.2.2a and E.2.2b, respectively.

Table E.148 below provides a summary of drawdown in the Jordan Sandstone aquifer under wet and drought conditions and drawdown in the Prairie Du Chien under drought conditions. The reported drawdown is relative to average 2016-2018 simulated groundwater elevations, which is considered a wet period. The available head is the difference between the average 2016-2018 simulated head and the elevation of the top of the aquifer. The percent of available head is the amount of available head that is taken up by drawdown under drought conditions.

Table E.148. Groundwater modeling analysis drawdown results for four water supply alternatives for the city of Oakdale.

Well	Jordan Sandstone Aquifer				Prairie Du Chien Aquifer		
	Drawdown (m)		Available Head (m)	Percent of Available Head (drought)	Drawdown (m)	Available Head (m)	Percent of Available Head (drought)
	Wet	Drought			Drought		
1	Off						
2	Off						
3	4	7	79	9	4	43	9
4	Off						
5	<1	<1	62	0	2	36	6
6	Off						
7	Off						
8	Off						
9	<1	<1	72	0	<1	37	0
10	5	8	83	10	4	46	9
Proposed Well 1	14	19	81	23	7	43	16
Proposed Well 2	12	17	79	9	7	42	17

Under drought conditions, drawdown does not exceed the 50% available head in the Jordan Sandstone nor in the Prairie Du Chien. Additionally, the effect of pumping is localized such that the general groundwater flow direction, which is from northeast to southwest, is not altered.

Forward particle tracking to 2040 was conducted under wet, normal, and drought climate conditions from known PFAS sources and areas where HI>1, as shown on Figures E.2.2c, E.2.2d, and E.2.2e, respectively. Model recharge for normal conditions was reduced to 87% of the current condition recharge rate based on modeling by the DNR using the Soil Water Balance model over a drier time period of 1989 to 2018. Wells 1, 2, 4, 6, 7, 8 were turned off for the particle tracking analysis as these wells were either replaced or will remain out of service. Wells 3, 5, 9, and 10 along with the proposed wells were operating at the average daily rates used for the drawdown analysis discussed above. Particles inserted into the model travel in the direction of groundwater flow (northeast to southwest in the Prairie Du Chien and Jordan Sandstone aquifers). Particles traveling under wet conditions were captured by Wells 5, 7, and the easternmost proposed well. Particles traveling under normal and drought conditions were also captured by the aforementioned wells in addition to being captured by Well 9.

E.2.2.9.5 Project alternatives

A summary of each alternative including WTP sizing is provided below and costs are provided in E.2.2.9.6. Water supply configurations for these alternatives are shown on Figures E.2.2.9.1 and E.2.2.9.2.

Alternative 1a – 2040 Two Centralized WTPs HI > 0

In this alternative, Wells 1 and 2 would be routed to the existing WTP that would be expanded by an additional 1,875 gpm. However, a dedicated raw water transmission line would be required to convey water from these two wells since their PFAS concentrations are much lower than Wells 5 and 9 and as such could disrupt the treatment system. Under this alternative, Well 7 would have a treatment facility installed on-site so that this well can be utilized to help meet peak demands. Wells 3 and 10 would also require treatment under this alternative, and flow from both wells would be conveyed to a centralized WTP with a capacity of 1,850 gpm.

Alternative 1b – 2040 One Centralized WTP HI ≥ 1

This alternative is identical to Alternative 1a, however, Wells 3 and 10 would not require treatment and would operate as they currently do without PFAS treatment.

Alternative 2a – 2040 Two Centralized WTPs HI > 0

This alternative looked at the option of replacing Well 7 that has a current capacity of 1,000 gpm with a well that was located closer to the existing treatment facility. The new replacement well would have a slightly increased pumping capacity of 1,100 gpm and would be routed to the expanded WTP (total capacity of 4,925 gpm) that would have an additional capacity of 2,525 gpm to treat Wells 1, 2, and the new replacement well. The new well would be located north of the treatment facility along 21st Street N. Similar to Alternative 1, Wells 1 and 2 would require their own dedicated raw water transmission lines due to the difference in PFAS concentrations from Wells 5 and 9. Based on the location of the new wells and the PFAS concentrations in the area, it was assumed that the new well's raw water transmission line could be tied into the existing line from Wells 5 and 9. Wells 3 and 10 would require treatment under this alternative, and flow from both wells would be conveyed to a centralized WTP with a capacity of 1,850 gpm.

Alternative 2b – 2040 One Centralized WTP HI ≥ 1

This alternative is identical to Alternative 2a, however, Wells 3 and 10 would not require treatment and would operate as they currently do without PFAS treatment.

Alternative 3a – 2040 Two Centralized WTPs HI > 0

This alternative looked at the option of replacing Wells 1, 2, and 7 that have a combined pumping capacity of 2,875 gpm with two new wells with individual pumping capacities of 1,100 gpm that would be located closer to the existing treatment facility. The new replacement wells would be routed to the expanded WTP that would have an additional capacity of 1,750 gpm for a total treatment capacity of 4,150 gpm. The new wells would be located north of the treatment facility along 21st Street N. Similar to the previous alternatives and based on the location of the new wells and the PFAS concentrations in the area, it was assumed that the new well's raw water transmission line could be tied into the existing line from Wells 5 and 9. Wells 3 and 10 would require treatment under this alternative, and flow from both wells would be conveyed to a centralized WTP with a capacity of 1,850 gpm. The new wells and WTPs are sized so a minimum treated capacity is 4,900 gpm MDD can be met with the largest well in either well field out-of-service.

Alternative 3b - 2040 One Centralized WTP HI ≥ 1

This alternative is identical to Alternative 3a, however, Wells 3 and 10 would not require treatment and would operate as they currently do without PFAS treatment.

Alternative 4a - 2040 One Centralized WTP HI ≥ 1

This alternative looked at the option of replacing Wells 1, 2, 7, 3 and 10 with four new wells with individual pumping capacities of 1,100 gpm that would be located closer to the existing treatment facility. The new replacement wells would be routed to the expanded WTP that would have an additional capacity of 2,500 gpm to match the City's 2040 maximum day demand of 4,900 gpm. Two new wells would be located north of the treatment facility along 21st Street N and the remaining two would be located south of the treatment facility along 15th Street N. The two new northern wells will require new 16-inch transmission lines to the treatment facility and because the two new southern wells are adding significant capacity they will also require a dedicated 16-inch raw water transmission line rather than using the existing transmission line for Wells 5 and 9. A parallel 20-inch effluent line from the treatment plant to the distribution system will also be required due to the increased capacity.

E.2.2.9.6 Cost estimate

The project alternatives included in this scenario for Oakdale include the expansion of the existing treatment facility and new treatment facilities to address municipal wells impacted by PFAS, the replacement of 58 wells with connections to the municipal water system, and the installation of GAC POET systems to account for residences that may not be connected to the municipal water system by 2040 due to feasibility or other unforeseen factors. A breakdown of capital and O&M costs for each alternative discussed above are provided in Tables E.149-E.155 below for projected 2040 conditions.

Table E.149. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for Oakdale - Alternative 1a.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	3	WTPs	4275 gpm (expand existing by 1875 gpm for W1,W2), 1,000 gpm	$14,210,000	$10,140,000

			(W7), 1850 gpm (W3&W10)		
Pretreatment at WTP	3	Lump Sum	Iron/Manganese	$3,700,000	$3,700,000
Well Modifications	5	Wells	Well & SCADA upgrades	$600,000	
Raw water transmission mains	2.71	Miles	from wells 1 and 2 to exist WTP	$5,630,000	
Service Laterals	58	Each	Connect homes to existing mains ($2500 ea)	$145,000	
Well Sealing	60	Each	$2,000 per well, including wells 6 & 8	$120,000	
Land acquisition (site + water mains)	5.3	Acres	1/2 acre per WTP, 20 ft easements (50%)	$720,000	
GAC POETS	13	POETS	Standard household systems, $2,500 per well	$40,000	
			Subtotal	$25,170,000	$21,100,000
			Contingency (25%)	$6,300,000	$5,280,000
			Professional services (15%)	$3,780,000	$3,170,000
			Total Capital	**$35,250,000**	**$29,550,000**
Annual O&M Cost					
PFAS WTPs	3	WTP	Media Cost	$490,460	$297,630
PFAS WTPs	3	WTP	Maint. and Operations	$820,000	$620,000
Raw water transmission mains	2.71	Miles	from wells 1 and 2 to exist WTP	$29,000	
GAC POETS	13	POETS	Standard household systems, $1,000 per well	$13,000	
			Subtotal	$1,352,460	$960,000
			20 years of annual O&M	$27,049,200	$19,200,000
			20 years of annual O&M future value[1]	$36,350,000	$25,800,000
			20 year costs (capital + O&M)	**$62,300,000**	**$48,750,000**
			20 year future value costs (capital + O&M)	**$71,600,000**	**$55,350,000**
			Capital and operating cost per 1,000 gal	$1.41	$1.09
			Operating only cost per 1,000 gallons	$0.71	$0.51
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$360,000	$280,000
Water Mains		1.67%	of Capital	$95,000	
			Subtotal	$460,000	$380,000
			20 years of recapitalization	**$9,200,000**	**$7,600,000**
			20 years of recapitalization future value[1]	**$12,370,000**	**$10,220,000**

20 year future value costs (capital + O&M + recapitalization)	**$83,970,000**	**$65,570,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.150. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for Oakdale - Alternative 1b.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	2	WTPs	4275 gpm WTP (expand existing WTP 1875 gpm), new 1,000 gpm WTP at Well 7	$9,000,000	$6,420,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$2,740,000	$2,740,000
Well Modifications	3	Wells	Well & SCADA upgrades	$360,000	
Raw water transmission mains	2.15	Miles	from wells 1 and 2 to exist WTP	$4,470,000	
Service Laterals	58	Each	Connect homes to existing mains ($2500 ea)	$145,000	
Well Sealing	60	Each	$2,000 per well, including wells 6 & 8	$120,000	
Land acquisition (site + water mains)	3.6	Acres	1/2 acre per WTP, 20 ft easements (50%)	$490,000	
GAC POETS	13	POETS	Standard household systems, $2,500 per well	$40,000	
			Subtotal	$17,370,000	$14,790,000
			Contingency (25%)	$4,350,000	$3,700,000
			Professional services (15%)	$2,610,000	$2,220,000
			Total Capital	**$24,330,000**	**$20,710,000**
Annual O&M Cost					
PFAS WTPs	2	WTP	Media Cost	$490,460	$297,630
PFAS WTPs	2	WTP	Maint. and Operations	$560,000	$430,000
Raw water transmission mains	2.15	Miles	from wells 1 and 2 to exist WTP	$23,000	
GAC POETS	13	POETS	Standard household systems, $1,000 per well	$13,000	
			Subtotal	$1,086,460	$770,000
			20 years of annual O&M	$21,729,200	$15,400,000
			20 years of annual O&M future value[1]	$29,200,000	$20,700,000
			20 year costs (capital + O&M)	**$46,060,000**	**$36,110,000**
			20 year future value costs (capital + O&M)	**$53,530,000**	**$41,410,000**
			Capital and operating cost per 1,000 gal	$1.70	$1.32

Operating only cost per 1,000 gallons			$0.93	$0.66
Recapitalization Costs Factored Annually				
WTPs	2%	of Capital	$240,000	$190,000
Water Mains	1.67%	of Capital	$75,000	
Subtotal			$320,000	$270,000
20 years of recapitalization			**$6,400,000**	**$5,400,000**
20 years of recapitalization future value[1]			**$8,600,000**	**$7,260,000**
20 year future value costs (capital + O&M + recapitalization)			**$62,130,000**	**$48,670,000**
Notes: 1. The 20-year future value costs were calculated using a 3% inflation rate				

Table E.151. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for Oakdale - Alternative 2a.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	2	WTPs	4925 gpm (expand existing by 2525 gpm for W1,W2,& new well), 1850 gpm (W3, W10)	$11,400,000	$8,130,000
Pretreatment at WTP	2	Lump Sum	Iron/Manganese	$3,510,000	$3,510,000
New Well	1	Wells	redrill W7 closer to WTP	$2,180,000	
Well Modifications	5	Wells	Well & SCADA upgrades	$600,000	
Raw water transmission mains	3.06	Miles	from wells 1, 2, new 7 to exist WTP, wells 3 and 10 to WTP	$6,360,000	
Service Laterals	58	Each	Connect homes to existing mains ($2500 ea)	$145,000	
Well Sealing	61	Each	$2,000 per well, including wells 6, 7, 8	$122,000	
Land acquisition (site + water mains)	6.2	Acres	1 acre per WTP, 20 ft easements (50%)	$840,000	
GAC POETS	13	POETS	Standard household systems, $2,500 per well	$40,000	
Subtotal				$25,200,000	$21,930,000
Contingency (25%)				$6,300,000	$5,490,000
Professional services (15%)				$3,780,000	$3,290,000
Total Capital				**$35,280,000**	**$30,710,000**
Annual O&M Cost					
PFAS WTPs	2	WTP	Media Cost	$414,290	$251,410

PFAS WTPs	2	WTP	Maint. and Operations	$680,000	$520,000
Wells	0	Wells	redrill W7 closer to WTP	$80,000	
Raw water transmission mains	3.06	Miles	from wells 1, 2, new 7 to exist WTP, wells 3 and 10 to WTP	$32,000	
GAC POETS	13	POETS	Standard household systems, $1,000 per well	$13,000	
			Subtotal	$1,219,290	$900,000
			20 years of annual O&M	$24,385,800	$18,000,000
			20 years of annual O&M future value[1]	$32,770,000	$24,190,000
			20 year costs (capital + O&M)	**$59,670,000**	**$48,710,000**
			20 year future value costs (capital + O&M)	**$68,050,000**	**$54,900,000**
			Capital and operating cost per 1,000 gal	$1.48	$1.19
			Operating only cost per 1,000 gallons	$0.71	$0.52
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$300,000	$240,000
Wells		2%	of Capital	$44,000	
Water Mains		1.67%	of Capital	$107,000	
			Subtotal	$460,000	$400,000
			20 years of recapitalization	**$9,200,000**	**$8,000,000**
			20 years of recapitalization future value[1]	**$12,370,000**	**$10,750,000**
			20 year future value costs (capital + O&M + recapitalization)	**$80,420,000**	**$65,650,000**

Notes:

1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.152. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for Oakdale - Alternative 2b.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	1	WTPs	4925 gpm (expand existing by 2525 gpm for W1,W2,new well)	$6,230,000	$4,450,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$2,560,000	$2,560,000
New Well	1	Wells	Redrill W7 close to central WTP	$2,180,000	
Well Modifications	3	Wells	Well & SCADA upgrades	$360,000	

Raw water transmission mains	2.41	Miles	from wells 1, 2, & new 7 to exist WTP	$5,010,000	
Service Laterals	58	Each	Connect homes to existing mains ($2500 ea)	$145,000	
Well Sealing	61	Each	$2,000 per well, including wells 6, 7, 8	$122,000	
Land acquisition (site + water mains)	3.9	Acres	1 acre per WTP, 20 ft easements (50%)	$530,000	
GAC POETS	13	POETS	Standard household systems, $2,500 per well	$40,000	
			Subtotal	$17,180,000	$15,400,000
			Contingency (25%)	$4,300,000	$3,850,000
			Professional services (15%)	$2,580,000	$2,310,000
			Total Capital	**$24,060,000**	**$21,560,000**
Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost	$414,290	$251,410
PFAS WTPs	1	WTP	Maint. and Operations	$420,000	$330,000
Wells	1	Wells	Redrill W7 close to central WTP	$80,000	
Raw water transmission mains	2.41	Miles	from wells 1, 2, & new 7 to exist WTP	$26,000	
GAC POETS	13	POETS	Standard household systems, $1,000 per well	$13,000	
			Subtotal	$953,290	$710,000
			20 years of annual O&M	$19,065,800	$14,200,000
			20 years of annual O&M future value[1]	$25,620,000	$19,080,000
			20 year costs (capital + O&M)	**$43,130,000**	**$35,760,000**
			20 year future value costs (capital + O&M)	**$49,680,000**	**$40,640,000**
			Capital and operating cost per 1,000 gal	$1.86	$1.52
			Operating only cost per 1,000 gallons	$0.96	$0.72
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$180,000	$150,000
Wells		2%	of Capital	$44,000	
Water Mains		1.67%	of Capital	$84,000	
			Subtotal	$310,000	$280,000
			20 years of recapitalization	**$6,200,000**	**$5,600,000**
			20 years of recapitalization future value[1]	**$8,330,000**	**$7,530,000**
			20 year future value costs (capital + O&M + recapitalization)	**$58,010,000**	**$48,170,000**

Notes:

1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.153. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for Oakdale - Alternative 3a.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	2	WTPs	4150 gpm (expand existing WTP by 1750 gpm), 1850 WTP (W3,W10)	$10,170,000	$7,260,000
Pretreatment at WTP	2	Lump Sum	Iron/Manganese	$3,110,000	$3,110,000
New Well	2	Wells	each well 1100 gpm (replace W1,W2,W7)	$4,360,000	
Well Modifications	2	Wells	Well & SCADA upgrades	$240,000	
Raw water transmission mains	1.03	Miles	from new wells to exist WTP, wells 3 and 10 to WTP	$2,160,000	
Service Laterals	58	Each	Connect homes to existing mains ($2500 ea)	$145,000	
Well Sealing	63	Each	$2,000 per well, including wells 1,2,6,7,8	$126,000	
Land acquisition (site + water mains)	4.2	Acres	1/2 acre per well, 1 acre at WTPs, 20 ft easements (50%)	$580,000	
GAC POETS	13	POETS	Standard household systems, $2,500 per well	$40,000	
			Subtotal	$20,940,000	$18,030,000
			Contingency (25%)	$5,240,000	$4,510,000
			Professional services (15%)	$3,150,000	$2,710,000
			Total Capital	**$29,330,000**	**$25,250,000**
Annual O&M Cost					
PFAS WTPs	2	WTP	Media Cost	$332,040	$201,500
PFAS WTPs	2	WTP	Maint. and Operations	$620,000	$470,000
Wells	2	Wells	each well 1100 gpm (replace W1,W2,W7)	$150,000	
Raw water transmission mains	1.03	Miles	from new wells to exist WTP, wells 3 and 10 to WTP	$11,000	
GAC POETS	13	POETS	Standard household systems, $1,000 per well	$13,000	
			Subtotal	$1,126,040	$850,000
			20 years of annual O&M	$22,520,800	$17,000,000
			20 years of annual O&M future value[1]	$30,260,000	$22,840,000

		20 year costs (capital + O&M)	**$51,860,000**	**$42,250,000**
		20 year future value costs (capital + O&M)	**$59,590,000**	**$48,090,000**
		Capital and operating cost per 1,000 gal	$1.57	$1.27
		Operating only cost per 1,000 gallons	$0.80	$0.60
Recapitalization Costs Factored Annually				
WTPs	2%	of Capital	$270,000	$210,000
Wells	2%	of Capital	$88,000	
Water Mains	1.67%	of Capital	$36,000	
		Subtotal	$400,000	$340,000
		20 years of recapitalization	**$8,000,000**	**$6,800,000**
		20 years of recapitalization future value[1]	**$10,750,000**	**$9,140,000**
		20 year future value costs (capital + O&M + recapitalization)	**$70,340,000**	**$57,230,000**

Notes:

1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.154. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for Oakdale - Alternative 3b.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	1	WTPs	4150 gpm (expand existing WTP by 1750 gpm)	$5,000,000	$3,570,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$2,150,000	$2,150,000
New Well	2	Wells	each well 1100 gpm (replace W1,W2,W7)	$4,360,000	
Raw water transmission mains	0.37	Miles	from new wells to exist WTP	$810,000	
Service Laterals	58	Each	Connect homes to existing mains ($2500 ea)	$145,000	
Well Sealing	63	Each	$2,000 per well, including wells 1,2,6,7,8	$126,000	
Land acquisition (site + water mains)	2.5	Acres	1/2 acre per well, 1 acre at WTP, 20 ft easements (50%)	$340,000	
GAC POETS	13	POETS	Standard household systems, $2,500 per well	$40,000	
			Subtotal	$12,980,000	$11,550,000
			Contingency (25%)	$3,250,000	$2,890,000
			Professional services (15%)	$1,950,000	$1,740,000
			Total Capital	**$18,180,000**	**$16,180,000**

Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost	$332,040	$201,500
PFAS WTPs	1	WTP	Maint. and Operations	$360,000	$290,000
Wells	2	Wells	each well 1100 gpm (replace W1,W2,W7)	$150,000	
Raw water transmission mains	0.37	Miles	from new wells to exist WTP	$5,000	
GAC POETS	13	POETS	Standard household systems, $1,000 per well	$13,000	
			Subtotal	$860,040	$660,000
			20 years of annual O&M	$17,200,800	$13,200,000
			20 years of annual O&M future value[1]	$23,110,000	$17,740,000
			20 year costs (capital + O&M)	**$35,390,000**	**$29,380,000**
			20 year future value costs (capital + O&M)	**$41,290,000**	**$33,920,000**
			Capital and operating cost per 1,000 gal	$2.23	$1.83
			Operating only cost per 1,000 gallons	$1.25	$0.96
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$150,000	$120,000
Wells		2%	of Capital	$88,000	
Water Mains		1.67%	of Capital	$14,000	
			Subtotal	$260,000	$230,000
			20 years of recapitalization	**$5,200,000**	**$4,600,000**
			20 years of recapitalization future value[1]	**$6,990,000**	**$6,190,000**
			20 year future value costs (capital + O&M + recapitalization)	**$48,280,000**	**$40,110,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.155. Year 2040 costs for conceptual projects included in Community-Specific Scenario A for Oakdale - Alternative 4a.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	1	WTPs	4900 gpm (expand existing WTP by 2500 gpm)	$6,140,000	$4,380,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$2,540,000	$2,540,000
New Well	4	Wells	each well 1100 gpm (replace W1,W2,W3,W7,W10)	$8,720,000	

Raw water transmission mains	1.22	Miles	from new wells to exist WTP, wells 3 and 10 to WTP	$2,610,000	
Service Laterals	58	Each	Connect homes to existing mains ($2500 ea)	$145,000	
Well Sealing	65	Each	$2,000 per well, including wells 1,2,3,6,7,8,10	$130,000	
Land acquisition (site + water mains)	4.5	Acres	1/2 acre per well, 1 acre at WTPs, 20 ft easements (50%)	$610,000	
GAC POETS	13	POETS	Standard household systems, $2,500 per well	$40,000	
			Subtotal	$20,940,000	$19,180,000
			Contingency (25%)	$5,240,000	$4,800,000
			Professional services (15%)	$3,150,000	$2,880,000
			Total Capital	**$29,330,000**	**$26,860,000**
Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost	$403,630	$332,040
PFAS WTPs	1	WTP	Maint. and Operations	$420,000	$330,000
Wells	4	Wells	each well 1100 gpm (replace W1,W2,W3,W7,W10)	$290,000	
Raw water transmission mains	1.22	Miles	from new wells to exist WTP, wells 3 and 10 to WTP	$14,000	
GAC POETS	13	POETS	Standard household systems, $1,000 per well	$13,000	
			Subtotal	$1,140,630	$980,000
			20 years of annual O&M	$22,812,600	$19,600,000
			20 years of annual O&M future value[1]	$30,650,000	$26,340,000
			20 year costs (capital + O&M)	**$52,150,000**	**$46,460,000**
			20 year future value costs (capital + O&M)	**$59,980,000**	**$53,200,000**
			Capital and operating cost per 1,000 gal	$2.31	$2.05
			Operating only cost per 1,000 gallons	$1.18	$1.01
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$180,000	$140,000
Wells		2%	of Capital	$175,000	
Water Mains		1.67%	of Capital	$44,000	
			Subtotal	$400,000	$360,000
			20 years of recapitalization	**$8,000,000**	**$7,200,000**
			20 years of recapitalization future value[1]	**$10,750,000**	**$9,680,000**

20 year future value costs (capital + O&M + recapitalization)	**$70,730,000**	**$62,880,000**

See Table E.156 below for a summary of the cost estimates for each Alternative.

Table E.156. Summary of Year 2040 costs with 3% inflation included for the four alternatives for the Community-Specific Scenario A for Oakdale in millions of dollars ($Ms).

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)		Capital and operating cost per 1000 gal		Operating Cost per 1000 gal	
					IX	GAC	IX	GAC	IX	GAC	IX	GAC	IX	GAC
Alt 1a	>0	3 WTPS (W7, expand existing WTP, new WTP for W3/10)	13	6.97	$30	$35	$1.0	$1.4	$66	$85	$1.1	$1.4	$0.5	$0.7
Alt 1b	>1	2 WTPS (W7 and expand WTP)	13	4.30	$21	$24	$0.8	$1.1	$49	$62	$1.3	$1.7	$0.7	$0.9
Alt 2a	>0	2 WTPs (expand existing, new WTP for W3/10), new well	13	6.32	$31	$35	$0.9	$1.2	$66	$81	$1.2	$1.5	$0.5	$0.7
Alt 2b	>1	1 WTP (expand existing), new well	13	3.66	$22	$24	$0.7	$1.0	$48	$58	$1.5	$1.9	$0.7	$1.0
Alt 3a	>0	2 WTPs (expand existing 4,150 gpm, new WTP for W3/10 1,850 gpm), 2 new wells	13	5.21	$25	$29	$0.9	$1.1	$58	$71	$1.3	$1.6	$0.6	$0.8
Alt 3b	>1	1 WTP (expand existing 4,150 gpm), 2 new wells	13	2.54	$16	$18	$0.7	$0.9	$40	$48	$1.8	$2.2	$1.0	$1.3
Alt 4a	>0	1 WTP (expand existing) 4 new wells	13	3.57	$27	$29	$1.0	$1.2	$64	$71	$2.1	$2.3	$1.0	$1.2

Notes:

1. Recapitalization and inflation costs are included in Total 20 year costs and are not included in the Capital and Annual O&M costs.

Alternatives 3a and 3b are the most cost-effective options and are included in the final summary table for this Community Scenario.

E.2.2.9.7 PFAS eligible cost summary

The cost estimates presented above include all related costs for each given alternative to meet Year 2040 water demands. However, for various reasons, some costs may not be covered by settlement funds. The guidelines used to determine project components that would be eligible for settlement funding were presenting in the Appendix E Introduction

All capital costs were considered eligible for PFAS funding for both Alternatives 3a and 3b. Operation and maintenance costs for the wells and raw water transmission mains were excluded along with recapitalization costs, as shown in Table E.157.

Table E.157. Summary of PFAS Eligible Costs Community-Specific Scenario A for Oakdale.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 3a	**>0**	2 WTPs (expand existing, new WTP for W3/10), 2 new wells	13	5.20	$25	$29	$0.9	$1.1	$57	$70
Alt 3b	**>1**	1 WTP (expand existing), 2 new wells	13	2.54	$16	$18	$0.7	$0.9	$40	$48

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.9.8 Cost summary with particle tracking costs removed

Costs presented in this section are reflective of the currently known areas of PFAS contamination and do not consider future costs associated with the potential migration of the groundwater contamination noted by the particle tracking exercise. These costs also consider only those cost considered to be eligible for funding as noted in the previous section. To evaluate the cost implications of particle tracking and the projection of future potential areas of PFAS impact, these costs were removed from the PFAS eligible cost estimate. This eliminated seven POETS in each Alternative 3a and 3b as shown in Table E.158 below.

Table E.158. Summary of Costs Community-Specific Scenario A for Oakdale with Particle Tracking costs removed.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 3a	**>0**	2 WTPs (expand existing, new	6	5.20	$25	$29	$0.7	$1.0	$44	$55

		WTP for W3/10), 2 new wells					
Alt 3b	**>1**	1 WTP (expand existing), 2 new wells	5	2.54	$16 $18	$0.5 $0.7	$30 $37

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.10 Conceptual projects – Prairie Island Indian Community

E.2.2.10.1 Project summary

The conceptual project considered for Prairie Island Indian Community (PIIC) under this scenario would include the installation of a WTP at the existing well to provide water service to the property as shown in Figure E.1.1.11.1.

E.2.2.10.2 Project improvements

For the year 2040, alternatives were developed under two conditions used to identify impacted wells that would receive treatment – those with a health index (HI) value greater than zero (> 0) and those with an HI value greater than or equal to one (≥ 1). For PIIC, the solution for both HI conditions is the same and would include installing a new water treatment plant.

Water supply

The existing well is assumed to be capable of providing 600 gpm based on the information provided. However, the well would need to be modified to meet the code for a potable drinking water supply well. Thus, a WTP would be installed at the existing 600 gpm well to serve its future residents for the foreseeable future. The parcel of land owned by PIIC has not yet been developed and there is currently an irrigation well that they are looking to convert to a potable water supply well. According to information provided by PIIC, this well can produce somewhere between 600 and 800 gpm once converted. Currently, the well has been impacted by PFAS contamination and has an HI value greater than 1. The well will require treatment under both HI conditions.

Water treatment plants (WTPs)

It is anticipated that the existing well will need treatment under both HI conditions. The new PFAS treatment facility will be sized to meet the flow from the well at approximately 600 gpm. Costs are included for pretreatment if needed.

E.2.2.10.3 Hydraulic modeling analysis

A drinking water distribution model was not created for this community as there is no municipal water system within Prairie Island Indian Community at this time.

E.2.2.10.4 Groundwater modeling analysis

Forward particle tracking to 2040 was conducted under wet, normal, and drought climate conditions from known PFAS sources and areas where HI>1, as shown on Figures E.2.2c, E.2.2d, and E.2.2e, respectively. Particles inserted into the model follow the direction of groundwater flow. In the vicinity of PIIC, the general direction of groundwater flow in the Prairie Du Chien and Jordan Sandstone aquifers is from west to east toward the St. Croix River, as represented by particle tracking figures. The new well is located within close proximity to Project 1007 and has been impacted by PFAS contamination. Additionally, in each of the particle tracking conditions, the new well is located along particle pathways that originate at upgradient areas where HI>1. Particle tracking also indicates the southern area of PIIC may be impacted; therefore, drilling a new well in the southern portion of PIIC is not a likely option for providing drinking water without treatment.

A drawdown analysis was not performed for PIIC since no new wells were proposed.

E.2.2.10.5 Project alternatives

There is only one alternative for PIIC. A summary of the alternative is provided below and costs are provided in E.2.2.10.6. Refer to Figures E.2.2.1.1 and E.2.2.1.2 for maps of PIIC with the projected PFAS impacted area in 2040.

***Alternative 1a – 2040 HI > 0* and HI>1**

This alternative includes well modifications to bring the existing irrigation well to drinking water standards and the installation of a water treatment plant for the existing well.

E.2.2.10.6 Cost estimate breakdown

A breakdown of capital and O&M costs is provided in Table E.159 for the year 2040.

Table E.159. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for Prairie Island Indian Community-Alternative 1a.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	1	WTP	600 gpm	$2,630,000	$1,880,000
Pretreatment at WTP	1	Lump Sum	Iron & Manganese	$320,000	$320,000
Well Modifications	1	Wells	Well upgrades	$20,000	
			Subtotal	$2,970,000	$2,220,000
			Contingency (25%)	$750,000	$560,000
			Professional services (15%)	$450,000	$340,000
			Total Capital	**$4,170,000**	**$3,120,000**
Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost	$780	$480
PFAS WTPs	1	WTP	Maint. and Operations	$190,000	$150,000
			Subtotal	$191,000	$151,000
			20 years of annual O&M	$3,820,000	$3,020,000
			20 years of annual O&M future value[1]	$5,140,000	$4,060,000
			20 year costs (capital + O&M)	**$7,990,000**	**$6,140,000**
			20 year future value costs (capital + O&M)	**$9,310,000**	**$7,180,000**
			Capital and operating cost per 1,000 gal	$1.48	$1.14

Operating only cost per 1,000 gallons			$0.81	$0.64
Recapitalization Costs Factored Annually				
WTPs	2%	of Capital	$60,000	$50,000
Subtotal			$60,000	$50,000
20 years of recapitalization			**$1,200,000**	**$1,000,000**
20 years of recapitalization future value[1]			**$1,620,000**	**$1,350,000**
20 year future value costs (capital + O&M + recapitalization)			**$10,930,000**	**$8,530,000**

Notes:

1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.160 below summarizes the 2040 summary costs for Prairie Island Indian Community.

Table E.160. Summary of Year 2040 costs with 3% inflation included for the Community-Specific Scenario A for Prairie Island Indian Community.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)		Capital and operating cost per 1000 gal		Operating Cost per 1000 gal	
					IX	GAC	IX	GAC	IX	GAC	IX	GAC	IX	GAC
Alt 1a	>0, >1	600 gpm WTP	0	0.86	$3.1	$4.2	$0.15	$0.19	$8.5	$10.9	$1.1	$1.5	$0.6	$0.8

Notes:

1. Recapitalization and inflation costs are included in Total 20 year costs and are not included in the Capital and Annual O&M costs.

E.2.2.10.7 PFAS eligible cost summary

The cost estimates presented above include all related costs for each given alternative to meet Year 2040 water demands. However, for various reasons, some costs may not be covered by settlement funds. The guidelines used to determine project components that would be eligible for settlement funding were presenting in the Appendix E Introduction.

Capital costs considered eligible for PFAS funding for Alternative 1a included the water treatment plant and pretreatment, whereas the costs to modify the existing well were removed. Operation and maintenance costs are only included for the treatment plant. Recapitalization costs were removed, as shown in Table E.161.

Table E.161. Summary of PFAS Eligible Costs Community-Specific Scenario A for Prairie Island Indian Community.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1a	>0, >1	600 gpm WTP	0	0.86	$3.1	$4.1	$0.15	$0.19	$7.1	$9.3

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.10.8 Cost summary with particle tracking costs removed

Costs presented in this section are reflective of the currently known areas of PFAS contamination and do not consider future costs associated with the potential migration of the groundwater contamination noted by the particle tracking exercise. These costs also consider only those cost considered to be eligible for funding as noted in the previous section. To evaluate the cost implications of particle tracking and the projection of future potential areas of PFAS impact, these costs were removed from the PFAS eligible cost estimate. However, no costs were removed due to particle tracking for this community as shown in Table E.162 below.

Table E.162. Summary of Costs Community-Specific Scenario A for Prairie Island Indian Community with Particle Tracking costs removed.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1a	>0, >1	600 gpm WTP	0	0.86	$3.1	$4.1	$0.15	$0.19	$7.1	$9.3

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.11 Conceptual projects – St. Paul Park

E.2.2.11.1 Project summary

The conceptual projects considered for St. Paul Park under this scenario would include installing a centralized WTP to treat the existing municipal supply wells, replacing non-municipals wells with connections to existing water mains, and installing GAC POET systems. A summary of the projects is provided below and the infrastructure modifications are shown in Figure E.2.2.11.1 for both HI conditions. The implications on St. Paul Park's private and non-municipal wells are shown in Figures E.2.2.1.1 and E.2.2.1.2 for both HI conditions. These two figures are regional maps illustrating the impact on private and non-municipal wells and which wells will receive GAC POETS or be connected to the distribution system as necessary.

Water supply

St. Paul Park currently has a municipal water system consisting of three existing municipal wells (Wells 2, 3, and 4) that have a total combined design capacity of 2,100 gpm and a firm capacity with their largest well out of service of 1,200 gpm, as shown in Table E.163. However, the City is not currently utilizing Wells 3 and 4 as those wells have HI values above 1, but once the temporary GAC treatment facility is operational it will be able to treat both wells and eventually all wells. With a 2040 MDD of just under 1,200 gpm, St. Paul Park is able to meet this demand with their existing wells under firm capacity conditions. The City's potential need for additional wells will be discussed in further detail in the remaining sections.

Table E.163. St. Paul Park municipal well HI values and Pumping rates

Well No.	Design Pumping Rate (gpm)	HI Value
2	600	0.871
3	600	1.409
4	900	1.324
Total	2,100	

E.2.2.11.2 Project improvements

Water treatment plants (WTPs)

The city is in the process of constructing a temporary WTP to treat groundwater supplied by Wells 3 and 4. Eventually, the city plans to connect Well 2 to the temporary WTP and upgrade it to meet 2040 maximum daily demands and what the city considers to be its ultimate buildout capacity. Under this scenario, the WTP would be made permanent and all municipal supply wells (including Well 2) would be routed to the WTP for both HI conditions. Raw water mains are necessary to connect the wells to the WTP. Although the existing well capacity for all three wells is 2,100 gpm, the capacity of the WTP is 2,200 gpm.

Water main extension to existing neighborhoods

Wherever possible, any residences on PFAS impacted non-municipal wells would be connected to the city's municipal water system. However, no additional distribution lines are required at this time. There are 28 existing non-municipal wells that can be replaced with connections to existing distribution lines by installing a service lateral and sealing the well.

GAC POET systems

This scenario would provide GAC POET systems for PFAS impacted non-municipal wells under 2040 conditions. As of October 2019 sample data, St. Paul Park has an estimated 49 existing non-municipal wells, of which 16 wells have been sampled. All sampled wells have a HI value less than 0.5, and thus, no GAC POET systems have been installed. Based on current sampling trends, it was estimated that by 2040 a total of 14 non-municipal wells would have HI values greater than or equal to 0 and would receive treatment through GAC POET systems. Groundwater modeling and flow path analysis indicate that 14 non-municipal wells will also require POETS in the HI≥1 alternative by 2040.

E.2.2.11.3 Hydraulic modeling analysis

Similar to other communities, St. Paul Park currently has hydraulic model that they have used to determine upgrades and improvements to their system. The existing model is an extended period simulation while the models the Wood had developed are steady state. Wood used pressure data provided by the City to calibrate the model so that it reflects actual conditions at a particular time. There were no pump curves available to use in the model, and a single point design curve was used for each of the pumps based off the data provided by the City. Using a pump curve allowed the flow and head or pressure from the pump to vary with changes made to the system and reflects how the pump would typically operate. It is recommended for future analysis that an extended period simulation be used and that the pump curves for the pumps currently in operation be located and used in the model.

There is an issue filling the two storage towers with the proposed WTP as one tower is located next to the WTP and fills at a faster rate. To address this, it is recommended that an altitude valve be installed at the Lincoln Tower to allow flow to be conveyed to the Broadway Tower. However, the city had reported that the closing of the altitude valve would cause pressure spikes around 30 psi. While the hydraulic model performed under this project was not an extended period analysis, the steady state results could not duplicate the 30 psi pressure spike but did see a pressure spike of approximately 23 psi near the tank. Pressures in this area increase from approximately 60 psi to 83 psi. To mitigate this pressure increase and facilitate flows to the Broadway Tower, the City had requested that two 12-inch lines be installed from the treatment facility up to the tower. Based on Wood's modeling results, it is recommended that a parallel 12-inch line along Summit Ave from 13th Ave to Broadway be installed.

E.2.2.11.4 Groundwater modeling analysis

Forward particle tracking to 2040 was conducted under wet, normal, and drought climate conditions from known PFAS sources and areas where HI>1, as shown on Figures E.2.2c, E.2.2d, and E.2.2e, respectively. Particles inserted into the model travel in the direction of groundwater flow. In St. Paul Park, groundwater flow in the Prairie Du Chien and Jordan Sandstone aquifers is generally from east/northeast to west/southwest, towards the Mississippi River. A cluster of groundwater samples with HI>1 is located within close proximity to the City's northeast boundary. The samples were collected from wells drilled into Prairie Du Chien and Jordan Sandstone aquifers. Particles inserted around this cluster of wells travel west/southwest into St. Paul Park and reach municipal and non-municipal wells within the city limits by the year 2040. A drawdown analysis was not performed for St. Paul Park since no new wells were proposed.

E.2.2.11.5 Project alternatives

Since St. Paul Park is currently implementing a treatment facility and it is estimated that all three municipal supply wells with have a HI ≥1 by 2040. Two alternatives were evaluated for both HI conditions, but they are essentially the same with only the number of POET systems different. The alternatives are described below, and costs are provided in E.2.2.11.6. Water supply configurations for these alternatives are shown on Figure E.2.2.11.1.

Alternative 1a – 2040 One Centralized WTP HI > 0

As mentioned above, all municipal and non-municipal wells with detectable levels of PFAS will be treated or connected to the system under this alternative and the treatment plant would have a capacity of 2,200 gpm. This alternative also includes connecting 28 non-municipal wells to the existing water distribution system, installing 16 POETS, a 12" water main from the WTP to the Broadway Tank, and raw water mains from the wells to the WTP.

Alternative 1b – 2040 One Centralized WTP HI ≥1

This alternative is similar to Alternative 1a, with the exception that all municipal and non-municipal wells with an HI≥1 will be treated or connected to the system. The treatment plant would have a capacity of 2,200 gpm. This alternative includes connecting 28 non-municipal wells to the existing water distribution system, installing 13 POETS, a 12" water main from the WTP to the Broadway Tank, and raw water mains from the wells to the WTP.

E.2.2.11.6 Cost estimate breakdown

A breakdown of capital and O&M costs for each alternative described above is provided in Tables E.164 and E.165 for the year 2040.

Table E.164. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for St. Paul Park-Alternative 1a.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	1	WTP	2200 gpm WTP for Wells 2,3,4	$5,710,000	$4,080,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$1,140,000	$1,140,000
Well Modifications	3	Wells	Well & SCADA upgrades	$360,000	
Raw water transmission mains	0.61	Miles	from wells to WTP	$1,450,000	
Water distribution mains	1.05	Miles	12" to Broadway Tank	$2,610,000	
Service Laterals	28	Each	Connect homes to existing mains ($2500 ea)	$10,000	
Well Sealing	28	Each	$2,000 per well	$56,000	
Land acquisition (site + water mains)	3.0	Acres	1 acre at WTP, 20 ft easements (50%)	$410,000	
GAC POETS	14	POETS	Standard household systems, $2,500 per well	$40,000	
			Subtotal	$11,790,000	$10,160,000
			Contingency (25%)	$2,950,000	$2,540,000
			Professional services (15%)	$1,770,000	$1,530,000
			Total Capital	**$16,510,000**	**$14,230,000**
Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost	$27,000	$17,000
PFAS WTPs	1	WTP	Maint. and Operations	$340,000	$260,000
Raw water transmission mains	0.61	Miles	from wells to WTP	$8,000	
Water distribution mains	1.05	Miles	12" to Broadway Tank	$20,000	
GAC POETS	14	POETS	Standard household systems, $1,000 per well	$14,000	
			Subtotal	$409,000	$320,000
			20 years of annual O&M	$8,180,000	$6,400,000
			20 years of annual O&M future value[1]	$10,990,000	$8,600,000
			20 year costs (capital + O&M)	**$24,690,000**	**$20,630,000**
			20 year future value costs (capital + O&M)	**$27,500,000**	**$22,830,000**
			Capital and operating cost per 1,000 gal	$1.18	$0.98
			Operating only cost per 1,000 gallons	$0.47	$0.37

Recapitalization Costs Factored Annually				
WTPs	2%	of Capital	$140,000	$110,000
Water Mains	1.67%	of Capital	$68,000	
		Subtotal	$210,000	$180,000
		20 years of recapitalization	**$4,200,000**	**$3,600,000**
		20 years of recapitalization future value[1]	**$5,650,000**	**$4,840,000**
		20 year future value costs (capital + O&M + recapitalization)	**$33,150,000**	**$27,670,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.165. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for St. Paul Park-Alternative 1b.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	1	WTP	2200 gpm WTP for Wells 2,3,4	$5,710,000	$4,080,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$1,140,000	$1,140,000
Well Modifications	3	Wells	Well & SCADA upgrades	$360,000	
Raw water transmission mains	0.61	Miles	from wells to WTP	$1,450,000	
Water distribution mains	1.05	Miles	12" to Broadway Tank	$2,610,000	
Service Laterals	28	Each	Connect homes to existing mains ($2500 ea)	$10,000	
Well Sealing	28	Each	$2,000 per well	$56,000	
Land acquisition (site + water mains)	3.0	Acres	1 acre at WTP, 20 ft easements (50%)	$410,000	
GAC POETS	14	POETS	Standard household systems, $2,500 per well	$40,000	
			Subtotal	$11,790,000	$10,160,000
			Contingency (25%)	$2,950,000	$2,540,000
			Professional services (15%)	$1,770,000	$1,530,000
			Total Capital	**$16,510,000**	**$14,230,000**
Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost	$27,000	$17,000
PFAS WTPs	1	WTP	Maint. and Operations	$340,000	$260,000
Raw water transmission mains	0.61	Miles	from wells to WTP	$8,000	

Water distribution mains	1.05	Miles	12" to Broadway Tank	$20,000	
GAC POETS	14	POETS	Standard household systems, $1,000 per well	$14,000	
			Subtotal	$409,000	$320,000
			20 years of annual O&M	$8,180,000	$6,400,000
			20 years of annual O&M future value[1]	$10,990,000	$8,600,000
			20 year costs (capital + O&M)	**$24,690,000**	**$20,630,000**
			20 year future value costs (capital + O&M)	**$27,500,000**	**$22,830,000**
			Capital and operating cost per 1,000 gal	$1.18	$0.98
			Operating only cost per 1,000 gallons	$0.47	$0.37
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$140,000	$110,000
Water Mains		1.67%	of Capital	$68,000	
			Subtotal	$210,000	$180,000
			20 years of recapitalization	**$4,200,000**	**$3,600,000**
			20 years of recapitalization future value[1]	**$5,650,000**	**$4,840,000**
			20 year future value costs (capital + O&M + recapitalization)	**$33,150,000**	**$27,670,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

A summary of the costs for the two alternatives along with capital and operating costs per 1000 gallons is shown in Table E.166 below.

Table E.166. Summary of Year 2040 costs with 3% inflation for the Community-Specific Scenario A for St. Paul Park.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)		Capital and operating cost per 1000 gal		Operating Cost per 1000 gal	
					IX	GAC	IX	GAC	IX	GAC	IX	GAC	IX	GAC
Alt 1a	>0	2200 gpm WTP	14	3.18	$14	$16.5	$0.32	$0.41	$28	$33	$1.0	$1.2	$0.4	$0.5
Alt 1b	>1	2200 gpm WTP	14	3.18	$14	$16.5	$0.32	$0.41	$28	$33	$1.0	$1.2	$0.4	$0.5

Notes:
1. Recapitalization and inflation costs are included in Total 20 year costs and are not included in the Capital and Annual O&M costs.

E.2.2.11.7 PFAS eligible cost summary

The cost estimates presented above include all related costs for each given alternative to meet Year 2040 water demands. However, for various reasons, some costs may not be covered by settlement funds. The guidelines used to determine project components that would be eligible for settlement funding were presenting in the Appendix E Introduction.

All capital costs were considered eligible for PFAS funding for both Alternatives 1a and 1b. Operation and maintenance costs for the raw water transmission mains and the water distribution mains were excluded along with recapitalization costs, as shown in Table E.167.

Table E.167. Summary of PFAS Eligible Costs Community-Specific Scenario A for St. Paul Park.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1a	>0	2200 gpm WTP	14	3.18	$14	$16.5	$0.30	$0.38	$22	$27
Alt 1b	>1	2200 gpm WTP	14	3.18	$14	$16.5	$0.30	$0.38	$22	$27

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.11.8 Cost summary with particle tracking costs removed

Costs presented in Table E.168 are reflective of the currently known areas of PFAS contamination and do not consider future costs associated with the potential migration of the groundwater contamination noted by the particle tracking exercise. These costs also consider only those cost considered to be eligible for funding as noted in the previous section. To evaluate the cost implications of particle tracking and the projection of future potential areas of PFAS impact, these costs were removed from the PFAS eligible cost estimate. For St. Paul Park, this applied to 14 POETS which were removed in Alternative 1b.

Table E.168. Summary of Costs Community-Specific Scenario A for St. Paul Park with Particle Tracking costs removed.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1a	>0	2200 gpm WTP	14	3.18	$14	$16.5	$0.30	$0.38	$22	$27
Alt 1b	>1	2200 gpm WTP	0	3.18	$14	$16.5	$0.28	$0.37	$22	$26

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.12 Conceptual projects – West Lakeland

E.2.2.12.1 Project summary

The conceptual projects considered for West Lakeland under this scenario would include the installation of a new municipal water treatment and distribution system to supply treated water to residences on PFAS impacted non-municipal wells under 2040 conditions. POET systems would also be provided to any residents with PFAS impacted wells that could not be connected to the proposed distribution system. Another alternative considered was the installation of POET systems on all impacted non-municipal wells. A summary of the projects is provided below and the infrastructure modifications are shown in Figures E.2.2.12.1 and E.2.2.12.2. The implications on West Lakeland's private and non-municipal wells are shown in Figures E.2.2.1.1 and E.2.2.1.2 for both HI conditions. These two figures are regional maps illustrating the impact on private and non-municipal wells and which wells will receive GAC POETS or be connected to the distribution system as necessary.

E.2.2.12.2 Project improvements

New municipal supply wells

West Lakeland Township is classified as rural residential and all water supplied is from private. However, if West Lakeland were to implement a municipal water treatment and distribution system, they would need to drill a new municipal well capable of producing approximately 680 gpm or 800 gpm depending on the alternative to provide water to the entire township. Alternatives 1-4 require a water supply of 680 gpm for an estimated 1190 connections and Alternatives 5 and 6 require 800 gpm for approximately 1340 connections. A redundant well is also necessary due to public health codes, so two wells were included in costs.

To assist in the location of the replacement supply wells, the ground water model was used to evaluate well placement through a well interference and drawdown analysis. Proposed well locations were inputted into the groundwater model along with the design flow rates to determine if the potential drawdown exceeded the current limits. This process will be discussed in the hydraulic and groundwater modeling sections (E.2.2.12.3 and E.2.2.12.4, respectively).

Water treatment plants (WTPs)

This scenario includes two conditions used to select wells for treatment based on the two HI values of HI > 0 and HI ≥ 1. Wells will also be selected to receive treatment if they fall within areas of future contamination as determined during the groundwater flow path analysis. According to available sampling data, many wells in the community have an HI value greater than 1 and have already been issued a GAC POET system. Groundwater modeling flow path analyses have indicated that the majority of the Township may have PFAS impacts by 2040. As such, it will be assumed that the new municipal supply well will need treatment under both the HI > 0 and HI ≥ 1 conditions.

New municipal water system

Under this scenario, the primary option is to install a new municipal water system for West Lakeland. This new municipal water system would require the implementation of two municipal supply wells (one being installed for redundancy), a PFAS treatment facility, and a water distribution system with storage facilities and any necessary booster pump stations and pressure reducing valves to control system pressures. In addition, GAC POET systems will be provided as necessary for PFAS impacted, non-municipal wells that could not be feasibly or economically connected to the existing distribution system.

GAC POET systems

The other alternative to implementing a new municipal treatment and distribution system for West Lakeland would be to continue providing GAC POET systems for all PFAS impacted, non-municipal wells. Under this scenario, non-municipal wells would be selected for treatment using the same HI categories as previously described. Current or anticipated PFAS impacted non-municipal wells would be provided with GAC POET systems that were not proposed to be connected to the municipal water system. According to PFAS sampling data from October 2019 and Minnesota Well Index (MWI) data, West Lakeland has an estimated 1,189 existing non-municipal wells. However, this number was less than and not representative of the actual number of wells in the township. A manual count, confirmed by the township, indicated that there are approximately 1340 wells. Of these wells, 689 have been sampled. Of the sampled wells, 377 currently have GAC POET systems installed for PFAS contamination while 111 wells have GAC POET systems in the northern region for TCE contamination. However, it is assumed that these wells cannot be reused for PFAS treatment and new POET systems would be required.

The groundwater model flow path analysis estimated that by 2040 all non-municipal wells would be impacted by PFAS contamination as indicated by the projected impact areas and will either receive treatment through existing or proposed GAC POET systems or be connected to the proposed distribution system. If the entire community is connected to the distribution system this will eliminate the existing 377 and 111 GAC POETS. However, if the entire community were to be provided GAC POET systems, an additional 852 systems would need to be installed and maintained.

Under alternatives 1 through 4 as described below, the distribution system was limited to certain regions of the community based on current PFAS sampling data and not projected 2040 conditions. Under these two alternatives, the proposed distribution system connected those homes currently impacted by PFAS and not TCE which is present in the northern half of the City. Wood also received feedback from the township regarding areas of the system that could be removed from the proposed system in an effort to reduce pipe lengths. Under these assumptions, only 1,190 wells would be connected and 150 GAC POET systems would be required for homes that may be impacted by 2040 according to the groundwater modeling.

Water main extension to existing neighborhoods

The available sample data indicates that the majority of non-municipal wells are currently impacted by PFAS and many have had a GAC POET system installed. Under both conditions of HI > 0 and HI ≥ 1, 1,190 existing homes on private wells could be connected to a new public water system. Table E.169 lists the number of homes, the cost of POET systems over 20 years, the costs of installing 46 miles of new water mains (Alternative 2 below), and the number of years it takes for POETS to exceed the cost of the water mains. This table highlights the difference between the higher O&M costs for POETS vs the lower long-term O&M costs of water mains.

Table E.169. Proposed neighborhoods and areas that could be connected to West Lakeland's new water system under this scenario.

Neighborhood	No. of Existing Homes	POETS ($K)			Extend Water Distribution Mains ($K)			No. of Years for POETS to Exceed Mains	No. of Years for POETS to Exceed Mains (PFAS eligible)[1]
		Capital	O&M	20 Year Total	Capital	O&M	20 Year Total		
8" Mains (80% of Township)	1,190	4,165	1,190	27,965	101,577	355	108,677	117	82
4"-8" Mains (80% of Township, Alt 4)	1,190	4,165	1,190	27,965	93,125	355	100,225	107	75
8" Mains (100% of Township*)	1,340	4,690	1,340	31,490	115,038	402	123,078	118	83

4"-8" Mains (100% of Township*)	1,340	4,690	1,340	31,490	112,805	394	120,685	115	81

Notes:

1. Operation and maintenance costs for water distribution mains are not eligible for funding under the settlement. This column represents the number of years for the costs of POETS for the entire neighborhood to exceed the costs of installing distribution mains.
2. Highlighted neighborhoods are included in the recommended options shown in Section E.4.
3. Cost estimates do not include inflation or recapitalization of assets.
4. Well sealing of $2,000 per non-municipal well is included in the distribution line estimates.
5. The options including 100% of the Township account for groundwater model flow path analyses which show groundwater flow paths from current areas of impact moving across the whole Township as opposed to the 80% currently impacted.
6. 6. No consideration was given to the potential generation of revenue through water sales or service associated with similar type public water systems have been applied to this analysis.

E.2.2.12.3 Hydraulic modeling analysis

To evaluate a new municipal water treatment and distribution system a few alternatives were evaluated that examined different physical characteristics and areas served. While these will be discussed in further detail in the following sections, they will also be briefly summarized here. The first alternative includes installing 8-inch lines throughout the system to allow for fire flow. The second, includes reducing line sizes to no less than 4 inches while removing the fire flow requirement. The third alternative includes the same lines sizes as presented in the first two alternatives but reduced the areas served. Currently, the model includes service to only those areas impacted by PFAS contamination and does not include some of the area to the north that has TCE contamination. If the township decides in the future to provide service to additional areas, a separate hydraulic model evaluation should be performed.

West Lakeland has widely varying topography with ground elevations ranging from 805 to 1,030 feet. The nature of its landscape creates hydraulic challenges for regulating system pressures. In order to maintain adequate pressures, a network consisting of pressure reducing valves and booster pumps would be required for all alternatives. The groundwater supply wells were placed on the west side of the township on a county owned parcel, as shown in Figures E.2.2.12.1 and E.2.2.12.2. Water storage towers were placed at high points in the system and needed to be located on private land. Due to the water storage towers being located at high points in the system and the need to mitigate pressures in the other areas of the system, booster pump stations were placed near the base of the proposed storage towers. Pressure reducing valves were used to isolate pressure zones along the eastern side of the town ship and keep system pressures below 90 psi.

E.2.2.12.4 Groundwater modeling analysis

Two new municipal wells were proposed for West Lakeland; one capable of producing at a maximum daily rate of 800 gpm and a redundant well which would be used for back-up according to current public health codes. The well would extract groundwater from the Jordan Sandstone aquifer. For the groundwater model analysis, only one of the proposed wells was pumping at an average rate of 292 gpm.

Using the guidance provided by the DNR, simulated head at the proposed location was evaluated under a drier setting that approaches drought like conditions (worst case and herein referred to as drought) to determine whether drawdown exceeds the 50% threshold. Model recharge for drought conditions was reduced by 66% of the current condition recharge rate based on modeling by the DNR using the Soil

Water Balance model over a drier time period of 2006 to 2009. For model scenarios run under drought conditions, the average rate for the proposed well was increased by multiplying the average rate by a factor of 1.33 (West Lakeland does not have an existing public water system, so water system characteristics for Lake Elmo were used. 1.33 is the ratio of maximum per capita demand over average per capita demand from Years 2005-2015 for Lake Elmo assuming a similar demand trend based on population). Pumping rates at irrigation wells were also increased by taking the maximum annual volume reported over a 20-year period (1988 – 2018). Drawdown for Scenario A under wet and dry conditions are shown on Figures E.2.2a and E.2.2b, respectively.

Under drought conditions, drawdown does not exceed the 50% available head in either the Jordan Sandstone or Prairie Du Chien aquifers. Additionally, the effect of pumping is localized such that the general groundwater flow direction is not altered. Table E.170 provides a summary of drawdown in the Jordan Sandstone aquifer under wet, normal, and drought conditions and drawdown in the Prairie Du Chien under drought conditions. The reported drawdown is relative to average 2016-2018 simulated groundwater elevations, which is considered a wet period. The available head is the difference between the average 2016-2018 simulated head and the elevation of the top of the aquifer. The percent of available head is the amount of available head that is taken up by drawdown under drought conditions.

Table E.170. Summary of drawdown in the Jordan Sandstone and Prairie Du Chien aquifers under wet, normal, and drought conditions.

Well	Jordan Sandstone Aquifer				Prairie Du Chien Aquifer		
	Drawdown (m)		Available Head (m)	Percent of Available Head (drought)	Drawdown (m)	Available Head (m)	Percent of Available Head (drought)
	Wet	Drought			Drought		
Proposed Well 1	7	10	59	17	1	15	7

Forward particle tracking to 2040 was conducted under wet, normal, and drought climate conditions from known PFAS sources and areas where HI>1, as shown on Figures E.2.2c, E.2.2d, and E.2.2e, respectively. Model recharge for normal conditions was reduced to 87% of the current condition recharge rate based on modeling by the DNR using the Soil Water Balance model over a drier time period of 1989 to 2018. The new proposed well (excluding the redundant well) is operating at the average daily rate used for the drawdown analysis discussed above. In each climate condition, the general groundwater flow direction in West Lakeland is from west to east towards the St. Croix River in both the Jordan Sandstone and Prairie Du Chien aquifers. Since the proposed well is located in an area where surrounding wells have an HI > 1, particles were captured by the well suggesting possible PFAS contamination by the year 2040 for both HI > 0 and HI ≥ 1 alternatives.

E.2.2.12.5 Project alternatives

Alternatives 1-6 consider installing a water distribution system for all or part of West Lakeland, where Alternative 7 is a POET only solution. A summary of each alternative is provided below and costs are provided in E.2.2.12.6. Water supply configurations for these alternatives are shown on Figures E.2.2.12.1 for Alternatives 1-4 and E.2.2.12.2 for Alternatives 5 and 6. Each alternative applies to both the HI>0 and the HI>1 categories as the impact to West Lakeland is the same for each.

Alternative 1 – 2040 One Centralized WTP and 8-inch Distribution System HI > 0, HI ≥ 1

As briefly mentioned above, this alternative included implementing a water distribution system that was capable of conveying fire flow with all 8-inch lines. It was assumed that the new municipal supply well would be capable of supplying approximately 680 gpm and would receive PFAS treatment. Other components such as water storage towers, booster pumps, and pressure reducing valves were also included. Under this alternative, approximately 1,190 properties with existing private wells out of the estimated total of 1,340 would be connected to the system.

Alternative 2 – 2040 One Centralized WTP and 8-inch Reduced Distribution System HI > 0, HI ≥ 1

This alternative kept the same pipe sizing and layout as in Alternative 1; however, certain pipe segments were eliminated from the proposed system in areas that, as decided by the township, did not need to be connected or in places where pipes could be eliminated due to looping in other areas of the system. This eliminated almost 20,000 LF of piping from the previous alternative. All other hydraulic elements remained the same except under this alternative approximately 1,190 properties with existing private wells out of the estimated total of 1,340 would be connected to the system.

Alternative 3 – 2040 One Centralized WTP and <8-inch Distribution System HI > 0, HI ≥ 1

This alternative kept the same layout as that presented in Alternative 1 but pipe diameters were reduced to examine the impact the smaller line sizes would have on cost. Pipe sizes were reduced to not less than 4 inches due to the difficulty of connecting service laterals to smaller sized lines. All other hydraulic elements remained the same under this alternative with the exception of certain operating and set points for pumps and PRVs, and approximately 1,190 properties with existing private wells out of the estimated total of 1,340 would be connected to the system.

Alternative 4 – 2040 One Centralized WTP and <8-inch Reduced Distribution System HI > 0, HI ≥ 1

A fourth alternative looked at keeping the same pipe sizing and layout as in alternative 3, with the exception of areas that, as decided by the township, did not need to be connected or in places where pipes could be eliminated due to looping in other areas of the system. This eliminated almost 20,000 LF of piping from the previous alternative. All other hydraulic elements remained the same except under this alternative approximately 1,190 properties with existing private wells out of the estimated total of 1,340 would be connected to the system. Alternative 4 was selected for the recommended options presented in E.4.

Alternative 5 – 2040 One Centralized WTP and 8-inch Distribution System for 100% of Township HI > 0, HI ≥ 1

A fifth alternative looked at expanding the water system to the entire Township using 8" water mains. Groundwater modeling has indicated the contamination is expected to include the entire Township by year 2040. Other elements of the water system are similar to Alternative 1, but with 800 gpm wells, an 800 gpm water treatment facility, and larger water storage tanks that are 300,000 gallons each. Under this alternative approximately 1,340 properties with existing private wells out of the estimated total of 1,340 would be connected to the system.

Alternative 6 – 2040 One Centralized WTP and <8-inch Distribution System for 100% of Township HI > 0, HI ≥ 1

A sixth alternative to serve the entire Township is similar to Alternative 5, but is using reduced water mains between 4-inch and 8-inch diameter that do not provide fire protection. Under this alternative approximately 1,340 properties with existing private wells out of the estimated total of 1,340 would be connected to the system.

Alternative 7 – POETS only HI > 0, HI ≥ 1

A seventh alternative considered the installation of GAC POETS only for the entire Township. Groundwater modeling indicates the entire community will potentially be impacted by PFAS contamination by 2040. Under this alternative approximately 820 POETS would be installed for a total of 1340 POETS for the entire community.

E.2.2.12.6 Cost estimate breakdown

The cost estimates for West Lakeland include the new municipal water system which would require one 680 gpm municipal supply well to meet 2040 water demands as well as a redundant well and various other components. A cost comparison of the new system versus GAC POETS is also provided.

In an effort to reduce costs of the new water distribution system, cost estimates in this table assume the water mains are polyvinyl chloride (PVC) instead of ductile iron pipe.

A breakdown of capital and O&M costs for alternatives 1 through 7 discussed above are provided in Tables E.171 through E.177 below, respectively for projected 2040 conditions. A summary of the seven alternatives is provided in Table E. 178.

Table E.171. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for West Lakeland – Alternative 1.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	1	WTPs	680 gpm	$2,840,000	$2,030,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$360,000	$360,000
New Well	2	Wells	each well 680 gpm	$3,100,000	
Pressure Reducing Valves	3	Stations	8" PRVs	$380,000	
Storage tanks	2	Tanks	0.6 MG total (0.3 MG each)	$2,454,000	
Booster Pump Station	3	Stations	3 BPS (300,100,10 gpm)	$750,000	
Water distribution mains	49.8	Miles	connecting distribution mains (PVC) for 1190 connections	$70,860,000	
Well Sealing	1190	Ea	$2,000 per well	$2,380,000	
Land acquisition (site + water mains)	63.9	Acres	1/2 acre per well, 1 acre at WTP, 20 ft easements (50%)	$8,630,000	
GAC POETS	200	POETS	Standard household systems, $2,500 per well	$500,000	
			Subtotal	$92,260,000	$91,450,000
			Contingency (25%)	$23,070,000	$22,870,000
			Professional services (15%)	$13,840,000	$13,720,000
			Total Capital	**$129,170,000**	**$128,040,000**

Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost	$12,000	$8,000
PFAS WTPs	1	WTP	Maint. and Operations	$250,000	$210,000
Wells	2	Wells	each well 680 gpm	$110,000	
Pressure Reducing Valves	3	Stations	Installed within right-of-way	$26,000	
Storage Tanks	2	Tanks	0.6 MG total (0.3 MG each)	$66,000	
Booster Pump Station	3	Stations	3 BPS (300,100,10 gpm)	$90,000	
Water distribution mains	49.8	Miles	connecting distribution mains (PVC) for 1190 connections	$355,000	
GAC POETS	200	POETS	Standard household systems, $1,000 per well	$200,000	
			Subtotal	$1,109,000	$1,070,000
			20 years of annual O&M	$22,180,000	$21,400,000
			20 years of annual O&M future value[1]	$29,800,000	$28,760,000
			20 year costs (capital + O&M)	**$151,350,000**	**$149,440,000**
			20 year future value costs (capital + O&M)	**$158,970,000**	**$156,800,000**
			Capital and operating cost per 1,000 gal	$21.16	$20.87
			Operating only cost per 1,000 gallons	$3.97	$3.83
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$70,000	$50,000
Wells		2%	of Capital	$62,000	
Booster Pump Stations		2%	of Capital	$20,000	
Storage Tanks			Rehab every 20 Years	$46,000	
Water Mains		1.67%	of Capital	$1,184,000	
			Subtotal	$1,390,000	$1,370,000
			20 years of recapitalization	**$27,800,000**	**$27,400,000**
			20 years of recapitalization future value[1]	**$37,350,000**	**$36,820,000**
			20 year future value costs (capital + O&M + recapitalization)	**$196,320,000**	**$193,620,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.172. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for West Lakeland-Alternative 2.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	1	WTPs	680 gpm	$2,840,000	$2,030,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$360,000	$360,000
New Well	2	Wells	each well 680 gpm	$3,100,000	
Pressure Reducing Valves	3	Stations	6" PRVs	$380,000	
Storage tanks	2	Tanks	0.6 MG total (0.3 MG each)	$2,454,000	
Booster Pump Station	3	Stations	3 BPS (300,100,10 gpm)	$750,000	
Water distribution mains	46	Miles	8" distribution mains (PVC) for 1190 connections, reduced looping	$64,820,000	
Well Sealing	1190	Ea	$2,000 per well	$2,380,000	
Land acquisition (site + water mains)	58.7	Acres	1/2 acre per well, 1 acre at WTP, 20 ft easements (50%)	$7,940,000	
GAC POETS	200	POETS	Standard household systems, $2,500 per well	$500,000	
			Subtotal	$85,530,000	$84,720,000
			Contingency (25%)	$21,390,000	$21,180,000
			Professional services (15%)	$12,830,000	$12,710,000
			Total Capital	**$119,750,000**	**$118,610,000**
Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost	$12,000	$8,000
PFAS WTPs	1	WTP	Maint. and Operations	$250,000	$210,000
Wells	2	Wells	each well 680 gpm	$110,000	
Pressure Reducing Valves	3	Stations	Installed within right-of-way	$26,000	
Storage Tanks	2	Tanks	0.6 MG total (0.3 MG each)	$66,000	
Booster Pump Station	3	Stations	3 BPS (300,100,10 gpm)	$90,000	
Water distribution mains	46	Miles	8" distribution mains (PVC) for 1190 connections, reduced looping	$325,000	

GAC POETS	200	POETS	Standard household systems, $1,000 per well	$200,000	
			Subtotal	$1,079,000	$1,040,000
			20 years of annual O&M	$21,580,000	$20,800,000
			20 years of annual O&M future value[1]	$29,000,000	$27,950,000
			20 year costs (capital + O&M)	**$141,330,000**	**$139,410,000**
			20 year future value costs (capital + O&M)	**$148,750,000**	**$146,560,000**
			Capital and operating cost per 1,000 gal	$19.80	$19.51
			Operating only cost per 1,000 gallons	$3.86	$3.72
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$70,000	$50,000
Wells		2%	of Capital	$62,000	
Booster Pump Stations		2%	of Capital	$20,000	
Storage Tanks			Rehab every 20 Years	$46,000	
Water Mains		1.67%	of Capital	$1,083,000	
			Subtotal	$1,290,000	$1,270,000
			20 years of recapitalization	**$25,800,000**	**$25,400,000**
			20 years of recapitalization future value[1]	**$34,670,000**	**$34,130,000**
			20 year future value costs (capital + O&M + recapitalization)	**$183,420,000**	**$180,690,000**

Notes:

1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.173. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for West Lakeland-Alternative 3.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	1	WTPs	680 gpm	$2,840,000	$2,030,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$360,000	$360,000
New Well	2	Wells	each well 680 gpm	$3,100,000	
Pressure Reducing Valves	3	Stations	6" PRVs	$380,000	
Storage tanks	2	Tanks	0.5 MG total (0.25 MG each)	$2,204,000	
Booster Pump Station	3	Stations	3 BPS (300,100,10 gpm)	$750,000	
Water distribution mains	49.8	Miles	4"-8" distribution mains (PVC) for 1190 connections	$68,320,000	

Well Sealing	1190	Ea	$2,000 per well	$2,380,000	
Land acquisition (site + water mains)	63.9	Acres	1/2 acre per well, 1 acre at WTP, 20 ft easements (50%)	$8,630,000	
GAC POETS	200	POETS	Standard household systems, $2,500 per well	$500,000	
			Subtotal	$89,470,000	$88,660,000
			Contingency (25%)	$22,370,000	$22,170,000
			Professional services (15%)	$13,430,000	$13,300,000
			Total Capital	**$125,270,000**	**$124,130,000**
Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost	$12,000	$8,000
PFAS WTPs	1	WTP	Maint. and Operations	$250,000	$210,000
Wells	2	Wells	each well 680 gpm	$110,000	
Pressure Reducing Valves	3	Stations	Installed within right-of-way	$26,000	
Storage Tanks	2	Tanks	0.5 MG total (0.25 MG each)	$62,000	
Booster Pump Station	3	Stations	3 BPS (300,100,10 gpm)	$90,000	
Water distribution mains	49.8	Miles	4"-8" distribution mains (PVC) for 1190 connections	$342,000	
GAC POETS	200	POETS	Standard household systems, $1,000 per well	$200,000	
			Subtotal	$1,092,000	$1,050,000
			20 years of annual O&M	$21,840,000	$21,000,000
			20 years of annual O&M future value[1]	$29,350,000	$28,220,000
			20 year costs (capital + O&M)	**$147,110,000**	**$145,130,000**
			20 year future value costs (capital + O&M)	**$154,620,000**	**$152,350,000**
			Capital and operating cost per 1,000 gal	$20.58	$20.28
			Operating only cost per 1,000 gallons	$3.91	$3.76
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$70,000	$50,000
Wells		2%	of Capital	$62,000	
Booster Pump Stations		2%	of Capital	$20,000	
Storage Tanks			Rehab every 20 Years	$40,000	
Water Mains		1.67%	of Capital	$1,141,000	
			Subtotal	$1,340,000	$1,320,000

20 years of recapitalization	**$26,800,000**	**$26,400,000**
20 years of recapitalization future value[1]	**$36,010,000**	**$35,470,000**
20 year future value costs (capital + O&M + recapitalization)	**$190,630,000**	**$187,820,000**

Notes:

1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.174. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for West Lakeland-Alternative 4.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	1	WTPs	680 gpm	$2,840,000	$2,030,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$360,000	$360,000
New Well	2	Wells	each well 680 gpm	$3,100,000	
Pressure Reducing Valves	3	Stations	6" PRVs	$380,000	
Storage tanks	2	Tanks	0.5 MG total (0.25 MG each)	$2,204,000	
Booster Pump Station	3	Stations	3 BPS (300,100,10 gpm)	$750,000	
Water distribution mains	45.6	Miles	4"-8" distribution mains (PVC) for 1190 connections	$62,520,000	
Well Sealing	1190	Ea	$2,000 per well	$2,380,000	
Land acquisition (site + water mains)	58.7	Acres	1/2 acre per well, 1 acre at WTP, 20 ft easements (50%)	$7,940,000	
GAC POETS	200	POETS	Standard household systems, $2,500 per well	$500,000	
			Subtotal	$82,980,000	$82,170,000
			Contingency (25%)	$20,750,000	$20,550,000
			Professional services (15%)	$12,450,000	$12,330,000
			Total Capital	**$116,180,000**	**$115,050,000**
Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost	$12,000	$8,000
PFAS WTPs	1	WTP	Maint. and Operations	$250,000	$210,000
Wells	2	Wells	each well 680 gpm	$110,000	
Pressure Reducing Valves	3	Stations	Installed within right-of-way	$26,000	
Storage Tanks	2	Tanks	0.5 MG total (0.25 MG each)	$62,000	

Booster Pump Station	3	Stations	3 BPS (300,100,10 gpm)	$90,000	
Water distribution mains	45.6	Miles	4"-8" distribution mains (PVC) for 1190 connections	$313,000	
GAC POETS	200	POETS	Standard household systems, $1,000 per well	$200,000	
			Subtotal	$1,063,000	$1,020,000
			20 years of annual O&M	$21,260,000	$20,400,000
			20 years of annual O&M future value[1]	$28,570,000	$27,410,000
			20 year costs (capital + O&M)	**$137,440,000**	**$135,450,000**
			20 year future value costs (capital + O&M)	**$144,750,000**	**$142,460,000**
			Capital and operating cost per 1,000 gal	$19.27	$18.96
			Operating only cost per 1,000 gallons	$3.80	$3.65
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$70,000	$50,000
Wells		2%	of Capital	$62,000	
Booster Pump Stations		2%	of Capital	$20,000	
Storage Tanks			Rehab every 20 Years	$40,000	
Water Mains		1.67%	of Capital	$1,045,000	
			Subtotal	$1,240,000	$1,220,000
			20 years of recapitalization	**$24,800,000**	**$24,400,000**
			20 years of recapitalization future value[1]	**$33,320,000**	**$32,790,000**
			20 year future value costs (capital + O&M + recapitalization)	**$178,070,000**	**$175,250,000**
Notes: 1. The 20-year future value costs were calculated using a 3% inflation rate					

Table E.175. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for West Lakeland-Alternative 5.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	1	WTPs	800 gpm	$3,120,000	$2,220,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$420,000	$420,000
New Well	2	Wells	each well 800 gpm	$3,420,000	
Pressure Reducing Valves	11	Stations	8" PRVs	$1,380,000	
Storage tanks	2	Tanks	0.6 MG total (0.3 MG each)	$2,454,000	

Booster Pump Station	3	Stations	3 BPS (400,100,10 gpm)	$840,000	
Water distribution mains	56.2	Miles	8" distribution mains (PVC) for 1340 connections	$80,260,000	
Well Sealing	1340	Ea	$2,000 per well	$2,680,000	
Land acquisition (site + water mains)	71.6	Acres	1/2 acre per well and WTP, 20 ft easements (50%)	$9,680,000	
GAC POETS	0	POETS	Standard household systems, $2,500 per well	$0	
			Subtotal	$104,260,000	$103,360,000
			Contingency (25%)	$26,070,000	$25,840,000
			Professional services (15%)	$15,640,000	$15,510,000
			Total Capital	**$145,970,000**	**$144,710,000**
Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost	$12,000	$8,000
PFAS WTPs	1	WTP	Maint. and Operations	$260,000	$220,000
Wells	2	Wells	each well 800 gpm	$110,000	
Pressure Reducing Valves	11	Stations	Installed within right-of-way	$94,000	
Storage Tanks	2	Tanks	0.6 MG total (0.3 MG each)	$66,000	
Booster Pump Station	3	Stations	3 BPS (400,100,10 gpm)	$90,000	
Water distribution mains	56.2	Miles	8" distribution mains (PVC) for 1340 connections	$402,000	
GAC POETS	0	POETS	Standard household systems, $1,000 per well	$0	
			Subtotal	$1,034,000	$990,000
			20 years of annual O&M	$20,680,000	$19,800,000
			20 years of annual O&M future value[1]	$27,790,000	$26,610,000
			20 year costs (capital + O&M)	**$166,650,000**	**$164,510,000**
			20 year future value costs (capital + O&M)	**$173,760,000**	**$171,320,000**
			Capital and operating cost per 1,000 gal	$20.66	$20.37
			Operating only cost per 1,000 gallons	$3.30	$3.16
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$80,000	$60,000
Wells		2%	of Capital	$69,000	
Booster Pump Stations		2%	of Capital	$20,000	
Storage Tanks			Rehab every 20 Years	$46,000	

Water Mains	1.67%	of Capital	$1,341,000	
		Subtotal	$1,560,000	$1,540,000
		20 years of recapitalization	**$31,200,000**	**$30,800,000**
		20 years of recapitalization future value[1]	**$41,920,000**	**$41,390,000**
		20 year future value costs (capital + O&M + recapitalization)	**$215,680,000**	**$212,710,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.176. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for West Lakeland-Alternative 6.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	1	WTPs	800 gpm	$3,120,000	$2,220,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$420,000	$420,000
New Well	2	Wells	each well 800 gpm	$3,420,000	
Pressure Reducing Valves	11	Stations	8" PRVs	$1,380,000	
Storage tanks	2	Tanks	0.6 MG total (0.3 MG each)	$2,454,000	
Booster Pump Station	3	Stations	3 BPS (400,100,10 gpm)	$840,000	
Water distribution mains	56.2	Miles	4"-8" distribution mains (PVC) for 1340 connections	$78,670,000	
Well Sealing	1340	Ea	$2,000 per well	$2,680,000	
Land acquisition (site + water mains)	71.6	Acres	1/2 acre per well, 1 acre at WTP, 20 ft easements (50%)	$9,680,000	
GAC POETS	0	POETS	Standard household systems, $2,500 per well	$0	
			Subtotal	$102,670,000	$101,770,000
			Contingency (25%)	$25,670,000	$25,450,000
			Professional services (15%)	$15,410,000	$15,270,000
			Total Capital	**$143,750,000**	**$142,490,000**
Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost	$12,000	$8,000
PFAS WTPs	1	WTP	Maint. and Operations	$260,000	$220,000
Wells	2	Wells	each well 800 gpm	$110,000	
Pressure Reducing Valves	11	Stations	Installed within right-of-way	$94,000	

Storage Tanks	2	Tanks	0.6 MG total (0.3 MG each)	$66,000	
Booster Pump Station	3	Stations	3 BPS (400,100,10 gpm)	$90,000	
Water distribution mains	56.2	Miles	4"-8" distribution mains (PVC) for 1340 connections	$394,000	
GAC POETS	0	POETS	Standard household systems, $1,000 per well	$0	
			Subtotal	$1,026,000	$990,000
			20 years of annual O&M	$20,520,000	$19,800,000
			20 years of annual O&M future value[1]	$27,570,000	$26,610,000
			20 year costs (capital + O&M)	**$164,270,000**	**$162,290,000**
			20 year future value costs (capital + O&M)	**$171,320,000**	**$169,100,000**
			Capital and operating cost per 1,000 gal	$20.37	$20.11
			Operating only cost per 1,000 gallons	$3.28	$3.16
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$80,000	$60,000
Wells		2%	of Capital	$69,000	
Booster Pump Stations		2%	of Capital	$20,000	
Storage Tanks			Rehab every 20 Years	$46,000	
Water Mains		1.67%	of Capital	$1,314,000	
			Subtotal	$1,530,000	$1,510,000
			20 years of recapitalization	**$30,600,000**	**$30,200,000**
			20 years of recapitalization future value[1]	**$41,120,000**	**$40,580,000**
			20 year future value costs (capital + O&M + recapitalization)	**$212,440,000**	**$209,680,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.177. 2040 Costs for POETS only for West Lakeland-Alternative 7.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
GAC POETS	820	POETS	Standard household systems, $2,500 per well	$2,050,000	
			Subtotal	$2,050,000	$2,050,000
			Contingency (25%)	$520,000	$520,000
			Professional services (15%)	$310,000	$310,000
			Total Capital	**$2,880,000**	**$2,880,000**
Annual O&M Cost					

GAC POETS	1340	POETS	Standard household systems, $1,000 per well	$1,340,000	
			Subtotal	$1,340,000	$1,340,000
			20 years of annual O&M	$26,800,000	$26,800,000
			20 years of annual O&M future value[1]	$36,010,000	$36,010,000
			20 year costs (capital + O&M)	**$29,680,000**	**$29,680,000**
			20 year future value costs (capital + O&M)	**$38,890,000**	**$38,890,000**
			Capital and operating cost per 1,000 gal	$15.96	$15.96
			Operating only cost per 1,000 gallons	$14.78	$14.78

Notes:

1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.178. Summary of Year 2040 costs with 3% inflation included for the seven alternatives for the Community-Specific Scenario A for West Lakeland.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)		Capital and operating cost per 1000 gal		Operating Cost per 1000 gal	
					IX	GAC	IX	GAC	IX	GAC	IX	GAC	IX	GAC
Alt 1	>0, >1	PWS for 80% Township, 2 wells, 1 WTP, 8" lines	200	1.03	$128	$129	$1.1	$1.1	$194	$196	$20.9	$21.2	$3.8	$4.0
Alt 2	>0, >1	PWS for 80% Township (reduced looping), 8" lines	200	1.03	$119	$120	$1.0	$1.1	$181	$183	$19.5	$19.8	$3.7	$3.9
Alt 3	>0, >1	Rural PWS for 80% Township, 4"-8" lines	200	1.03	$124	$125	$1.1	$1.1	$188	$191	$20.3	$20.6	$3.8	$3.9
Alt 4	>0, >1	Rural PWS, 80% Township (reduced looping, 4"-8" lines)	200	1.03	$115	$116	$1.0	$1.1	$175	$178	$19.0	$19.3	$3.6	$3.8
Alt 5	>0, >1	PWS for 100% Township, 8" lines	0	1.15	$145	$146	$1.0	$1.0	$213	$216	$20.4	$20.7	$3.2	$3.3
Alt 6	>0, >1	New Rural PWS for 100% Township (4"-8" lines)	0	1.15	$142	$144	$1.0	$1.0	$210	$212	$20.1	$20.4	$3.2	$3.3

Alt 7	>0,>1	POETS for entire community	1340	0.33	N/A	$3	N/A	$1.3	N/A	$39	N/A	$16.0	N/A	$14.8

Notes:

1. Recapitalization and inflation costs are included in Total 20 year costs and are not included in the Capital and Annual O&M costs.

Alternative 6 has the lowest 20-year cost between Alternatives 5 and 6 that included installing a water distribution system across the entire Township and is moved forward into the final summary table for the scenario. However, Alternative 4 was selected for the Recommendations Options presented in E.4.

E.2.2.12.7 PFAS eligible cost summary

The cost estimates presented above include all related costs for each given alternative to meet Year 2040 water demands. However, for various reasons, some costs may not be covered by settlement funds. The guidelines used to determine project components that would be eligible for settlement funding were presenting in the Appendix E Introduction.

All capital costs were considered eligible for PFAS funding for Alternative 4 and 6. Operation and maintenance costs for the well, raw water transmission mains, and water distribution mains were excluded along with recapitalization costs, as shown in Table E.179.

Table E.179. Summary of PFAS Eligible Costs Community-Specific Scenario A for West Lakeland.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 4	**>0, >1**	New Rural PWS for 80% Township (4”-8” lines)	200	1.03	$115	$116	$0.42	$0.46	$126	$129
Alt 6	**>0, >1**	New Rural PWS for 100% Township (4"-8" lines)	0	1.15	$142	$144	$0.2	$0.3	$149	$151

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.12.8 Cost summary with particle tracking costs removed

Costs presented in this section are reflective of the currently known areas of PFAS contamination and do not consider future costs associated with the potential migration of the groundwater contamination noted by the particle tracking exercise. Since approximately 80% of the community is currently impacted by PFAS, the distribution system would be unnecessary for the remaining 20% of the community. Therefore, Alternative 4 would be more representative of this scenario than Alternative 6. Due to the impact of the HI threshold on the number of existing non-municipal wells, Alternative 4 was broken into separate cost estimates for each HI threshold, as shown below in Table E.180. Alternative 4a requires 200 POETS outside of the planned distribution system for the HI>0 category. All capital costs are included along with operation and maintenance costs for the water treatment plant. All other operation and maintenance costs were excluded along with recapitalization costs.

Table E.180. Summary of Costs Community-Specific Scenario A for West Lakeland with Particle Tracking costs removed.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 4a	**>0**	Rural PWS, 80% Township (reduced looping, 4"-8" lines)	200	1.02	$115	$116	$0.4	$0.4	$125	$127
Alt 4b	**>1**	Rural PWS, 80% Township (reduced looping, 4"-8" lines)	0	0.98	$114	$115	$0.2	$0.3	$120	$123

Notes:

1. For these estimates; recapitalization costs are not included, O&M is only provided for the water treatment plant, and inflation is included in the Total 20 year costs.

E.2.2.13 Conceptual projects – Woodbury

E.2.2.13.1 Project summary

The conceptual projects considered for Woodbury under this scenario include the installation of centralized water treatment plants (WTPs) in various configurations to treat the existing and proposed municipal water supply wells; extending water distribution mains to nearby neighborhoods that currently or will in the future (as determined by groundwater modeling) have PFAS impacted non-municipal wells; and providing GAC POET systems for non-municipal wells that are currently or anticipated to be impacted by PFAS contamination in the future (as determined by groundwater modeling). A summary of the projects is provided below, and the infrastructure modifications are shown in Figures E.2.2.13.1 and E.2.2.13.2. The implications on Woodbury's private and non-municipal wells are shown in Figures E.2.2.1.1 and E.2.2.1.2 for both HI conditions. These two figures are regional maps illustrating the impact on private and non-municipal wells and which wells will receive GAC POETS or be connected to the distribution system as necessary.

Water supply wells

Woodbury currently has 19 municipal supply wells to provide drinking water to its residents. Table E.181 below summarizes the City's Wells HI values and pumping rates. Of the 19 wells, several have been taken out of service due to PFAS contamination. While the City has requested temporary treatment facilities in order to accommodate increased demands over coming summer months, none of the municipal wells are currently receiving treatment for PFAS compounds.

Table E.181. Woodbury municipal well HI values and Pumping rates

Well No.	Actual Pumping Rate (gpm)	HI Value
1	725	1.701

2	760	0.04
3	860	0.376
4	990	1.109
5	940	0.426
6	1,150	2.759
7	1,350	2.508
8	900	0.040
9	1,050	1.840
10	1,305	0.043
11	1,150	0.431
12	1,220	0.036
13	1,530	3.772
14	1,400	0.039
15	1,850	0.031
16	1,980	0.050
17	1,500	1.186
18	2,000	0.021
19	2,000	0.323
Total	24,660	

E.2.2.13.2 Project improvements

New municipal supply wells

In January of 2019, the Met Council approved revised water demand projections from the City of Woodbury that increased their 2040 MDD from 19.5 mgd to approximately 28.2 mgd or 19,575 gpm. In order to determine the number of additional municipal supply wells needed to meet the increased demands, the total available pumping rate or capacity of the Tamarack Well Field needed to be determined. However, due to the wells out of service because of PFAS contamination in the Tamarack Well Field, there was no pumping data available that would indicate how much the wells could produce while operating simultaneously (i.e., maximum operating capacity). Based on well pumping configurations provided by the City, it was estimated that the Tamarack Well Field could produce on average about 7,500 gpm with a maximum operating capacity of 10,500 gpm. To be conservative, it was assumed that the Tamarack Well Field could produce 8,500 gpm with the flexibility to turn on additional wells if a well were taken out of service in the East or Southern Well Field.

It is recommended that pump test(s) be performed to determine actual pumping rates. Furthermore, it was assumed that the Eastern Well Field could produce 2,850 – 2,980 gpm, and the Southern Well Field (i.e. Well 19) could produce 2,000 gpm. This meant that the City would require additional wells to collectively add approximately 6,150 gpm to meet the revised 2040 MDD. Groundwater modeling, as discussed further in E.2.2.13.3, indicates that five new wells could be implemented near Well 19 and could produce the additional flow required.

Water treatment plants (WTPs)

Discussions with the City led to an approximate number and location of treatment facilities for the municipal wells in Woodbury. Under the HI > 0 condition, two alternatives (Alternatives 1 and 2) were developed with one and two treatment facilities, respectively. In the first alternative, one WTP would be located near the Southern Well Field to treat all municipal supply wells. In the second alternative, two WTPs would be implemented in each of the Eastern and Southern Well Fields: the Eastern Well Field WTP would treat the three existing wells (Wells 15, 16, and 18); and the Southern Well Field WTP would treat flow from the remaining wells, including the existing wells in the Tamarack Well Field. In both Alternatives 1 and 2, it is assumed that all municipal wells will have PFAS of HI > 0.

As mentioned, non-municipal wells that had an HI > 0 or were anticipated to be impacted by PFAS contamination in the future were either replaced with connections to the existing distribution system or provided with POETS depending on which option was more cost-effective.

Under the HI ≥ 1 condition, only one alternative was evaluated (Alternative 3) that looked at treating all wells with an HI ≥ 1. Based on the existing sample data of all wells in the southern region and groundwater particle tracking, it was assumed that the proposed municipal supply wells in the southern region would have an HI value less than one. Since the Eastern Wells currently also have HI values less than one, the proposed WTP located in near the Southern Well Field would be sized to meet only the flow coming from the Tamarack Well Field under the assumption that even with the blending of water from various wells, the flow would still need to be treated.

Water main extension to existing neighborhoods

Only water lines that were necessary to address PFAS contamination were considered, including distribution lines to currently impacted neighborhoods and raw water and treated water transmission lines to and from the proposed WTPs. Water mains necessary to accommodate population growth alone (such as for future planned development) were not included in the costs for this scenario.

Under the HI > 0 condition for Alternatives 1 and 2, distribution lines would be extended to the neighborhoods of Salem Meadows, Erin Court, and the southwest corner of Woodbury, that currently rely on non-municipal wells that have detectable levels of PFAS contamination.

Under the HI ≥ 1 condition for Alternative 3, all non-municipal wells with an HI ≥ 1 were selected to receive treatment as described below. Based on the data currently available and pending the groundwater results for future impacted areas, no new distribution lines were extended to existing neighborhoods under this condition.

GAC POET systems

Under this scenario, non-municipal wells would be selected for treatment using the same HI categories as previously described. For the HI > 0 condition, GAC POET systems would be provided for sampled, non-municipal wells located primarily in the southern portion of Woodbury that have detectable levels of PFAS or are located within anticipated areas of future PFAS contamination. Whereas under the HI ≥ 1 condition, GAC POET systems would be provided for sampled, non-municipal wells that have an HI ≥ 1 or are located within anticipated areas of future PFAS contamination.

Current or anticipated PFAS impacted non-municipal wells would be provided with GAC POET systems that were not proposed to be connected to the municipal water system. According to PFAS sampling data from October 2019 and County Well Index (CWI) data, Woodbury has an estimated 632 existing non-municipal wells, of which 215 have been sampled.

Under 2040 conditions with an HI>0, one well had an existing GAC POET system that would remain on that system, and 189 wells would need to have GAC POETS installed the majority of which are located in the southeastern region that would not be connected to the distribution system as described below. Under the HI ≥ 1 condition, the same is true for the well with an existing GAC POET system and 28 wells would receive GAC POET systems. These counts exclude any wells that would be connected to the city's municipal water system through expedited projects, proposed water lines, or connections to existing water lines. Under both HI conditions (and in addition to the proposed neighborhoods under HI>0), a total of approximately 19 homes would be connected to either the existing distribution system or proposed distribution line extensions.

As mentioned above, a cost analysis was performed to compare the option of providing POET systems to wells with detectable levels of PFAS in the southwestern region and the neighborhoods of Salem Meadows and Erin Court, as opposed to running new distribution lines to serve the estimated 515 homes and based on existing sampling data an estimated 92 of these homes have been sampled. Table E.182 below provides the cost comparison based on wells currently sampled with detectible levels of PFAS.

Table E.182. 20 Year Capital & O&M Costs for neighborhood Extensions vs POET Systems

Neighborhood	No. of Existing Homes	POETS ($K)			Extend Water Distribution Mains ($K)			No. of Years for POETS to Exceed Mains	No. of Years for POETS to Exceed Mains (PFAS Eligible)[1]
		Capital	O&M	20 Year Total	Capital	O&M[1]	20 Year Total		
Salem Meadows[2,3]	43	151	43	1,011	1,697	6	1,817	43	36
Erin Court[2,3]	6	21	6	141	178	1	198	33	26
SW Woodbury[2,3]	466	1,631	466	10,951	24,202	78	25,762	58	35
Total	515	1,806	516	12,126	24,276	85	25,976		

Note:

1. Operation and maintenance costs for water distribution mains are not eligible for funding under the settlement. This column represents the number of years for the costs of POETS for the entire neighborhood to exceed the costs of installing distribution mains.
2. Highlighted neighborhoods are included in the recommended options shown in Section E.4. Note that no neighborhoods are highlighted here because these neighborhoods are not included in the recommended options.
3. These neighborhoods are included in the cost estimates presented in this section.
4. Cost estimates do not include inflation or recapitalization of assets.
5. Well sealing of $2,000 per non-municipal well is included in the distribution line estimates.
6. No consideration was given to the potential generation of revenue through water sales or service associated with similar type public water systems have been applied to this analysis.

E.2.2.13.3 Hydraulic modeling analysis

Woodbury currently operates across one pressure zone and the existing municipal supply wells discharge directly to the system. However, the implementation of centralized WTPs will require the addition of raw water transmission lines and upsizing of the existing pumps for all scenarios to maintain sufficient pressures in the system. In addition, the increase in demand would require an additional two million gallons (2 MG) of storage within the system for emergencies and fire flow.

The drinking water distribution model was run using set points provided by the city with the corresponding tank levels and pumps running. Once the preliminary calibration was performed, the alternatives were simulated with the proposed treatment plant locations. The model was set up such that the well pumps were sized to pump through the WTP and into the system while maintaining pressures typically seen by the City with their existing pumping conditions. In all three alternatives, flow from the various well fields were routed to the WTP located near the Southern Well Field. As such, pressures near and south of the Southern Well Field WTP were found to have higher pressures reaching between 110 psi – 120 psi. Therefore, a pressure zone was created for the southern region to help regulate pressures. This was consistent across all three scenarios. In the existing system, pressures resulting from all three alternatives were similar to higher pressures observed in the central low-lying areas near lakes and on the eastern side of the city parallel to Woodbury Drive as indicated from pressure data provided by the City. The low-pressure area is located in the northwestern region along Valley Creek Rd and I-494. The observed pressures ranged from approximately 40 to 120 psi for all three alternatives.

As mentioned, wells routing flow to the Southern Well Field WTP would need to have their well pumps upsized to provide the appropriate head.

E.2.2.13.4 Groundwater modeling analysis

Generally, groundwater flows from east/northeast to west/southwest in Woodbury. As described in Alternative 1 above, five additional municipal supply wells would be installed and operated in the South Well Field (near Well 19) as part of this scenario to meet 2040 MDD. The proposed wells along with Well 19 would extract groundwater from the Jordan Sandstone aquifer. Table E.183 provides a summary of pumping rates assigned to existing and proposed wells. The rates represent long-term average daily rates and were distributed such that existing wells are operating at their current average rates while the proposed wells produce the additional flow required to meet the 2040 average daily demand (ADD).

Table E.183. Woodbury maximum daily demands and average daily demands for each existing and proposed wells as simulated in the drawdown analysis.

Well	Unique Well Number	ADD (gpm)
1	208420	Off
2	208422	114
3	208423	150
4	208005	187
5	150353	179
6	151569	99
7	433281	89
8	509051	345
9	463539	108

10	541763	400
11	563000	345
12	596646	359
13	593657	136
14	611094	392
15	676415	472
16	706811	400
17	759572	348
18	786210	421
19	805361	376
Proposed Wells		2609

To ensure the aquifer does not become unconfined, the DNR has provided written guidance on assessing the risk for exceeding groundwater head thresholds. A 50% available head threshold was designated as a warning check that drawdown needs to be assessed further. If the simulated drawdown exceeds the 50% threshold, a transient simulation applying the MDD production rate to the well of interest over a short duration of pumping would then be necessary to evaluate whether simulated drawdown does not exceed 75% of the available head. The 75% available head threshold allows for a buffer to ensure the aquifer does not become unconfined. The available head is the difference between the "static" groundwater elevation (in this case the average 2016-2018 simulated head from the calibrated steady-state groundwater flow model) and the top elevation of the aquifer. The threshold is applied to the aquifer in which the assessed well produces from and overlying aquifers (e.g. a well producing from the Jordan Sandstone aquifer requires a threshold assessment for the Jordan Sandstone and the overlying Prairie du Chien if present).

Using the guidance provided by the DNR, simulated head at the existing and proposed locations were evaluated under a drier setting that approaches drought conditions (worst case and herein referred to as drought) to determine whether drawdown exceeds the 50% threshold. Model recharge for drought conditions was reduced to 66% of the current condition recharge rate based on modeling by the DNR using the Soil Water Balance model over a drier time period of 2006 to 2009. The currently modeled wet climate condition observed for the state of Minnesota is represented by higher precipitation rates and warmer temperatures, and is predicted in reports provided by the MDH to continue throughout this century with as much as an additional 3 inches of annual precipitation (MDH, 2015). The higher precipitation during the wetter climate will result in higher rates of groundwater recharge while a drought will result in lower recharge rates. Drought conditions will also necessitate increased pumping at community supply and irrigation wells. For scenarios run under drought conditions, average daily demand rates for the Woodbury water supply wells were increased by multiplying the current condition rates by a factor of 1.15 (the ratio of maximum per capita demand over average per capita demand from Years 2005-2015). Pumping rates at irrigation wells were also increased by taking the maximum annual volume reported over a 20-year period (1988 – 2018). Drawdown for Scenario A under wet and dry conditions are shown on Figures E.2.2a and E.2.2b, respectively.

Under drought conditions, drawdown does not exceed the 50% available head in either the Jordan Sandstone or Prairie Du Chien aquifers. Additionally, the effect of pumping is localized such that the general groundwater flow direction (which is from east/northeast to west/southwest in Woodbury) is not altered. Table E.184 provides a summary of drawdown in the Jordan Sandstone aquifer under wet, and drought conditions and drawdown in the Prairie Du Chien under drought conditions. The percent of available drawdown shown in Table E.184 is the difference between the average 2016-2018 simulated head and the elevation of the top of the aquifer. The reported drawdown is relative to average 2016-2018 simulated groundwater elevations, which is considered a wet period (MDH, 2015). The available head is the difference between the average 2016-2018 simulated head and the elevation of the top of the aquifer. The percent of available head is the amount of available head that is taken up by drawdown under drought conditions.

The drought drawdown computed in the Prairie Du Chien aquifer at wells located in the South Well Field approaches 50% of the available head for that aquifer; however, since the drawdowns do not exceed 50%, a transient analysis was not warranted.

Forward particle tracking to 2040 was conducted under wet, normal, and drought climate conditions from known PFAS sources and areas where HI>1, as shown on Figures E.2.2c, E.2.2d, and E.2.2e, respectively. Model recharge for normal conditions was reduced to 87% of the current condition recharge rate based on modeling by the DNR using the Soil Water Balance model over a drier time period of 1989 to 2018. With exception of Well 1, all of the existing and proposed wells were operating at the average daily rates used for the drawdown analysis discussed above. Particles were not captured by existing or proposed wells under wet and normal conditions. Particles traveling under drought conditions were captured by Wells 6 and 11.

Table E.184. Summary of drawdown in the Jordan Sandstone and Prairie Du Chien aquifer under wet and drought conditions.

Well	Jordan Sandstone Aquifer				Prairie Du Chien Aquifer		
	Drawdown (m)		Available Head (m)	Percent of Available Head (drought)	Drawdown (m)	Available Head (m)	Percent of Available Head (drought)
	Wet	Drought			Drought		
1	Off						
2	1	5	61	8	4	20	20
3	<1	5	60	8	4	19	21
4	<1	4	63	6	4	18	22
5	1.23	5	58	9	4	18	22
6	<1	4	63	6	3	20	15
7	<1	3	68	4	3	23	13
8	1	5	52	10	4	16	25
9	<1	3	59	5	4	16	25
10	<1	3	55	5	3	11	27
11	<1	3	56	5	3	13	23
12	<1	3	57	5	3	11	27
13	<1	2	60	3	4	16	25
14	<1	3	50	6	2	12	17
15	<1	2	69	3	2	19	11
16	<1	2	51	4	1	14	7
17	<1	4	68	6	4	23	17
18	<1	<1	58	1	0.8	13	6
19	8	17	70	24	13	33	39
Proposed Well 1	15	26	71	37	16	33	48
Proposed Well 2	11	21	69	30	14	30	47

Proposed Well 3	15	24	67	36	10	23	43
Proposed Well 4	16	26	74	35	14	36	39
Proposed Well 5	17	25	67	37	12	26	46

E.2.2.13.5 Project alternatives

A summary of each alternative including WTP sizing is provided below and costs are provided in Section E.2.2.13.6. Water supply configurations for these alternatives are shown on Figures E.2.2.12.1 and E.2.2.12.2.

Alternative 1 – 2040 One Centralized WTP HI > 0

Under this alternative, all wells are being treated and all are being pumped to a centralized WTP located near the Southern Well Field with a capacity to meet the MDD of 19,575 gpm. To reduce the overall demand on the Tamarack Well Field, flow from the Eastern and Southern Well Fields would be maximized. To meet the increased demand, five new wells were simulated in the Southern Well Field to provide a combined capacity of approximately 6,150 gpm. The resulting maximum and minimum flow (with the largest well out of service according to Ten State Standards) from the Southern Well field would be 8,150 and 6,150 gpm, respectively. As mentioned, it was also assumed that two wells could be operated simultaneously in the Eastern Well Field for a flow of 3,830 to 3,980 with the third well out of service. The remainder of the demand ranging from 7,445 to 9,595 gpm would need to be produced from the Tamarack Wells. In summary, the following centralized WTPs are examined in this alternative:

- 19,575 gpm Southern WTP (this is rounded and shown in the cost tables as 19,600 gpm).

This alternative also includes extending water mains into the neighborhoods of Salem Meadows, Erin Court, and the southwest corner of Woodbury.

Alternative 2 – 2040 Two Centralized WTPs HI > 0

Under this alternative, all wells are being treated via two centralized WTPs located in each of the Southern and Eastern Well Fields. Similar to Alternative 1, in the East Well Field, two out of the three wells would operate simultaneously, and flow would be routed to an Eastern WTP with a capacity of approximately 4,000 gpm. The second Southern Well Field WTP would treat flows from the Southern and Tamarack Well Fields with a capacity of 15,595 gpm. Again, this alternative would provide the City with the flexibility to optimize well operations as the raw water transmission lines would be sized to accommodate the maximum flow from either well field. In summary, the following centralized WTPs are examined in this alternative:

- 4,000 gpm Eastern WTP
- 15,595 gpm Southern WTP (this is rounded and shown in the cost tables as 15,600 gpm).

This alternative also includes extending water mains into the neighborhoods of Salem Meadows, Erin Court, and the southwest corner of Woodbury.

Alternative 3 – 2040 One Centralized WTP HI ≥ 1

Based on the sampling data currently available, wells in the southern and eastern regions of the City have HI values less than one. As such it was assumed that in 2040, wells in these regions will continue to have an HI value less than one. Therefore, the Tamarack Well Field is the only water supply source that will require treatment in this alternative. To treat these wells, the Tamarack wells will be hydraulically connected and conveyed to a WTP located near the Southern Well Field with a treatment capacity of 9,595 gpm. The untreated water from Southern Well Field would be hydraulically connected to the existing distribution system and the Eastern Well Field would remain connected as-is. In summary, the following centralized WTPs are examined in this alternative:

- 9,595 gpm Southern WTP (this is rounded and shown in the cost tables as 9,600 gpm).

E.2.2.13.6 Cost estimate

Year 2040 cost estimates for installation and O&M are shown in Tables E.185, E.186, and E.187 below for Alternatives 1, 2, and 3, respectively. Cost assumptions for all scenarios are outlined in Appendix F.

Table E.185 Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for Woodbury - Alternative 1 HI > 0.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plant	1	WTPs	19,600 gpm WTP	$21,300,000	$15,200,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$10,160,000	$10,160,000
New Wells	5	Wells	1225 gpm each (South Well Field)	$10,890,000	
Well Modifications	19	Wells	Well & SCADA upgrades	$2,280,000	
Pressure Reducing Valves	2	Stations	PRVs on 8" and 20" mains	$250,000	
Storage tanks	1	Tanks	2 MG at WTP	$4,090,000	
Raw Water Transmission Mains	16.24	Miles	from wells to WTPs	$30,640,000	
Water Distribution Mains	0.33	Miles	from WTP to distribution system	$870,000	
Water mains to Salem Meadows	1.30	Miles	Extend 8" water mains to Salem Meadows, 43 homes	$1,050,000	
Water mains to Erin Court	0.18	Miles	Extend 8" water mains to Erin Court, 7 homes	$110,000	
Water mains to Southwest Woodbury	18.90	Miles	Extend 8" and 12" water mains to SW Woodbury, 466 homes	$15,460,000	
Service Laterals	546	Ea	Connect homes to existing mains ($2500 ea)	$1,365,000	
Well Sealing	547	Ea	$2,000 per well, including Well 1	$1,094,000	

Land acquisition (site + water mains)	51.8	Acres	3 acre WTP, 20 ft easements (50%)	$7,000,000	
GAC POETS	189	POETS	Standard household systems, $2,500 per well	$480,000	
			Subtotal	$107,040,000	$100,940,000
			Contingency (25%)	$26,760,000	$25,240,000
			Professional services (15%)	$16,060,000	$15,150,000
			Total Capital	**$149,860,000**	**$141,330,000**
Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost	$98,000	$59,000
PFAS WTPs	1	WTP	Maint. and Operations	$1,170,000	$870,000
New Wells	5	Wells	1225 gpm each (South Well Field)	$360,000	
Pressure Reducing Valves	2	Stations	Installed within right-of-way	$17,000	
Storage Tanks	1	Tanks	2 MG at WTP	$72,000	
Raw Water Transmission Mains	16.24	Miles	from wells to WTPs	$154,000	
Water Distribution Mains	0.33	Miles	from WTP to distribution system	$5,000	
Water mains to Salem Meadows	1.30	Miles	Extend 8" water mains to Salem Meadows, 43 homes	$6,000	
Water mains to Erin Court	0.18	Miles	Extend 8" water mains to Erin Court, 7 homes	$1,000	
Water mains to Southwest Woodbury	18.90	Miles	Extend 8" and 12" water mains to SW Woodbury, 466 homes	$78,000	
GAC POETS	190	POETS	Standard household systems, $1,000 per well	$190,000	
			Subtotal	$2,160,000	$1,820,000
			20 years of annual O&M	$43,200,000	$36,400,000
			20 years of annual O&M future value[1]	$58,050,000	$48,910,000
			20 year costs (capital + O&M)	**$193,060,000**	**$177,730,000**
			20 year future value costs (capital + O&M)	**$207,910,000**	**$190,240,000**
			Capital and operating cost per 1,000 gal	$1.00	$0.91
			Operating only cost per 1,000 gallons	$0.28	$0.24
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$630,000	$510,000

Wells	2%	of Capital	$218,000		
Storage Tanks		Rehab every 20 Years	$79,000		
Water Mains	1.67%	of Capital	$810,000		
			Subtotal	$1,740,000	$1,620,000
			20 years of recapitalization	**$34,800,000**	**$32,400,000**
			20 years of recapitalization future value[1]	**$46,760,000**	**$43,540,000**
			20 year future value costs (capital + O&M + recapitalization)	**$254,700,000**	**$233,800,000**

Notes:

1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.186. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for Woodbury - Alternative 2 HI > 0.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	2	WTPs	15,600 gpm WTP (south), 4,000 gpm (east)	$26,790,000	$19,110,000
Pretreatment at WTP	2	Lump Sum	Iron/Manganese	$8,090,000	$8,090,000
New Wells	5	Wells	1225 gpm each (South Well Field)	$10,890,000	
Well Modifications	19	Wells	Well & SCADA upgrades	$2,280,000	
Pressure Reducing Valves	2	Stations	PRVs on 8" and 20" mains	$250,000	
Storage tanks	1	Tank	2.0 MG	$4,090,000	
Raw water transmission mains	11.23	Miles	from wells to WTPs	$22,730,000	
Water Distribution Mains	0.33	Miles	from wells to distribution system	$870,000	
Water mains to Salem Meadows	1.30	Miles	Extend 8" water mains to Salem Meadows, 43 homes	$1,050,000	
Water mains to Erin Court	0.18	Miles	Extend 8" water mains to Erin Court, 7 homes	$110,000	
Water mains to Southwest Woodbury	18.90	Miles	Extend 8" and 12" water mains to SW Woodbury, 466 homes	$15,460,000	
Service Laterals	546	Ea	Connect homes to existing mains ($2500 ea)	$1,365,000	
Well Sealing	547	Ea	$2,000 per well, including well 1	$1,094,000	

Land acquisition (site + water mains)	45.7	Acres	4 acres for WTPs, 20 ft easements (50%)	$6,180,000	
GAC POETS	189	POETS	Standard household systems, $2,500 per well	$480,000	
			Subtotal	$101,730,000	$94,050,000
			Contingency (25%)	$25,440,000	$23,520,000
			Professional services (15%)	$15,260,000	$14,110,000
			Total Capital	**$142,430,000**	**$131,680,000**
Annual O&M Cost					
PFAS Water Treatment Plants	2	WTPs	Media Cost	$69,000	$42,000
PFAS Water Treatment Plants	2	WTPs	Maint. and Operations	$1,496,000	$1,112,000
Wells	5	Wells	1225 gpm each (South Well Field)	$360,000	
Pressure Reducing Valves	2	Stations	Installed within right-of-way	$17,000	
Storage Tanks	1	Tank	2.0 MG	$72,000	
Raw water transmission mains	11.23	Miles	from wells to WTPs	$114,000	
Water Distribution Mains	0.33	Miles	from wells to distribution system	$5,000	
Water mains to Salem Meadows	1.30	Miles	Extend 8" water mains to Salem Meadows, 43 homes	$6,000	
Water mains to Erin Court	0.18	Miles	Extend 8" water mains to Erin Court, 7 homes	$1,000	
Water mains to Southwest Woodbury	18.90	Miles	Extend 8" and 12" water mains to SW Woodbury, 466 homes	$78,000	
GAC POETS	190	POETS	Standard household systems, $1,000 per well	$190,000	
			Subtotal	$2,410,000	$2,000,000
			20 years of annual O&M	$48,200,000	$40,000,000
			20 years of annual O&M future value[1]	$64,760,000	$53,750,000
			20 year costs (capital + O&M)	**$190,630,000**	**$171,680,000**
			20 year future value costs (capital + O&M)	**$207,190,000**	**$185,430,000**
			Capital and operating cost per 1,000 gal	$1.00	$0.89
			Operating only cost per 1,000 gallons	$0.31	$0.26
Recapitalization Costs Factored Annually					

WTPs	2%	of Capital	$700,000	$550,000
Wells	2%	of Capital	$218,000	
Storage Tanks		Rehab every 20 Years	$79,000	
Water Mains	1.67%	of Capital	$672,000	
		Subtotal	$1,670,000	$1,520,000
		20 years of recapitalization	**$33,400,000**	**$30,400,000**
		20 years of recapitalization future value[1]	**$44,880,000**	**$40,850,000**
		20 year future value costs (capital + O&M + recapitalization)	**$252,100,000**	**$226,300,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.187. Year 2040 costs for conceptual projects included in the Community-Specific Scenario A for Woodbury - Alternative 3 HI ≥ 1.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	1	WTPs	9,600 gpm WTP, total capacity	$13,880,000	$9,910,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$4,980,000	$4,980,000
New Wells	5	Wells	1225 gpm each (South Well Field)	$10,890,000	
Well Modifications	19	Wells	Well & SCADA upgrades	$2,280,000	
Pressure Reducing Valves	2	Stations	PRVs on 8" and 20" mains	$250,000	
Storage tanks	1	Tank	2 MG (growth based)	$4,090,000	
Raw water transmission mains	8.48	Miles	from wells to WTPs	$19,720,000	
Water Distribution Mains	0.33	Miles	from wells to distribution system	$790,000	
Service Laterals	18	Ea	Connect homes to existing mains ($2500 ea)	$45,000	
Well Sealing	19	Ea	$2,000 per well, including well 1	$38,000	
Land acquisition (site + water mains)	15.7	Acres	2 acre WTP, 20 ft easements (50%)	$2,120,000	
GAC POETS	28	POETS	Standard household systems, $2,500 per well	$70,000	
			Subtotal	$59,160,000	$55,190,000
			Contingency (25%)	$14,790,000	$13,800,000
			Professional services (15%)	$8,880,000	$8,280,000
			Total Capital	**$82,830,000**	**$77,270,000**

Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost	$69,000	$42,000
PFAS WTPs	1	WTP	Maint. and Operations	$798,000	$600,000
Wells	5	Wells	1225 gpm each (South Well Field)	$360,000	
Pressure Reducing Valves	2	Stations	Installed within right-of-way	$17,000	
Storage Tanks	1	Tank	2 MG	$72,000	
Raw water transmission mains	8.48	Miles	from wells to WTPs	$99,000	
Water Distribution Mains	0.33	Miles	from wells to distribution system	$4,000	
GAC POETS	29	POETS	Standard household systems, $1,000 per well	$29,000	
			Subtotal	$1,448,000	$1,223,000
			20 years of annual O&M	$28,960,000	$24,460,000
			20 years of annual O&M future value1	$38,910,000	$32,870,000
			20 year costs (capital + O&M)	**$111,790,000**	**$101,730,000**
			20 year future value costs (capital + O&M)	**$121,740,000**	**$110,140,000**
			Capital and operating cost per 1,000 gal	$1.20	$1.09
			Operating only cost per 1,000 gallons	$0.39	$0.33
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$380,000	$300,000
Wells		2%	of Capital	$218,000	
Storage Tanks			Rehab every 20 Years	$79,000	
Water Mains		1.67%	of Capital	$343,000	
			Subtotal	$1,020,000	$940,000
			20 years of recapitalization	**$20,400,000**	**$18,800,000**
			20 years of recapitalization future value[1]	**$27,410,000**	**$25,260,000**
			20 year future value costs (capital + O&M + recapitalization)	**$149,150,000**	**$135,400,000**

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate

Table E.188 below is a summary of the costs associated with the Woodbury alternatives. All costs account for 3% inflation.

Table E.188. Summary of Year 2040 costs with 3% inflation included for the three alternatives for the Community-Specific Scenario A for Woodbury in millions of dollars ($Ms).

Option	HI	Components	POETS	Treated Water	Capital cost ($Ms)	Annual O&M cost ($Ms)	Total 20 year costs ($Ms)	Capital and operating cost per 1000 gal	Operating Cost per 1000 gal

				provided (MGD)	IX	GAC	IX	GAC	IX	GAC	IX	GAC	IX	GAC
Alt 1	>0	1 WTP (19,600 gpm)	190	28.5	$141	$150	$1.8	$2.2	$234	$255	$0.91	$1.00	$0.24	$0.28
Alt 2	>0	2 WTPs (13,600, 4000 gpm)	190	28.5	$132	$142	$2.0	$2.4	$226	$252	$0.89	$1.00	$0.26	$0.31
Alt 3	>1	1 WTP (9,600 gpm)	29	13.8	$77	$83	$1.2	$1.4	$135	$149	$1.09	$1.20	$0.33	$0.39

Notes:

1. Recapitalization and inflation costs are included in Total 20 year costs and are not included in the Capital and Annual O&M costs.

Alternatives 2 (lowest capital cost for HI>0 option) and 3 (lowest cost HI>1 option) are carried forward into the final summary table for the Community Specific Scenario.

E.2.2.13.7 PFAS eligible cost summary

The cost estimates presented above include all related costs for each given alternative to meet Year 2040 water demands. However, for various reasons, some costs may not be covered by settlement funds. The guidelines used to determine project components that would be eligible for settlement funding were presenting in the Appendix E Introduction.

All of the water main extensions to new neighborhoods were removed from this scenario, as such there are no new connections to the existing water distribution system. Accordingly, all capital costs associated with the new wells, storage tanks, and service laterals were also removed. Pressure reducing valves (PRVs) are necessary to reduce pressures in the low-lying areas of the community which is a result of both growth of the community and by the installation of a centralized water treatment plant. As such, costs are included in this estimate for 50% of the capital and 50% of the O&M. Operation and maintenance costs are only included for the water treatment plants and the GAC POETS, whereas recapitalization costs were excluded in Table E.189.

Table E.189. Summary of PFAS Eligible Costs Community-Specific Scenario A for Woodbury.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 2	>0	2 WTPs (13,600, 4000 gpm)	557	28.4	$81	$92	$1.7	$2.1	$127	$149
Alt 3	>1	1 WTP (9,600 gpm)	45	13.8	$56	$61	$0.7	$0.9	$74	$86

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.13.8 Cost summary with particle tracking costs removed

Costs presented in this section are reflective of the currently known areas of PFAS contamination and do not consider future costs associated with the potential migration of the groundwater contamination noted by the particle tracking exercise. These costs also consider only those cost considered to be eligible for funding as noted in the previous section. To evaluate the cost implications of particle tracking and the projection of future potential areas of PFAS impact, these costs were removed from the PFAS eligible cost estimate. This had a minimal impact to Alternative 2 for HI>0 and only 4 POETS were excluded from the cost estimates. Alternative 3 for HI ≥1 has 44 POETS removed from the cost estimates, as shown in Table E.190.

Table E.190. Summary of Costs Community-Specific Scenario A for Woodbury with Particle Tracking costs removed.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 2	>0	2 WTPs (13,600, 4000 gpm)	553	28.4	$81	$92	$1.7	$2.1	$127	$149
Alt 3	>1	1 WTP (9,600 gpm)	1	13.8	$56	$61	$0.6	$0.9	$73	$85

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.2.14 Community-Specific Scenario A Summary

Below is a summary of the cost estimates for the all the Community-Specific Scenario A alternatives considered. Alternatives shown in bold were the alternatives included in the Community-Specific Scenario A costs. These bold "selected" alternatives were used to develop the overall scenario costs and additional cost analyses including PFAS eligible and particle tracking costs. A summary of the cost estimates that were considered eligible for settlement funding, and a summary of the costs associated with the current known limits of contamination are shown in the subsequent tables. The total cost for HI>0 and HI>1 is shown at the bottom of the table.

This section also includes an evaluation of the incremental costs associated with an incremental increase in the HI between O and 1. In addition, the total number of existing and proposed GAC POET systems for each community is provided in summary Table E.191 at the end of this section.

Table E.191. Cost estimate summary table of all alternatives for Year 2040 costs for conceptual projects included in Community-Specific Scenario A.

Option	HI	Community served	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
						IX	GAC	IX	GAC	IX	GAC
Alt 1	>0	Woodbury	1 WTP (19,600 gpm)	190	28.5	$141	$150	$1.8	$2.2	$234	$255
Alt 2	**>0**		2 WTPs (13,600, 4000 gpm)	190	28.5	$132	$142	$2.0	$2.4	$226	$252
Alt 3	**>1**		1 WTP (9,600 gpm)	29	13.8	$77	$83	$1.2	$1.4	$135	$149
Alt 1a	**>0**	Lake Elmo	1 WTP (4500 gpm), wells in NE	609	6.86	$81	$84	$1.6	$1.7	$147	$155

Option	HI	Community served	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
						IX	GAC	IX	GAC	IX	GAC
Alt 1b	**>1**		2 wells NE (no WTPs)	80	3.10	$64	$66	$0.8	$0.8	$104	$108
Alt 2a	>0		2 WTPS (3500, 2000 gpm), wells in North	609	8.30	$83	$88	$1.7	$1.9	$154	$166
Alt 2b	>1		2 wells North (no WTPs)	80	3.10	$62	$64	$0.8	$0.8	$102	$106
Alt 3a	>0		2 WTPS (3500, 2000 gpm), 2 wells SE	609	8.30	$76	$81	$1.6	$1.8	$143	$155
Alt 3b	>1		2 WTPs (2000 gpm for new wells, 1250 gpm for W5), 2 wells SE	80	3.10	$66	$69	$0.9	$1.0	$109	$117
Alt 1a	>0	Oakdale	3 WTPS (W7, expand existing WTP, new WTP for W3/10)	13	6.97	$30	$35	$1.0	$1.4	$66	$84
Alt 1b	>1		2 WTPS (W7 and expand WTP)	13	4.30	$21	$24	$0.8	$1.1	$49	$62
Alt 2a	>0		2 WTPs (expand existing, new WTP for W3/10), new well	13	6.32	$31	$35	$0.9	$1.2	$66	$80
Alt 2b	>1		1 WTP (expand existing), new well	13	3.65	$22	$24	$0.7	$1.0	$48	$58
Alt 3a	>0		2 WTPs (expand existing, new WTP for W3/10), 2 new wells	13	5.20	$25	$29	$0.9	$1.1	$57	$70
Alt 3b	>1		1 WTP (expand existing), 2 new wells	13	2.54	$16	$18	$0.7	$0.9	$40	$48
Alt 4a	>0		1 WTP (expand	13	3.56	$27	$29	$1.0	$1.1	$63	$71

Option	HI	Community served	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
						IX	GAC	IX	GAC	IX	GAC
			existing) 4 new wells								
Alt 1	>0, >1	W. Lakeland	PWS for 80% Township, 2 wells, 1 WTP, 8" lines	89	1.03	$128	$129	$1.1	$1.1	$193	$196
Alt 2	>0, >1		PWS for 80% Township (reduced looping), 8" lines	89	1.03	$118	$119	$1.0	$1.1	$180	$183
Alt 3	>0, >1		Rural PWS for 80% Township, 4"-8" lines	89	1.03	$124	$125	$1.1	$1.1	$187	$190
Alt 4	>0, >1		Rural PWS, 80% Township (reduced looping, 4"-8" lines)	200	1.03	$115	$116	$1.0	$1.1	$175	$178
Alt 5	>0, >1		PWS for 100% Township, 8" lines	0	1.15	$145	$146	$1.0	$1.0	$213	$216
Alt 6	>0, >1		New Rural PWS for 100% Township (4"-8" lines)	0	1.15	$142	$144	$1.0	$1.0	$210	$212
Alt 7	>0, >1		POETS only	1340	0.33	N/A	$3	N/A	$1.3	N/A	$39
Alt 1a	>0	Cottage Grove	2 WTPs (9800, 3200 gpm), 1 new well	460	18.90	$61	$70	$1.8	$2.2	$131	$152
Alt 1b	>1		2 WTPs (9300, 3200 gpm), 1 new well	133	15.91	$55	$63	$1.5	$1.8	$112	$133
Alt 1a	>0	Newport	New 420 gpm WTP	93	1.47	$7.2	$8.7	$0.28	$0.34	$17	$21
Alt 1b	>1		POETS only	16	0.01	N/A	$0.1	N/A	$0.02	N/A	$1
Alt 2a	>0		Interconnect with Woodbury	93	0.63	N/A	$2.0	N/A	$0.31	N/A	$11
Alt 3a	>0		Interconnect with Cottage Grove	93	0.63	N/A	$3.1	N/A	$0.31	N/A	$15

Option	HI	Community served	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
						IX	GAC	IX	GAC	IX	GAC
Alt 1a	>0	St. Paul Park	2200 gpm WTP	14	3.18	$14	$16.5	$0.32	$0.41	$28	$33
Alt 1b	>1		2200 gpm WTP	14	3.18	$14	$16.5	$0.32	$0.41	$28	$33
Alt 1a	>0	Lakeland, Lakeland Shores, Lake St. Croix Beach	2 WTPs (750 gpm each)	4	2.27	$9.4	$12	$0.3	$0.4	$19	$25
Alt 1b	>1		456 Service connections	4	0.11	$2.9	$3	$0.0	$0.0	$3.0	$3.0
Alt 1a	>0, >1	Prairie Island Indian Community	600 gpm WTP	0	0.86	$3.1	$4.2	$0.15	$0.19	$8.5	$10.9
Alt 1a	>0	Maplewood	water main extension for 35 connections	388	0.11	N/A	$4.0	N/A	$0.40	N/A	$15.5
Alt 1b	>1		water main extension for 35 connections	0	0.01	N/A	$2.6	N/A	$0.01	N/A	$3.7
Alt 1a	>0	Grey Cloud Island	POETS only	121	0.03	N/A	$0.3	N/A	$0.12	N/A	$3.5
Alt 1b	>1		POETS only	117	0.02	N/A	$0.3	N/A	$0.12	N/A	$3.4
Alt 1a	>0	Denmark	POETS only	426	0.16	N/A	$1.50	N/A	$0.426	N/A	$13.0
Alt 1b	>1		POETS only	0	0.00	N/A	$0.00	N/A	$0.000	N/A	$0.0
Alt 1a	>0	Afton	POETS only	821	0.34	N/A	$2.85	N/A	$0.82	N/A	$24.9
Alt 1b	>1		POETS only	232	0.09	N/A	$0.79	N/A	$0.23	N/A	$7.0
			Total for HI>0	**3138**	**70**	**479**	**493**	**10**	**11**	**894**	**979**
			Total for HI>1	**637**	**41**	**379**	**383**	**6**	**7**	**656**	**713**

Notes:

1. Recapitalization and inflation costs are included in Total 20 year costs and are not included in the Capital and Annual O&M costs.

For clarification and simplification, Table E.192 was recreated below but only includes those "selected" alternatives used for the overall costs and further cost analyses.

Table E.192. Cost estimate summary table for Year 2040 costs for conceptual projects included in Community-Specific Scenario A.

Option	HI	Community served	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 yea +r costs ($Ms)	
						IX	GAC	IX	GAC	IX	GAC
Alt 2	>0	Woodbury	2 WTPs (15,600, 4000 gpm)	190	28.5	$132	$142	$2.0	$2.4	$226	$252
Alt 3	>1		1 WTP (9,600 gpm)	29	13.8	$77	$83	$1.2	$1.4	$135	$149
Alt 2a	>0	Lake Elmo	1 WTP (4,500 gpm), 2 new wells in NE	609	6.86	$81	$84	$1.6	$1.7	$147	$155
Alt 2b	>1		2 wells NE (no WTPs)	80	3.10	$64	$66	$0.8	$0.8	$104	$108
Alt 3a	>0	Oakdale	2 WTPs (expand existing 4,150 gpm, new WTP for W3/10 1,850 gpm), 2 new wells	13	5.20	$25	$29	$0.9	$1.1	$57	$70
Alt 3b	>1		1 WTP (expand existing 4,150 gpm), 2 new wells	13	2.54	$16	$18	$0.7	$0.9	$40	$48
Alt 6	>0, >1	W. Lakeland	1 WTP 800 1 New Rural PWS for 100% Township (4"-8" lines)	0	1.15	$142	$144	$1.0	$1.0	$210	$212
Alt 1a	>0	Cottage Grove	2 WTPs (9800, 3200 gpm), 1 new well	459	18.90	$62	$50	$1.8	$2.2	$131	$152
Alt 1b	>1		2 WTPs (9300, 3200 gpm), 1 new well	132	15.91	$55	$45	$1.5	$1.8	$112	$133
Alt 1b	>1	Newport	POETS only	16	0.01	N/A	$0.1	N/A	$0.02	N/A	$1
Alt 2a	>0		Interconnect with Woodbury	93	0.63	N/A	$2.0	N/A	$0.31	N/A	$11
Alt 1a	>0	St. Paul Park	2200 gpm WTP	14	3.18	$14	$16.5	$0.32	$0.41	$28	$33

Option	HI	Community served	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 yea +r costs ($Ms)	
						IX	GAC	IX	GAC	IX	GAC
Alt 1b	>1		2200 gpm WTP	14	3.18	$14	$16.5	$0.32	$0.41	$28	$33
Alt 1a	>0	Lakeland, Lakeland Shores, Lake St. Croix Beach	2 WTPs (750 gpm each)	4	2.27	$9.4	$12	$0.3	$0.4	$19	$25
Alt 1b	>1		456 Service connections	4	0.11	$2.9	$3	$0.0	$0.0	$3.0	$3.0
Alt 1a	>0, >1	Prairie Island Indian Community	600 gpm WTP	0	0.86	$3.1	$4.2	$0.15	$0.19	$7.2	$9.3
Alt 1a	>0	Maplewood	water main extension for 35 connections	388	0.11	N/A	$4.0	N/A	$0.40	N/A	$14.6
Alt 1b	>1		water main extension for 35 connections	0	0.01	N/A	$2.6	N/A	$0.01	N/A	$3.5
Alt 1a	>0	Grey Cloud Island	POETS only	121	0.03	N/A	$0.2	N/A	$0.12	N/A	$3.5
Alt 1b	>1		POETS only	117	0.02	N/A	$0.2	N/A	$0.12	N/A	$3.4
Alt 1a	>0	Denmark	POETS only	426	0.16	N/A	$1.49	N/A	$0.43	N/A	$12.9
Alt 1b	>1		POETS only	0	0.00	N/A	$0.00	N/A	$0.00	N/A	$0.0
Alt 1a	>0	Afton	POETS only	821	0.34	N/A	$2.84	N/A	$0.82	N/A	$24.9
Alt 1b	>1		POETS only	232	0.09	N/A	$0.78	N/A	$0.23	N/A	$7.0
			Total for HI>0	**3139**	**70**	**480**	**517**	**10**	**12**	**886**	**984**
			Total for HI>1	**638**	**41**	**377**	**400**	**6**	**7**	**652**	**710**

Notes:

1. Recapitalization and inflation costs are included in Total 20 year costs and are not included in the Capital and Annual O&M costs.

The "selected" alternatives shown in the table above were used in additional costs analyses. A summary of the costs that are considered eligible for settlement funding are shown in Table E.193 below.

Table E.193. Cost estimate summary table for Year 2040 costs that are settlement funding eligible in Community-Specific Scenario A.

Option	HI	Community served	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
						IX	GAC	IX	GAC	IX	GAC
Alt 2	>0	Woodbury	2 WTPs (13,600, 4000 gpm)	557	28.4	$81	$92	$1.7	$2.1	$127	$149
Alt 3	>1		1 WTP (9,600 gpm)	45	13.8	$56	$61	$0.7	$0.9	$74	$86
Alt 1a	>0	Lake Elmo	1 WTP (4500 gpm), wells in NE	933	6.85	$42	$45	$1.4	$1.5	$78.0	$85
Alt 1b	>1		2 wells NE (no WTPs)	399	3.07	$15	$17	$0.7	$0.8	$34	$37
Alt 3a	>0	Oakdale	2 WTPs (expand existing, new WTP for W3/10), 2 new wells	13	5.20	$26	$30	$0.7	$1.0	$45	$56
Alt 3b	>1		1 WTP (expand existing), 2 new wells	13	2.54	$17	$19	$0.5	$0.7	$31	$38
Alt 6	>0, >1	W. Lakeland	New Rural PWS for 100% Township (4"-8" lines)	0	1.15	$142	$144	$0.2	$0.3	$149	$151
Alt 1a	>0	Cottage Grove	2 WTPs (9800, 3200 gpm), 1 new well	488	18.90	$53	$61.9	$1.5	$1.9	$94.7	$112.4
Alt 1b	>1		2 WTPs (9300, 3200 gpm), 1 new well	148	15.91	$45	$53.5	$1.2	$1.5	$76.5	$94.4
Alt 1b	>1	Newport	POETS only	16	0.01	N/A	$0.1	N/A	$0.02	N/A	$0.6
Alt 2a	>0	Newport	Interconnect with Woodbury	93	0.63	N/A	$2.0	N/A	$0.1	N/A	$4.5
Alt 1a	>0	St. Paul Park	2200 gpm WTP	14	3.18	$14	$16.5	$0.30	$0.4	$22	$27
Alt 1b	>1	St. Paul Park	2200 gpm WTP	14	3.18	$14	$16.5	$0.30	$0.4	$22	$27
Alt 1a	>0	Lakeland, Lakeland Shores, Lake	2 WTPs (750 gpm each)	4	2.27	$9.4	$12	$0.3	$0.4	$17	$22

Option	HI	Community served	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
						IX	GAC	IX	GAC	IX	GAC
Alt 1b	>1	St. Croix Beach	456 Service connections	4	0.11	$2.9	$2.9	$0.0	$0.0	$3.0	$3.0
Alt 1a	>0, >1	Prairie Island Indian Community	600 gpm WTP	0	0.86	$3.1	$4.1	$0.15	$0.2	$7.1	$9.3
Alt 1a	>0	Maplewood	water main extension for 35 connections	497	0.13	N/A	$1.7	N/A	$0.5	N/A	$15.1
Alt 1b	>1	Maplewood	water main extension for 35 connections	4	0.01	N/A	$0.0	N/A	$0.0	N/A	$0.1
Alt 1a	>0	Grey Cloud Island	POETS only	121	0.03	N/A	$0.2	N/A	$0.1	N/A	$3.5
Alt 1b	>1	Grey Cloud Island	POETS only	117	0.02	N/A	$0.2	N/A	$0.1	N/A	$3.4
Alt 1a	>0	Denmark	POETS only	426	0.16	N/A	$1.50	N/A	$0.4	N/A	$13.0
Alt 1b	>1	Denmark	POETS only	0	0.00	N/A	$0.00	N/A	$0.0	N/A	$0.0
Alt 1a	>0	Afton	POETS only	821	0.34	N/A	$2.84	N/A	$0.8	N/A	$24.9
Alt 1b	>1	Afton	POETS only	232	0.09	N/A	$0.78	N/A	$0.2	N/A	$7.0
			Total for HI>0	**3967**	**68**	**379**	**413**	**8**	**10**	**601**	**672**
			Total for HI>1	**992**	**41**	**297**	**319**	**4**	**5**	**408**	**457**

Notes:

1. For these estimates; recapitalization costs are not included, O&M is only provided for the water treatment plants, and inflation is included in the Total 20 year costs.

Costs associated with future areas of impact due to particle tracking in the groundwater model were removed from the settlement eligible costs presented in Table E.193 above. Costs associated with the currently known areas of contamination are shown in Table E.194 below. Table E.195 outlines the POET counts and connection summary for scenario A.

Table E.194. Cost estimate summary table for Year 2040 costs that exclude particle tracking costs in Community-Specific Scenario A.

Option	HI	Community served	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
						IX	GAC	IX	GAC	IX	GAC
Alt 2	>0	Woodbury	2 WTPs (13,600, 4000 gpm)	553	28.4	$81	$92	$1.7	$2.1	$127	$149
Alt 3	>1		1 WTP (9,600 gpm)	1	13.8	$56	$61	$0.6	$0.9	$73	$85
Alt 1a	>0	Lake Elmo	1 WTP (4500 gpm), wells in NE	894	6.86	$41	$45	$1.3	$1.4	$77	$84
Alt 1b	>1		2 wells NE (no WTPs)	19	2.97	$19	$19	$0.02	$0.02	$20	$20
Alt 3a	>0	Oakdale	2 WTPs (expand existing, new WTP for W3/10), 2 new wells	6	5.20	$26	$30	$0.7	$1.0	$44	$56
Alt 3b	>1		1 WTP (expand existing), 2 new wells	5	2.54	$17	$19	$0.5	$0.7	$30	$38
Alt 4a	>0	W. Lakeland	Rural PWS, 80% Township (reduced looping, 4"-8" lines)	200	1.03	$115	$116	$0.4	$0.5	$126	$129
Alt 4b	>1	W. Lakeland	Rural PWS, 80% Township (reduced looping, 4"-8" lines)	0	0.98	$114	$115	$0.2	$0.3	$120	$123
Alt 1a	>0	Cottage Grove	2 WTPs (9800, 3200 gpm), 1 new well	483	18.90	$53	$62	$1.5	$1.9	$94	$112
Alt 1b	>1		2 WTPs (7800, 3200 gpm), 1 new well	78	15.91	$39	$47	$1.0	$1.3	$67	$82
Alt 1b	>1	Newport	POETS only	0	0.00	N/A	$0.1	N/A	$0.00	N/A	$0
Alt 2a	>0	Newport	Interconnect with Woodbury	89	0.63	N/A	$2.0	N/A	$0.01	N/A	$4.6
Alt 1a	>0	St. Paul Park	2200 gpm WTP	14	3.18	$14	$16.5	$0.30	$0.38	$22	$27

Option	HI	Community served	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
						IX	GAC	IX	GAC	IX	GAC
Alt 1b	>1	St. Paul Park	2200 gpm WTP	0	3.18	$14	$16.5	$0.28	$0.37	$22	$26
Alt 1a	>0	Lakeland, Lakeland Shores, Lake St. Croix Beach	2 WTPs (750 gpm each)	4	2.27	$9.4	$12	$0.3	$0.4	$17	$22
Alt 1b	>1		456 Service connections	4	0.11	$2.9	$3	$0.0	$0.0	$3.0	$3.0
Alt 1a	>0, >1	Prairie Island Indian Community	600 gpm WTP	0	0.86	$3.1	$4.1	$0.15	$0.19	$7.1	$9.3
Alt 1a	>0	Maplewood	water main extension for 35 connections	497	0.13	N/A	$1.74	N/A	$0.50	N/A	$15.10
Alt 1b	>1	Maplewood	water main extension for 35 connections	0	0.01	N/A	$0.00	N/A	$0.00	N/A	$0.11
Alt 1a	>0	Grey Cloud Island	POETS only	114	0.02	N/A	$0.2	N/A	$0.1	N/A	$3.3
Alt 1b	>1	Grey Cloud Island	POETS only	69	0.01	N/A	$0.1	N/A	$0.1	N/A	$1.9
Alt 1a	>0	Denmark	POETS only	426	0.16	N/A	$1.50	N/A	$0.43	N/A	$12.9
Alt 1b	>1	Denmark	POETS only	0	0.00	N/A	$0.00	N/A	$0.00	N/A	$0.00
Alt 1a	>0	Afton	POETS only	780	0.34	N/A	$2.71	N/A	$0.78	N/A	$23.6
Alt 1b	>1	Afton	POETS only	16	0.09	N/A	$0.04	N/A	$0.02	N/A	$0.47
			Total for HI>0	**4060**	**68**	**352**	**385**	**8**	**10**	**575**	**647**
			Total for HI>1	**196**	**40**	**266**	**285**	**3**	**4**	**345**	**388**

Notes:

1. For these estimates; recapitalization costs are not included, O&M is only provided for the water treatment plants, and inflation at 3% is included in the Total 20 year costs.

Table E.195. Community-Specific Scenario A POET Count and Connections Summary

Community	All Inclusive Costs							PFAS Eligible Costs							Particle Tracking Costs						
	HI>0			HI>1			No. of Connections	HI>0			HI>1			No. of Connections	HI>0			HI>1			No. of Connections
	Existing	Proposed	Total	Existing	Proposed	Total		Existing	Proposed	Total	Existing	Proposed	Total		Existing	Proposed	Total	Existing	Proposed	Total	
Afton	11	810	821	11	221	232	N/A	11	810	821	11	221	232	N/A	11	769	780	11	5	16	N/A
Cottage Grove	57	402	459	57	75	132	89	59	429	488	59	89	148	0	58	450	508	58	19	77	0
Denmark Twp.	0	426	426	0	0	0	N/A	0	426	426	0	0	0	N/A	0	426	426	0	0	0	N/A
Grey Cloud Island Twp.	52	69	121	52	65	117	N/A	52	69	121	52	65	117	N/A	52	62	114	52	17	69	N/A
Lake Elmo	0	609	609	0	80	80	609	10	923	933	10	389	399	106	10	884	894	10	9	19	106
Lake St. Croix Beach	0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0	
Lakeland	1	3	4	1	3	4	453	1	3	4	1	3	4	453	1	3	4	1	3	4	453
Lakeland Shores	0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0	
Maplewood	0	388	388	0	0	0	35	4	493	497	4	0	4	0	4	493	497	4	0	4	0
Newport	0	93	93	0	16	16	9	0	93	93	0	16	16	9	0	89	89	0	0	0	9
Oakdale	0	13	13	0	13	13	58	0	13	13	0	13	13	58	0	6	6	0	5	5	58
Prairie Island Indian Community	0	0	0	0	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0
St. Paul Park	0	14	14	0	14	14	28	0	14	14	0	14	14	28	0	14	14	0	0	0	28
West Lakeland Twp.	0	0	0	0	0	0	1340	0	0	0	0	0	0	1340	111	49	160	0	0	0	1190
Woodbury	1	189	190	1	28	29	534	1	556	557	1	44	45	0	1	552	553	1	0	1	0
TOTALS	**122**	**3016**	**3138**	**122**	**515**	**637**	**3155**	**138**	**3829**	**3967**	**138**	**854**	**992**	**1994**	**248**	**3797**	**4045**	**137**	**58**	**195**	**1844**

E.2.2.15 Incremental HI costs for additional municipal and private wells added to Community-Specific Scenario A and C

This section considers the additional costs associated with incrementally decreasing the Health Index (HI) value used to select wells for treatment by 0.1 increments starting with HI>1 for Community Specific Scenarios A and C. This evaluation only considers infrastructure that is eligible for settlement funding and only accounts for the existing areas of groundwater contamination. Future migration of the PFAS contaminated groundwater as examine through particle tracking is not considered. Infrastructure and POET related costs associated are the same for both Scenario A and C. HI levels for municipal wells are shown below. The majority of the wells use the average of the last 4 quarterly samples while others use the most recent value, depending on how often they are sampled. Additional municipal wells considered in this evaluation include:

- Cottage Grove Well 9, HI = 0.905
- Saint Paul Park Well 2, HI = 0.871
- Cottage Grove Well 1, HI = 0.545
- Woodbury Well 11, HI = 0.431
- Woodbury Well 5, HI=0.426
- Woodbury Well 3, HI = 0.376
- Woodbury Well 19, HI=0.323
- Cottage Grove Well 11, HI=0.249

Each HI iteration below HI=1 is shown below. The associated additional cost of each iteration is reflected in Table E.196 found at the end of this section.

<u>HI ≥0.9</u>

This iteration only affects Cottage Grove Well 9, which is located in Cottage Grove's well field. To provide operational flexibility, this well was routed to the new centralized treatment plant in the HI>1 alternative.

<u>HI>0.8</u>

This iteration only affects Saint Paul Park Well 2. To provide operational flexibility in case one of the other two wells fail, this well was routed to the central water treatment plant in HI>1 costs.

<u>HI>0.7</u>

There are no municipal wells in this iteration.

<u>HI>0.6</u>

There are no municipal wells in this iteration.

<u>HI>0.5</u>

Cottage Grove Well 1 is impacted in this iteration. Well 1 is an aging low flow well, and it was already evaluated and determined that it was more cost-effective to abandon this well (and Well 2) and replace both wells with a single 1,200 gpm well in the lower pressure zone in the south. The cost for the new well and routing to the new centralized treatment plant was already included in the HI>1 alternative.

There are no additional capital costs associated with the well for this HI iteration. 40 new POETS are necessary for the private wells that fall between HI>0.5 and HI<1.0 in both Community Specific Scenario A and C.

HI>0.4

Woodbury Well 5 and Woodbury Well 11 are impacted in this iteration, however both wells are in the Tamarack Well Field and were connected to the central water treatment plant in HI>1 alternative.

HI>0.3

Woodbury Well 3 and Woodbury Well 19 are impacted in this iteration, however Well 3 is in the Tamarack Well Field and was connected to the central water treatment plant in HI>1 alternative. Well 19 was previously untreated and will now be routed to the water treatment plant with 1,000 linear feet of 16-inch diameter raw water line. The five proposed new wells in the South Well Field are assumed to have similar water quality as Well 19 and would also be routed to the centralized WTP with approximately 12,500 linear feet of 12-inch and 16-inch diameter raw water mains. The WTP will be expanded by an additional 6,000 gpm. 61 new POETS in Scenario A and Scenario C are necessary for the private wells that fall between HI>0.3 and HI<0.5.

HI>0.2

No municipal wells are impacted in this iteration.

HI>0.1

No municipal wells are impacted in this iteration.

Table E.196. Summary table of estimates of incremental costs for HIs between HI>0 and HI>1 for Year 2040 costs for conceptual projects included in Community-Specific Scenarios A and C.

		Municipal Wells Impacted						
HI Iteration	Proposed POETS[6]	Cumulative Proposed POETs	Capital Cost ($1,000s)	Annual O&M ($1,000s)	20 Years of Annual O&M ($1,000s)	Total 20 Year Cost[4] per increment ($1,000s)	Cumulative Total 20 Year Cost for HI Increment ($1,000s)	Notes
0.5 to < 1.0	*40*	40	*$140*	*$40*	*$800*	*$1,215*	$1,215	
0.3 to < 0.5	*61*	101	*$16,100*	*$400*	*$8,000*	*$26,900*	$28,115	Includes costs to route WDB Well 19 & 5 new wells to WTP and add 6000 gpm capacity. PFAS of new wells assumed to be similar to WDB Well 19.
Notes:	1. Only costs for GAC treatment are included; ion exchange is not considered here.							
	2. Italicized numbers/costs are incremental, while non-italicized numbers/costs are cumulative.							
	3. Recapitalization costs are not included in estimates.							
	4. Total 20 Year Cost includes inflation at 3%							
	5. POET counts only include the well types considered under this conceptual plan and do not include municipal wells; wells within designated source areas; wells covered by expedited projects; or wells that were previously connected prior to this evaluation.							
	6. POET counts are based on historical sampling and do not account for wells that may be contaminated in the future.							

E.2.3 Community Scenario B and C – St. Paul Regional Water Services

E.2.3.1 Scenario summary

Community-Specific Scenarios B and C (Scenarios B and C) are consistent with Community-Specific Scenario A (Scenario A) in terms of infrastructure modifications for all other communities with the exception of Oakdale, Lake Elmo, and Cottage Grove. Under Scenario B and C, St. Paul Regional Water Services (SPRWS) will supply Oakdale and Lake Elmo drinking water as opposed to their current and proposed treated drinking water supply wells under Scenario A. In addition, due to the change groundwater pumping from municipal supply wells, Cottage Grove Well 12 and the areas requiring granular activated carbon (GAC) point of entry treatment (POET) systems is impacted for all communities as well. As with Scenario A, Scenarios B and C were developed for the year 2040 under two conditions used to identify impacted wells that would receive treatment – those with a health index (HI) value greater than zero (> 0) and those with an HI value greater than or equal to one (≥ 1).

Under Scenario B, SPRWS would supply drinking water to only Oakdale; however, the remaining infrastructure improvements for the City as described in Scenario A would remain the same. These improvements include connecting previously identified non-municipal wells to the City's municipal water distribution system and/or providing GAC POET systems for those PFAS-impacted non-municipal wells as described below. Figures E.2.3.1.1 and E.2.3.1.2 are regional maps for the two HI conditions that illustrate the infrastructure modifications under Scenario B as well as the projected areas of PFAS impacts. Figure E.2.3.1.3 illustrates the infrastructure modifications necessary for the connection between SPRWS and Oakdale.

Under Scenario C, SPRWS would supply drinking water to both Oakdale and Lake Elmo with water being conveyed to Lake Elmo through Oakdale's exiting municipal water distribution system and proposed interconnects. Similar to Oakdale, the remaining infrastructure improvements as described in Scenario A would remain the same. These improvements include extending water mains to nearby neighborhoods currently on PFAS-impacted, non-municipal wells and providing GAC POET systems for any remaining PFAS-impacted non-municipal wells that could not be connected to the municipal water system based on cost or constructability constraints as described below. Existing groundwater supply wells in each community being supplied by SPRWS would be taken out of service and replaced with treated water supplied from SPRWS' McCarron's water treatment plant (WTP). Figures E.2.3.1.4 and E.2.3.1.5 are regional maps for the two HI conditions that illustrate the infrastructure modifications under Scenario B as well as the projected areas of PFAS impacts. Figure E.2.3.1.6 illustrates the infrastructure modifications necessary for the connection between Lake Elmo and Oakdale that is served by SPRWS.

E.2.3.2 SPRWS infrastructure components

According to SPRWS, the McCarron's WTP currently has 30 mgd of extra water treatment capacity. The existing McCarron's WTP is located in Maplewood between Roselawn Avenue and Larpenteur Avenue just West of Highway 35, as shown in Figure E.2.3.1.3 [currently provided as a separate document]. As part of their treatment process, SPRWS softens the water before pumping it into the distribution system. SPRWS charges a bulk water rate of $2.05 per 100 cubic feet ($2.74 per 1000 gallons) that should cover any costs associated with water supply improvements, WTP capacity expansion, or booster pump station upgrades at the plant and as such these are not addressed further in this estimate. If this is the preferred option to provide clean drinking water to the project area, further studies and a rate study may be necessary to further define the necessary upgrades, the cost of the upgrades, and a suitable bulk water rate.

In order to supply water to neighboring communities, SPRWS would need to implement some infrastructure changes to their existing distribution system. Discussions with SPRWS indicated that the best location to connect to their existing system would be their 10 million gallon (MG) Hillcrest Reservoir that is currently supplied by an existing 24 inch water main. SPRWS' hydraulic model indicates that their system could meet the max day demands (MDD) for both Oakdale and Lake Elmo with the addition of a 30 inch water main to the Hillcrest Reservoir location. In order to supply water to Oakdale and Lake

Elmo, a new booster pump station and distribution mains would need to be installed and will be discussed in greater detail in the following sections.

E.2.3.3 Oakdale and Lake Elmo Project Infrastructure Improvements

As mentioned above, with the exception of water supply, all other infrastructure modifications would remain the same as they were under Scenario A and are described below.

Oakdale Project Improvements

Currently, 96% of Oakdale's population is served by the existing municipal water distribution system. As such, no neighborhoods were proposed to be connected to the existing system. However, individual non-municipal wells in close proximity to the existing distribution system were proposed to be connected.

Lake Elmo Project Improvements

The available sample data indicates that the majority of non-municipal wells in Lake Elmo are currently impacted by PFAS and many have had a GAC POET system installed or been connected to the municipal system wherever possible. Under both conditions of HI > 0 and HI ≥ 1, all existing neighborhoods on private wells within the Special Well and Boring Construction Area (SWBCA) would be connected to the city's municipal water system. This SWBCA designation indicates and informs the public of potential health risks due to groundwater contamination in the area and/or provides controls on drilling municipal and non-municipal water supply wells. Table E.112 under the Scenario A section lists the neighborhoods and areas provided by the city that are proposed to be connected, with the exception of the expedited projects that have been approved (see Appendix A of the CDWSP). Residents with private wells or other non-municipal wells outside this area that are currently or are anticipated to be impacted by PFAS contamination will be addressed depending on whether it is more cost effective to provide them with GAC POET systems or connect them to the City's distribution system.

In addition to connecting neighborhoods, distribution lines were added during the hydraulic evaluation to complete loops within the system or increase system capacity and conveyance in certain areas where lines may be undersized. The additional or parallel distribution lines are described in the alternative description and the hydraulic modeling sections below.

Cottage Grove Project Improvements

Currently, Cottage Grove Well 12 was previously shown as impacted by PFAS for the HI>0 alternative in Community-Specific Scenario A, but not the HI>1 alternative. Due to the change in groundwater flow that is predicted for these two Scenarios, Cottage Grove Well 12 is now considered to be impacted by PFAS for both the HI>0 and the HI>1 alternatives in both Scenarios B and C. The additional infrastructure improvements included in the HI>1 alternative to send flow from Well 12 to the centralized water treatment plant in the intermediate zone include; 4,900 linear feet of 12-inch diameter raw water main, and a 500 gpm increase in the water treatment plant capacity. All other infrastructure improvements for Cottage Grove remained the same as shown in the HI>1 cost summary table in Community-Specific Scenario A.

E.2.3.4 Oakdale and Lake Elmo GAC POET Systems

Non-municipal wells would be selected for treatment using the same HI categories as previously described. Current or anticipated PFAS-impacted, non-municipal wells that were not proposed to be connected to the municipal water system would be provided with GAC POET systems. Groundwater particle tracking was performed for both scenarios and their respective pumping configurations.

Community Scenario B - Oakdale GAC POET Systems

According to PFAS sampling data from October 2019 and Minnesota Well Index (MWI) data, Oakdale has an estimated 124 existing non-municipal wells, of which 39 have been sampled. The groundwater model flow path analysis estimated that by the year 2040, 37 non-municipal wells would fall within areas potentially impacted by PFAS contamination. All 37 wells in the projected impact areas would either receive treatment through existing or proposed GAC POET systems or be connected to the distribution system in addition to those wells that fall outside the projected impact areas under the two HI conditions.

Under 2040 conditions with an HI>0, 11 wells would need to have GAC POETS installed while the other wells would be connected to the existing system. Under the HI ≥ 1 condition, the same 11 wells would receive GAC POET systems. These counts exclude any wells that would be connected to the city's municipal water system through expedited projects, proposed water lines, or connections to existing water lines. Under both HI conditions, a total of approximately 60 wells would be connected to either the existing distribution system or proposed distribution line extensions.

Community Scenario C - Oakdale and Lake Elmo GAC POET Systems

According to October 2019 sample data, Lake Elmo has an estimated 1,309 existing non-municipal wells, of which 503 have been sampled. Under Scenario C, Oakdale had a total of 37 wells that fell within the projected PFAS impact areas while Lake Elmo had a total of 693 wells for a total of 730 wells. All 730 wells in the projected impact areas would either receive treatment through existing or proposed GAC POET systems or be connected to the existing distribution system in addition to those wells that fall outside the projected impact areas, which would be provided treatment or replaced with a connection to the distribution system(s) depending on the two HI conditions.

Under 2040 conditions with an HI>0 or HI ≥1, neither Lake Elmo nor Oakdale had any wells with existing GAC POETS remaining as all existing wells with POETS proposed to be connected to the system. Under HI>0, Oakdale would require 13 wells to have GAC POET systems installed and Lake Elmo would require 609 wells to have POET systems installed. Under the HI ≥ 1 condition, Oakdale would require 13 wells to have GAC POET systems installed and Lake Elmo would require 62 wells to have systems installed. Tables E.197 and E.198 show the POET count and connections summary for Scenarios B and C.

Table E.197. Community-Specific Scenario B POET Count and Connections Summary

Community	All Inclusive Costs						
	HI>0			HI>1			No. of Connections
	Existing	Proposed	Total	Existing	Proposed	Total	
Afton	11	815	826	11	271	282	N/A
Cottage Grove	57	402	459	57	70	127	89
Denmark Twp.	0	426	426	0	0	0	N/A
Grey Cloud Island Twp.	53	75	128	53	69	122	N/A
Lake Elmo	0	560	560	0	68	68	609
Lake St. Croix Beach	0	0	0	0	0	0	
Lakeland	1	3	4	1	3	4	453
Lakeland Shores	0	0	0	0	0	0	
Maplewood	0	388	388	0	0	0	35
Newport	0	93	93	0	16	16	9
Oakdale	0	11	11	0	11	11	0
Prairie Island Indian Community	0	0	0	0	0	0	N/A
St. Paul Park	0	13	13	0	13	13	28
West Lakeland Twp.	0	0	0	0	0	0	1340
Woodbury	1	189	190	1	24	25	534
TOTALS	**123**	**2975**	**3098**	**123**	**545**	**668**	**3097**

Table E.198. Community-Specific Scenario C POET Count and Connections Summary

Community	All Inclusive Costs							PFAS Eligible Costs							Particle Tracking Costs						
	HI>0			HI>1			No. of Connections	HI>0			HI>1			No. of Connections	HI>0			HI>1			No. of Connections
	Existing	Proposed	Total	Existing	Proposed	Total		Existing	Proposed	Total	Existing	Proposed	Total		Existing	Proposed	Total	Existing	Proposed	Total	
Afton	11	763	774	11	225	236	N/A	11	763	774	11	225	236	N/A	11	728	739	11	5	16	N/A
Cottage Grove	58	402	460	58	70	128	89	59	429	488	59	83	142	0	59	424	483	59	19	78	0
Denmark Twp.	0	426	426	0	0	0	N/A	0	426	426	0	0	0	N/A	0	426	426	0	0	0	N/A
Grey Cloud Island Twp.	52	69	121	52	65	117	N/A	52	69	121	52	65	117	N/A	52	62	114	52	17	69	N/A
Lake Elmo	0	609	609	0	62	62	609	10	879	889	10	348	358	106	10	846	856	10	9	19	106
Lake St. Croix Beach	0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0	
Lakeland	1	3	4	1	3	4	453	1	3	4	1	3	4	453	1	3	4	1	3	4	453
Lakeland Shores	0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0	
Maplewood	0	388	388	0	0	0	35	4	493	497	4	0	4	0	4	493	497	4	0	4	0
Newport	0	93	93	0	16	16	9	0	93	93	0	16	16	9	0	89	89	0	0	0	9
Oakdale	0	13	13	0	13	13	58	0	13	13	0	13	13	58	0	6	6	0	5	5	58
Prairie Island Indian Community	0	0	0	0	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0
St. Paul Park	0	16	16	0	16	16	28	0	16	16	0	16	16	28	0	16	16	0	0	0	28
West Lakeland Twp.	0	0	0	0	0	0	1340	0	200	200	0	0	0	1340	111	49	160	0	0	0	1190
Woodbury	1	190	191	1	21	22	534	1	557	558	1	31	32	0	1	554	555	1	0	1	0
TOTALS	**123**	**2972**	**3095**	**123**	**491**	**614**	**3155**	**138**	**3941**	**4079**	**138**	**800**	**938**	**1994**	**249**	**3696**	**3945**	**138**	**58**	**196**	**1844**

E.2.3.5 Hydraulic modeling analysis

Scenario B and C - Water Demands

As with Scenario A, all water demands were based on 2040 population projections and the hydraulic model was ran using maximum day demands (MDD). Oakdale has a 2040 MDD of 4,861 gallons per minute (gpm) or approximately 7 million gallons per day (mgd). Lake Elmo has a 2040 MDD of 4,235 gallons per minute (gpm) or approximately 6 million gallons per day (mgd). The two communities together have an MDD of 13 mgd as summarized in Table E.199 below.

Table E.199. Water Demands for Scenario B and C

	Average Day Demand (ADD), mgd	Maximum Day Demand (MDD), mgd
Oakdale (Scenario B)	3	7
Lake Elmo	2	6
Total (Scenario C)	**5**	**13**

Scenario B – SPRWS and Oakdale Hydraulic Analysis

The hydraulic analysis for Scenario B focused on the sizing requirements for the transmission lines and booster pump station to convey water from SPRWS' Hillcrest Reservoir to Oakdale's distribution system. A 24 inch transmission line would be required to convey water east to Century Ave where it would split to convey water south along Century Ave and east along 34^{th} St. In order to minimize head losses and facilitate flow through Oakdale's existing distribution system, some of the existing lines also needed to be upsized. Tables E.200 and E.201 below summarizes the length and diameters of new lines and existing lines that were upsized from 8 inches. Since almost the entire City is connected to the municipal distribution system, no neighborhood distribution line extensions were required.

Table E.200. Scenario B - New Water Line Segments Lengths and Diameters

Diameter (in)	Length (ft)
12	2,713
16	1,198
16	1,745
16	2,529
16	2,634
24	2,631
24	56
24	1,317
24	1,228
24	1,639
24	987
Total (ft)	18,677
Total (mi)	3.54

Table E.201. Scenario B – Upsized Line Segments from 8 inches

Diameter (in)	Length (ft)
12	23

Diameter (in)	Length (ft)
12	22
12	416
12	341
12	326
12	325
12	321
12	314
12	308
12	301
12	279
12	210
12	209
12	154
12	88
12	52
12	36
12	29
12	11
12	13
12	13
12	9
Total (ft)	3,800
Total (mi)	0.72

In order to size the booster pump at the SPRWS reservoir, an iterative process was used to achieve similar pressures to what the City’s system is currently experiencing. The results from the hydraulic model indicate that implementing a booster pump(s) with an operating point of 5,000 gpm at a total dynamic head (TDH) of 203 ft would provide similar pressures throughout the system.

Scenario C – SPRWS and Oakdale/Lake Elmo Hydraulic Analysis

The hydraulic analysis for Scenario C was very similar to Scenario B and focused the sizing requirements for the transmission lines and booster pump station to convey water from SPRWS’ Hillcrest Reservoir to Oakdale’s distribution system as well as the interconnects between Oakdale and Lake Elmo’s existing distribution system. A 30 inch diameter transmission line would be required to convey water east to Century Ave where it would split to convey water south along Century Ave and east along 34th St. In order to minimize head losses and facilitate flow through Oakdale’s existing distribution system, some of the existing lines also needed to be upsized. Table E.202 below summarizes the length and diameters of new lines and existing lines that were upsized from 8 inches are shown in Table E.203.

Table E.202. Scenario C - New Water Line Segment Lengths and Diameters

Diameter (in)	Length (ft)
12	169
12	190
12	93

16	2,713
24	1,198
24	1,745
30	2,631
24	2,529
20	2,634
30	56
30	1,317
30	1,228
30	1,639
30	987
Total (ft)	19,129
Total (mi)	3.62

Table E.203. Scenario C – Upsized Line Segments

Existing Diameter (in)	Proposed Diameter (in)	Length (ft)
6	12	23
8	16	23
8	16	22
8	16	416
8	16	341
8	16	326
8	16	325
8	16	321
8	16	314
8	16	308
8	16	301
8	16	279
8	16	210
8	16	209
8	16	154
8	16	88
8	16	52
8	16	36
8	16	29
8	16	11
8	16	13
8	16	13
8	16	9
12	16	314
12	16	117
12	16	163

	Total (ft)	4,417
	Total (mi)	0.84

In addition to the water line modifications, three interconnects to Lake Elmo's system were included. The first interconnect upsized the existing interconnect near 40th St and Lake Jane Trail N from a 6 inch to a 12 inch. The other two interconnects were also sized at 12 inches and were located along Ideal Ave at 34th Street N and Stillwater Blvd. All three interconnects were located upstream of Lake Elmo's existing Inwood Ave booster pump station in an attempt to preserve the City's current operating procedures. The operating point of the booster pump station was iteratively modified to achieve system pressures consistent with what the City is currently experiencing. While it appears that the existing head on the pump created adequate system pressures, the flow rate needed to be increased. This may require either multiple pumps running simultaneously or modifications to the existing pumps which was accounted for in the cost estimates provided.

E.2.3.6 Groundwater modeling analysis

The groundwater model was used to evaluate the amount of "rebound" that would occur under Scenarios B and C. Rebound is the reverse of drawdown and occurs when groundwater elevations rise after a pumping well is turned off. Both Scenarios B (Oakdale municipal wells off) and C (Oakdale and Lake Elmo municipal wells off) resulted in rising water levels that exceeded "static" conditions (in this case average 2016-2018 simulated groundwater elevations). Rebound shown in Table E.204 is the difference between the resulting Jordan Sandstone groundwater elevations from Scenarios B and C and the "static" groundwater elevations at each of the existing and proposed community wells. The amount of rebound at Oakdale was similar in both scenarios; while rebound at Lake Elmo only occurred in Scenario C. Figures E.2.3.6.1 and E.2.3.6.2 shows Oakdale rebound from Scenario B under drought and wet conditions, respectively. Figures E.2.3.6.3 and E.2.3.6.4 shows Oakdale and Lake Elmo rebound from Scenario C under drought and wet conditions, respectively.

Table E.204. Scenario C Rebound Analysis at City of Oakdale and Lake Elmo

Community	Well	Rebound (m)	
		Wet	Drought
Oakdale	1	3	3
	2	3	4
	3	7	9
	4	<1	<1
	5	16	20
	6	<1	<1
	7	3	3
	8	<1	<1
	9	21	26
	10	5	5
	Proposed Well 1	3	4
	Proposed Well 2	4	5
Lake Elmo	1	<1	< 1
	2	2	2

	3	<1	< 1
	4	4	5
	5	<1	< 1
	Proposed Well 1	<1	< 1
	Proposed Well 2	<1	< 1

Forward particle tracking to 2040 was conducted under wet, normal, and drought climate conditions from known PFAS sources and areas where HI>1 for both Scenarios B and C. Particles inserted into the model travel in the direction of groundwater flow. Particle paths are shown in Figures E.2.3.6.5-E.2.3.6.7 for Scenario B and Figures E.2.3.6.8-E.2.3.6.10 for Scenario C. A comparison of particle extent for Scenarios A, B, and C are shown in Figure E.2.3.6.11.

In general, shutting off Oakdale wells delayed westward migration of particles originating directly upgradient of the City of Oakdale wells. Scenario A particles have a further westward extent in the vicinity of Oakdale and Woodbury than Scenario B and C particles. Rebound at the Oakdale community wells prevent the Oakdale wells from capturing particles. As a result, particles stop short of Oakdale Wells 5 and 7 and do not travel further west of those wells. Rebound at Oakdale wells range between less than 1 meter to 21 meters under wet conditions and up to 26 meters under drought conditions. The greatest amount of rebound occurs at Well 9. Rebound that is less than 1 meter occurs at wells that were not pumping under current conditions (2016-2018).

Overall, turning off Lake Elmo community supply wells had minimal impact on the movement of particles from PFAS sources and areas where HI>1. With exception of Well 1, Lake Elmo existing and proposed wells are upgradient of source areas and areas where HI>1. Well 5 did capture particles in Scenarios A and B under drought conditions; however, since the well is turned off in Scenario C, particles travel south of that well. Well 1 is downgradient from the Washington County Landfill and is within the pathway of particles originating at the landfill; however, the well is not pumping in each of the scenarios and, therefore, particles are not captured by the well. Rebound at the Lake Elmo wells range between less than 1 meter (Wells 1, 3, 5 and the proposed wells) to four meters under wet conditions and up to five meters under drought conditions. The greatest amount of rebound occurs at Well 4.

Scenario B and Scenario C particles originating upgradient to the Woodbury Tamarack wellfield do not reach the western extent of Scenario A particles. In addition, Scenario B and C particles originating at the Woodbury 3M site reach Cottage Grove Well 12 whereas Scenario A particles are not captured by that well. Therefore, the well is shown as impacted in HI>1 alternative under Scenarios B and C.

E.2.3.7 Cost estimates

The cost estimates for Scenario B and C are shown below.

E.2.3.7.1 Scenario B Cost Estimate

Scenario B costs includes new transmission lines and booster pump station; the replacement of 61 PFAS-impacted wells with connections to Oakdale's municipal water system; and the installation of 11 GAC POET systems to account for residences that may not be connected to the municipal water system by 2040 due to feasibility or other unforeseen factors. The cost implications of SPRWS supplying Oakdale alone are shown in Table E.205. Improvements are common to both HI>0 and HI≥1. A summary of total costs for Scenario B including the costs associated with the other communities is shown in Table E.206.

Table E.205. Year 2040 costs for conceptual projects included in Community-Specific Scenario B for HI>0 and HI≥1.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
Booster Pump Station	1	Station	4880 gpm at 10 MG Hillcrest Reservoir	$2,430,000	
Water distribution mains	0.72	Miles	Upsize mains from 8" to 12"	$1,510,000	
Water distribution mains	3.54	Miles	Distribution mains from Hillcrest Reservoir to Oakdale	$8,830,000	
30" water main (SPRWS)	1.70	Miles	Hazel Park BPS to Hillcrest Reservoir	$5,526,000	
Service Laterals	58	Ea	Connect homes to existing mains ($2500 ea)	$145,000	
Well Sealing	58	Ea	$2,000 per private well	$116,000	
Land acquisition (site + water mains)	7.7	Acres	1/2 acre per BPS, 20 ft easements (50%)	$1,050,000	
GAC POETS	11	POETS	Standard household systems, $2,500 per well	$28,000	
			Subtotal	$19,640,000	$19,640,000
			Contingency (25%)	$4,910,000	$4,910,000
			Professional services (15%)	$2,950,000	$2,950,000
			Total Capital	**$27,500,000**	**$27,500,000**
Annual O&M Cost					
Bulk Water Cost from SPRWS	1	LS	$2.05 / 100 cu.ft. (3 MGD average daily demand)	$3,000,794	
Booster Pump Station	1	Station	4880 gpm at 10 MG Hillcrest Reservoir	$160,000	
Upsize water distribution mains	0.72	Miles	Upsize mains from 8" to 12"	$8,000	
Water distribution mains	3.54	Miles	Distribution mains from Hillcrest Reservoir to Oakdale	$45,000	
30" water main (SPRWS)	1.70	Miles	Hazel Park BPS to Hillcrest Reservoir	$28,000	
GAC POETS	11	POETS	Standard household systems, $1,000 per well	$11,000	
			Subtotal	$3,260,000	$3,260,000
			20 years of annual O&M	$65,200,000	$65,200,000
			20 years of annual O&M future value	$87,600,000	$87,600,000
			20 year costs (capital + O&M)	**$92,700,000**	**$92,700,000**

20 year future value costs (capital + O&M)			**$115,100,000**	**$115,100,000**
Capital and operating cost per 1,000 gal[2]			$2.24	$2.24
Operating only cost per 1,000 gallons[2]			$1.70	$1.70
Recapitalization Costs Factored Annually				
Booster Pump Stations	2%	of Capital	$50,000	
Water Mains	1.67%	of Capital	$265,000	
Subtotal			$320,000	$320,000
20 years of recapitalization			**$6,400,000**	**$6,400,000**
20 years of recapitalization future value			**$8,600,000**	**$8,600,000**
20 year future value costs (capital + O&M + recapitalization)			**$123,700,000**	**$123,700,000**
Notes: 1. 20 year future value includes inflation at 3%.				

The Scenario B summary Table E.206 below includes the updated costs for each community that reflect the revised POET counts associated with the changing groundwater conditions and projected PFAS impacted areas in 2040.

Table E.206. Year 2040 costs summary for conceptual projects included in Community-Specific Scenario B for HI>0 and HI≥1.

Option	HI	Community served	Components	POETS	Treated Water provided (MGD	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
						IX	GAC	IX	GAC	IX	GAC
Alt 2	>0	Woodbury	2 WTPs (13,600, 4000 gpm)	190	28.5	$130	$140	$2.0	$2.4	$224	$250
Alt 3	>1	Woodbury	1 WTP (9,600 gpm)	25	13.8	$77	$83	$1.2	$1.4	$135	$149
Alt 1a	>0	Lake Elmo	1 WTP (4500 gpm), wells in NE	560	6.84	$82	$85	$1.5	$1.7	$148	$156
Alt 1b	>1	Lake Elmo	2 wells NE (no WTPs)	68	3.09	$65	$67	$0.8	$0.9	$107	$110
Alt 6	>0, >1	W. Lakeland	New Rural PWS for 100% Township (4"-8" lines)	0	1.15	$142	$144	$1.0	$1.0	$210	$212
Alt 1a	>0	Cottage Grove	2 WTPs (9800, 3200 gpm), 1 new well	459	18.90	$61	$70	$1.8	$2.2	$131	$152
Alt 1b	>1	Cottage Grove	2 WTPs (9800, 3200 gpm), 1 new well	127	15.91	$60	$68	$1.5	$1.8	$120	$140

Option	HI	Community served	Components	POETS	Treated Water provided (MGD	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
						IX	GAC	IX	GAC	IX	GAC
Alt 1b	>1	Newport	POETS only	16	0.01	$0.1	$0.1	$0.02	$0.02	$1	$1
Alt 2a	>0		Interconnect with Woodbury	93	0.63	$2	$2.0	$0.3	$0.31	$11	$11
Alt 1a	>0	St. Paul Park	2200 gpm WTP	13	3.18	$14	$16.5	$0.32	$0.41	$28	$33
Alt 1b	>1		2200 gpm WTP	13	3.18	$14	$16.5	$0.32	$0.41	$28	$33
Alt 1a	>0	Lakeland, Lakeland Shores, Lake St. Croix Beach	2 WTPs (750 gpm each)	4	2.27	$9.4	$12	$0.3	$0.4	$17	$22
Alt 1b	>1		456 Service connections	4	0.11	$2.9	$3	$0.0	$0.0	$3.0	$3.0
Alt 1a	>0, >1	Prairie Island Indian Community	600 gpm WTP	0	0.86	$3.1	$4.2	$0.15	$0.19	$7.2	$9.3
Alt 1a	>0	Maplewood	water main extension for 35 connections	388	0.11	$4.0	$4.0	$0.40	$0.40	$14.7	$14.7
Alt 1b	>1		water main extension for 35 connections	0	0.01	$2.6	$2.6	$0.01	$0.01	$3.7	$3.7
Alt 1a	>0	Grey Cloud Island	POETS only	127	0.03	$0.3	$0.3	$0.13	$0.13	$3.7	$3.7
Alt 1b	>1		POETS only	121	0.03	$0.2	$0.2	$0.12	$0.12	$3.5	$3.5
Alt 1a	>0	Denmark	POETS only	426	0.16	$1.5	$1.5	$0.43	$0.43	$12.9	$12.9
Alt 1b	>1		POETS only	0	0.00	$0.0	$0.0	$0.00	$0.00	$0.0	$0.0
Alt 1a	>0	Afton	POETS only	826	0.34	$2.9	$2.9	$0.83	$0.83	$25.0	$25.0
Alt 1b	>1		POETS only	282	0.12	$1.0	$1.0	$0.28	$0.28	$8.5	$8.5
SPRWS	>0,>1	Oakdale	4880 gpm BPS and mains	11		$28	$28	$3.3	$3.3	$124	$124
Total for HI>0 (Scenario B)				**3097**	**68.17**	**$480**	**$510**	**$12**	**$14**	**$954**	**$1,024**
Total for HI>1 (Scenario B)				**667**	**38.30**	**$397**	**$417**	**$9**	**$9**	**$749**	**$798**

Notes:

1. Recapitalization costs and inflation (at 3%) are included in Total 20 year costs and are not included in the Capital and Annual O&M costs.

E.2.3.7.2 Scenario C Cost Estimate

Scenario C includes new transmission lines and booster pump station; three interconnects between Oakdale and Lake Elmo; the replacement of 611 PFAS-impacted wells with connections to a municipal water system excluding any connections resulting from expedited projects; and the installation of 572 and 75 (HI>0 and HI>1, respectively) GAC POET systems to account for residences that may not be connected to the municipal water system by 2040 due to feasibility or other unforeseen factors. Tables E. 207 and E.208 below list the detailed costs associated with SPRWS supplying both Oakdale and Lake Elmo for HI>0 and HI>1, respectively. Table E.209 provides a summary of total costs for Scenario C.

Table E.207. Year 2040 costs for conceptual projects included in Community-Specific Scenario C for HI>0.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
Interconnects	3	Stations	From Oakdale to Lake Elmo	$375,000	
Booster Pump Station Upgrades	1	Ea	Pump Upgrades to Lake Elmo BPS	$400,000	
Booster Pump Station	1	Stations	9000 gpm at 10 MG Hillcrest Reservoir	$3,510,000	
Water distribution mains	0.84	Miles	Upsize mains from 8" to 16"	$1,820,000	
Water distribution mains	3.62	Miles	Distribution mains from Hillcrest Reservoir to Oakdale	$10,620,000	
Neighborhood mains	14.64	Miles	Connect 609 homes in ELM	$15,208,192	
30" water main (SPRWS)	1.70	Miles	Hazel Park BPS to Hillcrest Reservoir	$5,526,000	
Service Laterals	667	Ea	Connect homes to existing mains ($2500 ea)	$1,667,500	
Well Sealing	667	Ea	$2,000 per private well	$1,334,000	
Land acquisition (site + water mains)	25.7	Acres	1/2 acre per BPS, 20 ft easements (50%)	$3,480,000	
GAC POETS	622	POETS	Standard household systems, $2,500 per well	$1,555,000	
			Subtotal	$45,500,000	$45,500,000
			Contingency (25%)	$11,380,000	$11,380,000
			Professional services (15%)	$6,830,000	$6,830,000
			Total Capital	**$63,710,000**	**$63,710,000**
Annual O&M Cost					

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Interconnects	3	Stations	Installed within right-of-way	$7,500	
Bulk Water Cost from SPRWS	1	LS	$2.05 / 100 cu.ft. (5 MGD average daily demand)	$5,002,000	
Booster Pump Station	1	Stations	9000 gpm at 10 MG Hillcrest Reservoir	$240,000	
Upsize water distribution mains	0.84	Miles	Upsize existing mains to 16"	$10,000	
Water distribution mains	3.62	Miles	Distribution mains from Hillcrest Reservoir to Oakdale	$54,000	
Neighborhood mains	14.64	Miles	Connect 609 homes in ELM	$83,000	
30" water main (SPRWS)	1.70	Miles	Hazel Park BPS to Hillcrest Reservoir	$28,000	
GAC POETS	622	POETS	Standard household systems, $1,000 per well	$622,000	
			Subtotal	$6,050,000	$6,050,000
			20 years of annual O&M	$121,000,000	$121,000,000
			20 years of annual O&M future value	$162,570,000	$162,570,000
			20 year costs (capital + O&M)	**$184,710,000**	**$184,710,000**
			20 year future value costs (capital + O&M)	**$226,280,000**	**$226,280,000**
			Capital and operating cost per 1,000 gal[2]	$2.33	$2.33
			Operating only cost per 1,000 gallons[2]	$1.67	$1.67
Recapitalization Costs Factored Annually					
Booster Pump Stations		2%	of Capital	$80,000	
Water Mains		1.67%	of Capital	$554,000	
			Subtotal	$640,000	$640,000
			20 years of recapitalization	**$12,800,000**	**$12,800,000**
			20 years of recapitalization future value	**$17,200,000**	**$17,200,000**
			20 year future value costs (capital + O&M + recapitalization)	**$243,480,000**	**$243,480,000**
Notes: 1. 20 year future value costs include inflation at 3%.					

Table E.208. Year 2040 costs for conceptual projects included in Community-Specific Scenario C for HI≥1.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					

Interconnects	3	Stations	From Oakdale to Lake Elmo	$375,000	
Booster Pump Station Upgrades	1	Ea	Pump Upgrades to Lake Elmo BPS	$400,000	
Booster Pump Station	1	Stations	9000 gpm at 10 MG Hillcrest Reservoir	$3,510,000	
Water distribution mains	0.84	Miles	Upsize mains from 8" to 16"	$1,820,000	
Water distribution mains	3.62	Miles	Distribution mains from Hillcrest Reservoir to Oakdale	$10,620,000	
Neighborhood mains	14.64	Miles	Connect 609 homes in ELM	$15,208,192	
30" water main (SPRWS)	1.70	Miles	Hazel Park BPS to Hillcrest Reservoir	$5,526,000	
Service Laterals	667	Ea	Connect homes to existing mains ($2500 ea)	$1,667,500	
Well Sealing	667	Ea	$2,000 per private well	$1,334,000	
Land acquisition (site + water mains)	25.7	Acres	1/2 acre per BPS, 20 ft easements (50%)	$3,480,000	
GAC POETS	75	POETS	Standard household systems, $2,500 per well	$188,000	
			Subtotal	$44,130,000	$44,130,000
			Contingency (25%)	$11,040,000	$11,040,000
			Professional services (15%)	$6,620,000	$6,620,000
			Total Capital	**$61,790,000**	**$61,790,000**
Annual O&M Cost					
Interconnects	3	Stations	Installed within right-of-way	$7,500	
Bulk Water Cost from SPRWS	1	LS	$2.05 / 100 cu.ft. (5 MGD average daily demand)	$5,002,000	
Booster Pump Station	1	Stations	9000 gpm at 10 MG Hillcrest Reservoir	$240,000	
Upsize water distribution mains	0.84	Miles	Upsize existing mains to 16"	$10,000	
Water distribution mains	3.62	Miles	Distribution mains from Hillcrest Reservoir to Oakdale	$54,000	

Neighborhood mains	14.64	Miles	Connect 609 homes in ELM	$83,000	
30" water main (SPRWS)	1.70	Miles	Hazel Park BPS to Hillcrest Reservoir	$28,000	
GAC POETS	75	POETS	Standard household systems, $1,000 per well	$75,000	
			Subtotal	$5,500,000	$5,500,000
			20 years of annual O&M	$110,000,000	$110,000,000
			20 years of annual O&M future value	$147,790,000	$147,790,000
			20 year costs (capital + O&M)	**$171,790,000**	**$171,790,000**
			20 year future value costs (capital + O&M)	**$209,580,000**	**$209,580,000**
			Capital and operating cost per 1,000 gal[2]	$2.18	$2.18
			Operating only cost per 1,000 gallons[2]	$1.54	$1.54
Recapitalization Costs Factored Annually					
Booster Pump Stations		2%	of Capital	$80,000	
Water Mains		1.67%	of Capital	$554,000	
			Subtotal	$640,000	$640,000
			20 years of recapitalization	**$12,800,000**	**$12,800,000**
			20 years of recapitalization future value	**$17,200,000**	**$17,200,000**
			20 year future value costs (capital + O&M + recapitalization)	**$226,780,000**	**$226,780,000**

Note:

1. 20 year future value included inflation at 3%.

The Scenario C summary table below includes the updated costs for each community that reflect the revised POET counts associated with the changing groundwater conditions and projected PFAS impacted areas in 2040.

Table E.209. Summary of Year 2040 community costs for Scenario C.

Option	HI	Community served	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
						IX	GAC	IX	GAC	IX	GAC
Alt 2	>0	Woodbury	2 WTPs (13,600, 4000 gpm)	191	28.5	$129	$140	$2.0	$2.4	$223	$249
Alt 3	>1		1 WTP (9,600 gpm)	22	13.8	$77	$83	$1.2	$1.4	$135	$149
Alt 6	>0, >1	W. Lakeland	New Rural PWS for 100% Township (4"-8" lines)	0	1.15	$142	$144	$1.0	$1.0	$210	$212
Alt 1a	>0		2 WTPs (9800, 3200	459	18.90	$61	$70	$1.8	$2.2	$131	$152

Option	HI	Community served	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
						IX	GAC	IX	GAC	IX	GAC
		Cottage Grove	gpm), 1 new well								
Alt 1b	>1		2 WTPs (9300, 3200 gpm), 1 new well	127	15.91	$59	$68	$1.5	$1.8	$119	$140
Alt 1b	>1	Newport	POETS only	16	0.01	N/A	$0.1	N/A	$0.02	N/A	$1
Alt 2a	>0		Interconnect with Woodbury	93	0.63	N/A	$2.0	N/A	$0.31	N/A	$11
Alt 1a	>0	St. Paul Park	2200 gpm WTP	16	3.18	$14	$16.5	$0.33	$0.41	$28	$33
Alt 1b	>1		2200 gpm WTP	16	3.18	$14	$16.5	$0.33	$0.41	$28	$33
Alt 1a	>0	Lakeland, Lakeland Shores, Lake St. Croix Beach	2 WTPs (750 gpm each)	4	2.27	$9.4	$12	$0.3	$0.4	$17	$22
Alt 1b	>1		456 Service connections	4	0.11	$2.9	$3	$0.0	$0.0	$3.0	$3.0
Alt 1a	>0, >1	Prairie Island Indian Community	600 gpm WTP	0	0.86	$3.1	$4.2	$0.15	$0.19	$7.2	$9.3
Alt 1a	>0	Maplewood	water main extension for 35 connections	388	0.11	N/A	$4.0	N/A	$0.40	N/A	$14.7
Alt 1b	>1		water main extension for 35 connections	0	0.01	N/A	$2.6	N/A	$0.01	N/A	$3.7
Alt 1a	>0	Grey Cloud Island	POETS only	121	0.03	N/A	$0.2	N/A	$0.12	N/A	$3.5
Alt 1b	>1		POETS only	117	0.02	N/A	$0.2	N/A	$0.12	N/A	$3.4
Alt 1a	>0	Denmark	POETS only	426	0.16	N/A	$1.49	N/A	$0.426	N/A	$12.9
Alt 1b	>1		POETS only	0	0.00	N/A	$0.00	N/A	$0.000	N/A	$0.0
Alt 1a	>0	Afton	POETS only	774	0.32	N/A	$2.67	N/A	$0.77	N/A	$23.5
Alt 1b	>1		POETS only	236	0.10	N/A	$0.79	N/A	$0.24	N/A	$7.1
SPRWS	>0	Oakdale, Lake Elmo	9000 gpm BPS and mains	622		$63.7	$63.7	$6.05	$6.05	$243.5	$243.5

Option	HI	Community served	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
						IX	GAC	IX	GAC	IX	GAC
SPRWS	>1		9000 gpm BPS and mains	75		$61.8	$61.8	$5.50	$5.50	$226.8	$226.8
Total for HI>0 (Scenario C)				3094		$434	$460	$14	$15	$924	$986
Total for HI>1 (Scenario C)				613		$365	$384	$10	$11	$744	$789

E.2.3.7.3 PFAS eligible cost summary

The cost estimates presented in Scenario B and C above include all related costs for each given alternative to meet Year 2040 water demands. However, for various reasons, some costs may not be covered by settlement funds. The guidelines used to determine project components that would be eligible for settlement funding were presenting in the Appendix E Introduction. Only Scenario C was evaluated further to determine what costs would be eligible for settlement funding. All capital costs associated with providing SPRWS water to the communities of Oakdale and Lake Elmo are included, along with the annual operation and maintenance costs associated with purchasing water from SPRWS, and the annual costs for the 1024 GAC POETS. Settlement eligible cost estimates for the other communities are taken from Scenario A. Recapitalization costs are not included. Settlement eligible costs are presented in Table E.210 below for the costs associated with SPRWS supplying water to Oakdale and Lake Elmo. Table E.211 is a summary of the costs associated for Scenario C.

Table E.210. Summary of PFAS Eligible Costs Community-Specific Scenario C for SPRWS to Oakdale and Lake Elmo.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
SPRWS	>0	9000 gpm pump station and mains	1024	13.3	N/A	$43	N/A	$6.0	N/A	$205
SPRWS	>1	9000 gpm pump station and mains	477	13.1	N/A	$44	N/A	$5.5	N/A	$192

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

Table E.211. Summary of PFAS Eligible Costs for Community-Specific Scenario C.

Option	HI	Community served	Components	POETS	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC

Alt 2	>0	Woodbury	2 WTPs (13,600, 4000 gpm)	558	$78	$89	$1.7	$2.1	$124	$146
Alt 3	>1		1 WTP (9,600 gpm)	32	$56	$61	$0.7	$0.9	$74	$85
Alt 6	>0, >1	W. Lakeland	New Rural PWS for 100% Township (4"-8" lines)	0	$142	$144	$0.2	$0.3	$149	$151
Alt 1a	>0	Cottage Grove	2 WTPs (9800, 3200 gpm), 1 new well	547	$49	$58	$1.6	$1.9	$92	$110
Alt 1b	>1		2 WTPs (9800, 3200 gpm), 1 new well	196	$47	$56	$1.2	$1.6	$80	$98
Alt 1b	>1	Newport	POETS only	16	$0.1	$0.1	$0.02	$0.02	$1	$1
Alt 2a	>0		Interconnect with Woodbury	93	$2.0	$2.0	$0.29	$0.29	$10	$10
Alt 1a	>0	St. Paul Park	2200 gpm WTP	16	$14	$16.5	$0.30	$0.38	$22	$27
Alt 1b	>1		2200 gpm WTP	16	$14	$16.5	$0.30	$0.38	$22	$27
Alt 1a	>0	Lakeland, Lakeland Shores, Lake St. Croix Beach	2 WTPs (750 gpm each)	4	$9.4	$12	$0.3	$0.4	$17	$22
Alt 1b	>1		456 Service connections	4	$2.9	$3	$0.0	$0.0	$3.0	$3.0
Alt 1a	>0, >1	PIIC	600 gpm WTP	0	$3.1	$4.1	$0.2	$0.2	$7.1	$9.3
Alt 1a	>0	Maplewood	water main extension for 35 connections	497	$1.7	$1.7	$0.5	$0.5	$15.1	$15.1
Alt 1b	>1		water main extension for 35 connections	4	$0.0	$0.0	$0.0	$0.0	$0.1	$0.1
Alt 1a	>0	Grey Cloud Island	POETS only	121	$0.3	$0.3	$0.1	$0.1	$3.5	$3.5
Alt 1b	>1		POETS only	117	$0.3	$0.3	$0.1	$0.1	$3.4	$3.4
Alt 1a	>0	Denmark	POETS only	426	$1.5	$1.5	$0.4	$0.4	$13.0	$13.0
Alt 1b	>1		POETS only	0	0.0	0.0	0.0	0.0	$0.0	$0.0
Alt 1a	>0	Afton	POETS only	774	$2.7	$2.7	$0.8	$0.8	$23.5	$23.5
Alt 1b	>1		POETS only	236	$0.8	$0.8	$0.2	$0.2	$7.2	$7.2

SPRWS	>0	Oakdale, Lake Elmo	9000 gpm BPS and mains	1024	$43	$43	$6.0	$6.0	$205	$205
SPRWS	>1		9000 gpm BPS and mains	477	$44	$44	$5.5	$5.5	$192	$192
			Total for HI>0 (Scenario C)	**4060**	**$348**	**$374**	**$12**	**$13**	**$682**	**$735**
			Total for HI>1 (Scenario C)	**1098**	**$311**	**$330**	**$8**	**$9**	**$538**	**$577**

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.3.7.4 Cost summary with particle tracking costs removed

Costs presented in this section are reflective of the currently known areas of PFAS contamination and do not consider future costs associated with the potential migration of the groundwater contamination noted by the particle tracking exercise. These costs also consider only those cost considered to be eligible for funding as noted in the previous section. To evaluate the cost implications of particle tracking and the projection of future potential areas of PFAS impact, these costs were removed from the PFAS eligible cost estimate. The only impacts were the overall reduction in POETS to 978 and 54 in Lake Elmo and Oakdale, as shown in Table E.212. Costs for the entire Scenario C is shown in Table E.213.

Table E.212. Summary of 2040 Costs for Community-Specific Scenario C for SPRWS to Oakdale and Lake Elmo with Costs Associated with Particle Tracking and Projected Impacts Removed.

Option	HI	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
SPRWS	>0	9000 gpm BPS and mains	553	13.3	978	$66	$66	$6.0	$6.0	$227
SPRWS	>1	9000 gpm BPS and mains	1	13.0	54	$63	$63	$5.1	$5.1	$199

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

Table E.213. Summary of Costs Community-Specific Scenario C with Costs Associated with Particle Tracking and Projected Impacts Removed.

Option	HI	Community served	Components	POETS	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1	>0	Woodbury	1 WTP (19,600 gpm)	555	$140	$149	$2.2	$2.5	$242	$263

Option	HI	Community served	Components	POETS	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 2	>0	Woodbury	2 WTPs (13,600, 4000 gpm)	555	$78	$89	$1.7	$2.1	$124	$146
Alt 3	>1		1 WTP (9,600 gpm)	1	$55	$61	$0.6	$0.9	$73	$84
Alt 4	>0	West Lakeland	Rural PWS, 80% Township (reduced looping, 4"-8" lines)	160	$115	$116	$0.4	$0.4	$125	$127
Alt 4	>1			0	$114	$115	$0.2	$0.3	$120	$123
Alt 6	>0, >1	W. Lakeland	New Rural PWS for 100% Township (4"-8" lines)	0	$142	$144	$0.2	$0.3	$149	$151
Alt 1a	>0	Cottage Grove	2 WTPs (9800, 3200 gpm), 1 new well	541	$50	$59	$1.6	$1.9	$93	$111
Alt 1b	>1		2 WTPs (9800, 3200 gpm), 1 new well	95	$37	$45	$1.1	$1.4	$66	$81
Alt 1b	>1	Newport	POETS only	0	$0.1	$0.1	$0.00	$0.00	$0	$0
Alt 2a	>0		Interconnect with Woodbury	89	$2.0	$2.0	$0.29	$0.29	$10	$10
Alt 1a	>0	St. Paul Park	2200 gpm WTP	16	$14	$16.5	$0.30	$0.38	$22	$27
Alt 1b	>1		2200 gpm WTP	0	$14	$16.5	$0.28	$0.37	$22	$26
Alt 1a	>0	Lakeland, Lakeland Shores, Lake St. Croix Beach	2 WTPs (750 gpm each)	4	$9.4	$12	$0.3	$0.4	$17	$22
Alt 1b	>1		456 Service connections	4	$2.9	$3	$0.0	$0.0	$3.0	$3.0
Alt 1a	>0, >1	PIIC	600 gpm WTP	0	$3.1	$4.1	$0.2	$0.2	$7.1	$9.3
Alt 1a	>0	Maplewood	water main extension for 35 connections	497	$1.7	$1.7	$0.5	$0.5	$15.1	$15.1

Option	HI	Community served	Components	POETS	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
					IX	GAC	IX	GAC	IX	GAC
Alt 1b	>1		water main extension for 35 connections	4	$0.0	$0.0	$0.0	$0.0	$0.1	$0.1
Alt 1a	>0	Grey Cloud Island	POETS only	114	$0.2	$0.2	$0.1	$0.1	$3.3	$3.3
Alt 1b	>1		POETS only	69	$0.1	$0.1	$0.1	$0.1	$1.9	$1.9
Alt 1a	>0	Denmark	POETS only	426	$1.5	$1.5	$0.4	$0.4	$13.0	$13.0
Alt 1b	>1		POETS only	0	0.0	0.0	0.0	0.0	$0.0	$0.0
Alt 1a	>0	Afton	POETS only	739	$2.6	$2.6	$0.7	$0.7	$22.4	$22.4
Alt 1b	>1		POETS only	16	$0.0	$0.0	$0.0	$0.0	$0.5	$0.5
SPRWS	>0	Oakdale, Lake Elmo	9000 gpm BPS and mains	978	$66	$66	$6.0	$6.0	$227	$227
SPRWS	>1		9000 gpm BPS and mains	54	$63	$63	$5.1	$5.1	$199	$199
			Total for HI>0 (Scenario C)	**4119**	**$343**	**$369**	**$12**	**$13**	**$678**	**$731**
			Total for HI>1 (Scenario C)	**243**	**$290**	**$308**	**$7**	**$8**	**$492**	**$528**

Notes:

1. For these estimates, recapitalization costs are not included; O&M is only provided for water treatment facilities and POETS only; and 3% inflation is included in the Total 20 year costs.

E.2.4 Community Scenario D – Prairie Island Indian Community Serving West Lakeland Township

E.2.4.1 Scenario summary

Community-Specific Scenario E (Scenario D) is consistent with Scenario A in terms of infrastructure modifications for all other communities except Prairie Island Indian Community (PIIC) and West Lakeland Township (WLT) to address PFAS-related drinking water quality and quantity for the two communities. Under Scenario D, WLT is supplied drinking water by PIIC via an interconnect as opposed to implementing treated drinking water supply wells for the two communities separately. Figure E.2.4.1 illustrates the infrastructure modifications required under this scenario.

As with Community-Specific Scenario A (Scenario A), Scenario D was developed for the year 2040 under two conditions used to identify impacted wells that would receive treatment – those with a health index (HI) value greater than zero (> 0) and those with an HI value greater than or equal to one (≥ 1).

E.2.4.2 Prairie Island Indian Community Project Improvements

As mentioned above, with the exception of water supply for PIIC and WLT, all other infrastructure modifications would remain the same as they were under Scenario A and are described below.

Water supply

The parcel of land owned by PIIC has not yet been developed and there is currently an irrigation well that they are looking to convert to a potable water supply well. However, based on the information provided by PIIC's engineer, the modifications necessary to convert the irrigation well to meet the Minnesota Well Code for a potable drinking water supply well are such that it cannot meet the combined demands of PIIC and WLT. In addition, the well would need to be modified. Therefore, in order for PIIC to provide potable water to WLT they would need to construct two new wells that are both able to accommodate the drinking water demands of PIIC and WLT with one well serving as a back-up. The existing irrigation well would be taken out of service and properly sealed. Currently, the existing irrigation well has been impacted by PFAS contamination at an HI value greater than 1 and it is assumed that the two new wells will require treatment under both HI conditions.

Water treatment plants (WTPs)

Since it is assumed that the two new wells will require treatment, a new 900 gpm PFAS treatment facility was used for estimating purposes and to meet the demands of both PIIC and WLT. Costs are included for pretreatment if needed.

E.2.4.3 West Lakeland Project Improvements

Under Scenario A, several alternatives were examined with regards to a new municipal water distribution system which were described in detail in the Scenario A section of Appendix E. The new water distribution system would include storage facilities and any necessary booster pump stations and pressure reducing valves to control system pressures.

Under the previous Alternatives 1 through 4, the distribution system was limited to certain regions of the community based on current PFAS sampling data and not projected 2040 conditions. Under these alternatives, the proposed distribution system connected those homes currently impacted by PFAS and not TCE which is present in the northern half of the City. The result was a "partial" distribution system that served primarily the southern two thirds of WLT, or approximately 1,190 residents. The remaining homes in West Lakeland would continue to be supplied by their existing non-municipal wells, mostly in the northern half of the township. Wood also received feedback from the township regarding areas of the system that could be removed from the proposed system in an effort to reduce pipe lengths and various pipe diameters were also considered. Alternatives 5 and 6 however, examined the possibility of serving the entire community or approximately 1,340 residents considering various pipe diameters as well. For the purposes of this evaluation, the distribution system as described in WLT's previous Alternative 6 was used and will be described in a later section.

GAC POET systems

While almost all WLT residents would be proposed as being connected to the new municipal water distribution system, there were some potential industrial users that would remain on their private wells. Under this condition, GAC POET systems would be provided as necessary for PFAS impacted, non-municipal wells that could not be feasibly or economically connected to the existing distribution system.

E.2.4.4 Hydraulic modeling analysis

To evaluate a new municipal water treatment and distribution system, a few alternatives were evaluated that examined different physical characteristics and areas served. While these will be discussed in further detail in the following sections, they will also be briefly summarized here. The first alternative includes installing 8-inch lines throughout the system to allow for fire flow. The second, includes reducing line sizes to no less than 4 inches which eliminates the fire flow capability of the distribution system. The third alternative includes the same lines sizes as presented in the first two alternatives but with reduced areas served by the distribution system. It should be noted that the hydraulic model includes only the distribution system to those areas impacted by PFAS contamination and does not include some of the area to the north that has TCE contamination. If the township decides in the future to provide service to additional areas, a separate hydraulic model evaluation should be performed. However, the distribution system was extended to the whole community for cost estimating purposes only.

West Lakeland has widely varying topography with ground elevations ranging from 805 to 1,030 feet. The nature of its landscape creates hydraulic challenges for regulating system pressures. In order to maintain adequate pressures, a network consisting of pressure reducing valves and booster pumps would be required for all alternatives. Water storage towers were placed at high points in the system and were located on private land. Due to the water storage towers being located at high points in the system and the need to mitigate pressures in the other areas of the system, booster pump stations were placed near the base of the proposed storage towers. Pressure reducing valves were used to isolate pressure zones along the eastern side of the township and keep system pressures below 90 psi.

E.2.4.5 Groundwater modeling analysis

No additional groundwater modeling was conducted for Scenario E. The changes represented in Scenario E relative to Scenario A are minor with rates that are anticipated to be supported by the aquifer. Additionally, groundwater flow in the area is predominantly to the east toward the Saint Croix River and would remain so under Scenario E and would not alter the particle tracking results on a larger scale.

E.2.4.6 Project alternatives

As previously mentioned, only Alternative 6 from Scenario A was considered for this evaluation with the modification that water supply would be coming from PIIC’s treated groundwater wells. With PIIC providing water to West Lakeland, a 150,000 gallon water storage tank was included at the location of the wells in addition to the 600,000 gallons of water storage provided in the proposed West Lakeland water distribution system. The new water supply system configuration for this scenario is shown on Figure E.2.4.1. The selected alternative applies to both the HI>0 and the HI>1 category as the alternatives for WLT are determined by the distribution system and not by HI values.

Alternative 6 – 2040 One Centralized WTP and <8-inch Distribution System for 100% of Township and PIIC Water Supply for HI > 0, HI ≥ 1

This alternative included serving the entire township through a new municipal water distribution system with treated water being supplied by PIIC. The water lines in the proposed system are reduced in sized between 4-inch and 8-inch diameter that do not provide fire protection. Under this alternative, all of the approximately 1,340 properties within WLT with existing private wells would be connected to the system. Under this alternative PIIC would drill two new wells that would route raw water to a PFAS treatment facility within PIIC. Treated water would then be conveyed to residents of PIIC and WLT.

E.2.4.7 Cost estimate breakdown

A breakdown of capital and O&M costs is provided in Table E.214 for the year 2040. As mentioned, costs were only evaluated using the WLT Alternative 6. Since this scenario does not include WLT's previously proposed municipal supply wells, the six million dollar savings that was found by supplying WLT with PIIC treated water could be applied across all alternatives that were evaluated under Scenario A. However, only the detail cost breakdown for Alternative 6 was included in this section.

Table E.214. Year 2040 costs for conceptual projects included in the Community-Specific Scenario D-PIIC to W. Lakeland.

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Capital Cost					
PFAS Water Treatment Plants	1	WTPs	900 gpm	$3,360,000	$2,400,000
Pretreatment at WTP	1	Lump Sum	Iron/Manganese	$470,000	$470,000
New well	2	Wells	each well 900 gpm	$3,670,000	
Pressure reducing valves	11	Stations	8" PRVs	$1,380,000	
Storage tanks	3	Tanks	0.75 MG total (0.3 MG each in WLT, 0.15 in PIIC)	$3,272,000	
Booster pump station	3	Stations	3 BPS (400,100,10 gpm)	$840,000	
Water transmission main	0.34	Miles	8" from PIIC to West Lakeland	$275,120	
Water distribution mains	56.2	Miles	4"-8" distribution mains (PVC) for 1340 connections	$78,670,000	
Well sealing	1340	Ea	$2,000 per well	$2,680,000	
Land acquisition (site + water mains)	72.0	Acres	1/2 acre per well, 1 acre at WTP, 20 ft easements (50%)	$9,730,000	
GAC POETS	0	POETS	Standard household systems, $2,500 per well	$0	
			Subtotal	$105,170,000	$104,210,000
			Contingency (25%)	$26,300,000	$26,060,000
			Professional services (15%)	$15,780,000	$15,640,000
			Total Capital	**$147,250,000**	**$145,910,000**
Annual O&M Cost					
PFAS WTPs	1	WTP	Media Cost	$12,000	$8,000
PFAS WTPs	1	WTP	Maint. and Operations	$190,000	$150,000

Item	Quantity	Units	Description	Total Cost (GAC)	Total Cost (IX)
Wells	2	Wells	each well 900 gpm	$70,000	
Pressure Reducing Valves	11	Stations	Installed within right-of-way	$94,000	
Storage Tanks	3	Tanks	0.75 MG total (0.3 MG each in WLT, 0.15 in PIIC)	$92,000	
Booster pump station	3	Stations	3 BPS (400,100,10 gpm)	$90,000	
Water transmission main	0.34	Miles	8" from PIIC to West Lakeland	$2,000	
Water distribution mains	56.2	Miles	4"-8" distribution mains (PVC) for 1340 connections	$394,000	
GAC POETS	0	POETS	Standard household systems, $1,000 per well	$0	
			Subtotal	$944,000	$900,000
			20 years of annual O&M	$18,880,000	$18,000,000
			20 years of annual O&M future value	$25,370,000	$24,190,000
			20 year costs (capital + O&M)	**$166,130,000**	**$163,910,000**
			20 year future value costs (capital + O&M)	**$172,620,000**	**$170,100,000**
			Capital and operating cost per 1,000 gal[2]	$18.25	$17.98
			Operating only cost per 1,000 gallons[2]	$2.68	$2.56
Recapitalization Costs Factored Annually					
WTPs		2%	of Capital	$80,000	$60,000
Wells		2%	of Capital	$74,000	
Booster Pump Stations		2%	of Capital	$20,000	
Storage Tanks			Rehab every 20 Years	$60,000	
Water Mains		1.67%	of Capital	$1,319,000	
			Subtotal	$1,560,000	$1,540,000
			20 years of recapitalization	**$31,200,000**	**$30,800,000**
			20 years of recapitalization future value	**$41,920,000**	**$41,390,000**
			20 year future value costs (capital + O&M + recapitalization)	**$214,540,000**	**$211,490,000**
Note: 1. 20 year future value costs include inflation at 3%.					

Table E.215 below is a comparison of the costs estimates for each community to provide their own potable water with new groundwater wells that is presented in the Community Specific Scenario A versus Scenario D table below. Overall, PIIC serving W. Lakeland with potable water has a savings of approximately $6 or $7 million over 20 years, as shown below.

Table E.215. Year 2040 costs for conceptual projects included in the Community-Specific Scenario D versus Scenario A.

Option	HI	Community served	Components	POETS	Treated Water provided (MGD)	Capital cost ($Ms)		Annual O&M cost ($Ms)		Total 20 year costs ($Ms)	
						IX	GAC	IX	GAC	IX	GAC
Scen A, Alt 6	>0, >1	W. Lakeland	New Rural PWS for 100% Township (4"-8" lines)	0	1.15	$142	$144	$1.0	$1.0	$210	$212
Scen A, Alt 1a	>0, >1	Prairie Island Indian Community	600 gpm WTP	0	0.86	$3	$4	$0.2	$0.2	$7	$9
Total from Scenario A (WLT Alt 6 + PIIC Alt1a)				**0**	**2.02**	**$146**	**$148**	**$1.14**	**$1.22**	**$217**	**$222**
Scen E	>0, >1	PIIC to W. Lakeland	900 gpm WTP, 2 wells, storage, and distribution system	0	1.30	$146	$147	$0.90	$0.94	$211	$215
Total Scenario E (PIIC to WLT)				**0**	**1.30**	**$146**	**$147**	**$0.90**	**$0.94**	**$211**	**$215**

Notes:

1. Recapitalization and inflation costs at 3% are included in Total 20 year costs and are not included in the Capital and Annual O&M costs.

E.2.5 Community Scenario A to D – Impacted Municipal Wells

Municipal wells included in the recommended solutions for each Community-Specific Scenario A, B, C, and D are listed in Table E.216 below. Communities or wells that are greyed out are either off-line or abandoned. Those wells with a Yes, are included in the scenario. Wells are shown for the both the HI>0 and HI>1 alternatives. Wells that were included in the initial evaluation due to particle tracking results from the groundwater model were excluded in the particle tracking (PT) columns, such as HI>0 PT.

Table E.216. Municipal wells impacted in Scenarios A, B, C, D for HI>0 and HI>1

	Well No.	Scenario A				Scenario B				Scenario C				Scenario D			
		HI>0	HI>0 PT	HI>1	HI>1 PT	HI>0	HI>0 PT	HI>1	HI>1 PT	HI>0	HI>0 PT	HI>1	HI>1 PT	HI>0	HI>0 PT	HI>1	HI>1 PT
AFT	N/A																
CTG	1																
CTG	2																
CTG	3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CTG	4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

	Well No.	Scenario A				Scenario B				Scenario C				Scenario D			
		HI> 0	HI> 0 PT	HI> 1	HI> 1 PT	HI> 0	HI> 0 PT	HI> 1	HI> 1 PT	HI> 0	HI> 0 PT	HI> 1	HI> 1 PT	HI> 0	HI> 0 PT	HI> 1	HI> 1 PT
CTG	5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CTG	6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CTG	7	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CTG	8	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CTG	9	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CTG	10	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CTG	New W1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CTG	11	Yes	Yes	Yes		Yes	Yes	Yes		Yes	Yes	Yes		Yes	Yes	Yes	
CTG	12	Yes	Yes			Yes	Yes	Yes		Yes	Yes	Yes		Yes	Yes		
DEN	N/A																
GCI	N/A																
LE	2	Yes	Yes			Yes	Yes							Yes	Yes		
LE	4	Yes	Yes			Yes	Yes							Yes	Yes		
LE	5	Yes	Yes	Yes		Yes	Yes	Yes						Yes	Yes	Yes	
LE	New W1	Yes	Yes			Yes	Yes							Yes	Yes		
LE	New W2	Yes	Yes			Yes	Yes							Yes	Yes		
LKLD	1	Yes	Yes			Yes	Yes			Yes	Yes			Yes	Yes		
LKLD	2	Yes	Yes			Yes	Yes			Yes	Yes			Yes	Yes		
MPL WD	N/A																
NEW	1	Yes	Yes			Yes	Yes			Yes	Yes			Yes	Yes		
NEW	2	Yes	Yes			Yes	Yes			Yes	Yes			Yes	Yes		
OAK	1																
OAK	2																
OAK	3	Yes	Yes											Yes	Yes		
OAK	5	Yes	Yes	Yes	Yes									Yes	Yes	Yes	Yes

	Well No.	Scenario A				Scenario B				Scenario C				Scenario D			
		HI> 0	HI> 0 PT	HI> 1	HI> 1 PT	HI> 0	HI> 0 PT	HI> 1	HI> 1 PT	HI> 0	HI> 0 PT	HI> 1	HI> 1 PT	HI> 0	HI> 0 PT	HI> 1	HI> 1 PT
OAK	6																
OAK	7																
OAK	8																
OAK	9	Yes	Yes	Yes	Yes									Yes	Yes	Yes	Yes
OAK	10	Yes	Yes											Yes	Yes		
OAK	New W1	Yes	Yes	Yes	Yes									Yes	Yes	Yes	Yes
OAK	New W2	Yes	Yes	Yes	Yes									Yes	Yes	Yes	Yes
PIIC	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SPP	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SPP	3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SPP	4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WLKD	New W1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
WLKD	New W2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
WDB	1																
WDB	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDB	3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDB	4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDB	5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDB	6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDB	7	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDB	8	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDB	9	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDB	10	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDB	11	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDB	12	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

	Well No.	Scenario A				Scenario B				Scenario C				Scenario D			
		HI> 0	HI> 0 PT	HI> 1	HI> 1 PT	HI> 0	HI> 0 PT	HI> 1	HI> 1 PT	HI> 0	HI> 0 PT	HI> 1	HI> 1 PT	HI> 0	HI> 0 PT	HI> 1	HI> 1 PT
WDB	13	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDB	14	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDB	15	Yes	Yes			Yes	Yes			Yes	Yes			Yes	Yes		
WDB	16	Yes	Yes			Yes	Yes			Yes	Yes			Yes	Yes		
WDB	17	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDB	18	Yes	Yes			Yes	Yes			Yes	Yes			Yes	Yes		
WDB	19	Yes	Yes			Yes	Yes			Yes	Yes			Yes	Yes		
WDB	New W1	Yes	Yes			Yes	Yes			Yes	Yes			Yes	Yes		
WDB	New W2	Yes	Yes			Yes	Yes			Yes	Yes			Yes	Yes		
WDB	New W3	Yes	Yes			Yes	Yes			Yes	Yes			Yes	Yes		
WDB	New W4	Yes	Yes			Yes	Yes			Yes	Yes			Yes	Yes		
WDB	New W5	Yes	Yes			Yes	Yes			Yes	Yes			Yes	Yes		
	Total	**55**	**55**	**35**	**33**	**49**	**49**	**32**	**29**	**44**	**44**	**31**	**29**	**53**	**53**	**33**	**31**

Notes:

1. Wells shaded gray are either taken off-line or abandoned.
2. Columns with PT (particle tracking) do not include wells that were determined to be impacted by the estimated movement of PFAS by the Year 2040. Wells with a Yes are currently impacted or are part of the scenarios for areas of known PFAS contamination.
3. Columns without a PT (particle tracking), include wells that are impacted by the estimated movement of PFAS by the Year 2040.

E.3 Revised Treatment scenarios

E.3.1 Treatment scenarios overview

This section provides the detailed cost results for the Revised Treatment Scenario. These scenarios would provide treatment for existing drinking water wells, both municipal and non-municipal, at the individual well sites for 2040 population demands. Two treatment technologies were evaluated under these scenarios – GAC and IX. An assessment of these and other PFAS treatment technologies is provided in Appendix F.

Relative costs associated with the levels of contamination described below (Revised Treatment Scenarios 3A-3D) are provided as a desktop exercise, but do not reflect efficiencies that may be realized upon additional analysis (for example, via centralized WTPs as opposed to treating each well individually). Those efficiencies are explored in the other scenarios.

The determination of providing treatment to wells impacted above health risk limits (HRLs) is based off of the MDH HI calculation. The HI is calculated as the sum of the PFAS concentrations divided by their respective (most conservative) Health Based Values (HBV), as described in Chapter 7.

The following treatment scenarios were identified:

E. Revised Treatment Scenario 3A – This scenario would provide treatment at each well (both municipal and non-municipal drinking water wells) with PFAS detections of HI(PFAS) > 1.

F. Revised Treatment Scenario 3B – This scenario would provide treatment at each well (both municipal and non-municipal drinking water wells) with PFAS detections of HI(PFAS) > 0.5.

G. Revised Treatment Scenario 3C – This scenario would provide treatment at each well (both municipal and non-municipal drinking water wells) with detection of PFOS, PFOA, and/or PFHxS. PFBA has been detected in groundwater and other media across not only the Twin Cities metro area, but across the world. Requiring treatment of drinking water based on a PFBA and/or PFBS detection alone (i.e., no other PFAS are detected), which is potentially the case in Scenario 3D, has cost implications as well as implications for communities outside the East Metropolitan Area.

H. Revised Treatment Scenario 3D – This scenario would provide treatment at each well (both municipal and non-municipal drinking water wells) with PFAS detections of HI(PFAS) > 0.

E.3.1.1 Assumptions/considerations

The following records were obtained for the East Metropolitan Area and used to estimate the total number of non-municipal wells requiring treatment per community:

- Minnesota Well Index (a.k.a. County Well Index) records
- Water Supply Plans from each community
- Correspondence and first-hand knowledge from city staff
- Well sampling data from MDH as of 10/24/2019
- Correspondence and first-hand knowledge from MDH staff
- In-home GAC installation records from MPCA as of 10/24/2019

Non-municipal well treatment systems: Quantities and costs for treatment of non-municipal wells were determined by the following approach and assumptions:

- The total number of non-municipal wells requiring treatment for year 2040 was estimated using the groundwater model particle tracking analysis. Those wells falling within the projected areas of PFAS impacts as determined by the particle tracking analysis were treated as though their HI value was greater than or equal to one (HI≥1).
- The treatment system would be GAC POET equipment for each household served by non-municipal wells. Wells requiring treatment under each HI category were selected using the most recently available sampling data.
- Based on MPCA's current POET contract pricing and Wood's prior experience, the capital cost to supply and install a POET system is estimated to be $2,500 for an indoor GAC unit.
- The annual Operation and maintenance (O&M) cost to service and replace the carbon in a POET system is estimated to be $1,000 per unit.
- It is assumed that existing infrastructure would be utilized for non-municipal wells.

Municipal water treatment systems: Quantities and costs for the treatment of municipal supply wells were estimated by the following approach and assumptions:

- Records suggest that the municipal supply wells are connected to the distributed water supply independently and that centralized WTPs are not currently available. As a result, for the basis of this estimate, it was assumed that each municipal supply well would receive an independent treatment system, for a maximum of 49 independent municipal supply installations under Revised Treatment Scenario 3D (HI > 0).
- Cost estimates were prepared for both GAC and IX treatment systems. GAC and IX are similar media in column style treatment systems. GAC treatment generally requires a slightly longer contact time compared to an IX treatment system. The difference generally leads to slightly larger equipment, buildings, and higher overall capital costs for GAC as compared to IX.
- In both GAC and IX drinking water treatment systems the media used for treatment would be single use and replaced and discarded after use. The consumption of media for both GAC and IX can be influenced by the water composition, as well as the concentration of individual PFAS that require treatment. Where available, site-specific operating or pilot test data can provide the most reliable estimates.
    - The consumption of GAC media was estimated based on Freundlich isotherm based GAC loading capacity of 12,500 ug PFOA per g GAC at 80% of MDH HBV, which was developed based on published information from the City of Oakdale PFAS treatment plant,[4] along with an estimated delivered cost of $2.75 per pound. Development of the loading capacity was documented separately[5].

[4] G. Hohenstein, B. Bachmeier, 3M Poster – Granular Activated Carbon Treatment of Groundwater, presented at Fluoros Conference, 2015.
[5] J. De Klerk, B. Malyk, Estimate of Media Consumption for Water Treatment Systems, Memo, April 6, 2020.

- The consumption of IX media was estimated based ion exchange media loading capacity for PFOA that was 8 times greater than the capacity of GAC. This multiplier was based on Wood and Purolite case studies. Cost was based on an estimated delivered cost of $450 per cubic foot.

- Other operating and maintenance costs were estimated as an industry standard 5% of the capital cost.
- Drinking water distribution modeling was not conducted for these scenarios. Infrastructure costs were included in the costs for municipal well treatment systems, which are assumed to be installed at or near each individual municipal supply well or in an existing building.
- Treatment facilities were sized to meet either the total flow from the connected supply wells or the 2040 MDD depending on the well locations, operations, and treatment requirements.

E.3.2 Treatment Scenarios 3A-3D for Year 2040

The following sections describe the treatment scenarios for year 2040.

E.3.2.1 LGU water supplies and infrastructure

Table E.217 provides a summary of the number of drinking water wells that would be treated under the different scenarios for year 2040 for the. Wells that already have permanent PFAS treatment were excluded from the capital cost estimate, and were included in the operating cost estimate.

Table E.217. Number of municipal and non-municipal drinking water wells that would be treated under each 2040 scenario.

	Municipal supply wells				Non-municipal wells			
Scenario	3A.2	3B.2	3C.2	3D.2	3A.2	3B.2	3C.2	3D.2
Community	HI > 1.0	HI > 0.5	PFOS, PFOA, PFHxS > 0	HI > 0	HI > 1.0	HI > 0.5	PFOS, PFOA, PFHxS > 0	HI > 0
Afton					232	232	771	821
Cottage Grove	8	10	11	12	192	206	246	519
Denmark					0	0	328	426
Grey Cloud Island					117	119	118	121
Lake Elmo	0	0	1	3	618	619	1090	1217
Lake St. Croix Beach					0	0	0	0
Lakeland	0	0	0	2	4	4	4	4
Lakeland Shores					0	0	0	0
St. Mary's Point								
Maplewood					4	5	436	497
Newport	0	0	0	1	16	16	68	101
Oakdale	6	6	6	9	42	42	42	42
Prairie Island Indian Community[1]	0	0	0	0	0	0	0	0
St. Paul Park	3	3	3	3	40	40	40	40

West Lakeland					1340	1340	1340	1340
Woodbury	7	8	11	19	45	50	344	557
Total (region)	24	27	32	49	2,650	2,673	4,827	5,685

Notes:

1. Well types include: commercial, domestic, irrigation, municipal, other, community supply, public supply/non-comm.-transient, public supply/non-community-non-transient, public supply/non-community, and unknown.
2. HI categories are not exclusive of each other and have overlap from one HI category to the next.
3. Counts for Oakdale do include 2 municipal wells that are already receiving treatment. These wells were not included in the counts used to calculate costs to install new treatment systems.
4. The GAC counts exclude those residences that will be connected to a municipal system as a result of the approved expedited projects.

E.3.2.2 Hydrogeologic impacts

The groundwater model was used to simulate current pumping conditions (existing municipal supply wells, irrigations wells, etc.) for each of the communities. Particles were placed in the groundwater model in areas of known residential well PFAS impacts above an HI of 1(HI>1). Forward tracking flowpaths were established through the Year 2040. Based on the flowpath analysis, it was estimated a total of between 2,650 and 5,685 new POET systems would be required by the year 2040.

E.3.2.3 Cost estimate breakdown

The tables below (Tables E.218-E.225) provide a screening level cost estimate breakdown for the initial installation costs, annual O&M costs, and the total costs for a 20-year period up to the Year 2040 for Treatment Scenarios 3A-3D. Costs include land acquisition and water treatment costs applied to wells for the different scenarios while utilizing existing municipal water systems. Cost to extend SPRWS distribution lines to Maplewood residents is not included as those residents with impacted wells currently have individual POET systems.

Table E.218. Capital costs of 2040 Treatment Scenario 3A (HI > 1.0).

Item	Quantity	Units	Description	Total cost (IX)	Total cost (GAC)
Land Acquisition	12.4	Acres	150x150 ft Lots for facilities	$1,620,000	
Municipal Well Treatment	24	EA	25,400 Gallons per Minute Total Capacity	$57,003,000	$79,905,000
"GAC POETS (total, 721 existing)"	2,650	EA	Standard household systems, $2,500 per well	$4,823,000	
			Subtotal	$63,446,000	$86,348,000
			Contingency (20%)	$12,690,000	$17,270,000
			Professional Services (15%)	$11,421,000	$15,543,000
			Total	$87,557,000	$119,161,000

Table E.219. Annual O&M costs for of 2040 Treatment Scenario 3A (HI > 1.0).

Item	Cost basis	Total cost (IX)	Total cost (GAC)
Municipal supply well treatment annual media cost	Media consumption varies based on concentration: IX: at $450/ft^3$	$3,647,000	$5,238,000

	GAC: at $2.75/lb		
Municipal supply well treatment annual operating cost	5% of capital costs		
GAC POETS	$1,000/year	$3,371,000	
	Total annual O&M	$7,018,000	$8,609,000
	20 years of annual O&M	$140,360,000	$172,180,000
	Total 20 year costs (capital + O&M)	$227,917,000	$291,341,000
	Capital and operating cost per 1,000 gal	$0.84	$1.07
	Operating only cost per 1,000 gallons	$0.52	$0.63

Table E.220. Capital costs of 2020 Treatment Scenario 3B (HI > 0.5).

Item	Quantity	Units	Description	Total cost (IX)	Total cost (GAC)
Land Acquisition	13.95	Acres	150x150 ft Lots for facilities	$1,823,000	
Municipal Well Treatment	27	EA	26,575 Gallons per Minute Total Capacity	$64,678,000	$90,665,000
GAC POETS (total, 721 existing)	2,673	EA	Standard household systems, $2,500 per well	$4,880,000	
			Subtotal	$71,381,000	$97,368,000
			Contingency (20%)	$14,277,000	$19,474,000
			Professional Services (15%)	$12,849,000	$17,527,000
			Total	$98,507,000	$134,369,000

Table E.221. Annual O&M costs of Treatment Scenario 3B (HI > 0.5).

Item	Cost basis	Total cost (IX)	Total cost (GAC)
Municipal supply well treatment annual media cost	Media consumption varies based on concentration: IX: at $450/ft^3 GAC: at $2.75/lb	$4,039,684	$5,791,146
Municipal supply well treatment annual operating cost	5% of capital costs		
GAC POETS	$1,000/year	$3,394,000	
	Total annual O&M	$7,433,684	$9,185,146
	20 years of annual O&M	$148,673,686	$183,702,928
	Total 20 year costs (Capital + O&M)	$247,180,686	$318,071,928
	Capital and operating cost per 1,000 gal	$0.81	$1.04
	Operating only cost per 1,000 gallons	$0.49	$0.60

Table E.222. Capital costs of Treatment Scenario 3C (PFOS, PFOA and PFHxS > 0).

Item	Quantity	Units	Description	Total cost (IX)	Total cost (GAC)
Land acquisition	16.53	Acres	150x150 ft Lots for facilities	$2,160,000	

Municipal supply well treatment	32	EA	37,675 Gallons per Minute Total Capacity	$80,141,000	$112,340,000
GAC POETS (total, 721 existing)	4,827	EA	Standard household systems, $2,500 per well	$10,265,000	
			Subtotal	$92,566,000	$124,765,000
			Contingency (20%)	$18,514,000	$24,953,000
			Professional Services (15%)	$16,662,000	$22,458,000
			Total	$127,742,000	$172,176,000

Table E.223. Annual O&M costs of Treatment Scenario 3C (PFOS, PFOA and PFHxS > 0).

Item	Cost basis	Total cost (IX)	Total cost (GAC)
Municipal supply well treatment annual media cost	Media consumption varies based on concentration: IX: at $450/ft^3 GAC: at $2.75/lb	$4,820,160	$6,887,017
Municipal supply well treatment annual operating cost	5% of capital costs		
GAC POETS	$1,000/year	$5,548,000	
Total annual O&M		$10,368,160	$12,435,017
20 Years of annual O&M		$207,363,208	$248,700,339
Total 20 year costs (capital + O&M)		$335,105,208	$420,876,339
Capital and operating cost per 1,000 gal		$0.88	$1.10
Operating only cost per 1,000 gallons		$0.54	$0.65

Table E.224. Capital costs of Treatment Scenario 3D (HI > 0).

Item	Quantity	Units	Description	Total cost (IX)	Total cost (GAC)
Land acquisition	25.31	Acres	150x150 ft Lots for facilities	$3,308,000	
Municipal supply well treatment	49	EA	55,075 Gallons per Minute Total Capacity	$128,437,000	$180,041,000
GAC POETS (total, 721 existing)	5,685	EA	Standard household systems, $2,500 per well	$12,410,000	
			Subtotal	$144,155,000	$195,759,000
			Contingency (20%)	$28,831,000	$39,152,000
			Professional Services (15%)	$25,948,000	$35,237,000
			Total	$198,934,000	$270,148,000

Table E.225. Annual O&M costs of Treatment Scenario 3D (HI > 0).

Item	Cost basis	Total cost (IX)	Total cost (GAC)
Municipal supply well treatment annual media cost	Media consumption varies based on concentration, IX: at $450/ft^3	$7,236,600	$10,274,747

	GAC: at $2.75/lb		
Municipal supply well treatment annual operating cost	5% of capital costs		
GAC POETS	$1,000/year	$6,406,000	
	Total annual O&M	$13,642,600	$16,680,747
	20 years of annual O&M	$272,852,008	$333,614,940
	Total 20 year costs (capital + O&M)	$471,786,008	$603,762,940
	Capital and operating cost per 1,000 gal	$0.77	$0.99
	Operating only cost per 1,000 gallons	$0.45	$0.55

E.3.3 Treatment scenarios summary

These scenarios provide raw costs associated with an individual well treatment approach. As expected, the scenario with the lowest HI tolerance (HI > 0) and the highest number of wells to be treated is the most expensive, ranging from over $471M for IX to over $603M for GAC treatment systems across the East Metro Area for 2040 conditions. A summary of the cost estimates for the treatment scenarios is provided in Table E.226 below

Table E.226. Cost estimate summary for the revised treatment scenarios.

Option	Community served	Components	Water provided (MGD)	Capital cost (1000s)		Annual O&M cost (1000s)		Total 20 year costs (1000s)[1]		Capital and operating cost per 1K gal		Operating only cost per 1K gal	
				IX	GAC	IX	GAC	IX	GAC	IX	GAC	IX	GAC
3A – HI > 1.0	All except Maplewood, Newport, and PIIC	Treatment at 24 municipal and 2,650 non-municipal wells	38	$87,557	$119,161	$7,018	$8,609	$227,917	$291,341	$0.84	$1.07	$0.52	$0.63
3B – HI > 0.5	All except Newport and PIIC	Treatment at 27 municipal and 2,673 non-municipal wells	42	$98,507	$134,369	$7,434	$9,186	$247,181	$318,072	$0.81	$1.04	$0.49	$0.60
3C – PFOS, PFOA and PFHxS >0	All except PIIC	Treatment at 32 municipal and 4,827 non-municipal wells	53	$127,742	$172,176	$10,369	$12,436	$335,106	$420,877	$0.88	$1.10	$0.54	$0.65
3D – HI > 0	All except PIIC	Treatment at 49 municipal and 5,685 non-municipal wells	84	$198,934	$270,148	$13,643	$16,681	$471,787	$603,763	$0.77	$0.99	$0.45	$0.55

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate.

E.4 Recommended options

E.4.1 Final options overview

The Final Recommended Options 1, 2, and 3 presented in this section are representative of the Final Options 1, 2, and 3 discussed in Chapter 7. Recommended Options 1, 2, and 3 are as follows:

- Recommended Option 1 –Community-Specific Scenario A for HI ≥ 1 as shown in Appendix E.2,
  - Modified to an HI>0.5 per the Incremental HI Section E.2.2.15
  - Includes an interconnect between Woodbury and Lake Elmo
  - Includes an interconnect between Woodbury and Newport
- Recommended Option 2 – Community-Specific Scenario A for HI ≥1 as shown in Appendix E.2,
  - Modified to an HI>0.3 per the Incremental HI Section E.2.2.15
  - Includes an interconnect between Woodbury and Lake Elmo
  - Includes an interconnect between Woodbury and Newport
- Recommended Option 3 – Community-Specific Scenario C for HI ≥1 as shown in Appendix E.2,
  - St. Paul Regional Water System supplies water to Oakdale and Lake Elmo
  - Modified to an HI>0.5 per the Incremental HI Section E.2.2.15
  - Includes an interconnect between Woodbury and Newport

E.4.1.1 Assumptions/considerations

Neighborhoods

Table E.227 shows the neighborhoods that are included in Recommended Options 1, 2, and 3. Water distribution mains will be extended to these neighborhoods where every residential and non-residential well would be connected to the new water distribution mains and tied into the existing public water system. For each neighborhood that following data is presented:

- Number of existing homes
- Number of non-residential wells
- Sampling data for homes in the neighborhood and corresponding HI value
- Number of existing wells with GAC POETS currently installed.
- 20-year total costs (capital and annual operation and maintenance) if a GAC POET was installed on every well in the neighborhood
- Capital cost to extend water distribution mains into neighborhood
- Number of years it takes for the cost of the GAC POETS to exceed the capital cost of the water distribution mains
- Other factors considered for each neighborhood that are not shown in the table include the proximity to existing PFAS source areas and the neighborhood's proximity to the public water system.

Table E.227. Neighborhoods included in Final Scenarios

Neighborhoods or areas	No. of Existing Homes	No. of Non-res. Conn.[2]	No. of Existing Homes at HI values:						No. of Wells with GAC POETS	POETS ($K)	Extend Water Distribution Mains (Capital, $K)[4]	No. of Years for POET Costs to Exceed Mains[5]
			NS[1]	ND	>ND - 0.5	>0.5- 0.75	>0.75 -1.0	>1.0		20 Year Total[3]		
Cottage Grove Neighborhoods Included in Recommended options												
Goodview Ave	43	0	16	0	13	7	4	3	3	$1,000	$1,335	28
Harkness Ave	9	0	2	0	3	0	1	3	2	$205	$680	73
Point Douglas Rd	15	0	1	1	2	0	0	11	11	$314	$1,446	95
Lake Elmo Neighborhoods Included in Recommended options												
Parkview Estates	62	4	0	1	12	0	2	47	41	$1,314	$4,177	66
Torre Pines	22	0	0	1	8	2	0	11	11	$479	$1,269	56
Homestead	18	0	0	0	11	1	1	5	5	$406	$720	37
20th Circle	4	0	1	0	0	0	0	3	3	$84	$117	28
Whistling Valley	37	0	5	0	14	0	0	18	17	$810	$2,856	75
Packard/Eden Park	62	0	37	0	15	2	0	8	8	$1,429	$2,848	43
38th & 39 St.	49	0	13	2	24	4	1	5	0	$1,152	$2,437	46

NS = Not sampled

ND = No detect

Notes:

1. If a home was assumed to have a well but was not included in the CWI it was counted as a "Not Sampled" or "NS" well.
2. It is assumed that Non-residential wells will be replaced on a 1:1 basis with a connection; however, there may be instances where multiple wells would be replaced with one connection during implementation.
3. Includes the initial POET installation cost for homes that do not have POETS and 20 years of the annual operation and maintenance costs for all homes. Inflation nor recapitalization costs are included.
4. Only the installation cost of the water distribution mains is eligible for settlement funding.
5. This column shows the breakeven point in years where the installation and annual operation and maintenance costs of the POETS exceeds the installation cost of the water distribution mains.

Newport Interconnect

Recommended Scenario's 1, 2, and 3 include the installation of an interconnect from Woodbury to Newport to provide resiliency and an alternative water supply for the City. The two water systems would be connected with an 8-inch water transmission main along Bailey Road as described in the Community-Specific Scenario A, Newport Alternative 2a in Section E.2.2.8.6. An interconnect was estimated to cost $1.6 M for installation as shown in Table E.141.

E.4.2 Recommended Option 1

Recommended Option 1 consists of the selected community-specific alternatives identified in Section E.2, Scenario A for the condition of HI>0.5. Projects include those required under HI≥1 as well as projects incorporated under the HI iterations (See Section E.2.2.15) from HI>0.5 through HI>0.9. The costs for this recommended scenario consider only those that are considered to be PFAS eligible and do not consider those costs incurred as a result of the particle tracking analysis.

By reducing the HI to >0.5 instead of ≥1.0, this recommended scenario includes an additional 40 POETS that are impacted. However, reducing the HI to >0.5 does not incur additional cost for the municipal systems since the impacted municipal wells at the lower HI threshold are all part of a well field in either Cottage Grove, St. Paul Park, or Woodbury that were already routed to a centralized treatment plant for operational redundancy and resiliency. Municipal wells included in the Recommended Option 1 are still consistent with Scenario A at HI>1 in Table E.216 in section E.2.5.

Woodbury Interconnect to Lake Elmo

Recommended Option's 1 and 2 include the installation of an interconnect from Woodbury to Lake Elmo to provide an alternative water supply for the City to meet their 2040 MDD. Due to potential groundwater pumping restrictions to mitigate reduced water levels at White Bear Lake, Woodbury would provide sufficient potable water to accommodate Lake Elmo's growth from Year 2020 to Year 2040. During this time period Lake Elmo's demand will increase by approximately 2,700 gpm and will need to be supplied by Woodbury. Cost estimates associated with this alternative are only interconnect related and do not consider the existing municipal wells in Lake Elmo, non-municipal wells, or extending water mains to neighborhoods. Two new wells in Woodbury are needed along with expanded capacity at the water treatment plant, the interconnect, pump upgrades to Lake Elmo's booster pump station, and a pump station in Woodbury to send water to Lake Elmo. The cost estimate for the interconnect is presented in Table E.228. These costs are eligible for funding.

Table E.228. Cost estimate summary for Woodbury to Lake Elmo Interconnect

Item	Quantity	Units	Description	Total Cost (GAC)
Capital Cost				
PFAS Water Treatment Plants	0	WTPs	+2700 gpm capacity at Woodbury plant	$6,140,000
Pretreatment at WTP	0	Lump Sum	Iron/Manganese	$1,400,000
Interconnects	1	Stations	Woodbury to Lake Elmo	$375,000
Booster Pump Station Upgrades	1	Ea	Pump Upgrades to Lake Elmo Booster Pump Station	$400,000

Item	Quantity	Units	Description	Total Cost (GAC)
Booster Pump Station	1	Stations	Woodbury to Lake Elmo Booster Pump Station	$1,710,000
Raw Water distribution mains	0.76	Miles	Wells to treatment plant	$1,590,000
Water distribution mains	0.15	Miles	800 linear feet under highway for interconnect	$660,000
Land acquisition (site + water mains)	2.1	Acres	1/2 acre per well, 20 ft easements (50%)	$285,000
			Subtotal	$12,560,000
			Contingency (25%)	$3,140,000
			Professional services (15%)	$1,890,000
			Total Capital	**$17,590,000**
Annual O&M Cost				
PFAS WTPs	0	WTP	Media Cost	$20,000
PFAS WTPs	0	WTP	Maint. and Operations	$360,000
			Subtotal	$380,000
			20 years of annual O&M	$7,600,000
			20 years of annual O&M future value	$10,220,000
			20 year costs (capital + O&M)	**$25,190,000**
			20 year future value costs (capital + O&M)	**$27,810,000**

Notes:

1. The 20-year future value costs were calculated using a 3% inflation rate.

Table E.229 below presents a summary of the estimated infrastructure costs included in Recommended Option 1. Costs for this recommended option are PFAS eligible and do not consider costs incurred as a result of the particle tracking analysis.

Table E.229. Cost estimate summary for Recommended Option 1

Community served	Alternative	Capital cost ($Ms)	Annual O&M cost ($Ms)	POET Annual O&M Cost ($s)	Total 20 year costs ($Ms)	Capital and operating cost per 1000 gal	Operating Cost per 1000 gal
		GAC	GAC		GAC	GAC	GAC
Woodbury (WDB)	3	**$61.31**	**$0.87**	**$6,000**	**$84.77**	**$0.84**	**$0.23**
WDB-ELM Interconnect		**$17.59**	**$0.38**	**$0.00**	**$27.81**	N/A	N/A
Lake Elmo (ELM)	1b	**$17.80**	**$0.03**	**$23,000**	**$18.61**	**$0.86**	**$0.04**
Oakdale	3b	**$18.14**	**$0.70**	**$5,000**	**$36.87**	**$1.99**	**$1.01**

Community served	Alternative	Capital cost ($Ms)	Annual O&M cost ($Ms)	POET Annual O&M Cost ($s)	Total 20 year costs ($Ms)	Capital and operating cost per 1000 gal	Operating Cost per 1000 gal
		GAC	GAC		GAC	GAC	GAC
W. Lakeland	4b	**$115.48**	**$0.26**	**$0.00**	**$122.53**	**$17.14**	**$0.99**
Cottage Grove	1b	**$46.59**	**$1.34**	**$100,000**	**$82.57**	**$0.71**	**$0.31**
Newport (Interconnect w/ WDB)	1b	**$1.65**	**$0.00**	**$0.00**	**$1.65**	**$0.37**	**$0.00**
St. Paul Park	1b	**$16.46**	**$0.37**	**$0.00**	**$26.33**	**$1.14**	**$0.43**
Lakeland, Lakeland Shores, Lake St. Croix Beach	1b	**$2.88**	**$0.00**	**$4,000**	**$2.99**	**$3.82**	**$0.14**
Prairie Island Indian Community	1a	**$4.14**	**$0.19**	**$0.00**	**$9.28**	**$1.47**	**$0.81**
Maplewood	1b	**$0.005**	**$0.01**	**$5,000**	**$0.14**	**$14.33**	**$13.81**
Grey Cloud Island	1b	**$0.08**	**$0.08**	**$75,000**	**$2.10**	**$18.32**	**$17.60**
Denmark	1b	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Afton	1b	**$0.03**	**$0.02**	**$18,000**	**$0.52**	**$9.60**	**$9.12**
	Total Scenario A	**$302**	**$5**	**$236,000**	**$417**		

Notes:

1. The 20-year future value costs were calculated using a 3% inflation rate.

E.4.3 Recommended Option 2

Recommended Option 2 consists of the selected community-specific alternatives identified in Section E.2, Scenario A for the condition of HI>0.3. Projects include those required under HI≥1 as well as projects incorporated under the HI iterations (See Section E.2.2.15) from HI>0.3 through HI>0.9.

This recommended scenario includes the additional POETS that are impacted by reducing the HI to >0.3 from >0.5 in Recommended Option 1. Reducing the HI to >0.3 will incur additional costs since Woodbury will need to expand the centralized water treatment plant by 6,000 gpm for the five new wells required for growth and Well 19. The five new wells are all assumed to require treatment due to their proximity to Woodbury Well 19 and the available sampling data for the area.

This scenario also includes two interconnects. The first interconnect from Woodbury to Lake Elmo will supply water for the future growth of Lake Elmo (see Table E.228 for a cost estimate). The second interconnect between Woodbury and Newport is included to provide an alternative water supply to Newport in case PFAS groundwater contamination at the Newport wells increases in the future.

Table E.230 presents a summary of the estimated infrastructure costs included in Recommended Option 2. Costs for this recommended option are PFAS eligible and do not consider costs incurred as a result of the particle tracking analysis.

Table E.230. Cost estimate summary for Recommended Option 2

Community served	Alternative	HI	Capital cost ($Ms) GAC	Annual O&M cost ($Ms) GAC	POET Annual O&M Cost ($s)	Total 20 year costs ($Ms)[1] GAC	Capital and operating cost per 1000 gal GAC	Operating Cost per 1000 gal GAC
Woodbury (WDB)	3	>1	$77.00	$1.13	$24,000	$107.26	$1.06	$0.30
WDB-ELM Interconnect			$17.59	$0.38	$0.00	$27.81	N/A	N/A
Lake Elmo (ELM)	1b	>1	$17.86	$0.04	$36,000	$18.94	$0.87	$0.05
Oakdale	3b	>1	$18.85	$0.70	$5,000	$37.58	$2.03	$1.01
W. Lakeland	4b	>1	$115.48	$0.26	$0.00	$122.53	$17.14	$0.99
Cottage Grove	1b	>1	$47.02	$1.36	$120,000	$83.54	$0.72	$0.31
Newport (interconnect with Woodbury)	1b	>1	$1.65	$0.003	$3,000	$1.74	$0.39	$0.02
St. Paul Park	1b	>1	$16.46	$0.37	$0.00	$26.33	$1.14	$0.43
Lakeland, Lakeland Shores, Lake St. Croix Beach	1b	>1	$2.88	$0.004	$4,000	$2.99	$3.82	$0.14
Prairie Island Indian Community	1a	>1	$4.14	$0.191	$0.00	$9.28	$1.47	$0.81
Maplewood	1b	>1	$0.008	$0.006	$6,000	$0.17	$14.50	$13.81
Grey Cloud Island	1b	>1	$0.096	$0.079	$79,000	$2.23	$18.41	$17.62
Denmark	1b	>1	$0.005	$0.001	$1,000	$0.03	$11.75	$9.91
Afton	1b	>1	$0.028	$0.019	$19,000	$0.55	$9.66	$9.17
	Total Scenario A		**$320**	**$5**	**$297,000**	**$441**		

Notes:
1. The 20-year future value costs were calculated using a 3% inflation rate.

E.4.4 Recommended Option 3

Recommended Option 3 consists of the selected community-specific alternatives identified in Section E.2.3, Scenario C for the condition of HI>0.5. Projects include those required under HI≥1 as well as projects incorporated under the HI iterations (See Section E.2.2.15) from HI>0.5 through HI>0.9. However, there are no changes to impacted municipal or non-municipal wells in the HI Iterations between Option A and Option C since the results of the particle tracking analysis are not being considered.

This recommended scenario includes the additional POETS that are impacted by reducing the HI to >0.5 instead of >1.0. Reducing the HI to >0.5 does not have additional cost impacts for the municipal systems, as the impacted municipal wells at the lower HI threshold are all part of a well field in either Cottage

Grove, St. Paul Park, or Woodbury that were already routed to a centralized treatment plant for operational redundancy and resiliency.

An interconnect between Woodbury and Newport is included to provide an alternative water supply to Newport in case PFAS groundwater contamination at the Newport wells increases in the future.

Table E.231 below shows a summary of the estimated infrastructure costs included in Recommended Option 3. Costs for this recommended option are PFAS eligible and do not consider costs incurred as a result of the particle tracking analysis.

Table E.231. Cost estimate summary for Recommended Option 3

Community served	Alternative	HI	Capital cost ($Ms) GAC	Annual O&M cost ($Ms) GAC	POET Annual O&M Cost ($s)	Total 20 year costs ($Ms)[1] GAC	Capital and operating cost per 1000 gal GAC	Operating Cost per 1000 gal GAC
Woodbury (WDB)	3	>1	$61.31	$0.87	$6,000	$84.77	$0.84	$0.23
SPRWS-Oakdale-Lake Elmo		>1	$50.46	$5.03	$28,000	$185.62	$1.95	$1.42
W. Lakeland	4b	>1	$115.48	$0.26	$0.00	$122.53	$17.14	$0.99
Cottage Grove	1b	>1	$46.75	$1.36	$100,000	$83.22	$0.72	$0.31
Newport (Interconnect w/ WDB)	1b	>1	$1.65	$0.0	$0.00	$1.65	$0.37	$0.00
St. Paul Park	1b	>1	$16.46	$0.37	$0.00	$26.33	$1.14	$0.43
Lakeland, Lakeland Shores, Lake St. Croix Beach	1b	>1	$2.88	$0.00	$4,000	$2.99	$3.82	$0.14
Prairie Island Indian Community	1a	>1	$4.14	$0.19	$0.00	$9.28	$1.47	$0.81
Maplewood	1b	>1	$0.005	$0.005	$5,000	$0.15	$14.84	$14.33
Grey Cloud Island	1b	>1	$0.08	$0.08	$75,000	$2.10	$18.28	$17.57
Denmark	1b	>1	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Afton	1b	>1	$0.03	$0.02	$18,000	$0.51	$9.49	$9.01
		Totals	**$299**	**$8**	**$236,000**	**$520**	**$71**	**$46**

Notes:

1. The 20-year future value costs were calculated using a 3% inflation rate.

E.4.5 Recommended Options 1-3 – Impacted Municipal Wells

Municipal wells included in the Recommended Options 1, 2, and 3 are listed in Table E.232 below. Communities or wells that are greyed out are either off-line or abandoned. Those wells with a Yes, are included in the scenario. Wells that were included in the initial evaluation due to particle tracking results from the groundwater model were excluded in the particle tracking (PT) columns.

Table E.232. Municipal wells impacted in Recommended Options 1, 2, and 3

	Well No.	Scenario 1 (HI>0.5)		Scenario 2 (HI>0.3)		Scenario 3 (HI>0.5)	
		Original	PT	Original	PT	Original	PT
AFT	N/A						
CTG	1						
CTG	2						
CTG	3	Yes	Yes	Yes	Yes	Yes	Yes
CTG	4	Yes	Yes	Yes	Yes	Yes	Yes
CTG	5	Yes	Yes	Yes	Yes	Yes	Yes
CTG	6	Yes	Yes	Yes	Yes	Yes	Yes
CTG	7	Yes	Yes	Yes	Yes	Yes	Yes
CTG	8	Yes	Yes	Yes	Yes	Yes	Yes
CTG	9	Yes	Yes	Yes	Yes	Yes	Yes
CTG	10	Yes	Yes	Yes	Yes	Yes	Yes
CTG	New W1	Yes	Yes	Yes	Yes	Yes	Yes
CTG	11	Yes		Yes		Yes	
CTG	12					Yes	
DEN	N/A						
GCI	N/A						
LE	2						
LE	4						
LE	5	Yes		Yes			
LE	New W1						
LE	New W2						
LKLD	1						
LKLD	2						
MPL WD	N/A						
NEW	1						
NEW	2						
OAK	1						
OAK	2						
OAK	3						
OAK	5	Yes	Yes	Yes	Yes		
OAK	6						
OAK	7						
OAK	8						

	Well No.	Scenario 1 (HI>0.5)		Scenario 2 (HI>0.3)		Scenario 3 (HI>0.5)	
		Original	PT	Original	PT	Original	PT
OAK	9	Yes	Yes	Yes	Yes		
OAK	10						
OAK	New W1	Yes	Yes	Yes	Yes		
OAK	New W2	Yes	Yes	Yes	Yes		
PIIC	1	Yes	Yes	Yes	Yes	Yes	Yes
SPP	2	Yes	Yes	Yes	Yes	Yes	Yes
SPP	3	Yes	Yes	Yes	Yes	Yes	Yes
SPP	4	Yes	Yes	Yes	Yes	Yes	Yes
WLKD	New W1	Yes	Yes	Yes	Yes	Yes	Yes
WLKD	New W2	Yes	Yes	Yes	Yes	Yes	Yes
WDB	1						
WDB	2	Yes	Yes	Yes	Yes	Yes	Yes
WDB	3	Yes	Yes	Yes	Yes	Yes	Yes
WDB	4	Yes	Yes	Yes	Yes	Yes	Yes
WDB	5	Yes	Yes	Yes	Yes	Yes	Yes
WDB	6	Yes	Yes	Yes	Yes	Yes	Yes
WDB	7	Yes	Yes	Yes	Yes	Yes	Yes
WDB	8	Yes	Yes	Yes	Yes	Yes	Yes
WDB	9	Yes	Yes	Yes	Yes	Yes	Yes
WDB	10	Yes	Yes	Yes	Yes	Yes	Yes
WDB	11	Yes	Yes	Yes	Yes	Yes	Yes
WDB	12	Yes	Yes	Yes	Yes	Yes	Yes
WDB	13	Yes	Yes	Yes	Yes	Yes	Yes
WDB	14	Yes	Yes	Yes	Yes	Yes	Yes
WDB	15						
WDB	16						
WDB	17	Yes	Yes	Yes	Yes	Yes	Yes
WDB	18			Yes	Yes		
WDB	19			Yes	Yes		
WDB	New W1			Yes	Yes		
WDB	New W2			Yes	Yes		
WDB	New W3			Yes	Yes		
WDB	New W4			Yes	Yes		
WDB	New W5			Yes	Yes		
	Total	**35**	**33**	**42**	**40**	**31**	**29**

	Well No.	Scenario 1 (HI>0.5)		Scenario 2 (HI>0.3)		Scenario 3 (HI>0.5)	
		Original	PT	Original	PT	Original	PT

Notes:

1. Wells shaded gray are either taken off-line or abandoned.
2. Columns with PT (particle tracking) do not include wells that were determined to be impacted by the estimated movement of PFAS by the Year 2040. Wells with a Yes are currently impacted or are part of the scenario for areas of known PFAS contamination.
3. Columns without a PT (particle tracking), include wells that are impacted by the estimated movement of PFAS by the Year 2040.

E.4.6 Recommended Options 1-3 – PFAS Water Treatment Plants

Table E.233 presents a summary of the water treatment plants (WTP) included in the Recommended Options.

Table E.233. PFAS water treatment plants included in Recommended Options 1, 2, and 3

Water Treatment Plants (WTP)	New Treatment Capacity (gpm)			Notes
	Recommended Scenario 1	Recommended Scenario 2	Recommended Scenario 3	
Woodbury WTP	9,600	15,600	9,600	
W. Lakeland WTP	680	680	680	
Cottage Grove WTP 1	7,300	7,300	7,300	
Cottage Grove WTP 2	3,200	3,200	3,200	
St. Paul Park WTP	2,200	2,200	2,200	
Oakdale WTP	1,750	1,750		Total capacity is 4,150 gpm, expanding existing by 1,750 gpm
Prairie Island Indian Community WTP	600	600	600	
Subtotal	25,330	31,330	23,580	
Add WTP Capacity for the Woodbury Interconnect to Lake Elmo	2,700	2,700		Add this capacity to Woodbury's new treatment plant above what is shown in the Woodbury WTP row
Total	**28,030**	**34,030**	**23,580**	