Final Water Supply Master Plan Update

City of Guelph

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Executive Summary

ES-1 Background

In 2007, the City of Guelph (City) completed the Water Supply Master Plan (WSMP) project to ensure that the City's water supply continues to meet current and future demands. The 2014 WSMP Update covered a 25-year period from 2013 to 2038 to make it consistent with the current needs of the City. The purpose of the current WSMP Update is to review and revise the 2014 WSMP covering a 30-year period from 2021 to 2051 to align with the Provincial Growth Plan, **A Place to Grow: Growth Plan for the Greater Golden Horseshoe** (amended in August 2020), and the update to the City's Official Plan (in progress). This update will build upon the previous work, review the 2014 WSMP recommendations as well as examine new water supply alternatives in accordance with the Class Environmental Assessment (EA) process for Municipal Water projects, resulting in the listing of recommended water supply projects, including phased implementation schedules and recommended Class EA schedules. Class EA approvals for Schedule "B" and "C" projects can then be conducted by using the Master Plan as a starting point.

The study area for the project includes the area within 5 kilometres of the City boundary as was used as the study area in previous WSMP updates. This area is considered to be a reasonable estimate of a search area for new water that will limit potential effects on adjacent municipalities. It is also based on the practicality of connecting new sources to the City's existing water supply (i.e., costs to transmit water into the City).The study area footprint is similar to, but does not completely overlap with, the City's Wellhead Protection Area for water quantity (WHPA-Q). The WHPA-Q represents the cumulative drawdown of all water takings in the local area of the City water supply system. Further information on the City's WHPA-Q is available in the Tier Three Water Budget and Local Area Risk Assessment report [(https://www.sourcewater.ca/en/source-protection-areas/Guelph-and-Guelph-Eramosa-Tier-3.aspx)](https://www.sourcewater.ca/en/source-protection-areas/Guelph-and-Guelph-Eramosa-Tier-3.aspx).

ES-2 Challenge and Opportunity Statement

Phase 1 of the Class EA planning process requires the proponent of an undertaking to first document factors leading to the conclusion that the

improvement or change is needed, and ultimately, develop a clear statement of the identified problems, deficiencies or opportunities to be investigated. The Challenge and Opportunity Statement for the 2021 WSMP Update was developed through engagement and consultation with the public and stakeholders in the first round of consultation.

> *The City of Guelph is committed to managing population growth as it continues to develop strategies for ensuring adequate water supply. The goal is to develop a reliable and sustainable supply of water to meet the current and future needs of all residential, industrial, commercial and institutional customers.*
>
> *The 2014 WSMP confirmed that the existing water supply capacity will not meet future demands and set out a strategy for meeting future demand. It is, therefore, prudent to undertake an update to the water demand forecast, the existing water system capacity and the status of ongoing projects, in order to review the plan and make adjustments as required.*
>
> *The proposed implementation strategy must deliver, through to 2051, an adequate amount of water in a safe and cost-effective manner and ensure that environmental sustainability is not compromised.*

ES-3 Population and Water Demand Projections

ES-3.1 Population Projections

Population projections are required to determine future water supply requirements. The projections developed for the WSMP Update include the serviced population and employment population within the City. This later category includes the population representative of industrial, commercial and institutional (ICI) land use. The combined total population forms the basis for developing existing and future water demands. Two future population and employment growth scenarios were considered when developing the demand forecasts for the WSMP Update, including the "reference" and "low" growth scenarios from the Province of Ontario's August 28th, 2020 report **A Place to Grow: Growth Plan for the Greater Golden Horseshoe** (P2G). The "reference" growth rate represents the expected rate and was ultimately used to identify the 2051 water supply

demand projections. The population projections from 2021 to 2051, in five-year increments are presented in **Table ES-1**.

Table ES-1: Projected "Reference" Growth Population and Employment Rates

Year	Population	Employment
2021	145,777	84,359
2026	155,314	89,633
2031	164,852	94,906
2036	174,389	100,180
2041	183,926	105,453
2046	193,463	110,727
2051	203,000	116,000

ES-4 Water Demand Projections

Design Basis for Average Day Demands

The basis for projecting demands from the residential and ICI sectors, as well as non-revenue water[1] (NRW), was to apply historical per capita demands to population projections, i.e., representative of per capita demands without the influence of future conservation, efficiency and demand management efforts. This baseline was used to measure the effect of potential future programs and their associated costs against the costs and efforts to provide new water supply.

The baseline demand for the residential and ICI sectors considered historical customer demand and analysis of recent trends from the 2010-2019 period. It was evaluated that, while per capita water production and demand rates in litres per capita per day[2] (Lcd) have declined since 2010, the rate of decline was lower between 2015 to 2019 than it was from 2010 to 2015. The per capita NRW rates fluctuated through the review period; however, the 2019 rates are very similar to the rates in 2010. This observation suggests that future per capita customer water demand declines associated with

1. Non-Revenue Water - The difference in water consumed by customers as measured directly through utility billings and that which is pumped at water facilities to the water distribution system. This includes water that is lost from the distribution system through leakage, flows used in fire fighting, watermain flushing and other losses.
2. Litres per capita per day – the amount of water each person in the City uses on a daily basis.

conservation, efficiency and demand management programming and natural water savings may be more difficult to achieve moving forward.

To be conservative when projecting water demand rates to 2051, the average per capita residential, employment, and NRW demand rates between 2015 and 2019 were applied to the years 2020 to 2051. This means that the projected demands assume that further reductions in Lcd customer demands will not occur. The values used in the projection analysis are as follows:

- Average per capita residential demand rate: 167 Lcd
- Average per capita employment demand rate: 191 Lcd
- Average per capita NRW demand rate: 61 Lcd

Design Basis for Maximum Day Demand

The Maximum Day Factor (MDF) for a water system is generally defined as the ratio between the water production rate on the highest single production day each year (maximum day) and the average day production rate for the entire year, after removing extreme anomalous events. The average MDF in Guelph between 2010 and 2019 was 1.24 and the highest ratio of 1.34 occurred in 2011. To be conservative, a MDF of 1.34 was used when projecting future maximum day water demands in Guelph.

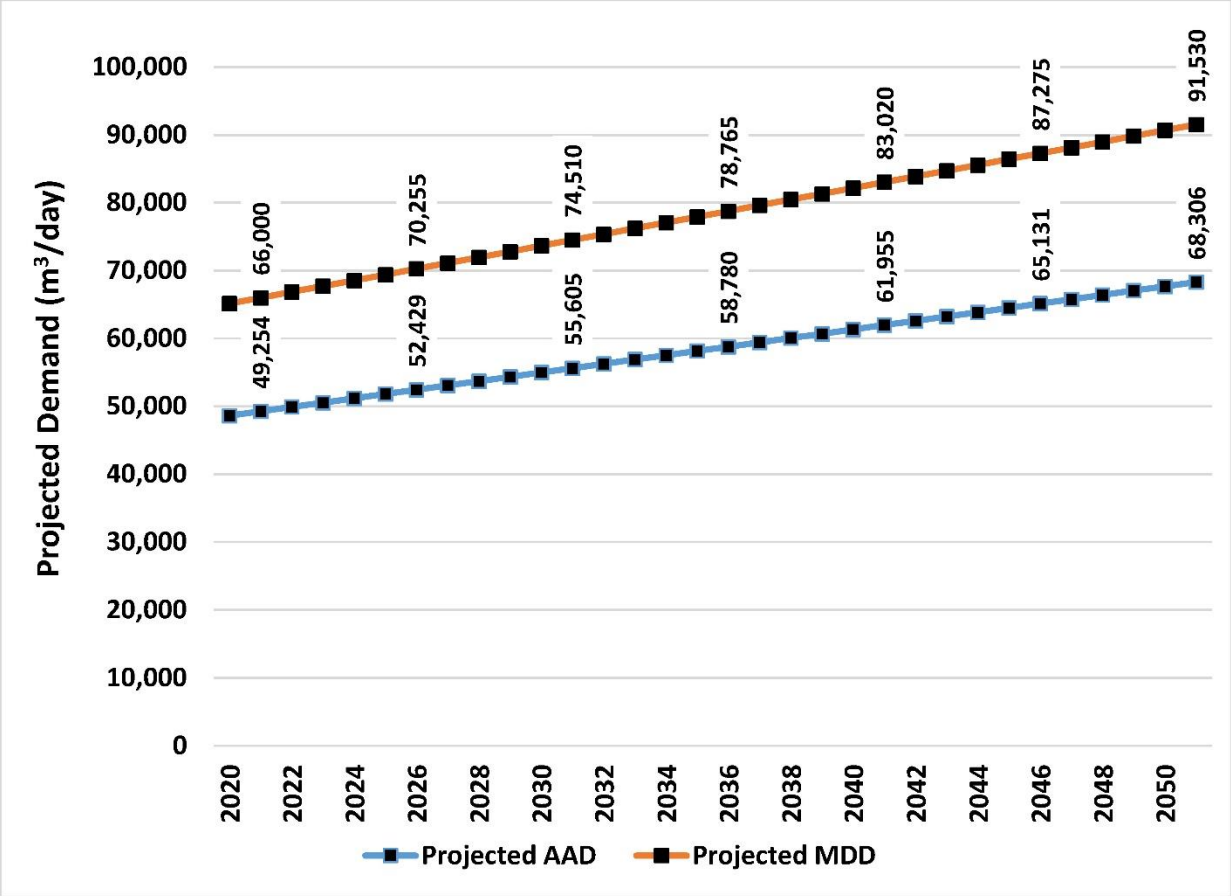
Projected 2051 Water Supply Requirements

Table ES-2 and **Figure ES-1** present the projected average annual day and maximum day water demand from 2021 to 2051, based on the design per capita demands. These estimates represent the projected total demand rates on an average annual and maximum day for each year in the planning period (i.e., combined residential, ICI and NRW demands).

Table ES-2: Total Projected Average Annual Day and Maximum Day Water Demands – Reference Growth Scenario

Demand	2021	2026	2031	2036	2041	2046	2051
Average Annual Day Demand (AAD) (m^3/day)	49,254	52,429	55,605	58,780	61,955	65,131	68,306
Maximum Day Demand (MDD) using MDF of 1.34 (m^3/day)	66,000	70,255	74,510	78,765	83,020	87,275	91,530

Figure ES-1: Total Projected Average Annual Day and Maximum Day Water Demands – Reference Growth Scenario



ES-5 Existing Water Supply System Capacity Assessment

The City relies almost exclusively on groundwater to meet customer water demands. The groundwater supply system comprises 25 drilled wells screened within overburden and shallow and deep bedrock aquifers, as well as one groundwater collection system.

A detailed assessment of the capacity of the existing water supply system was completed to determine: the current maximum capacity for each individual groundwater supply source; any constraints to operating at the maximum; the total sustainable capacity of the groundwater supply system; and an evaluation of potential risks to system operation and the vulnerability of the identified sustainable capacity from a hydrogeological and operational perspective (i.e., the Security of Supply).

Evaluation of the system was completed with reference to the four quadrants of the City for the purposes of assessment: Southeast, Southwest, Northeast and Northwest. Historical records (from 1997 through 2019) for each groundwater supply source and quadrant provided the daily pumping total, the monthly average of the daily pumping total, observed groundwater elevation, the Ministry of the Environment, Conservation and Parks (MECP) permitted rate and maximum pumping elevations. Based on a review of these data, the capacity of each supply well and the collector system was re-evaluated relative to the 2014 WSMP.

The identified maximum capacity of the existing system is interpreted to be approximately 79,422 m^3/day. This estimate reflects normal operating conditions (i.e., non-drought conditions), and recognizes interference effects amongst the groundwater supply sources, as well as other interferences such as that from dewatering of the Dolime Quarry. This represents a decrease of 4,414 m^3/day, relative to the maximum system capacity reported within the 2014 WSMP. The results are presented in **Table ES-3**, along with an explanation of the capacity values that have changed from the 2014 assessment.

Table ES-3: Updated Capacity Assessment Summary – City of Guelph Groundwater Supply Active Sources

City Quadrant	Groundwater Supply Source	2014 WSMP (m^3/day)	WSMP Update (m^3/day)	Comments on Updated Capacity
Southeast	Arkell Well 1	2,000	2,000	Unchanged
Southeast	Arkell Well 6	28,800	28,800	Unchanged
Southeast	Arkell Well 7	-[b]	-[b]	Unchanged
Southeast	Arkell Well 8	-	-	Unchanged
Southeast	Arkell Well 14	-	-	Unchanged
Southeast	Arkell Well 15	-	-	Unchanged
Southeast	Glen Collector	6,900	5,100	Decreased to reflect available capacity with artificial recharge system inactive
Southeast	Burke Well	6,500	6,500	Unchanged
Southeast	Carter Well 1	5,500[c]	5,184[c]	Decreased by 316 m^3/day based on uncertainty of potential effects on Torrance Creek
Southeast	Carter Well 2	-[c]	-[c]	-

City Quadrant	Groundwater Supply Source	2014 WSMP (m^3/day)	WSMP Update (m^3/day)	Comments on Updated Capacity
Southwest	Membro/Rocco	6,000	5,200	Decreased by 800 m^3/day based on preliminary OTP results
Southwest	Water Street Well	2,700	1,901	Decreased by 799 m^3/day based on well field testing that evaluated mutual interference with Membro site
Southwest	Dean Well	1,500	1,500	Unchanged
Southwest	University Well	2,500	2,500	Unchanged
Southwest	Downey Well	5,236	5,237	Unchanged
Northeast	Park Well 1	8,000[d]	8,000[d]	Unchanged
Northeast	Park Well 2	-[d]	-[d]	
Northeast	Emma Well	2,800	2,800	Unchanged
Northeast	Helmar Well	1,500	800	Decreased by 700 m^3/day based on performance record, rehabilitation results and interference drawdown.
Northwest	Paisley Well	1,400	1,400	Unchanged
Northwest	Calico Well	1,400	1,400	Unchanged[a]
Northwest	Queensdale Well	1,100	1,100	Unchanged
Total	**-**	**83,836**	**79,422**	**-**

Notes:
a) Capacity is total for site (Membro Well and Membro Replacement Well)
b) 28,800 m^3/day is the total daily capacity of the Arkell bedrock wells (Wells 6,7, 8, 14, and 15).
c) Total daily capacity of Carter Well 1 and 3.
d) 8,000 m^3/day is the total daily capacity of Park Well 1 and 2.
e) Capacity increased by 1 m^3/day to match PTTW No. 8468-BCVQAN
f) Well is currently off-line due to casing failure, assigned value represents capacity for the site.

The security of supply assessment considered a series of potential risks to the system including drought conditions, loss of a well (i.e., a contamination event, equipment failure, structural failure, etc.), regulatory permitting changes, and risks to the well facilities and distribution system. These results indicate that that City should continue on-going monitoring of available system capacity, with the objective of maintaining a system redundancy of 15%. With respect to the existing system, 15% of the existing available water supply system capacity should continue to be reserved for servicing of existing customers (i.e., not available for future growth).

ES-6 Water Supply Alternatives

The 2014 WSMP implementation plan set out a strategy for the City to investigate and execute the necessary steps to optimize existing and develop new water supplies, with a focus on local sustainability. As part of the initial WSMP, City Council provided direction in 2003 "That the focus of the WSMP establish a sustainable water supply to regulate future growth". Public response to the 2007 WSMP helped shape the definition of local sustainability to refer to available local water supplies, which included local groundwater and surface water sources.

The utmost importance was placed on water conservation and as a result, the City has become a renowned leader in water conservation, efficiency and demand management in Canada. The City's Official Plan calls for the WSMP to "develop programs and policies to conserve water and to reduce requirements for additional water supply and treatment, including the implementation of the Water Conservation Efficiency Strategy". It is the aim of this update to document demand reductions achieved to date, and to determine feasible reduction strategies and goals moving forward for comparison to other water supply alternatives.

Public feedback in 2007 and 2014 indicated that the City first examine groundwater supply opportunities within the City's boundaries in order to minimize potential effects on its neighbours. As a result, the City has since implemented a number of programs and studies to maintain and optimize existing supply facilities within the City and in areas of existing municipal well supply infrastructure, including (since 2014):

- Completed construction of new well facilities (Arkell 14 and 15) and completed the Arkell Adaptive Management Plan and Operational Testing Program;
- Upgrades to the Arkell artificial groundwater recharge system;
- Completed upgrades to the existing Burke Well facility, including iron and manganese treatment;
- Class EA for a Clythe Well water treatment facility (existing, off-line well);
- Replacement well on the Membro site, referred to as the Membro Replacement Well or the Rocco Well; and

- Through mediation with the Dolime Quarry owner, identified a potential solution to address the City's concerns about how operations at the quarry could affect local groundwater.

Also included in the short- to mid-term implementation strategy was the initiation of various hydrogeological investigations inside the City and just outside the City's boundaries to explore the potential for new water supplies in these areas. These include the Guelph South Groundwater Supply Investigation (on-going) and the Southwest Guelph Water Supply Class EA to evaluate additional water supply sources within southwest Guelph, including a long-term Operational Testing Program at the Dolime Quarry and surrounding existing municipal wells (on-going).

In addition to the above initiatives, the City has completed the following regional studies and plans to ensure the protection and long-term sustainability of the existing water supply system:

- The Guelph and Guelph/Eramosa Township Tier Three Water Budget and Local Area Risk Assessment (Tier Three Study) was completed to evaluate the sustainability of the City's water supply system from a quantity perspective and to identify potential threats to that sustainability (Matrix Solutions Inc., 2017). This study and the Tier Three Groundwater Flow model (Tier Three Model) of Guelph's municipal aquifer system (in and outside the City) provide invaluable insights into reviewing the current water supply system and its reliability now and into the future. It is also referenced herein in determining the feasibility of new water supplies from both a potential capacity and environmental effect perspective.
- A Threats Management Strategy was developed to address the results of the Tier Three Study and guide the development of associated water quantity policies.
- The Grand River Source Protection Plan was developed within a watershed context to identify and evaluate potential water quality threats to the municipal supply system. This process also included the development of policies to protect existing and future drinking water sources from unwanted impacts and harmful contaminants. At this time, the City is currently working on updates to the plan

and development of policies to address the potential water quantity impacts.

The objective of the WSMP Update is to continue to ensure that the City can provide an adequate, safe and sustainable supply of water to meet the current and future needs of all customers over the next 30 years (i.e., to 2051). The water supply demand forecast, and the existing water supply system capacity assessment concluded that under a "do nothing" scenario with continued growth, in 2051, the City would require an additional water supply capacity of approximately 26,000 m^3/day to satisfy maximum day demand with an additional 15% allowance for security of supply.

The following alternatives are evaluated with respect to their capability to contribute to the total water supply solution. It is acknowledged that each does not address the challenge and opportunity statement as a stand-alone alternative. Therefore, each alternative is discussed and evaluated on its own merit as part of the total solution.

ES-6.1 Water Conservation, Efficiency and Demand Management

Based on past success and public support, it is anticipated that water conservation, efficiency and demand management will continue to form part of the preferred sustainable water supply solution (via reductions in water demand) in the future. Four scenarios are developed to consider the potential reductions associated with various combinations of initiatives in order to set a reasonable and publicly supported reduction target, as follows:

Scenario 1: No further reductions - ceasing non-provincially mandated water efficiency measures (baseline scenario)

Scenario 2: Potential reduction through maintaining a level of programming similar to the current water conservation, efficiency and demand management program

Scenario 3: Potential reduction through a focus on high water use customers

Scenario 4: Potential reduction through a focus on the current level of programming *and* water reuse initiatives

A summary of potential reclaimed water supply capacity and costs associated with each scenario is included in **Table ES-4**. Also included in this table is a blended scenario (Scenario 5) that was recommended through the assessment of alternatives step. Scenario 5 considers the modification of programming through the planning period (2021 to 2051) in response to successfully achieving demand reductions under Scenario 2 in the short-term and subsequently shifting the focus of programming as described in Scenarios 3 and 4 in the mid- and long-term, respectively.

Table ES-4: Summary of Potential Savings and Program Cost Estimates for Each Scenario

Scenario	Projected Reduction in Average Annual Day Demand (m^3/day)	Estimated Program Cost (million $)	Estimated Average Annual Cost ($)	Capital Cost per m^3/day ($)	Life Cycle Cost* – Cost per m^3 avoided ($)
1	-	-	-	-	-
2	4,424	11.41	380,000	2,600	0.53
3	2,220	4.73	157,670	2,100	0.44
4	4,952	15.04	501,333	3,000	0.62
5^	3,683	8.99	299,792	2,400	0.50

Notes: * Life cycle cost is the cost per m^3 of avoided capacity over a 20-year period.
^Blended scenario.

The above water conservation, efficiency and demand management scenarios were developed and reviewed to demonstrate the range of potential savings and associated costs of various combinations of programs, for discussion through public consultation. Implementation of the scenarios would be further developed through future updates to the City's Water Efficiency Strategy.

ES-6.2 Expand Existing Groundwater Supply System

The approach undertaken in investigating opportunities for optimizing the City's existing groundwater supplies and developing new sources followed direction provided through the previous WSMP consultation processes (2007 and 2014 update). Public response clearly indicated that the City should consider groundwater opportunities within its municipal boundaries prior to exploring beyond. As noted in the 2014 WSMP, the development of new water supply sources in the surrounding Townships (Guelph/Eramosa and Puslinch) would require concurrence of both the respective Township and the

County of Wellington. In this update, consistent with previous plans, potential groundwater sources outside of the City boundaries are limited to a distance of approximately 5 km. This parameter was initially determined with consideration to limiting potential effects on surrounding municipalities, as well as the practicality of connecting to the City's existing water distribution system.

The first step in the evaluation of groundwater sources was to review the potential sources on a City quadrant basis and identify those that could potentially provide additional capacity. The potential groundwater opportunities for expansion of the existing supply system are grouped into the alternatives below, following the order established in the 2014 WSMP:

- Alternative 2A - Optimize existing municipal sources
- Alternative 2B - Restore off-line municipal sources
- Alternative 2C/D - Develop municipal test wells (includes Dolime Quarry)
- Alternative 2E - Develop new sources inside City
- Alternative 2F - Install new Aquifer Storage and Recovery wells inside City to optimize excess Arkell Collector system volumes
- Alternative 2G - Develop new wells outside City

A summary of potential new water supplies within each Alternative is provided below.

Optimize Existing Municipal Sources

An extensive assessment of existing municipal production wells was undertaken to determine sustainable concurrent water takings from all supplies, and to identify wells where upgrades and/or modifications could be considered to improve the well performance, water quality and general security of the source. The only well identified as possibly having more capacity available as compared to its current Permit to Take Water (PTTW) is the Downey Well which could potentially pump at a rate 5,700 m^3/day. The potential for increasing the capacity of the Downey Well will be reviewed within the ongoing Southwest Guelph Water Supply Class EA.

Restore Off-line Municipal Sources

This alternative includes wells that are permitted by MECP but where the City has discontinued their use due to concerns regarding existing water quality issues. In general, these wells require upgrades for water quality treatment and to provide the required disinfection contact time. The primary method for evaluating the potential sustainable capacity associated with each source was use of the Tier Three Model. The following sections outline the potential additional capacity available from off-line sources within each City quadrant.

Southeast Quadrant – Lower Road Collector

A review of historical collector production indicates that the Lower Road Collector produced between 600 and 6,000 m^3/day. The collector has been off-line for two decades and would require a full re-build to return to service. The Tier Three Model assessment indicated that a re-built collector could add 4,000 m^3/day to the current minimum collector output.

Coordination with the on-going Water and Wastewater Servicing Master Plan indicates that the City's F.M. Woods Ultraviolet (UV) system has sufficient capacity for the total flows from Arkell. Limitations, that may be partially addressed through infrastructure upgrades, have been identified for flow rates associated with the combined maximum capacity of the Arkell wells and collector PTTW maximum flows (C3, 2018).

The Arkell Collectors are located near the Eramosa River and Eramosa River Blue Springs Creek Provincially Significant Wetland complex. As this is a previously permitted water source and an increase to the PTTW maximum[3] for the system is not being proposed, it is not anticipated that future operation of the Lower Road Collector would cause an impact to the natural environment. As the system has been offline since 2000, a review of existing conditions would be required to confirm this interpretation.

Northeast Quadrant – Clythe Well

The modelling assessment estimated a sustainable capacity for the Clythe Well with consideration of potential effects on the natural environment. The

3. The Glen and Lower Road Collectors are included on a single PTTW with a maximum permitted flow rate of 25,000 m^3/day.

well is located near Clythe Creek and the Clythe Creek Provincially Significant Wetland (PSW) and under long-term pumping conditions the modelling assessment indicated the potential for a greater than 10% baseflow reduction to Clythe Creek. Although the creek has historically been identified as a coldwater feature, current temperature monitoring suggests that the middle and lower reaches of the creek, in the vicinity of this well, are no longer coldwater. With respect to the modelling results, the Tier Three Study (Matrix, 2017) noted that insufficient data were available to calibrate the model to shallow conditions locally. As such, the results presented herein should be considered preliminary and further evaluated along with future field data. Evaluation of the Clythe Well alternative cost is based on the upper range of the steady-state modelled capacity of 1,180 m^3/day and the field-tested rate of 3,370 m^3/day (**Table ES-5**).

Northwest Quadrant - Sacco and Smallfield Wells

The modelling assessment estimated a sustainable additional capacity for the NWQ of 1,275 m^3/day, which would include pumping from Sacco, Smallfield and Hauser. Testing completed by the City in 2009 (Stantec, 2009) has demonstrated a capacity of 1,150 m^3/day for the Sacco Well and 1,408 m^3/day for the Smallfield Well. Additional capacity developed from these wells would contribute to system redundancy. Evaluation of the costs associated with re-instating these wells is based on the full potential capacity of 2,560 m^3/day (**Table ES-5**).

The Smallfield Well and to a lesser extent, the Sacco Well are impacted by Volatile Organic Contaminants (VOCs) within the aquifer. There has been a lack of action remediating these sources, going back to 1994 when the issue first affected the wells. As such, there remains great uncertainty and risk for the City in the design of a treatment system with respect to the maximum raw water contaminant concentrations, the concentration trend with time, the duration of treatment, and the potential liability of pulling contaminated groundwater across areas which are not yet impacted. To that end, the City is proposing to defer re-instating these already permitted water supply sources through the update of the WSMP until such time as the sources of groundwater contamination in the area have been remediated. However, these wells should remain as part of the WSMP as future drinking water sources (i.e., post-2051, or until source remediation occurs).

Develop Existing Municipal Test Wells

An extensive review and assessment of existing municipal test wells was undertaken to determine potential well yields and water quality treatment requirements. The following sections outline the potential additional capacity available from test wells within each City quadrant.

Southwest Quadrant – Steffler, Ironwood, and Guelph South

The Tier Three Model assessment concluded that these wells could contribute an additional capacity of 4,500 m^3/day to the overall system capacity under current quarry dewatering conditions. These wells have demonstrated individual well capacities above this combined capacity of 3,600, 8,000, and 4,320 m^3/day for Steffler, Ironwood and Guelph South, respectively. Therefore, additional capacity developed from these wells would contribute to system redundancy. Baseflow reduction of >10% was simulated using the Tier Three Model for Hanlon and Irish Creeks, although there is uncertainty with the results for Irish Creek due to its proximity to the model boundary. These test wells will be further assessed through a detailed Operational Testing Program being completed for the Southwest Guelph Water Supply Class EA, including monitoring of surface water features for baseflow reductions. The cost estimates for these test wells are presented in and are based on the noted individual well capacities of 3,600, 8,000, and 4,320 m^3/day for Steffler, Ironwood and Guelph South, respectively (**Table ES-5**).

Dolime Quarry

Significant dewatering occurs within the Dolime Quarry on an on-going basis to maintain the water level within the quarry pond (i.e., to prevent flooding of the quarry). Recent dewatering rates, as reported by the quarry owners (River Valley Developments Inc.), have typically ranged from 8,000 to 11,000 m^3/day. The agreement in place between the City and RVD includes, in part, the City assuming control of water management, thereby controlling the groundwater elevation within the quarry at a level below the surrounding area, resulting in groundwater inflow to the quarry pond (via a hydraulic gradient). This strategy will be evaluated as a potential alternative within the on-going Southwest Guelph Water Supply Class EA. Through this process, the City will determine the pumped flow from the quarry necessary to protect the water supply and, subject to the technical assessment process,

the Class EA may consider the feasibility of an additional alternative of capturing groundwater directly from the quarry as a potential future source. The groundwater modelling assessment reported daily groundwater discharge to the quarry that ranged from approximately 3,400 to 6,100 m^3/day. Acknowledging the uncertainty in assigning a potential volume that could be available from the quarry under Pond Level Management, a conservative range of 1,000 to 3,000 m^3/day was carried forward for costing and evaluation purposes. The cost estimate for the Dolime Quarry water treatment facility, provided in **Table ES-5**, is based on a capacity of 3,000 m^3/day. The cost for a full-scale water treatment facility is high and will be refined through the Southwest Guelph Water Supply Class EA and associated Operational Testing Program.

Northeast Quadrant – Logan and Fleming

The Tier Three Model assessment concluded that these wells could contribute an additional capacity of 4,180 m^3/day, similar to the 2014 WSMP result of 4,700 m^3/day. The City has initiated a project to reconstruct the Logan Test Well to target the Gasport aquifer by drilling out the existing borehole to below the Vinemount Member (regional aquitard) and installing a new casing. This project will include an assessment of potential effects on surrounding private wells and the natural environment. Consultation with Guelph/Eramosa Township will be required to develop the Logan supply. The cost estimate presented in **Table ES-5** is based on a capacity of 4,700 m^3/day.

Northwest Quadrant – Hauser

The modelling assessment estimated a sustainable additional capacity for the NWQ of 1,275 m^3/day, which would include pumping from Sacco, Smallfield and Hauser. The estimated capacity of a well at this site is approximately 900 m^3/day; however, this requires significant study for verification. Additional studies would be required to determine if water quality impacts would occur from long-term pumping due to known contaminated sites in the Smallfield Well area located 2.2 km to the northeast. Future work should also focus on potential effects on the local natural environment, which includes Ellis/ Chilligo Creek and the Ellis Creek PSW Complex. The cost estimate is presented in **Table ES-5** and reflects a capacity of 900 m^3/day.

Develop New Sources Inside City

Two locations in the SEQ and one location in the NWQ for potential new wells were evaluated on a preliminary basis but were not carried forward to the detailed evaluation of alternatives. The modelling output suggested that any new wells would reduce the capacity of existing municipal wells, resulting in little to no net capacity increase.

Install new ASR wells inside City for Excess Arkell Flows

This alternative consists of capturing and treating a portion of the excess flow available from the Arkell collector systems, when it is not required to meet customer demands, and storing it underground in aquifers for recovery when demands are higher. This option is referred to as an aquifer storage recovery (ASR) system. Based on the completed modelling assessment, the estimated excess flow available from the collectors for ASR, on a monthly basis, was 451,000 m^3. The aquifer injection and recovery system was simulated with six ASR wells located within the Guelph Innovation District Lands. The modelling output suggests that the ASR wells should be operated at 60% of the target withdrawal rates tested in the model, while the existing municipal wells are operated at baseline rates (i.e., system total of 53,551 m^3/day). These were the rates identified to accomplish withdrawal at the ASR wells, while allowing the existing municipal wells to continue operating sustainably.

The modelling output further indicated that with optimization of ASR well locations, higher volumes could be extracted. Further evaluation to optimize the efficiency of the system is recommended should the City wish to pursue ASR as a future water supply option. It is recommended that additional work focus on the potential to site ASR wells that maximize the ability for existing municipal wells to form part of this alternative, thereby greatly reducing the associated cost.

With an optimized strategy, a net zero injection/ withdrawal water balance would be achieved and significant interference effects on existing groundwater dependent natural features or users are not anticipated.

The total potential additional system capacity from the Arkell ASR is 1,170 m^3/day (in consideration of the 60% withdrawal constraint). With optimization of both the artificial recharge system and the injection/

withdrawal strategy, it is anticipated that additional capacity is possible. The cost estimate for capital works for preliminary investigations, and design, land acquisition where required, construction of new wells, dechlorination and rechlorination systems, and approvals is provided in **Table ES-5**. The total cost presented is very high in comparison to other water supply alternatives and illustrates the need to further develop this alternative through an optimization strategy that maximizes the capacity available through ASR, minimizes the number of new ASR wells required for the system and utilizes existing municipal supply wells as part of the injection/withdrawal process.

Develop New Sources Outside City

Guelph Southeast

A potential test well area, located southeast of the City (east of Victoria Road, on Maltby Road) within the Mill Creek catchment area was modelled in the completed assessment. The estimated available sustainable capacity of a modelled groundwater supply well in this general area is 1,600 m^3/day on an average basis with a low potential for effects on baseflow within Mill Creek. The cost estimate for the Guelph Southeast Well is included in **Table ES-5** and is based on the modelled capacity value of 1,600 m^3/day.

Guelph North

A second potential test well area, located north of the City (the western limit of Conservation Road) within the Marden Creek catchment area was modelled in the completed assessment. The estimated available sustainable capacity of a modelled groundwater supply well in this general area is 2,935 m^3/day on an average basis. A baseflow reduction greater than 10% was modelled for Marden Creek.

Future work associated with the Guelph Southeast and North locations would require a detailed assessment of potential effects on surrounding private wells and the natural environment after specific potential well locations are identified. As these well areas are located outside of the City, there is a higher density of active private wells. New property would be required for test wells and future well facilities. Consultation and collaboration with Puslinch Township (Southeast) and Guelph/Eramosa Township (North) would be required in advance of initiating these projects.

The cost estimate for this alternative is included in **Table ES-5** and is based on a capacity of 2,935 m^3/day.

Summary

Table ES-5 summarizes, for all groundwater alternatives, the cost estimate for capital works for preliminary investigations, design, land acquisition (where required), construction of new wells and treatment systems, and approvals. In addition to the capital costs, operating and maintenance costs were also estimated including labour and energy costs.

Table ES-5: Summary of Potential Capacity and Cost Estimates for Each Groundwater Alternative

Alternative Name	Alternative Category	Potential Capacity Range (m^3/day)	Estimated Cost	Cost per m^3/day
Clythe Well	Off-line source	1,180 – 3,370	$6,781,000	$2,012
Smallfield/Sacco Wells	Off-line source	850 – 2,560	$13,116,000	$5,127
Lower Road Collector	Off-line source	4,000	$13,874,000	$3,469
Fleming/ Logan Well	Test well	4,180 – 4,700	$10,103,000	$2,150
Guelph South Well	Test well	2,250 – 4,320	$4,800,000	$1,111
Steffler Well	Test well	2,250 – 3,600	$6,194,000	$1,721
Ironwood Well	Test well	2,250 – 8,000	$5,125,000	$640
Hauser Well	Test well	425 - 900	$5,832,000	$6,480
Dolime	Test well	1,000 - 3,000	$18,976,440	$6,325
Arkell ASR	ASR	1,170	$25,284,000	$21,610
Guelph SE	Well outside City	1,600	$6,862,000	$4,289
Guelph N	Well outside City	2,935	$12,841,000	$4,375

ES-6.3 Establish New Local Surface Water Supply

Two local surface water sources were assessed as potential supply on a continuous or seasonal basis, including the Speed River (at Guelph Lake) and the Eramosa River (at the Arkell Spring Grounds). Surface water must either be treated to provide a continuous flow into the distribution system, or alternatively, volumes of water can be used within an ASR system, as described for the Arkell site. The supply capacity available from this source on a continuous basis is equal to the volume taken from surface water when available and treated and injected, and then removed over the period of a full year.

For both continuous flow and ASR approaches, construction of a water treatment plant (WTP) is required to fully treat the surface water to meet Ontario Drinking Water Quality Standards. In the first option, the WTP is sized to treat a continuous input to the plant with direct discharge to the City's distribution system. In the second option, the WTP would be required to treat varying flows ranging from the continuous flow requirement to the maximum design capacity based on high seasonal river flows.

To evaluate potential quantity available through this alternative, the Grand River Conservation Authority (GRCA) provided their expert opinion on this managed watershed. It was determined that only the Guelph Lake option provided a reasonable surface water alternative for continuous and seasonal flows. Through this evaluation, a base level water taking was established which would be available year-round, while maintaining minimum river flows and minimizing potential environmental effects associated with reducing total river flows. The GRCA also reviewed historical records to establish reliability of taking additional volumes during times of higher river flows.

Historical water quality information for the Speed River was referenced to determine treatment processes required to achieve drinking water quality. Conventional treatment is proposed with treatment for taste and odour on a seasonal basis, as necessary. The proposed WTP has been sized to accommodate the following alternatives at Guelph Lake:

- continuous taking of 150 L/s (12,960 m^3/day) – Municipal Base Taking
- maximum taking of 300 L/s (25,920 m^3/day) – ASR option

The total increase in potential quantity available from surface water treatment and ASR systems based on after treatment flows is 25,825 m^3/day (i.e., a continuous taking from Guelph Lake of 150 L/s and a step taking of 300 L/s with a 5% loss at the WTP). This can be viewed as two alternatives, the first being a continuous surface WTP, and the second an expansion to the WTP and development of the ASR well system. Similar to the Arkell ASR evaluation, the modelling output suggests that the ASR wells should be operated at 60% of the target withdrawal rates tested in the model. Further evaluation to optimize the efficiency of the system is recommended should the City wish to pursue ASR as a future water supply option.

Table ES-6 summarizes the cost estimate for implementation of the two surface water alternatives.

Table ES-6: Cost Estimate for Guelph Lake Surface Water Alternatives

Item Description	WTP	WTP + ASR
Potential Capacity (m^3/day)*	**12,312**	**25,825**
Estimated Cost	**$51,322,000**	**$57,283,000**
Cost per m^3/day	**$4,168**	**$4,239^**

Notes: * Values assume that 5% of raw water is lost during treatment process.
^ Cost to increase WTP capacity from 12,312 to 25,825

ES-7 Environmental Assessment Process

Evaluation criteria were developed based on the environmental components that address the broad definition of the environment described in the Environmental Assessment Act, as summarized in **Table ES-7**. The criteria were refined through the project consultation and engagement process.

Table ES-7: Evaluation Criteria Components Summary

Component	Criteria
Effect on Indigenous values, culture, and Traditional use	■ An evaluation of the effect on Indigenous values, culture, and Traditional use. Key themes shared with the Project Team that help guide the evaluation include: – valuing and respecting the agency of water – understanding the spirit and personhood of water, – good stewardship of the connected ecosystem including protection of water's pureness, – consideration of First Nations, Métis and Inuit Peoples culture and worldview in aspects of the evaluation.
Technical Considerations	■ Constructability ■ Potential productivity and reliability ■ Water treatment requirements ■ Approval requirements
Natural Environmental	■ Effect of construction and operation on aquatic and terrestrial species and habitat ■ Effect on surface water quantity and quality
Built Environment	■ Effect on existing and/or planned residences, businesses, community, institutional or recreational facilities ■ Effect on private and municipal wells

Component	Criteria
Social/Cultural Environment	■ Ability to meet municipal and provincial growth targets ■ Public acceptance ■ Effect of noise/vibration on sensitive receptors ■ Effect on cultural heritage landscapes and built heritage resources ■ Effect on potential archaeological resources
Legal/Jurisdictional Considerations	■ Location inside versus outside of City boundaries
Financial Considerations	■ Estimated capital costs; capital cost per capacity ■ Estimated operation and maintenance costs ■ Life cycle cost (per volume produced)

Each potential alternative was assessed using a consistent approach and evaluation criteria along with specific indicators for each. The evaluation was qualitative – not a numerical ranking system – and considered the suitability of the identified alternative solutions and strategies based on significant advantages and disadvantages. The summary evaluation tables (included within the report) provide an overall recommendation for each of the alternatives which can be compared to the other alternatives. This provides a means to rank the alternatives to allow for incorporation into an implementation plan to meet the water supply requirement to 2051. The alternatives are listed in **Table ES-8** in order of the priority as determined by the summary outputs:

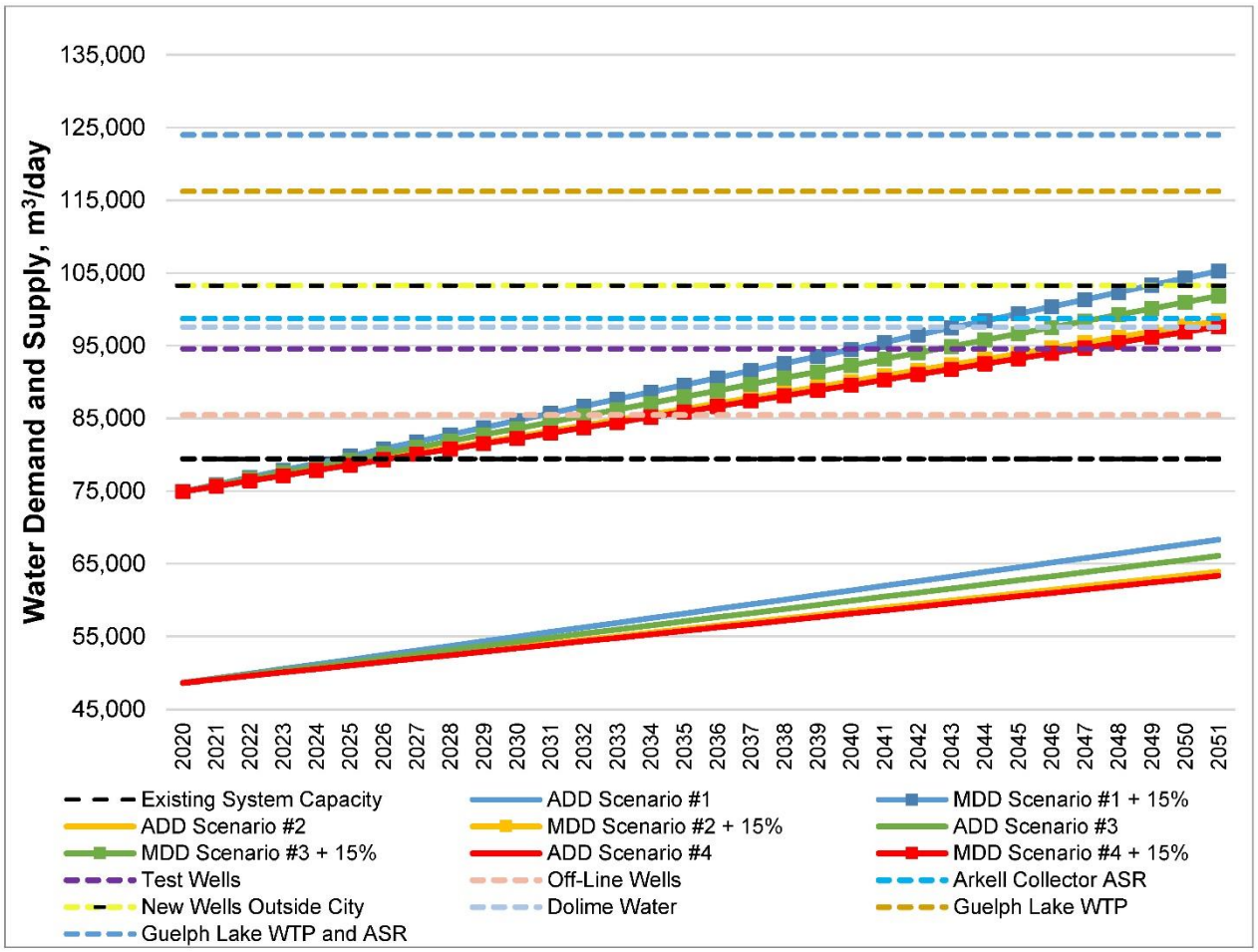
Table ES-8: Summary of Evaluation Outputs

Alternative	Result	Comments
1A – Conservation, Efficiency & Demand Management	Part of preferred solution – high priority	Strong public support for continued programming; strategy must be adjusted through planning period in response to performance; target reduction explored further through financial analysis
2B – Groundwater: Restore Off-line Municipal Wells	Part of preferred solution – high priority	Support for restoring capacity within the City; order of implementation to be determined by the City with consideration for regulatory, treatment, financial constraints. Timeline for Smallfield/Sacco wells uncertain, not currently feasible.
2C/D – Groundwater:	Part of preferred solution – high priority	Support for pursuing test wells within City/on City property; order of implementation to be determined by the

Alternative	Result	Comments
Develop Municipal Test Wells		City with consideration for regulatory, treatment, financial constraints. Assessment of groundwater quality within NWQ required prior to pursuing Hauser site.
2F – Groundwater: Arkell Collectors & ASR Wells	Part of preferred solution – medium priority	ASR alternative requires additional feasibility investigation with respect to Eramosa River PTTW optimization; water volumes available via collector systems; optimization of ASR configuration; option of changing existing well permits to allow for flexible takings
2G – Groundwater: Develop New Wells Outside City	Part of preferred solution – low priority	Incorporates Townships' staff and public response to maximize water takings inside the City before pursuing wells in the Townships
3A – Surface water: Guelph Lake Water Treatment Plant	Part of preferred solution – low priority	While this alternative is not required to provide water supply within the study period (with continued conservation, efficiency and demand management programming) the City will track timeline to determine 10-year lead-in required prior to implementation; Speed River/Guelph Lake water taking requires GRCA policy approvals
3B – Surface water: Guelph Lake Water Treatment Plant & ASR Wells	Part of preferred solution – low priority	While this alternative is not required to provide water supply within the study period (with continued conservation, efficiency and demand management programming) the City will track timeline to determine 10-year lead-in required prior to implementation; Speed River/Guelph Lake water taking requires GRCA policy approvals
Limit Growth	Not preferred	This alternative does not meet the Study Challenge and Opportunity Statement and contravenes the Provincial growth targets
Do Nothing	Not preferred	This alternative does not meet the Study Challenge and Opportunity Statement and contravenes the Provincial growth targets

Figure ES-2 compares the implementation of all of the water supply alternatives to the water demand curve with and without conservation programming to 2051. It can be seen that with conservation programming, new wells outside of the City and the Guelph Lake surface water alternative may not be required prior to 2051. As there is uncertainty about the water supply capacity that each potential source will yield, as the City progresses with implementation of the projects, the water supply deficit will subsequently be evaluated, and the implementation plan will be revised as necessary. This process may result in additional projects falling outside of the planning period.

Figure ES-2: Water Demand Projection with All Water Supply Alternatives



ES-8 Engagement and Consultation

Community input is an essential part of the WSMP Update process. People care about where their water comes from, and they want to see a safe and sustainable supply maintained for present and future generations, and Guelph residents, agencies, stakeholders and Indigenous Peoples were engaged throughout the project. The following provides an overview of the main consultation and engagement activities completed for the project:

- newspaper advertising and electronic mailing to inform people about the start of the WSMP Update;
- a project website to provide useful information, including links to the previous 2014 WSMP Update, contact information and invitations to online and in-person engagement opportunities;
- Online engagement through the City's online community engagement site, Have Your Say Guelph, linked through the project website and promoted via the electronic mailing list, social media and a monthly Have Your Say newsletter;
- One meeting with Mississaugas of the Credit First Nation to provide an overview of the on-going water-related City Master Plans;
- One meeting with Six Nations of the Grand River to provide an overview of the on-going water-related City Master Plans;
- An inclusive and diverse **Community Liaison Group** (CLG) was established to advise and provide feedback to the project team throughout the process. The group met formally on three occasions;
- Two **Municipal / Agency Workshops** provided crucial inputs from a government and approval agency perspective;
- Two public **Open Houses** were held during the course of the study (one in-person and one virtual), giving community members an opportunity to discuss the project with the Study Team and provide comments;
- Presentations and discussion related to the WSMP Update were included at two meetings of the Water Conservation and Efficiency Public Advisory Committee;

- Presentations were made at Puslinch Township and Guelph/Eramosa Township Council meetings at their request;
- Co-ordination other related master plan updates (i.e., Water and Wastewater Servicing Master Plan, Wastewater and Biosolids Master Plan, Stormwater Master Plan and the Municipal Comprehensive Review / Official Plan Update); and
- 90 day period for public review of the draft final WSMP Update Report.

The feedback received through the various engagement tools and activities indicates that there is a continued interest from community members and stakeholders about water supply in Guelph. Several themes emerged related to the key engagement topics of this phase, including:

- prioritizing conservation;
- protecting the natural environment;
- managing growth and development;
- controlling groundwater impacts from large water users;
- concerns about source protection areas and land use constraints particularly with respect to impacts on the Townships;
- concerns about potential well interference effects with existing wells particularly with respect to impacts on the Townships;
- prioritizing supply within the City before considering sources within Township(s);
- considering potential climate change impacts on water supply;
- questions about the Dolime Revitalization Plan and how it fits into the WSMP
- monitoring emerging contaminants;
- limiting impacts to aquatic and terrestrial wildlife; and
- valuing the agency of water.

There are Indigenous Peoples—First Nations, Métis and Inuit Peoples–living in Guelph who have worked with the City and contributed to the development of the WSMP Update. Specifically, through the Community

Liaison Group, Indigenous Peoples shared their perspectives on the spirit of water and the importance of respecting the agency of water.

Overall, the community has played an important role in providing feedback to the project team and contributing various perspectives on water supply planning. The main points of discussion at the Community Open Houses were water conservation programming, the impact of major water users on the water system, protecting the natural environment, source water protection (including revitalization of the Dolime Quarry), climate change and water quality. The quality of questions and the engagement of those present at the Community Open Houses was a positive indicator of the interest in water supply issues within the City and the surrounding area.

The additional consultation offered and provided to the Townships at their request resulted in additional feedback that focused on the alternatives outside of the City. Township representatives raised concerns including source protection issues, potential constraints on land uses resulting from new water supplies, the availability of water to support growth outside of the City, and the importance of establishing a process for regional water management. These meetings provide a good starting point for future discussions around the potential for new water supply sources to be located just outside the City's boundaries in the neighbouring Townships.

ES-9 Implementation Recommendations

ES-9.1 Financial Evaluation Approach

Based on the evaluation outputs for each of the alternatives, a priority was established for the proposed water supply projects that determines how the City will proceed to develop its water supply over time to meet future needs. This implementation strategy is to ensure that there will always be sufficient supply including an additional allowance for security of supply in place prior to approving growth.

The timeline for this plan is dependent on the water conservation scenarios. A financial evaluation was carried out to determine the optimal water conservation scenario when viewed in the context of cost, impact on demand and the resulting timeline and costs for all of the water supply projects.

The financial evaluation takes into consideration the following:

- Timeline and costs associated with each alternative – including technical investigations, water quality analysis, environmental impact studies, land acquisition, preliminary and detailed design, and construction and commissioning. The timeline allowed in advance of water supply availability is as follows:
  - Groundwater – 5 year timeline
  - Arkell Collector ASR wells – 8 year timeline
  - Surface Water – 10 year timeline
- The exception to the above is that the investigative phase for the test wells and inside-City groundwater options is scheduled to occur early in the implementation timeline so that the City has sufficient information to determine whether the alternative is feasible, to identify any constraints, and to confirm capacity and treatment requirements prior to the next WSMP Update. For the proposed wells outside the City, budget is allocated in the short- to mid-term for additional modeling work to update and substantiate the estimated capacities and potential effects related to the Guelph North and Guelph Southeast alternatives for use in future WSMP Updates.
- An assumed order of groundwater projects is based on the prioritization of alternatives identified in the evaluation of alternatives. It is important to note that the assumptions made in the prioritization of projects were for the purpose of determining the requirement for new supplies against the demand curve in comparison to varying conservation scenarios. Most of these projects would be in investigation and design phases concurrently and the schedule for each would be a function of constraints and ease of implementation.
- The schedule for implementation is such that new water supply projects will be brought online when required capacity reaches 90% of system capacity to ensure sufficient capacity for proposed development commitments, and industrial/ commercial applications, as well as to respond to large increases in demand by current customers, in particular major industries or ICI consumers. This flexibility is important to address growth needs or demands that do not follow the planned demand projection.

ES-9.2 Recommended Water Conservation Strategy

Five water conservation, efficiency and demand management scenarios were developed to represent a range of possible target reductions and associated costs. These programs are forecasted to range in cost from $0/year to approximately $501,333/year, and reduce average day water demand by 0 m^3/day to 4,952 m^3/day (Table ES-9). This includes a blended scenario that envisions implementing the current level of programming in the short-term (approximately years 0-10), adjusting the focus to high demand and/or inefficient customers in the mid-term (approximately years 11-20) and incorporating water reuse in the long-term (approximately years 21-30). Each of the water conservation scenarios explored (except Scenario 1) will delay the need to implement proposed projects for increasing the water supply, assuming that conservation is successfully implemented to achieve the desired targets.

Table ES-9: Water Conservation Scenarios

Scenario	Reduction in Average Day Demand (m^3/day)	Est. Total Program Cost (Non-Discounted; million $)
1	-	-
2	4,424	11.41
3	2,220	4.73
4	4,952	15.04
5	3,683	8.99

The analysis compares the forecasted impacts of the five scenarios on: the demand for potable water, the timing of the City's proposed water supply projects, and the City's capital spending and operating expenditure on water supply projects and water conservation.

The forecasted timing of proposed water supply projects under the different scenarios is presented in **Table ES-10**. Included in each project expenditure is the preceding timeline for work and associated costs outlined in the assumptions.

Table ES-10: Timing of Proposed Water Supply Projects Under Different Conservation Scenarios

Order of Implementation	Project Name	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Project 1	Clythe Well	2023	2023	2023	2023	2023
Project 2*	Ironwood/ Steffler Well	2027	2027	2027	2027	2027
Project 3*	Guelph South Well	2028	2030	2028	2030	2030
Project 4*	Dolime Quarry	2031	2032	2031	2032	2032
Project 5	Fleming/ Logan	2033	2036	2034	2037	2036
Project 6	Lower Road Collector	2037	2042	2038	2042	2040
Project 7	Arkell Collector ASR Wells	2041	2047	2044	2047	2045
Project 8	Hauser test well	2042	2049	2045	2049	2047
Project 9	Guelph North	2043	2049	2046	2050	2048
Project 10	Guelph Southeast	2046	Post-2051	2048	Post-2051	Post-2051
Project 11	Guelph Lake WTP	2048	Post-2051	2051	Post-2051	Post-2051
Project 12	Smallfield/ Sacco Wells	Post-2051	Post-2051	Post-2051	Post-2051	Post-2051
Project 13	Guelph Lake WTP and ASR wells	Post-2051	Post-2051	Post-2051	Post-2051	Post-2051

Notes: *Project implementation subject to outcome of on-going Southwest Guelph Water Supply EA

The timing of the water supply projects is dependent on the City's overall demand for water and is different under each scenario.

ES-9.3 Preferred Water Supply Alternative

The preferred water supply alternative consists of the blended conservation scenario as well as Projects 1 through 9 listed in **Table ES-11**. These are all groundwater projects included in the preferred alternatives in the evaluation process, consisting of existing municipal off-line wells, existing municipal test wells, Dolime Pond Level Management, Arkell ASR, and a new well (Guelph North) outside of the City. A recommended implementation strategy for all required projects is provided in detail in the full report.

Table ES-11: Preferred Water Supply Alternatives

Alternative	Timeline	Projects
1A – Conservation, Efficiency & Demand Management	Throughout	■ Blended Conservation Scenario
2B – Groundwater: Restore Off-line Municipal Wells	Short-term	■ Clythe Well (completion in 2023)

Alternative	Timeline	Projects
2B – Groundwater: Restore Off-line Municipal Wells	Mid-term	■ Lower Road Collector (completion in 2037)
2C/D – Groundwater: Develop Municipal Test Wells	Short-term	■ Ironwood/Steffler (completion in 2027) ■ Guelph South (completion in 2028) ■ Dolime Quarry (pumping station component completed to align with Ironwood/ Steffler) ■ Logan/ Fleming (completion in 2030)
2C/D – Groundwater: Develop Municipal Test Wells	Long-term	■ Hauser (completion in 2047)
2F – Groundwater: Arkell Collectors & ASR Wells	Long-term	■ Arkell ASR (completion in 2045)
2G – Groundwater: Develop New Wells Outside City	Long-term	■ Guelph North (completion in 2048)

It will be important for the City to closely track the success of the water conservation and efficiency program to ensure that the predicted reductions are being achieved, and to be able to trigger the initial phases of supply projects noting the lengthy lead-in time to complete all of the necessary investigations, approvals and design such that the water is available when needed. This is particularly important for the mid- and long-term projects as there are five supply facilities scheduled to come online in the 2022 to 2031 portion of the timeline. The City may decide to take a more conservative approach to complete more of the preliminary steps in advance to allow for a shorter final implementation time required for final construction and commissioning once triggered. This would also assist in identifying project issues early, and also securing land requirements.

ES-9.4 Recommendations

A series of recommendations are provided in the full report and a subset are provided here as an overview.

General Program Recommendations

- As each new supply source is developed, it is recommended that the total water budget be re-evaluated as compared to the conditions at the time of assessment to ensure that additional groundwater extraction does not result in adverse environmental or well interference effects.

- As each new water supply project is developed, it is recommended that additional surface water and groundwater monitoring programs be put in place to monitor for potential environmental effects to adapt the water takings to mitigate impacts, if necessary. Since water taking effects may extend outside of the City, collaboration with the GRCA and the Townships may be required to implement programs outside of the City.
- Groundwater modelling is recommended as an important tool to assess potential cumulative effects and environmental effects. It is recommended that the City's groundwater flow model be continuously updated and maintained for application in the various WSMP projects.
- A basic premise of the WSMP Update is that the existing supply system is protected, and the City does not lose supply through contamination events or as a result of other non-municipal water takings. Therefore, it is important that the City enhance/maintain its source protection programs, particularly with respect to contaminated sites and to support, and in some cases, sponsor source protection programs outside of the City to provide equal protections. In addition, it is recommended that the preferred solution (i.e., future drinking water sources) in this WSMP Update be incorporated into the City's Source Protection Program for protection of water quantity of future drinking sources as required by the purpose of the Clean Water Act and the objective of the Source Protection Plan.
- In comparison to the 2014 WSMP Update, capital and unit costs for the development of new groundwater supplies have increased, for a variety of reasons. Pandemic-related, supply-chain issues have been identified in developing cost estimates but there is uncertainty if some of the increased material and service costs will persist into the future. With Guelph City Council's direction of growth paying for the cost of growth, it is recommended that cost estimates in the WSMP Update be updated as part of Class EA projects once additional design details are available and with each subsequent WSMP Update (approximate frequency of five years).
- It is recommended, as part of feasibility studies or the Class EA process, that each potential new source of water supply require additional field work and environmental impact assessments, particularly with respect to water budget and sustainability issues.

- Through the WSMP Community Engagement Plan, the Project Team heard concerns from adjacent municipalities on source protection and land use constraints as well as potential impacts to domestic wells from well interference. It is recommended that future programs have a focus on enhanced engagement and development of intergovernmental relations with the goal to promote more regional water resources management, to support water supply needs for all affected municipalities and to address attendant environmental effects with the support of provincial agencies (i.e., Ministry of the Environment, Conservation and Parks) to meet provincial growth targets.
- It is recommended that the City build on the existing Drinking Water Quality Management System process by developing a risk management plan that includes mitigation and response strategies. This will include current risks to the existing groundwater-based system and may be expanded upon to include additional risks relevant to future water supplies, whether groundwater or surface water based.
- The feasibility of both the Arkell and Guelph Lake ASR alternatives should be further developed, and this process should include an optimization study to evaluate the placement of ASR wells that best utilize the existing municipal supply wells to efficiently recover injected water.

Water Supply Planning Recommendations

- Build on the current process and guidelines for review of applications from new large volume users (e.g., industry), which considers a balance of employment and water use. Future projections are based on allocated amounts dedicated to the residential and ICI sectors, where the volume for ICI relates to a specified employment number. If high volume water users are not coupled with high employment, water demand projections will need to be revisited to establish a revised schedule for new water supply without jeopardizing the needs of planned growth.
- Investigate more robust policies for supply capacity allocation for both new and existing customers that take into account the relatively large capital expenses and lengthy timelines required to fully commission new water supply facilities. These policies would ensure maximum value to the City for supply capacity allocated to both new and existing customers.

- Complete an update of the 2016 Water Efficiency Strategy, commencing as early as 2022, based on the blended water conservation (Scenario 5), efficiency and demand management scenarios presented through the WSMP. This will include evaluation of non-potable reuse options in alignment with the City's other water-related Master Plans.
- Continue, and refine as necessary, the tracking system that closely monitors sectoral demand management (i.e., conservation and efficiency programs) and optimization successes and review whether results are in-line with the forecasted demand for the preferred scenario and are achieving the goals of the Water Efficiency Strategy. Trends must be monitored with a long-term view recognizing that the effect of some direct programs may be more immediate, resulting in short-term deviations from the forecast.
- Consider time limits on development commitments such that water capacity is not 'held' for long periods of time. Review possible mechanisms to synchronize approvals of significant capacity increases with the proposed timing of new supplies in accordance with the master planning schedule.
- Assess the Development Charges planning process for the ability to provide flexibility in funding in relation to COVID cost increases.
- Review land acquisition requirements for all projects, both short- and long-term, to ensure future flexibility when implementing alternatives. Consider delegation of authority to staff to execute strategic land procurement requirements for future water supply provided property values fall within 20% of study estimates, subject to the approval of the DCAO and City solicitor.

Supply Capacity Management Recommendations

- Water Services should conduct annual reviews of each component of the water supply system to determine the supply capacity and to identify any changes in the capacity from previous years or any constraints in delivering the optimal supply capacity.

- Based on the annual reviews of water supply capacity, Water Services should develop programs and implement maintenance and upgrades to the water supply system so that the system can deliver its optimal supply capacity.
- To protect water quantity and to mitigate potential impacts on quantity from other water takings, the City should consider implementing a municipal by-law to prohibit new private groundwater supply wells in the City as well as other areas where municipal water services are present.

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1. Introduction

In 2007, the City of Guelph (City) completed the Water Supply Master Plan (WSMP) project to ensure that the City's water supply continues to meet current and future demands. As part of the initial WSMP, City Council provided direction in 2003 "That the focus of the WSMP establish a sustainable water supply to regulate future growth". The WSMP provided recommendations for the planning of development of future water supply capacity for the City through to 2054 (50-year planning horizon). This included recommendations for short-term, mid-term and long-term water supply options to meet the predicted demand. The short-term recommendations included water conservation and demand management programs and expansion of the existing groundwater supply system. Mid- and long-term recommendations included continuation of groundwater development within the City along with consideration of groundwater sources outside of the City in consultation with the neighbouring Townships. All options were prefaced with the need to consider the investigation and feasibility of options prior to implementation. In 2007, City Council approved the WSMP and directed staff to implement all components of the WSMP including the water conservation and efficiency strategy with the exception of the Great Lakes Water Supply alternative. One of the recommendations was that the WSMP be updated every five years, and the City moved forward with the first update in 2014. The 2014 WSMP Update covered a 25-year period from 2013 to 2038 to make it consistent with the needs of the City at that time.

The purpose of the current WSMP Update is to review and revise the 2014 WSMP covering a 30 year period from 2021 to 2051 to align with the Provincial Growth Plan: A Place to Grow: Growth Plan for the Greater Golden Horseshoe (amended in August 2020), and the Municipal Comprehensive Review of the City's Official Plan (in progress). The WSMP Update applies to water supply only; however, references to other City studies including the Wastewater Treatment and Biosolids Master Plan (WWTBMP) and Water and Wastewater Servicing Master Plan (WWSMP) are relevant in terms of infrastructure planning co-ordination. The distribution and servicing of the municipal potable water system including watermains, pumping stations and reservoirs are addressed in the WWSMP.

The WSMP Update builds upon the work previously completed taking into account more recent studies and the work activities completed since 2014. This update will review the 2014 WSMP recommendations as well as examine new water supply alternatives in accordance with the Class Environmental Assessment (EA) process for Municipal Water projects. This project provides an update to the following components of the 2014 WSMP:

- Community engagement and consultation and engagement of Indigenous communities – complete the required consultation to collect and incorporate public and agency input into the update; contact and engage with First Nations, Métis and Inuit Peoples living in Guelph and Indigenous communities identified by the Ministry of the Environment, Conservation and Parks (MECP);
- Population and water demand projections – review potential population and industrial/ commercial/ institutional (ICI) growth and historical water demands to establish future water supply demand projections;
- Water supply capacity – review and assess the current water supply system and establish a range of system capacities under several scenarios;
- Water supply alternatives – review existing hydrogeological information and recent water supply projects to identify potential areas of additional groundwater supply capacity; and develop and evaluate feasible concepts for alternative municipal water supplies;
- Implementation recommendations – develop an implementation plan for new water supply capacity to satisfy future demand forecasts; and
- WSMP Update Report – document all findings and recommendations.

The update will provide a listing of the recommended water supply projects, including phased implementation schedules and recommended Class EA Schedules. Class EA approvals for Schedule "B" and "C" projects can then be conducted by using the Master Plan as a starting point.

1.1 Background

The City relies almost exclusively on groundwater to meet the municipality's residential, industrial, commercial and institutional water demands. It is one of the largest cities in Canada relying on groundwater.

In 1990, the City initiated a multi-phase study of its water system. The water system was broadly defined to include not only groundwater and its protection but also the supply, distribution and conservation of water. The study area encompassed the City of Guelph and included the southern portion of Wellington County. The Phase 1 report was completed in April 1991. As part of this project, it was recognized that, for the City to continue to utilize their groundwater resources while sustaining the quality of these resources, it was necessary to pursue multiple initiatives. The four major areas of sustainable water resources, supply and/or management were identified as follows:

- Water Conservation and Efficiency – public education and awareness programs, and conservation initiatives to promote the conservation of water by all (residential, ICI), in the City.
- Water Supply/Distribution – optimization of the City's water supply and distribution system and expansion to meet growth requirements to ensure capital works meet supply and demand needs.
- Water Resource Evaluations – investigations to characterize the City's groundwater resources and its general relationship within the natural environment.
- Water Resource Protection – the development of strategies and implementation measures to ensure the protection of ground and surface water quantity and quality.

Since the completion of this first phase, various investigations and studies were completed pertaining to all four areas, with a primary focus on the evaluation of the water resource. This effort involved the collection of a substantial volume of information on the physical setting, the evaluation of water supply aquifers through extensive testing of existing municipal wells and the development of a groundwater flow model. The evaluation of this information led to a more comprehensive understanding of the City's water resources.

In 1999, the City of Guelph initiated the Water Supply Strategy (WSS) project to address the supply of water to meet future projected demands. Climatic conditions, well interference and water quality degradation had reduced the yield of the existing system. The WSS examined alternatives in accordance with the Class EA process for Municipal Water projects. The first phases of the EA were conducted in 2000 and included a review of the following:

- Current system capacity and long-term water supply system capacity;
- Water demand, average day water demand and maximum day water demand;
- Population projections;
- Water demand projections; and
- Alternatives to meet projected water demands.

Based on comparisons of demand to capacity, the WSS concluded that there was a need to supplement the existing water supply system, both immediately and in the long term. The alternatives to meet the projected water demands included the following:

- Do nothing;
- Reduce water demand through conservation and unaccounted for water (UFW);
- Limit community growth;
- Increase takings from established sources;
- Develop additional groundwater supplies; and
- Develop alternative municipal supplies.

The Class EA concluded that the City should implement immediately the alternatives to reduce water demand through conservation, to identify unaccounted for water use; and to increase taking from established sources (Arkell Spring Grounds). In the longer term, it was recommended that the City should pursue the alternatives of developing additional groundwater supplies and alternative municipal supplies.

Subsequently the City completed the WSMP study in 2007 and an update in 2014. The WSMP implementation plan set out a strategy for the City to

investigate and execute the necessary steps to optimize existing and develop new water supplies, with a focus on local sustainability. Public response to the 2007 WSMP helped shape that definition of sustainable to refer to available local water supplies, which included local groundwater and surface water sources. A Great Lakes pipeline alternative was considered in the long list of alternatives within the 2007 Plan but was determined to be unsustainable in the local context and City Council removed discussion of the pipeline alternative from the Plan. Consistent with this direction of Council, a Great Lakes pipeline alternative has not been included in subsequent updates.

The utmost importance was placed on water conservation and as a result, the City has become a renowned leader in water conservation and demand management in Canada. The City's Official Plan calls for the WSMP to "develop programs and policies to conserve water and to reduce requirements for additional water supply and treatment, including the implementation of the Water Conservation Efficiency Strategy". It is the aim of this update to document demand reductions achieved to date, and to determine feasible reduction strategies and goals moving forward for comparison to other water supply alternatives.

Public feedback in 2007 and 2014 indicated that the City first examine groundwater supply opportunities within the City's boundaries in order to minimize potential impacts on its neighbours. Although groundwater flow does not respect geographic borders, effects from pumping from aquifers may result in potential local effects on the natural environment and also on private and municipal wells in close proximity as well as potential land use constraints from source water protection requirements. As a result, the City has since implemented a number of programs and studies to maintain and optimize existing supply facilities within the City and in areas of existing municipal well supply infrastructure, including (since 2014):

- Completed construction of new well facilities (Arkell 14 and 15) and completed the Arkell Adaptive Management Plan and Operational Testing Program;
- Upgrades to the Arkell artificial groundwater recharge system;
- Completed upgrades to the existing Burke Well facility, including iron and manganese treatment;

- Class EA for a Clythe Well water treatment facility (existing, off-line well);
- Replacement well on the Membro site, referred to as the Membro Replacement Well or the Rocco Well; and
- Through mediation with the Dolime Quarry owner, identified a potential solution to address the City's concerns about how operations at the quarry could affect local groundwater.

Also included in the short- to mid-term implementation strategy was the initiation of various hydrogeological investigations inside the City and just outside the City's boundaries to explore the potential for new water supplies in these areas. These include the Guelph South Groundwater Supply Investigation (on-going) and the Southwest Guelph Water Supply Class EA to evaluate additional water supply sources within southwest Guelph, including a long-term Operational Testing Program at the Dolime Quarry and surrounding existing municipal wells (on-going).

In addition to the above initiatives, the City has completed the following regional studies and plans to ensure the protection and long term sustainability of the existing water supply system:

- The Guelph and Guelph/Eramosa Township Tier Three Water Budget and Local Area Risk Assessment (Tier Three Study) was completed to evaluate the sustainability of the City's water supply system from a quantity perspective and to identify potential threats to that sustainability (Matrix Solutions Inc., 2017). This study concluded that the Queensdale Well had a significant risk of not meeting future pumping requirements under drought conditions and that all other City wells are expected to meet future needs. However, a high level of uncertainty was also associated with the results for the Arkell 1 Well. As a result of this assessment, and since the City's drinking water system is dependent on the contribution of water from the Eramosa River intake, a Well Head Protection Area for water quantity (WHPA-Q) was developed for the water supply aquifer and an Intake Protection Zone for water quantity (IPZ-Q) was established for the Eramosa River. This study and the Tier Three Groundwater Flow model (Tier Three Model) of Guelph's municipal aquifer system (in and outside the City) provide

invaluable insights into reviewing the current water supply system and its reliability now and into the future. It is also referenced herein in determining the feasibility of new water supplies from both a potential capacity and environmental effects perspective.

- A Threats Management Strategy was developed to address the results of the Tier Three Study and guide the development of associated water quantity policies.
- The Guelph Drinking Water Source Protection Plan was developed within a watershed context to identify and evaluate potential water quality threats to the municipal supply system. The City and other municipalities within the Grand River Watershed, through the Lake Erie Source Protection Authority, have developed policies to protect existing and future drinking water sources from unwanted impacts and harmful contaminants. At this time, the City is currently working on updates to the plan and development of policies to address the potential water quantity impacts.

1.1.1 Water Resource Protection

Recognizing the importance of protecting the City's water resources, groundwater and water resources protection policies have been incorporated into the City's Official Plan. The June 2021 consolidation provides the rationale for protection policies and describes these as follows:

> *"**4.3 Watershed Planning and Water Resources***
>
> *Protection, conservation and enhancement of the City's water resources are integral to sustaining the environmental, social and economic well-being of the community. The City employs a watershed/subwatershed based planning approach to inform broader scale natural heritage, land use and infrastructure planning policy. The City emphasizes water resource protection and conservation, ensuring long term safety and security through the identification of potential quality and quantity threats to surface water and groundwater resources. Additional measures to protect the City's existing and future sources of water supply are anticipated through the development and implementation of a Source Protection Plan.*

Objectives

a) To use a watershed/subwatershed planning systems approach to inform the identification, evaluation and protection of the natural environment.

b) To protect, improve or restore the quality and quantity of the City's surface water and groundwater resources through municipal initiatives and community stewardship.

c) To practice and encourage effective management of stormwater drainage in order to maintain or enhance the water resources of the City.

d) To use stormwater management to assist in regulating the quantity and quality of stormwater run-off to receiving natural watercourses, wetlands and recharge facilities.

e) To work with the Grand River Conservation Authority and Lake Erie Source Protection Committee to develop a Source Protection Plan.

4.3.2 Water Resource Protection and Conservation

1. The City will protect, improve or restore the quality and quantity of water by:

i) minimizing potential negative impacts, including cross jurisdictional and cross-watershed impacts;

ii) implementing necessary restrictions on development and site alteration to protect all municipal drinking water supplies and designated vulnerable areas;

iii) promoting efficient and sustainable use of water resources, including practices for water conservation and sustaining water quality; and

iv) ensuring stormwater management practices minimize stormwater volumes and contaminant loads.

2. Reduction in water consumption will be encouraged through upgrading/retrofitting of existing buildings and facilities. The City may require a Water Conservation Efficiency Study in conjunction with new development.

3. Landscaping and maintenance practices that minimize water consumption and reduce the use of potable water for irrigation associated with development are encouraged.

4. The use of potable water for outdoor watering is discouraged.

5. The City will increase the use of low maintenance and drought tolerant landscaping at municipal facilities.

6. The City will encourage and implement Low Impact Development (LID) where appropriate.

7. Alternative water supply and demand management systems such as rain water harvesting and grey water reuse is encouraged throughout the city and in all new development.

8. The City will ensure, through consultation with the Province and the Grand River Conservation Authority, that all development meets provincial water quality and quantity objectives for surface water and groundwater.

9. The City will ensure that development activities do not impair the future ability of the area's groundwater and surface water resources to provide a quality water supply to satisfy the residential and business needs of the city and to sustain the area's natural ecosystem.

10. Development shall be restricted in or near sensitive surface water features and sensitive groundwater features and tributaries such that these features and their related hydrologic functions and water quality functions shall be protected, improved or restored. Mitigative measures and/or alternative development approaches may be required to protect, improve or restore sensitive surface water features, sensitive groundwater features and their hydrologic functions.

11. The City will implement the recommendations of the Water Conservation and Efficiency Strategy Update (2009) or successor thereto.

4.3.3 Source Protection

Source protection planning is designed to protect existing and future sources of municipal drinking water thereby safeguarding human health and the environment. A Source Protection Plan is being developed by the

Lake Erie Source Protection Committee. The Source Protection Plan will place restrictions on land use activities within Wellhead Protection Areas, Intake Protection Zones and Issues Contributing Areas. Once approved by the Ministry of the Environment, the Source Protection Plan policies will be incorporated into this Plan through amendment. In the interim, the City will continue to place restrictions on land use activities that have the potential to impact the City's water supply and may implement risk management measures required by the Clean Water Act.

1. The entire City area is considered to be a recharge area for municipal drinking water supply. To protect this valuable water resource, the City will introduce conditions of development approval that:

i) protect wetlands and other areas that make significant contributions to groundwater recharge;

ii) ensure that stormwater management systems protect water quality and quantity;

iii) require all storage of liquid waste, petroleum, fuels, solvents, fertilizers and related chemicals be provided for in properly designed and engineered containment areas in accordance with all applicable policies, guidelines, technical standards and legislation;

iv) restrict the placement of underground chemical/fuel storage tanks;

v) require impact studies and risk management plans where proposed development has the potential to affect the quantity or quality of groundwater resources;

vi) require that contaminated properties be restored to the appropriate condition in compliance with applicable Provincial legislation and regulations; vii) place restrictions on land use in areas of greatest risk to contamination of groundwater resources. Uses that may be restricted include, but are not limited to: industrial landfills, lagoons, waste disposal facilities, asphalt and concrete batching plants not associated with mineral aggregate operations, the storage or processing of chemical products, gasoline or oil depots and service stations, and vehicle salvage, maintenance, service yards and other activities identified as significant drinking water threats; and

viii) may require risk management measures for specific land uses and prescribed drinking water threat activities, in Wellhead Protection Areas A, B and C identified on Schedule 7.

2. The City's Wellhead Protection Areas, Intake Protection Zones and Issues Contributing Areas extend into the County of Wellington and the Region of Halton. The City will work co-operatively with the upper and lower tier municipalities within Wellington County and Halton Region to develop source protection policies to ensure the long-term protection of the water resources of all these municipalities.

3. The City may require that technical studies be prepared by a qualified professional to assess and mitigate the potential impacts of a proposed development application within the City's wellhead protection areas as part of a complete application. These studies may include but are not limited to a Disclosure Report, detailed Hydrogeological Study and a Spill Prevention and Contingency Plan.

4. Interim Risk Management Plans may be required to reduce the risk of significant drinking water threat activities identified through the Assessment Reports or by other means."

As defined by the Source Protection Program based on the location of the Wellhead Protection Areas (WHPA), Wellington County has responsibilities under Ontario's Clean Water Act to protect drinking water sources in the County. In addition to the City's policies, the Wellington County Official Plan contains some protection measures for the City's wells located in Puslinch and Guelph/Eramosa Townships. The Arkell Spring Grounds is designated as a protection area with specific development constraints. The City is circulated by the County on all development proposals that are in close proximity to the Arkell Spring Grounds. Each application is reviewed for any potential risk posed to the City's water resource.

1.2 Environmental Assessment Master Planning Process

Master Plans are long range plans which integrate infrastructure requirements for existing and future land use with environmental assessment planning principles. These plans examine an infrastructure system, or group of related projects, to outline a framework for planning for

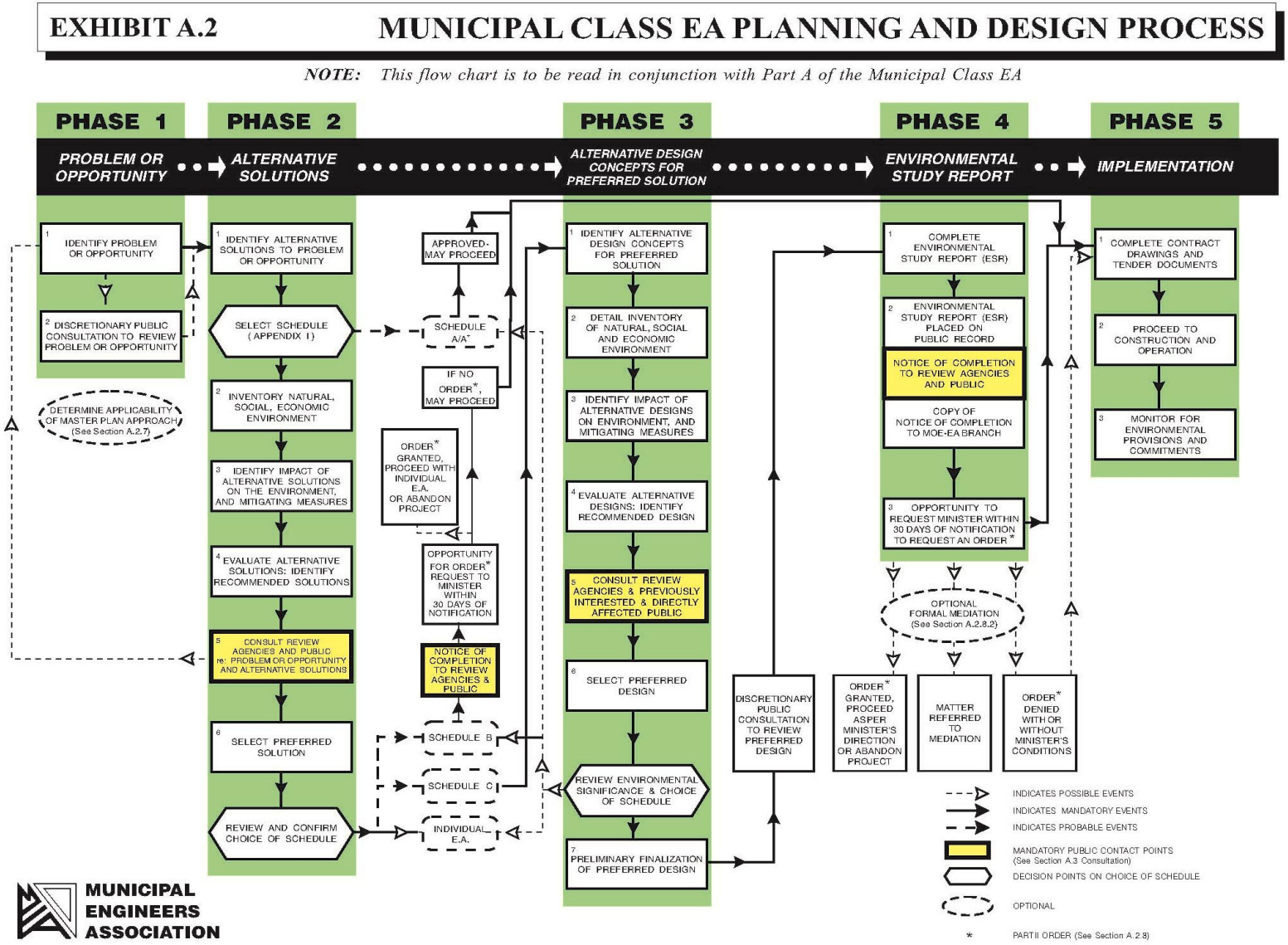
subsequent projects and/or developments. As a minimum, Master Plans should address Phases 1 and 2 of the Municipal Class EA process to the extent possible (**Figure 1-1**). Master planning provides a municipality with a broad framework through which the need and justification for specific projects can be established such that the environmental assessment process can be satisfied. Key features of a Master Plan include:

- Addressing the key principles of successful environmental planning.
- Addressing at least the first two phases of the Municipal Class EA to the extent possible.
- Allowing for an integrated process with other planning initiatives.
- Providing a strategic level assessment of various options to better address overall system needs and potential impacts and mitigation.
- Long term planning.
- Taking a system-wide approach to planning which relates infrastructure either geographically, or by function.
- Recommending an infrastructure master plan which can be implemented through separate projects.
- A description of specific projects.

Examples of Master Plans include: wastewater and water servicing plans for entire or major portions of a municipality; wastewater treatment plans and water supply plans for a community or municipality; watershed plans; transportation master plans; stormwater management master plans and infrastructure master plans.

This Guelph WSMP Update document was prepared at the conclusion of Phases 1 and 2 of the Municipal Class EA process. The draft Master Plan document will be made available for public comment pending approval by City Council. The WSMP has been completed at a broad level of assessment, requiring more detailed investigations at the project-specific level to fulfill Municipal Class EA documentation requirements for any specific Schedule B or C projects, as applicable, identified within the Master Plan. The Master Plan will therefore become the basis for, and be used in support of, future investigations for any specific Schedule B and C projects identified within it. Schedule B projects will require filing of the Project file for public review while Schedule C projects will have to fulfill Phases 3 and 4 of the process prior to filing an Environmental Study Report (ESR) for public review.

Figure 1-1: Planning and Design Process for Municipal Class EA Projects



Source: (Municipal Engineers Association, 2011)

The WSMP will continue to be reviewed approximately every five years to determine the need for a detailed formal review and/or updating. In general, potential changes which may trigger the need for a detailed review include:

- Major changes to original assumptions;
- Major changes to components of the Master Plan;
- Significant new environmental effects;
- Major changes in the proposed timing and/or scope of projects recommended within the Master Plan.

Specific to this update, it is critical to track the progress and success of the recommended projects identified herein, as changes to scope or timing has the potential to impact the City's ability to provide water supply to meet projected demand.

1.2.1 Master Plan Approach

Key aspects of the WSMP Update approach are provided in **Table 1-1**.

Table 1-1: Master Plan Update Approach Overview

Task No.	Task Description
Task 1 – Public Consultation	■ WSMP Community Liaison Group (CLG) meetings (3) ■ Municipality / Agency workshops (2) ■ Community Open Houses (2) ■ Water Conservation and Efficiency Public Advisory Committee meetings (2) ■ Master Plan briefings for First Nation Communities (2) ■ Presentations to Township Councils (2)
Task 2 – Population and Water Demand Forecasts	■ Develop population projections – residential and Industrial/Commercial/Institutional (included 2020 Places to Grow amendment to 2051) ■ Develop water demand projections
Task 3 – Existing Water Supply Capacity Assessment	■ Update the assessment of existing well/supply system performance, maximum system capacity and minimize potential constraints for each supply source ■ Compare existing capacity with demand forecast to identify future supply needs

Task No.	Task Description
Task 4 – Water Supply Alternatives	Review potential alternatives including: ■ Conservation, Efficiency and Demand Management programs (including water reuse) ■ Groundwater sources inside city ■ Groundwater sources outside city ■ Local surface water supply ■ Limit growth/Do nothing
Task 5 – WSMP Update	■ Evaluate alternatives ■ Develop Implementation Strategy ■ Complete WSMP Update Report

This report documents outcomes of each of the above tasks, commencing with development of the Master Plan Challenge and Opportunity Statement.

1.2.2 Challenge and Opportunity Statement

Phase 1 of the Class EA planning process requires the proponent of an undertaking to first document factors leading to the conclusion that the improvement or change is needed, and ultimately, develop a clear statement of the identified problems, deficiencies, or opportunities to be investigated. As such, the Challenge and Opportunity Statement is the principle starting point in the undertaking of a Class EA study and becomes the central theme and integrating element of the project. It also assists in setting the scope of the project. A draft Challenge and Opportunity Statement for the City of Guelph WSMP Update was provided to the public for comment at the Community Liaison Group, Municipality and Agency workshop, and Community Open House in the winter of 2020. Suggestions provided by the public, agencies and municipalities were reviewed and incorporated in developing the final statement:

> *The City of Guelph is committed to managing population growth as it continues to develop strategies for ensuring adequate water supply. The goal is to develop a reliable and sustainable supply of water to meet the current and future needs of all residential, industrial, commercial and institutional customers.*
>
> *The 2014 WSMP confirmed that the existing water supply capacity will not meet future demands and set out a strategy for*

> *meeting future demand. It is, therefore, prudent to undertake an update to the water demand forecast, the existing water system capacity and the status of ongoing projects, in order to review the plan and make adjustments as required.*
>
> *The proposed implementation strategy must deliver, through to 2051, an adequate amount of water in a safe and cost-effective manner and ensure that environmental sustainability is not compromised.*

It is, therefore, necessary to carry out the WSMP Update to identify a strategy that will increase the capacity of the City's existing water system and provide additional security of supply. The strategy will ensure that an adequate amount of water can be provided in a safe, reliable and cost-effective manner to satisfy current and long-term municipal demand requirements. The study will have regard to innovative technologies, and established sustainability and environmental planning principles that properly consider potential impacts to sensitive land uses such as the natural environment and agriculture, both inside and outside of the current City municipal boundaries. Furthermore, the update will define and factor in the role of water conservation, efficiency and demand management measures which can extend the life of existing supply capacity and defer the need for future water supply capacity.

2. Study Area Profile

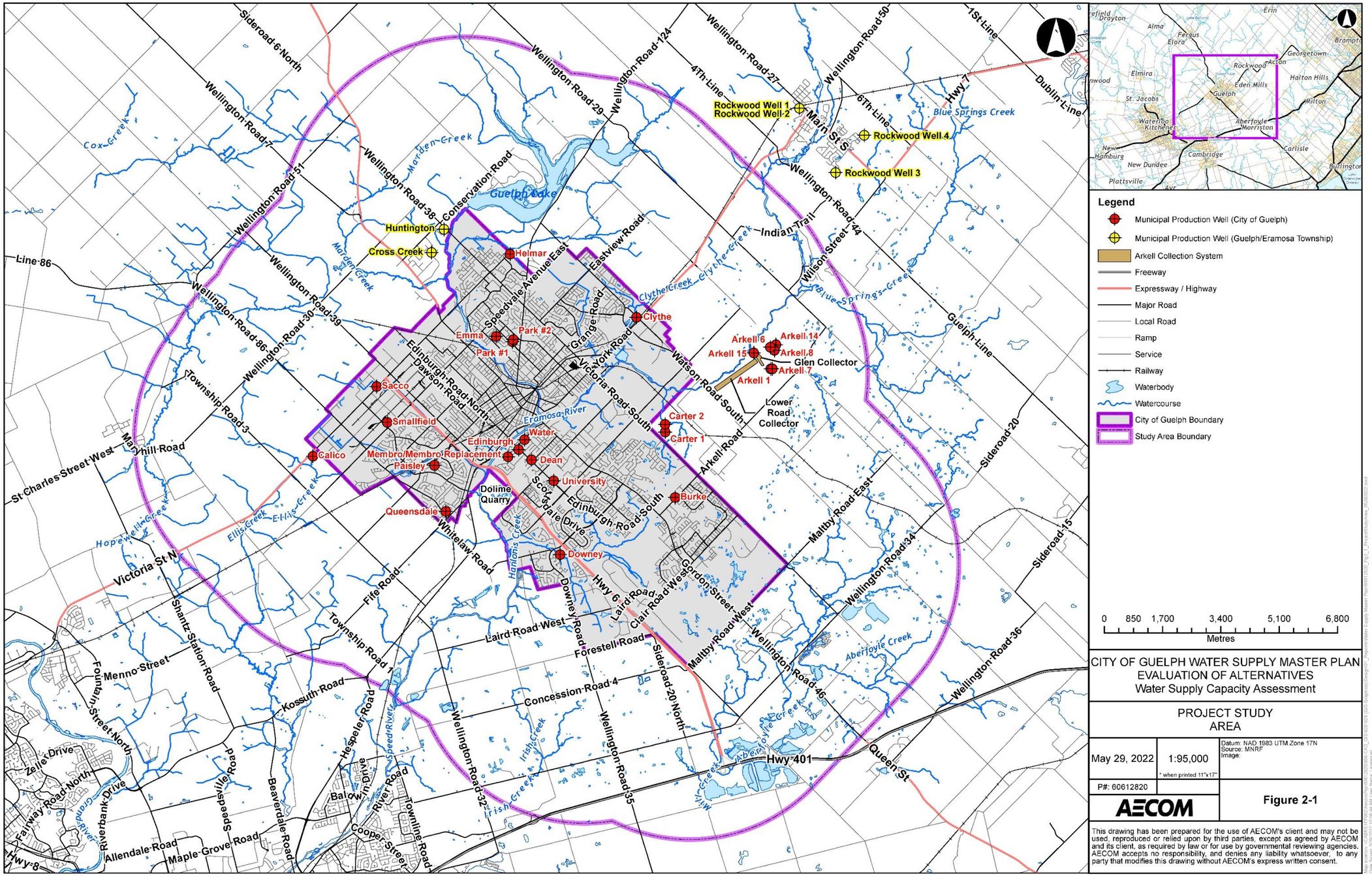
The source of Guelph's drinking water is a series of 21 operational groundwater wells and a shallow groundwater collector system located within the City and the surrounding Townships (Puslinch and Guelph/Eramosa). The water system is operated to meet daily, seasonal, and other operational demands with various combinations of supply sources in operation at any given time. The distribution system (including storage, watermains, valves, fire hydrants, water services, and meters) serves a population of approximately 131,794[4] within the City. The groundwater that supplies water to the City system is a shared resource that is utilized by the residents of Guelph, the surrounding County and Townships and the natural environment. Additional information about the existing water supply sources is provided in Section 4.

The study area for the project includes the area within 5 kilometres of the City boundary as was used as the study area in previous WSMP updates (**Figure 2-1**). This area is considered to be a reasonable estimate of a search area for new water that will limit potential effects on adjacent municipalities. It is also based on the practicality of connecting new sources to the City's existing water supply (i.e., costs to transmit water into the City).The study area footprint is similar to, but does not completely overlap with, the City's Wellhead Protection Area for water quantity (WHPA-Q). The WHPA-Q represents the cumulative drawdown of all water takings in the local area of the City water supply system. Further information on the City's WHPA-Q is available in the Tier Three Water Budget and Local Area Risk Assessment report (https://www.sourcewater.ca/en/source-protection-areas/Guelph-and-Guelph-Eramosa-Tier-3.aspx).

Background data were collected on existing regulatory, environmental, social and economic conditions in the study area[5] (**Figure 2-1**). These existing conditions were used to characterize the study area and provide a basis for assessment and evaluation purposes for future water supply alternatives.

4. Statistics Canada, 2016 Census of Population.
5. The project study area includes the City of Guelph and the area within 5 kilometres of the City limits.

Figure 2-1: Project Study Area



Reference is made to some of the evaluation criteria utilized in the assessment of alternatives, and a full description of the criteria is provided in Section 6. The conditions are described as follows:

- Consideration of First Nations, Métis and Inuit Peoples culture and worldview in all aspects of the evaluation. The intent is to assess the potential effect of each alternative on Indigenous values, culture, and Traditional use.
- Current status of the regulatory environment in which alternatives must be developed to meet current and future water quality, Source Protection, and environmental requirements.
- The natural environments in those areas impacted by any or all of the water supply alternatives to be developed and evaluated.
- The current and proposed built environment recognizing potential impacts to land uses and landowners.
- The social/cultural issues to be taken into account based on those policies and/or that information available from the various areas impacted by any proposed water supply alternatives.
- The economic and financial measures to be utilized for alternative assessment and evaluation purposes.
- The legal/jurisdictional issues to be addressed, specifically issues that are a result of a proposed alternative being located in a separate jurisdiction.
- The technical considerations to be taken into account for implementation and operation of water supply alternatives.

Details are outlined in the following sections.

2.1 Indigenous Peoples

At the outset of the project, MECP notified the Project Team of the Indigenous communities to contact regarding the WSMP Update and included Six Nations of the Grand River, Haudenosaunee Confederacy Chiefs Council and Mississaugas of the Credit First Nation. These contacts were provided with a formal letter, the Notice of Commencement and invitation to the first workshop with agencies and other municipalities, and the notice and

invitation to the first community open house. Follow-up with the communities was conducted by the City in June 2020 to determine if there is any specific consultation format that is preferred in addition to the tools and activities utilized to date. In addition, the City conducted general communication and engagement with the Indigenous communities identified above with the intent to improve relationships with the communities and to share information with respect to the City's Municipal Comprehensive Review and updating of a number of the City Master Plans. These contacts resulted in meetings to discuss the City's general master planning processes and the WSMP Update in particular. To date, specific feedback on the water supply alternatives has not been received.

There are Indigenous Peoples — First Nations, Métis and Inuit Peoples living in Guelph who are working with the City and contributing to the development of the WSMP Update. These individuals do not formally represent a specific community in the WSMP process, rather, they contributed ideas and information to the Project Team that represents their culture and worldview with respect to water and its use.

Key themes shared with the Project Team that help guide the evaluation include:

- valuing and respecting the agency of water,
- understanding the spirit and personhood of water,
- good stewardship of the connected ecosystem including protection of water's pureness, and
- consideration of First Nations', Métis' and Inuit Peoples' culture and worldview in all aspects of the evaluation.

2.2 Regulatory Environment

The City of Guelph, like all municipalities in Ontario, must operate within the administrative, legislative and financial framework established by senior levels of government. The key provincial and federal initiatives that provide directives, and are considered under the master planning process, are provided below.

The ***Environmental Assessment Act (EAA),1990***, generally requires an environmental assessment of any major public or designated private undertaking in order to determine the ecological, cultural, economic and social impacts of the project. The Act established a "Class Environmental Assessment" (Class EA) process for planning certain municipal projects. Municipal projects that may be affected include municipal road, water, sewage and stormwater projects. For water projects, the purpose of the municipal class environmental assessment is to ensure that projects will be "undertaken to address problems affecting the operation and efficiency of existing water systems, to accommodate future growth of communities, or to address water source contamination problems".

The ***Environmental Bill of Rights (EBR), 1993***, led to the establishment of an Environmental Registry to notify the public of important environmental decisions and to solicit public comment. The EBR also established an independent Environmental Commissioner who oversees the province's environmental practices and consideration. Through the EBR, the public has the right to request reviews of inadequate laws, regulations, policies or instruments, and to comment on proposed legislation and regulations.

The ***Ontario Water Resources Act (OWRA), 1990***, is the statutory foundation of Ontario's water policy. It assigns to the Minister of the Environment and his or her delegates broad oversight of Ontario's waters, including powers to approve works and facilities, enter property and carry out inspections, make orders and enforce them. Regulations under the Act provide drinking water quality requirements, licensing of well drillers, Permits to Take Water (PTTW), sewage treatment plant obligations, duties to collect and report information, and a range of other matters. To protect sustainable water supplies, the Province of Ontario has a program to manage water takings through the OWRA and the Water Taking and Transfer Regulation (Ontario Regulation 387/04). Through the regulation, the MECP permits water taking and establishes limits on the total quantity of water for each permit, along with the duration of the permit. Water taking permits are issued for a maximum of up to 10 years. Under Section 34 of the OWRA, anyone taking more than 50,000 L of water in a day from a lake, stream, river or groundwater source, with some exceptions, must obtain a PTTW.

The ***Environmental Protection Act (EPA)***, ***1990,*** is the primary pollution control legislation in Ontario and can be used somewhat interchangeably

with the Ontario Water Resources Act. The legislation prohibits discharge of any contaminants into the environment that cause or are likely to cause adverse effects. Amounts of approved contaminants must not exceed limits prescribed by the regulations.

The ***Lakes and Rivers Improvement Act (LRIA), 1990*** was introduced to protect the province's surface water resources. The Act regulates the public and private use of Ontario's lakes and rivers, including the construction, repair and use of dams.

A number of other important policies and pieces of legislation have also had an impact on water systems and their owners and operators since the Walkerton tragedy. These include:

- The ***Safe Drinking Water Act (SWDA), 2002,*** and its regulations impose a licensing/certification regime for drinking water providers. Through SDWA changes, water taking rules have been redrafted to protect water supplies. Reviews of PTTWs now have a greater emphasis on environmental considerations such as the potential for proposed taking to impact natural water flows, fish habitats, water levels and water budgets and on the inter-relation between groundwater and surface water. This is in addition to ensuring that conservation programs have been applied in the existing water taking and future water supply planning.
- The ***Sustainable Water and Sewage Systems Act (SWSSA), 2002,*** and its associated regulations require municipalities to develop full-cost recovery plans and set their water and wastewater rates accordingly. The cost recovery plans are to be based on asset management plans, as required by the SDWA and must be certified by a professional engineer.
- The ***Nutrient Management Act (NMA), 2002*** and its regulations require farm operators to develop nutrient management strategies as part of source water protection. The legislation, and source protection in general, has an impact on the quality of source water for municipal drinking water, and therefore on their costs to treat it. As part of Ontario's Clean Water Strategy, this Act was designed to reduce the potential for water and environmental contamination from some agricultural practices. The Nutrient Management Act also

provides standards for nutrient storage and how nutrients are applied to farmland, in order to reduce the likelihood of ground or surface water contamination.

- The ***Great Lakes – St. Lawrence River Basin Sustainable Water Resources Agreement (December 2005).*** The Great Lakes Charter Annex agreements are intended to implement the 2001 Great Lakes Charter Annex, in which Ontario, Quebec and the eight Great Lakes States (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin) committed to protect and manage the waters of the Great Lakes and the St. Lawrence River Basin through agreements that set a common standard decision basis for proposed water uses. Ontario has already passed strict laws banning water diversions. The province has also introduced tough rules for water taking and stronger conservation measures. Through the Charter Annex agreements, the province will continue its ban of water diversions and will further advance its programs to protect Ontario water resources. The Great Lakes Agreement will restrict the development of Great Lake water supply systems and imposes conditions on how and when the Great Lakes may be used as a source.
- The ***Safeguarding and Sustaining Ontario's Water Act, 2007*** is intended to amend the Ontario Water Resources Act to safeguard and sustain Ontario's water, to make related amendments to the Safe Drinking Water Act, 2002 and to repeal the Water Transfer Control Act.
- The ***Clean Water Act (CWA), 2007*** is intended to ensure communities are able to protect their municipal drinking water supplies, as well as non-municipal supplies where added by municipalities or the Minister, now and in the future from overuse and contamination, through locally developed science-based source protection plans. The Act substantially implements the drinking water source protection recommendations made by Justice Dennis O'Connor in Part II of the Walkerton Inquiry Report. Municipalities are primarily responsible for the implementation and enforcement of the Source Protection Plan using existing powers, including those under the Planning Act and Municipal Act, as well as the CWA.

The Grand River Source Protection Plan is a document that sets out the policies to protect sources of drinking water against threats identified in an Assessment Report. The Plan sets out how drinking water threats will be reduced, eliminated or monitored, who is responsible for taking action, timelines, and how progress will be measured. Implementation of the Source Protection Plan is led by municipalities in most cases. In some cases, conservation authorities, public health units, or other organizations may be involved in implementing Source Protection Plans. The implementers use a range of programs and tools, including instruments or mechanisms such as zoning by-laws, and amendments to the Official Plans, or voluntary initiatives, if appropriate. Actions are mandatory for significant risks. Risk management plans are required for some activities and land uses within designated municipal wellhead protection areas deemed to be significant threats, in order to reduce their risk to the municipal drinking water source.

The Source Protection Committee has identified the potential risks to local water sources and the Source Protection Plan is designed to reduce or eliminate these risks. The overall objective of the Lake Erie Region Source Protection Committee, in partnership with local communities and the Ontario government, is to protect the quality and quantity of present and future sources of municipal drinking water in the Lake Erie Source Protection Region. The City of Guelph together with surrounding municipalities and the Grand River Conservation Authority participated on this committee in development of the Source Protection Plan in order to:

- propose policies that are environmentally protective, effective, economical, and fair to local communities;
- develop policies that are practical and implementable, and that focus limited resources on areas that net the greatest benefit, while recognizing that the plan must address significant threats so that they cease to exist;
- develop policies and programs that provide a benefit to broader protection of water quality and quantity; and

  - assess drinking water threats and issues based on the best available science, and where there is uncertainty, to follow a precautionary approach.

  Guelph-specific Source Water Protection policies for water quality were presented and endorsed by the City Council on February 4, 2013. These policies were rolled up into the Grand River Source Protection Plan which forms part of the Lake Erie Region Source Protection Plan. The Lake Erie Region Source Protection Plan has been approved and the most recent update came into effect February 3, 2021. The MECP developed a list of prescribed drinking water threats. The Guelph-specific policies in the approved Plan address 19 of the 21 prescribed drinking water threats, specifically those related to water quality threats. The two remaining threats are water quantity threats, and the City is currently working on updates to the plan to address the potential water quantity impacts identified through the Tier Three Water Budget Study.

- The ***Water Opportunities and Conservation Act, 2010*** is to foster innovative water, wastewater and stormwater technologies, services and practices in the private and public sectors; to create opportunities for economic development and clean-technology jobs in Ontario; and to conserve and sustain water resources for present and future generations.
- The ***Canadian Environmental Assessment Act, 2012*** requires municipal groundwater takings that qualify as a "designated project" based on the project descriptions listed in the Regulations Designating Physical Activities to undergo a federal environmental assessment process if the Canadian Environmental Assessment Agency (CEAA) determines that a federal environmental assessment (EA) is required. There are limited circumstances that would trigger such a requirement. The City could be subject to the Act and required to undertake a federal environmental assessment for new groundwater wells that would result in a taking in excess of 200,000 m^3/year or an expansion of a groundwater extraction well/facility that would increase production capacity by more than 35% (groundwater taking). There is a decision making step that requires the further review of a project by CEAA to determine if it

will be required to undergo a federal EA. A proponent is required to submit a project description for a designated project to CEAA that includes mandatory information about the project and potential environmental impacts as set out under the Prescribed Information for the Description of a Designated Project Regulations. This consists of a general description of the project and a description of the potential environmental effects relating only to areas of federal jurisdiction: With this information, CEAA will then conduct a screening to determine whether an environmental assessment of the designated project will be required. If a federal EA is required, the process would require similar scope, time and resources to complete to a provincial individual environmental assessment under Part II of the Environmental Assessment Act (Ontario).

- The Province of Ontario ***A Place to Grow: Growth Plan for the Greater Golden*** **Horseshoe, 2020*;*** places priority on intensification of existing developed areas over greenfield development. The City of Guelph is located within the jurisdiction of the Growth Plan in the "Outer Ring" of the western region of the Greater Golden Horseshoe (G.G.H.). The Growth Plan is intended to "support economic prosperity, protect the environment, and help communities achieve a high quality of life." The August 2020 office consolidation extends and updates population and employment projections to 2051. All municipalities within the Growth Plan area were required to bring their official plans in conformity with the amendment by July 1, 2022. Schedule 3 of the August 2020 Growth Plan forecasts Guelph's population and employment base to reach 203,000 and 116,000, respectively by 2051.

2.3 Natural Environment

2.3.1 Natural Heritage Systems

This section presents the natural heritage features such as wetlands, watercourses, fisheries, Species at Risk, and Areas of Natural and Scientific Interest within the study area. Due the conceptual nature of this WSMP Update, existing information was referenced to determine the location of

natural heritage areas generally present within the study area rather than associated with a specific site. The following documents were reviewed:

Official Plans

- City of Guelph Official Plan
- Wellington County Official Plan

Other Documents

- City of Guelph Natural Heritage Strategy
- Grand River Conservation Authority website
- Soil Survey of Wellington County
- Ontario Reptile and Amphibian Atlas
- Ontario Butterfly Atlas
- Department of Fisheries and Oceans Species at Risk Mapping
- Ministry of Natural Resources and Forestry, Natural Heritage Information Centre website
- Wellington County website Interactive Mapping Tool
- Atlas of the Breeding Birds of Ontario
- Mammals of Ontario
- iNaturalist Online

The study area (**Figure 2-1**) consists of the City of Guelph and its immediate neighbouring municipalities within Wellington County (Puslinch Township, and Guelph/Eramosa Township) in which existing and proposed water supply alternatives may be considered.

The following provides a general description of the natural environment within the study area. Each individual Class EA for the identified water supply alternatives will include a more detailed review utilizing Wetland Evaluations, Environmental Significant Area Reports and Fisheries Information. Further details along with the referenced extracts from Official Plan documents can be found in **Appendix A**.

City of Guelph

As noted in the Natural Heritage Strategy, with a total coverage of approximately 22%, the City of Guelph contains a fairly diverse natural heritage system comprised primarily of wetland complexes, woodlands and ravines associated with the City's river systems (City of Guelph, 2018). The City of Guelph includes the following natural heritage features:

- Five Subwatershed/Watershed Areas:
    1. Schneider Creek-Grand River;
    2. Ellis Creek-Speed River;
    3. Eramosa River;
    4. Guelph Line-Speed River; and
    5. Mill Creek-Grand River.
- Three Areas of Natural and Scientific Interest (ANSIs):
    1. Paris Moraine Provincial Earth Science;
    2. Guelph Correctional Centre Quarry Provincial Earth Science; and
    3. Guelph Interstadial Site Regional Earth Science.
- Ten Provincially Significant Wetlands (PSWs) Complexes (partially or entirely within the Study Area):
    1. Clythe Creek Wetland Complex;
    2. Ellis Creek Wetland Complex;
    3. Eramosa River Blue Springs Creek Wetland Complex;
    4. Guelph Northeast Wetland Complex;
    5. Halls Pond Wetland Complex;
    6. Hanlon Creek Swamp;
    7. Marden South Wetland Complex;
    8. Mill Creek Puslinch Wetland Complex
    9. Speed River Wetland Complex; and
    10. Torrance Creek Swamp.
- One Locally Significant Wetland (LSW):
    1. Guelph Southwest Wetland Complex.

- The Speed, Eramosa, Hanlon, Torrance, Clythe and Ellis River Systems;
- Several Locally Significant Woodland Areas (i.e., of 1 hectare or greater); and
- Large areas of what are currently identified as ecological corridors, buffers and linkages (i.e., 'Other Natural Heritage Features' in the Official Plan, March 2018 consolidation).

Within and surrounding the City, a total of 58 species listed as Endangered, Threatened or Special Concern (referred to as Species at Risk [SAR]) under the Endangered Species Act, 2007 (ESA) have been recorded. Species that have been observed more recently in the last 20 years within the City of Guelph include: Least Bittern (*Ixobrychus exilis*), Prothonotary Warbler (*Protonotaria* citrea), Butternut (*Juglans cinera*), Blanding's Turtle (*Emydoidea blandingii*) and Redside Dace (*Clinostomus elongatus*).

As stated in the City of Guelph's Official Plan, the protection and enhancement (where appropriate) of natural heritage features and their associated ecological functions is required. Natural heritage features are defined as areas containing significant wetlands and other wetlands, significant habitats of endangered and threatened species, significant ANSIs, surface water features and fish habitat, significant woodlands, significant landform, significant valleylands, ecological linkages and significant wildlife habitat, restoration areas, habitat of significant species and cultural woodlands.

A copy of Schedule 4 "Natural Heritage Features and Development Constraints", from the City Guelph's Official Plan as well a copy of Schedule 2 "Land Use Plan" is provided in **Appendix A**.

Wellington County

The topography and geology of Wellington County on a whole is made up of elongated hills, known as drumlins. These occupy much of the southern and northern parts of Wellington County, while the central part consists of undulating moraine. In general, the land slopes from east to west and from north to south. Some of the drainage features include the Grand, Speed and Eramosa Rivers, the Grand being the most prominent. Guelph Lake, a result of the construction of Guelph Lake Dam in 1974, is located north of the City.

Loam textured till materials predominate in the northern and southern ends of the County. The till plains in these areas are drumlinized and contain many low broad oval hills with smooth slopes that are characteristic of drumlins.

A total of 58 SAR are known to occur within Wellington County. In addition to this, one species that has been designated as Special Concern by the Committee on the Status of Endangered Wildlife in Canada but has no status in Ontario is also known to occur within Wellington County.

Natural heritage features are located throughout the County and include PSWs, LSWs, unevaluated wetlands, ANSIs and woodlands.

A copy of Appendix 1 "South Wellington Watershed Study Areas" and Appendix 3 "Provincially Significant Wetlands" is provided in **Appendix A**.

2.4 Social/Cultural and Built Environment

The Social/Cultural and Built environments are considered in the evaluation of water supply alternatives referencing the following considerations.

2.4.1 Municipal Growth Targets

The City of Guelph forms part of one of the fastest growing regions in the Province of Ontario, and has experienced considerable growth during the last decade. Defining growth, where it will occur and to what extent, will have a significant impact on the WSMP.

The Province's Places to Grow Plan designated Guelph as an Urban Growth Centre, and prescribed population and employment projections, and intensification and Greenfield density targets for Guelph/ Wellington County and 24 other Greater Golden Horseshoe municipalities (see Section 2.3 and Province of Ontario ***A Place to Grow: Growth Plan for the Greater Golden*** **Horseshoe, 2020)**. The Guelph Growth Management Strategy was a detailed strategy to implement the City's vision to encompass Growth Management Policies consistent with the Provincial Places to Grow requirements to be incorporated into the City's Official Plan. This strategy included completing background research, including several significant studies examining environmental, social/cultural and economic parameters of growth. The City has also completed several public engagement sessions with the Guelph community and on-going discussions with government

partners, the surrounding municipalities around Guelph and the Provincial Government. The City Council received the final phase of the strategy, the implications of the growth plan, in 2009. The growth plan is being implemented through the recent City's Official Plan update, which includes a municipal comprehensive review. The update process must consider the growth plan targets to 2051 and be completed by July 1, 2022.

For the evaluation of alternative solutions, the ability to meet municipal growth management targets was considered in a broad sense (i.e., ability to supply water to meet planned growth).

2.4.2 Land Use

Land use impacts relate to potential positive and negative impacts as part of the implementation of alternative solutions. These impacts include consideration of potential effects from construction and operations on residents, businesses, agricultural, cultural/heritage (i.e., archaeological) and/or tourist and recreational resources. The evaluation in turn may also include short- and long-term impacts to groundwater and surface water users as well as individual residents and surrounding communities.

The ***Clean Water Act (CWA), 2007*** is intended to ensure communities are able to protect their municipal drinking water supplies, as well as non-municipal supplies where added by municipalities or the Minister, now and in the future from overuse and contamination, through locally developed science-based source protection plans. The CWA substantially implements the drinking water source protection recommendations made by Justice Dennis O'Connor in Part II of the Walkerton Inquiry Report.

Municipalities (and Conservation Authorities, where appointed) are primarily responsible for the implementation and enforcement of the Source Protection Plan using existing powers, including those under the Planning Act and Municipal Act, as well as new Part IV powers under the CWA.

The Source Protection Plan is a provincially approved document that sets out the policies to protect sources of drinking water against threats and activities identified in an Assessment Report. The province has identified 22 "prescribed drinking water threats" under the CWA and associated regulations. Threats are classified as significant, moderate, or low,

depending upon the location, of the activity relative to a municipal drinking water system and the quantity or volume of the threat of concern. Significant drinking water threats must be managed under the CWA.

The Source Protection Plan sets out how drinking water threats will be reduced, eliminated, or monitored, who is responsible for taking action, timelines, and how progress will be measured. Implementation of the Source Protection Plan, once it has been approved by the Minister of the Environment, is led by municipalities in most cases. In some cases, conservation authorities, public health units, or other organizations may be involved in implementing Source Protection Plans. The implementing bodies will be able to use a range of policy tools, including instruments or mechanisms such as zoning by-laws, and amendments to the Official Plans, or voluntary initiatives, if appropriate. Risk Management Plans may be required for certain threat activities within designated municipal wellhead protection areas deemed to be significant threats, in order to reduce their risk to the municipal drinking water source.

The Source Protection Committee, comprised of municipal, business and industry representatives and public interest organizations, in consultation with the municipalities developed a set of Source Protection Plan policies to manage the threats on the landscape. The overall objective of the Lake Erie Region Source Protection Committee, in partnership with local communities and the Ontario government, is to protect the quality and quantity of existing and future sources of municipal drinking water in the Lake Erie Source Protection Region. The City of Guelph together with surrounding municipalities and the Grand River Conservation Authority participated on this committee in development of the Source Protection Plan in order to:

- propose policies that are environmentally protective, effective, economical, and fair to local communities;
- develop policies that are practical and implementable, and that focus limited resources on areas that net the greatest benefit, while recognizing that the plan must address significant threats so that they cease to exist;
- develop policies and programs that provide a benefit to broader protection of water quality and quantity; and

- assess drinking water threats and issues based on the best available science, and where there is uncertainty, to follow a precautionary approach.

Guelph-specific Source Water Protection policies for water quality were presented and endorsed by the City Council on February 4, 2013. These policies were rolled up into the Grand River Source Protection Plan which forms part of the Lake Erie Region Source Protection Plan. The Lake Erie Region Source Protection Plan was approved by the Minister of the Environment on July 1, 2016, and has been updated on a regular basis since. The Grand River Source Protection Plan is available online at*: https://www.sourcewater.ca/en/source-protection-areas/Grand-River-Source-Protection-Plan.aspx*.

As part of The Sourcewater Protection program, the MECP developed a list of "prescribed drinking water threats". A significant drinking water threat requires action to reduce the risk of impact to drinking water sources. Significant drinking water quality threats were identified in the Grand River Assessment Report, and the Grand River Source Protection Plan was then prepared to address those threats through a variety of Source Protection Plan policies.

The Guelph-specific policies in the Approved Source Protection Plan address 19 of the 21 prescribed drinking water threats, specifically those related to water quality threats. The two remaining prescribed drinking water threats are categorized as water quantity threats. The City is currently working to develop a set of water quantity policies, that upon approval by the province will be added to the Source Protection Plan to address the potential water quantity impacts identified through the Tier Three Water Budget Study.

As outlined in Appendix C of the Municipal Engineers Association (MEA) Municipal Class Assessment March 2015 Proposed Amendments as follows:

> *Projects Located Within A Vulnerable Area:*
>
> *Projects being proposed in a vulnerable area may pose a risk to drinking water and may be subject to policies in a source protection plan. When projects are proposed within a vulnerable area, the policies in source protection plans must be considered and the impact of the policies on those who may need to implement the policies or those who are otherwise impacted (e.g., landowners) should be given*

adequate consideration during the planning stage. Proponents undertaking a Municipal Class EA project must identify early in their process whether a project is or could potentially be occurring within a vulnerable area; this would fall within Phase 1 of the Class EA process and must be clearly documented in the project file or Environmental Study Report (ESR), as may be appropriate.

Projects that create new or amended vulnerable areas:

For any proposed projects that alter or result in new vulnerable areas, the vulnerable areas will have to be incorporated into updated Source Protection Plans/Assessment Reports. Examples of such projects include but are not limited to: municipal well or surface water intake (existing or draw on a new source of drinking water), new storm sewersheds due to new development (which can expand an intake protection zone). When this happens, landowners within new or amended vulnerable areas (IPZs or WHPAs) will be subject to source protection plan policies. These policies may impact existing or proposed land uses and the activities carried out by landowners. To fully understand the impact of establishing a new or expanded drinking water systems, it is recommended that the technical work required by the CWA to identify the vulnerable areas and potential drinking water threats be undertaken concurrently with the Municipal Class EA process. This will facilitate the assessment of potential impacts and allow a more comprehensive consultation process with potentially affected stakeholders. Coordinating this work will also expedite Source Protection Plan/Assessment Report amendments to incorporate the new system or any changes to existing systems that may be required. It will also minimize the likelihood of Municipal Class EA proponents having to amend completed Municipal Class EA projects to reflect the technical work required by the CWA.

The City of Guelph understands that the above approach must be considered, now that the Clean Water Act is in place. We also understand that changes in the vulnerable areas will be a function of the location of any new water supply and the anticipated pumping rate. Only then can a municipality understand the potential changes in the WHPA-footprint and potential impacts on land use and activities which become part of the new vulnerable area.

The Source Protection Plan policy implications for a given property are quite variable and dependent upon several factors, including: the nature of the activities and circumstances taking place on the property, the WHPA zone(s) that the property is in and the vulnerability score(s) within the property. Prohibition policies in the Source Protection Plan for Guelph are limited and restricted to WHPA-A, where such activities and circumstances present the greatest threat to the drinking water supply. A risk management plan may be required in certain cases associated with handling and storage of DNAPLs, fuels and organic solvents or fertilizers and pesticides, typically associated with industrial or commercial business operations.

The City of Guelph will take a phased approach to any proposed additional drinking water supply well. The vulnerable area will need to be determined for each new water supply and appropriate consultations will be required with the landowners once the details outlined above are available.

The Planning Act requires municipalities to prepare an Official Plan which defines local land use. An Official Plan is a document, adopted by the Council of the municipality and approved by the Ministry of Municipal Affairs and Housing (MMAH) or their delegate under Section 17 of the Planning Act. As such, an Official Plan, once approved by the Minister, is a legal document that requires compliance for municipal land use activities and initiatives. Municipalities use Official Plans to guide land use decisions based on land use designations and policies. The Planning Act also requires that each municipality periodically (every five years) review its Official Plan to ensure that it is up to date, reflects community needs and values, and conforms to the current legislative environment and policies.

2.4.3 Education Programs

Various alternative solutions can provide the opportunity to be combined with water conservation, efficiency and management initiatives that have a positive impact on servicing approved growth and managing natural resources. The nature of (e.g., partnerships) and the degree to which an alternative provides educational opportunities were considered.

2.5 Economic/Financial Considerations

Economic/financial impacts are also a consideration to be taken into account when evaluating various water supply alternatives. Estimated capital costs

were determined based on current tender and/or material cost information for relative comparison amongst the various water supply alternatives. The cost comparisons were done on a total estimated capital cost and cost per cubic-metre-per-day capacity basis.

Operating and maintenance costs were also estimated to develop life cycle costs for each proposed water supply alternative, for relative comparison between alternatives. Overall, economic/financial considerations were just one of a number of criteria that were assessed for overall preferred alternative identification purposes.

2.6 Legal Jurisdiction

Legal jurisdictional issues were also considered given the potential effects that groundwater taking, or other water alternatives may have on areas outside the current City boundaries. As such, alternatives were assessed with respect to implementation outside the City boundary, and the added complexity and approvals that may be required, and the potential to share control and resources if implemented. In this context each alternative was assessed in terms of location inside or outside of City boundaries, relative land and/or easement requirements, right-of-way needs, etc. and related costs, where possible. With respect to Source Water Protection implications, potential effects on agricultural operations and other land uses were also considered for water supply alternatives outside of the City.

2.7 Technical

Technical considerations included the capability of each alternative to meet the water supply requirements from a technical feasibility perspective. These factors range from the reliability and history of a specific technology, to constructability, (e.g., ease of implementation, capability of expansion, flexibility in operation, etc.). Therefore, the criteria included within this category include:

- The ability to implement an alternative. This criterion could be impacted by ease of approvals, and the need to satisfy regulatory requirements, and the need for modifications to existing facilities to accommodate the alternative;

- Maintaining operation during construction and considering impacts to existing infrastructure (e.g., existing wells, the aqueduct, etc.), and maintaining service to City residents and businesses;
- Minimizing disruptions/downtime by taking into consideration required changes to existing infrastructure to implement;
- Constructability to reflect ease of construction, and impacts to operations;
- Scheduling and timing to confirm whether an alternative can be brought online in a timely manner to meet possible demand;
- Water quality and related requirements for treatment. The treatment requirement for each alternative varies depending on the source. Within the groundwater sources, there are some wells with better water quality than others. Surface water generally requires the greatest degree of treatment;
- Allowances for future treatment needs. With increasingly stringent drinking water standards, any treatment process implemented will need to be flexible to accommodate future processes;
- Expandability and ability to increase the capacity of an alternative solution if additional source water is available; and
- The ability of an alternative to use existing infrastructure. This criterion reflects the opportunity to reuse existing buildings, distribution systems and storage. It also infers how well an alternative could be integrated to complement other alternatives.

3. Population and Water Supply Demand Projections

This section presents the population projection and future water supply requirements (demand projections or an estimate of the volume of water that the City will need to provide customers in the future) used for this Water Supply Master Plan Update.

During the WSMP Update Report public review period, Puslinch and Guelph/Eramosa Townships requested that the City consider future growth and associated water demand projections for the Townships within the updated WSMP. The City requested that the Townships and/or County provide information on the potential population growth and the related future water demands and the distribution of the demands in the Townships. With the timing of this final report, the City information request was still outstanding, and the County/Townships have committed to providing the information when it is available. Therefore, there is currently insufficient information to incorporate this data into the Final WSMP Update Report; however, the City will review the data when it is provided and incorporate it into future modeling exercises, including for the Southwest Guelph Water Supply Class Environmental Assessment and the next WSMP Update.

3.1 Population Projections

3.1.1 Historical Population Data

Historical serviced population and employment (job) rates within the City between 2010 and 2019 (inclusive), are presented in **Table 3-1**. The serviced population consists of households to which the City's Water Services Department provides treated water (i.e., connected to the municipal distribution system).

Table 3-1: Historical Population and Employment Rates

Year	Population	Employment
2010	125,332	74,200
2011	127,305	75,000
2012	128,599	76,000
2013	130,669	77,000
2014	133,231	78,000
2015	134,654	79,000
2016	136,325	79,600
2017	138,375	80,500
2018	140,015	81,150
2019	141,963	82,250

3.1.2 Population Growth Targets

Two future population and employment growth scenarios were considered when developing the demand forecasts for the WSMP Update, including:

1. The "reference" growth scenario, which reflects *expected* population and employment growth rates based on the Province of Ontario's August 28th, 2020 report **A Place to Grow Growth Plan for the Greater Golden Horseshoe** (P2G), Schedule 3, Distribution of Population and Employment for the Greater Golden Horseshoe, i.e., a 2051 residential population and employment population in the City of 203,000 and 116,000, respectively.

2. The "low" growth scenario, which reflects slightly lower population and employment growth rates based on Hemson Consulting Ltd.'s August 26th, 2020 technical report **Greater Golden Horseshoe: Growth Forecasts to 2051**, i.e., a 2051 residential population and employment population of 198,000 and 115,000, respectively.

Ultimately the province limited the growth targets in the final P2G report to the "reference" growth scenario. In addition, the initial analysis of potential additional water supplies indicated that the availability of sufficient water supply was not anticipated to limit the "reference" growth scenario. As such, the "low" target is not discussed further herein.

3.1.2.1 Reference Population Growth Scenario

Table 3-2 presents projected "reference" residential population and employment population rates between 2020 and 2051, based on the 2051

P2G values of 203,000 and 116,000, respectively and an assumed linear growth rate between 2019 and 2051.

The COVID-19 pandemic occurred during the WSMP Update project and has introduced uncertainty in terms of anticipated growth rates from year to year within the planning period. The necessary data required to assess the impact, if any, was not available during the project but will be incorporated into subsequent master plan updates.

Table 3-2: Projected "Reference" Growth Population and Employment Rates

Year	Population	Employment
2020	143,870	83,305
2021	145,777	84,359
2022	147,685	85,414
2023	149,592	86,469
2024	151,500	87,523
2025	153,407	88,578
2026	155,314	89,633
2027	157,222	90,688
2028	159,129	91,742
2029	161,037	92,797
2030	162,944	93,852
2031	164,852	94,906
2032	166,759	95,961
2033	168,666	97,016
2034	170,574	98,070
2035	172,481	99,125
2036	174,389	100,180
2037	176,296	101,234
2038	178,204	102,289
2049	180,111	103,344
2040	182,018	104,398
2041	183,926	105,453
2042	185,833	106,508
2043	187,741	107,563
2044	189,648	108,617
2045	191,555	109,672
2046	193,463	110,727
2047	195,370	111,781
2048	197,278	112,836
2049	199,185	113,891
2050	201,093	114,945
2051	203,000	116,000

3.2 Water Production Rates and Demand Projections

3.2.1 Basis for Projections

The projections for future water supply requirements were developed by evaluating recent customer water demands within the City, evaluating how these demands may change in the future, and applying the resulting daily demand estimates to the population forecast discussed in the previous section.

3.2.1.1 Historical Water Production Rates and Demand Data

Table 3-3 presents average annual day (AAD) water production rates in the City for the years 2010 to 2019 inclusive. AAD water production is the total volume of water produced by the City each year divided by 365 days. This represents the average daily volume of water produced by the City for each year in this period of time.

Table 3-3: Historical AAD Water Production Rates, m^3/day

Water Production	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
m^3/day	48,519	47,627	45,267	44,443	45,742	46,873	46,285	46,360	47,449	47,015

Table 3-4 presents the AAD water demand of residential and industrial/ commercial/ institutional (ICI) customers in the City for the years 2010 to 2019 inclusive. AAD water demand is the total volume of water distributed to the noted customers divided by 365 days. These values are determined through a review of City billing records and represent a lower volume of water than the total amount produced or pumped (**Table 3-3**). This occurs because the City does not bill for certain types of water use, some water may not pass through a water meter (water used for fire fighting, watermain flushing, etc.), some unauthorized water use may occur, and some water is lost through system leakage. The water within this category is called non-revenue water[6] (NRW).

6. Non-revenue water is water produced by the City that does not generate revenue.

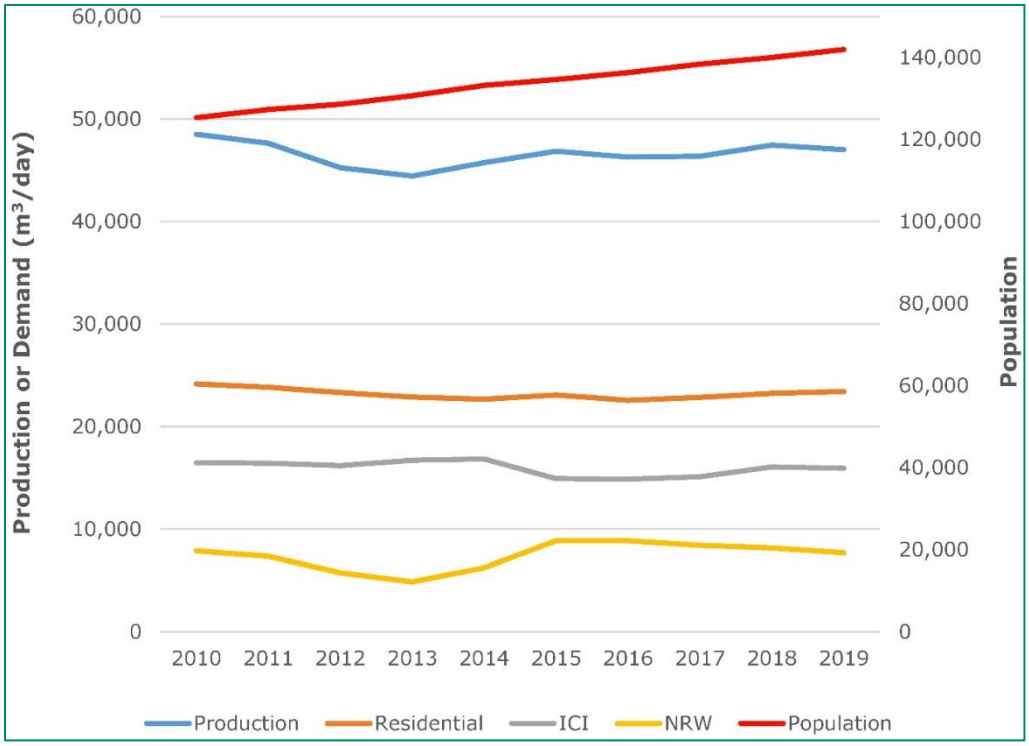
Table 3-4: Historical AAD Water Demands Based on Customer Type, m^3/day

Customer Type	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Residential	24,160	23,843	23,324	22,875	22,655	23,084	22,564	22,843	23,233	23,408
ICI	16,482	16,425	16,186	16,700	16,835	14,930	14,862	15,104	16,069	15,924
Total	**40,642**	**40,267**	**39,510**	**39,575**	**39,489**	**38,014**	**37,426**	**37,947**	**39,302**	**39,333**

Figure 3-1 illustrates historical AAD water production rates, AAD water demand rates (by customer type), NRW rates (i.e., total production (**Table 3-3**) minus total demand (**Table 3-4**)), and population values for the City between 2010-2019 inclusive. In this figure, the population values are displayed on the right-hand y-axis and the water production rates on displayed on the left-hand axis. The residential, ICI and NRW demands sum to the total production value, plotted using a blue line.

An assessment of this figure indicates that the water production, demand, and NRW rates in **Figure 3-1** remained relatively flat during this period even though the City's population increased from 125,332 to 141,963 (an increase of 13.3%).

Figure 3-1: AAD Production, Demand, NRW & Population



The annual changes in production and demand rates between 2010 and 2019 can be further assessed by converting the AAD water production and demand rates into average daily volume per capita[7] and per employee rates. In **Figure 3-2**, daily water production rates, residential demand rates, and NRW rates have been divided by the City's residential population identified in **Table 3-1**, while the ICI demand rates have been divided by the City's employment population identified in **Table 3-1**. This results in a measurement called litres per capita per day (Lcd), or the average number of litres of water used per day by each person or employee in the City for each year shown.

Figure 3-2: AAD Per Capita Water Production, Demand and NRW Rates

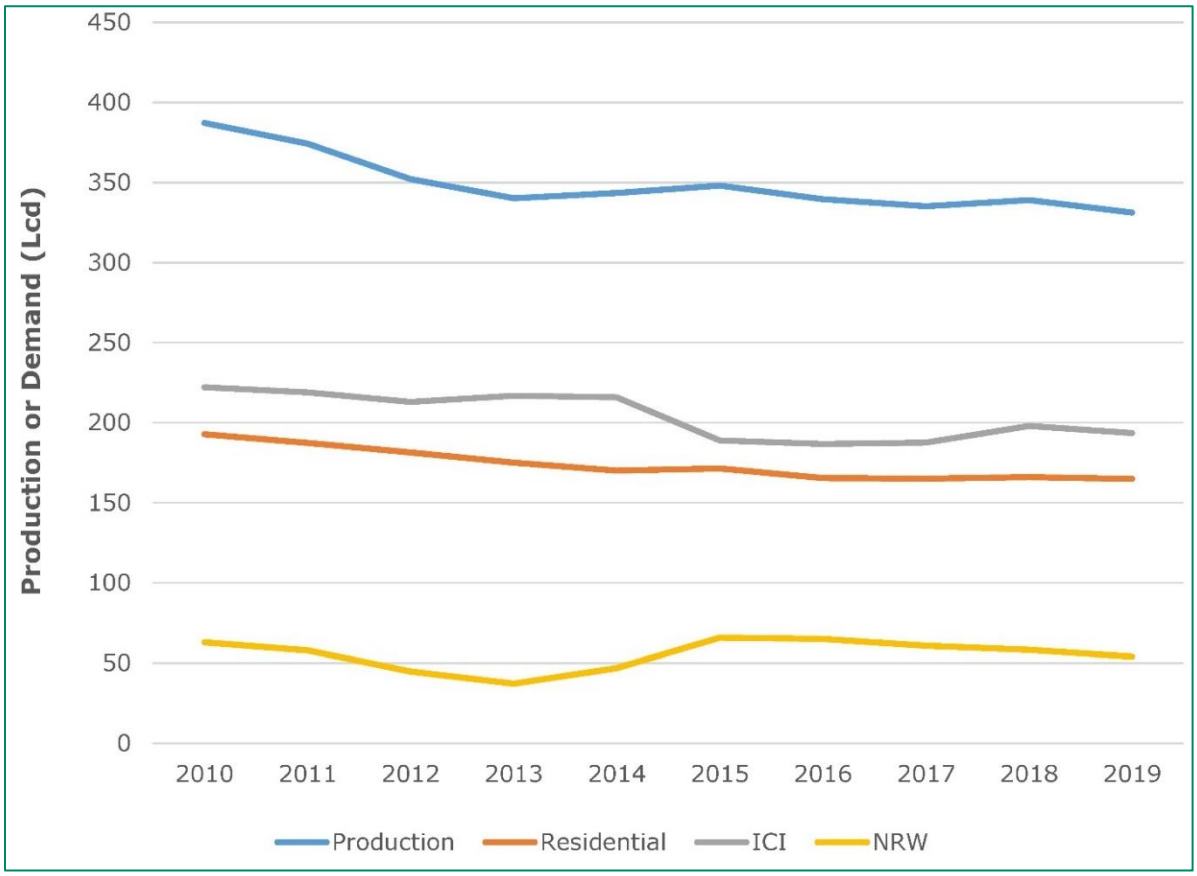


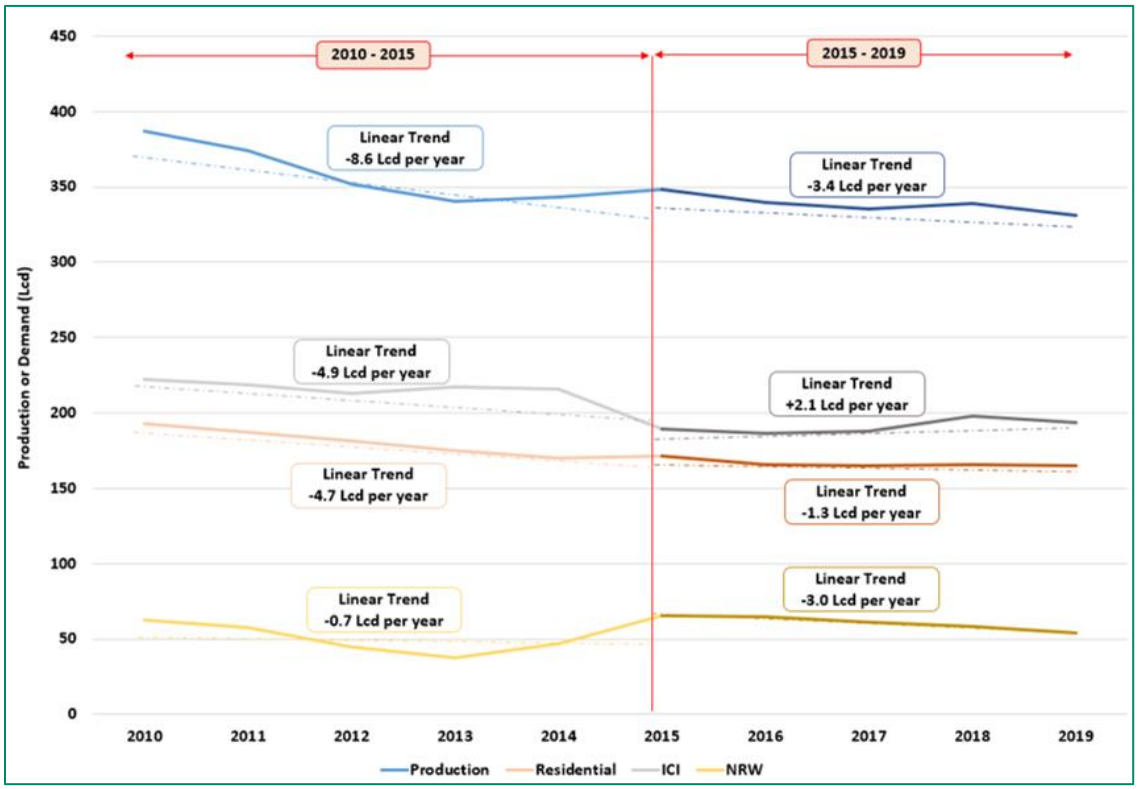
Figure 3-2 illustrates that there has been a decline in per capita water production and demand rates since 2010. **Figure 3-2** also illustrates that,

7. Per capita is the volume of water used by each person or employee in the City.

while NRW rates have fluctuated between 2010 and 2019, the per capita NRW rates in 2019 are very similar to the rates in 2010.

While per capita water production and demand rates have declined since 2010, the rate of decline was lower between 2015 to 2019 than it was from 2010 to 2015. **Figure 3-3** illustrates the average annual decline in per capita demands (based on linear trends) for the periods 2010-2015 and 2015-2019.

Figure 3-3: Average Annual Per Capita Demand Rates: 2010 to 2015 vs. 2015 to 2019



The relative 'flatness' of the per capita water production rate and both the residential and employment water demand rates from 2015 to 2019 indicates that customer water demands may be beginning to stabilize after approximately two decades of significant decline. This observation suggests that future per capita customer water demand declines associated with conservation, efficiency and demand management programming and natural water savings may be more difficult to achieve moving forward. This trend is considered in the projection of future water supply demands and when setting targets for future conservation, efficiency and demand management programming.

3.2.2 Water Supply Projections to 2051

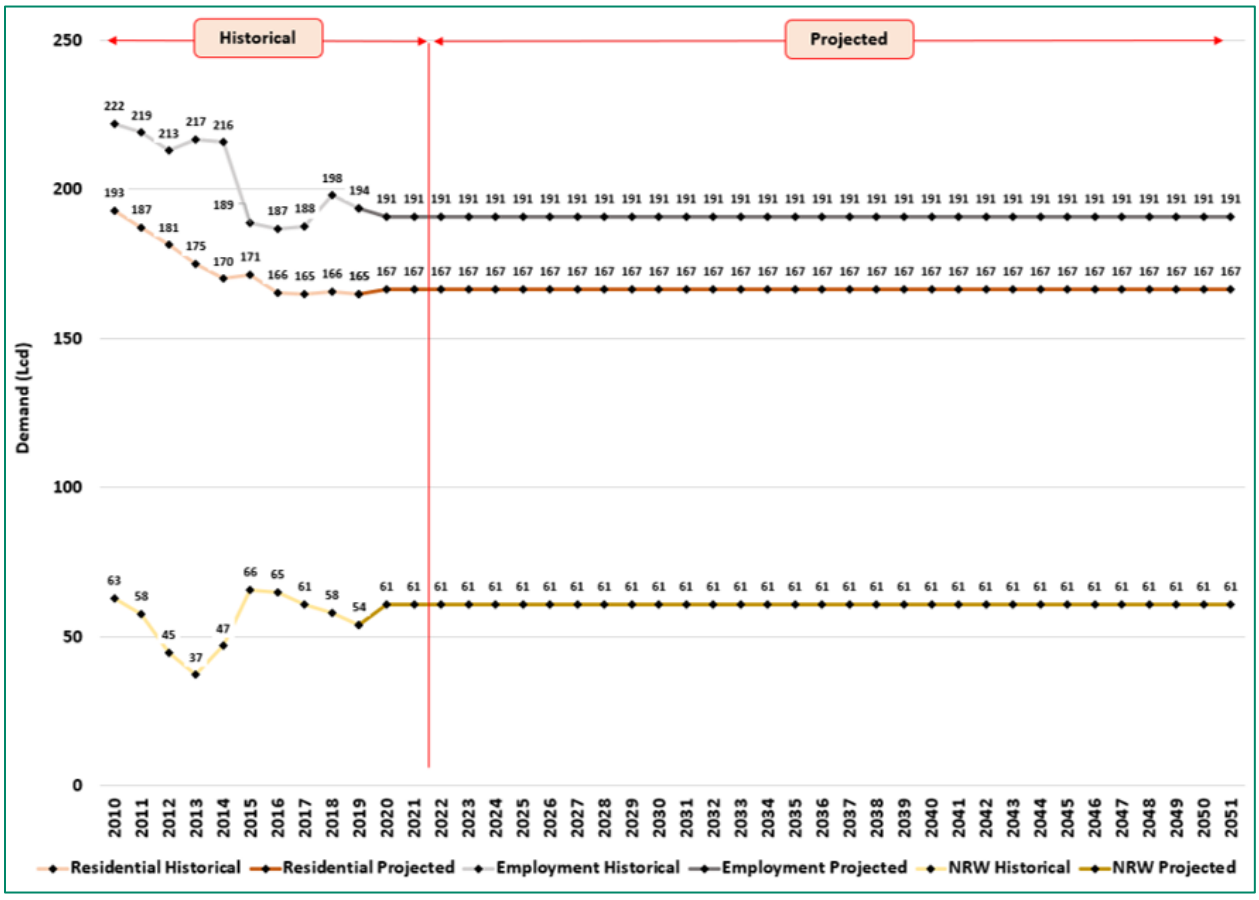
3.2.2.1 Per Capita Projections

To be conservative when projecting water demand rates to 2051, the average per capita residential, employment, and NRW demand rates between 2015 and 2019 have been applied to the years 2020 to 2051 as follows and as illustrated in **Figure 3-4**:

- Average per capita residential demand rate 2015-2019: 167 Lcd
- Average per capita employment demand rate 2015-2019: 191 Lcd
- Average per capita NRW demand rate 2015-2019: 61 Lcd

These projected demands assume that further reductions in Lcd customer demands will not occur.

Figure 3-4: Historical and Projected Per Capita Water Demand Rates



3.2.2.2 Reference Growth Water Demand Projections

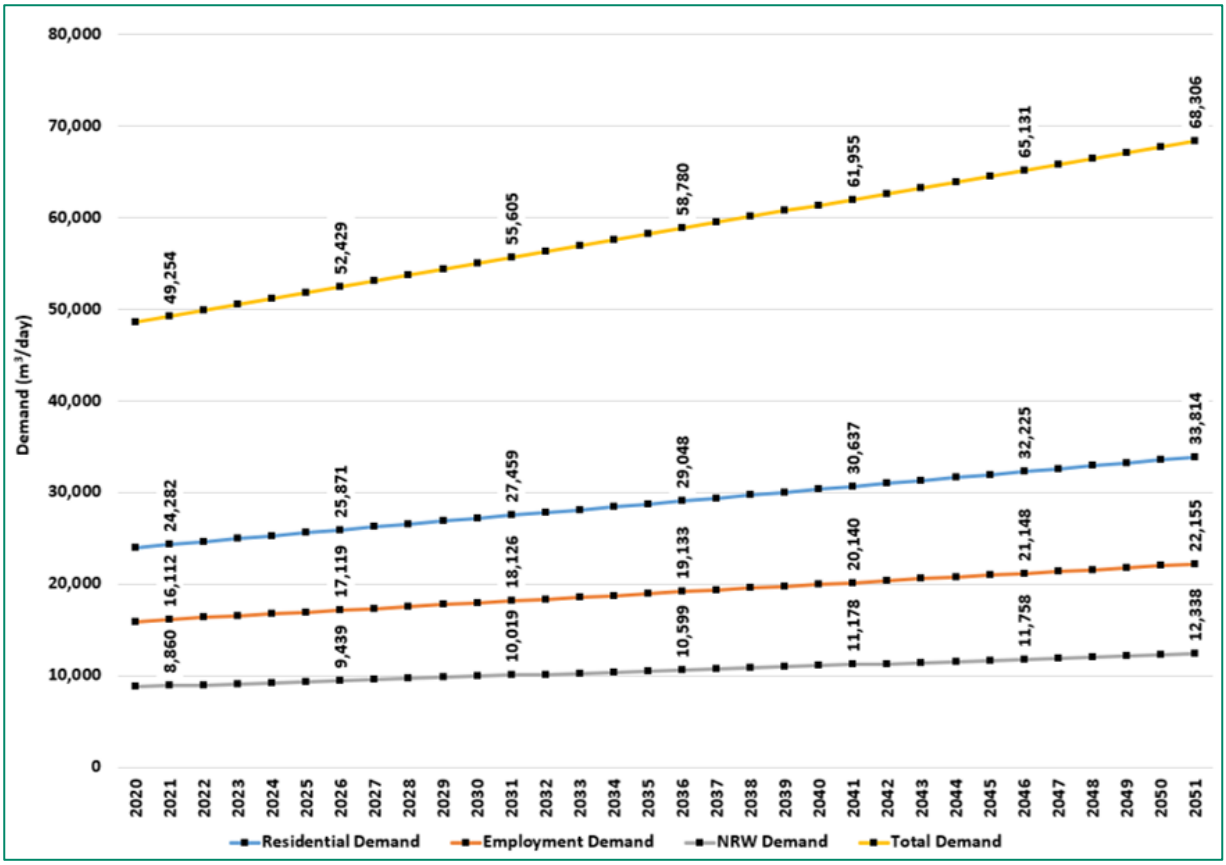
Average Annual Day Projections

The 2020 to 2051 per capita water demand values illustrated in **Figure 3-4**, along with the "reference" growth rate population and employment values in **Table 3-2**, were used to project AAD residential, employment, and NRW water demands until 2051 (**Table 3-5** and **Figure 3-5**). For clarity, the term production is used in this report to refer to historical records of City water supply production based on pumping records (i.e., total daily volume of water pumped by the City). The total demand projections presented here represent the estimated future total daily volume of water required on an average day and this total is comprised of the Residential, ICI and NRW demands.

Table 3-5: Projected Average Annual Day Water Demand – "Reference" Growth Scenario, m^3/day

Demand Type	2021	2026	2031	2036	2041	2046	2051
Residential	24,282	25,871	27,459	29,048	30,637	32,225	33,814
ICI	16,112	17,119	18,126	119,133	20,140	21,148	22,155
NRW	8,860	9,439	10,019	10,559	11,178	11,758	12,338
Total Demand	**49,254**	**52,429**	**55,605**	**58,780**	**61,955**	**65,131**	**68,306**

Figure 3-5: Projected Average Annual Day Water Demand – "Reference" Growth Scenario



Maximum Day Projections

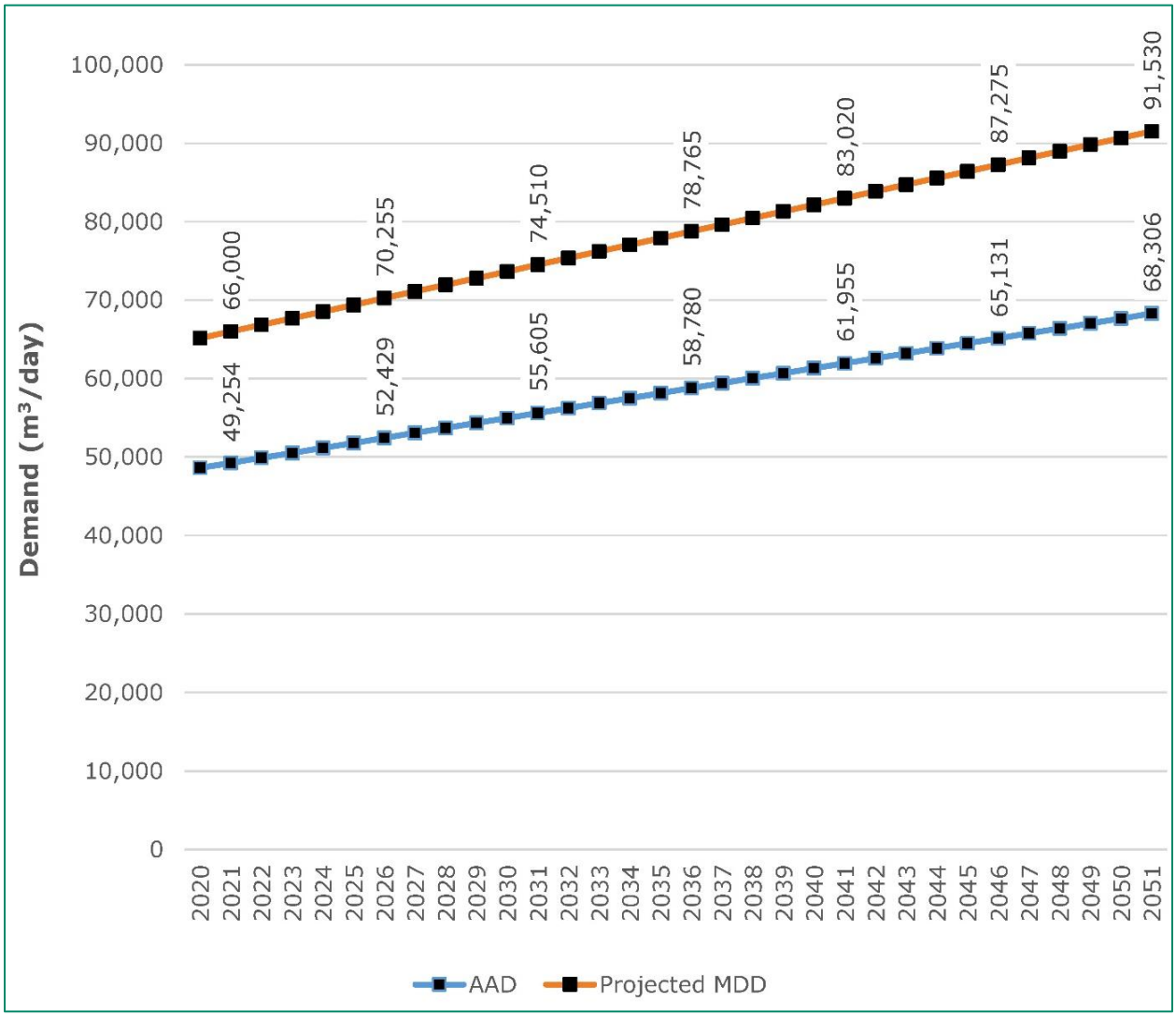
The Maximum Day Factor (MDF) for a water system is generally defined as the ratio between the water production rate on the highest single production day each year (maximum day) and the AAD production rate for the entire year, after removing extreme anomalous events. The average MDF in Guelph between 2010 and 2019 was 1.24 (i.e., the average maximum day production rate was 24% higher than the AAD production rate) and the highest ratio of 1.34 occurred in 2011.

To be conservative, a Maximum Day Factor of 1.34 was used when projecting future maximum day water demands in Guelph, i.e., the projected Average Annual Day demands identified in **Table 3-6** were multiplied by 1.34 (see **Table 3-6** and **Figure 3-6**).

Table 3-6: Total Projected Average Annual Day and Maximum Day Water Demands – Reference Growth Scenario

Parameter	2021	2026	2031	2036	2041	2046	2051
Average Annual Day Demand (m^3/day)	49,254	52,429	55,605	58,780	61,955	65,131	68,306
Maximum Day Demand using Maximum Day Factor of 1.34 (m^3/day)	66,000	70,255	74,510	78,765	83,020	87,275	91,530

Figure 3-6: Projected "Reference" Growth Average Annual Day and Maximum Day Demands



3.3 Water Demand Forecasts vs. Required Water Supply Capacity

In previous versions of the WSMP, the projected maximum day demand included the estimated residential and employment consumption and NRW, as well as a 'safety factor' to address risks to the water supply sources (i.e., groundwater aquifer, surface water lake or river), City facilities and/or distribution system. A similar assessment was completed for this WSMP Update and is presented in Section 4.2. Because the projected water demands provided in Section 3.2 do not include this safety factor, it is noted that the total future values will appear 10 to 15% lower than previous master plan projections. However, the additional facility capacity needed to address potential risks and to provide system redundancy is included in the study and is presented in Section 4.2.

For the purpose of evaluating the water supply deficit and planning for future water supply sources, the "reference" growth scenario presented above was utilized. Determination of the supply deficit is based on the projected maximum day demands as the system must be designed to meet this demand. Therefore, implementation of projects to develop the required water supply and construct the required infrastructure is planned to meet the maximum day requirements.

4. Existing Water Supply System Capacity Assessment

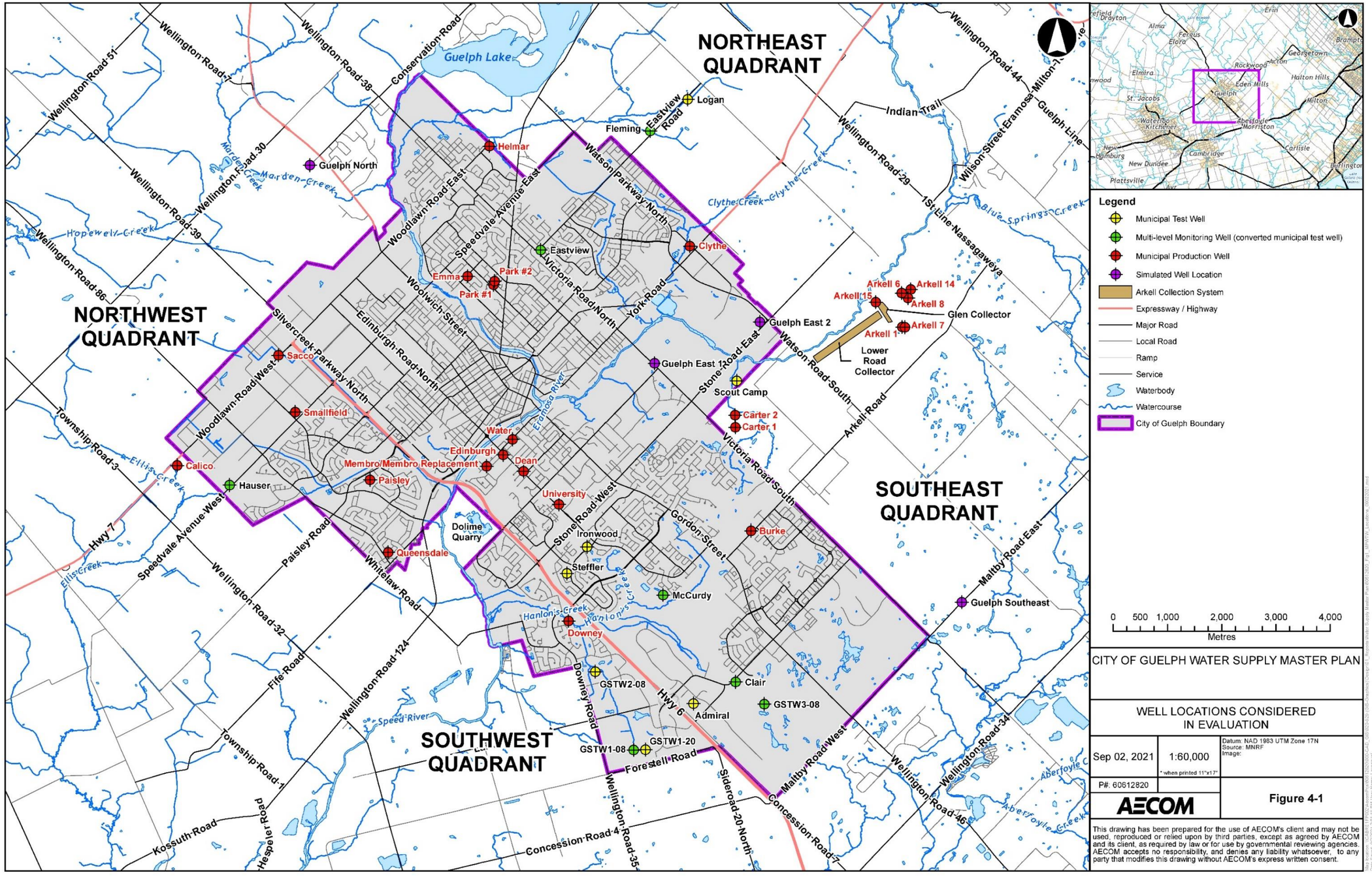
The City relies almost exclusively on groundwater to meet the residential and ICI water demands and has done so since 1908. The groundwater supply system, which comprises 25 drilled wells screened within overburden and shallow and deep bedrock aquifers, as well as one groundwater collection system located within the City and the surrounding Townships (Puslinch and Guelph/Eramosa) (**Figure 4-1**). The groundwater that supplies water to the City system is a shared resource that is utilized by the residents of Guelph, the surrounding County and Townships and the natural environment.

A detailed assessment of the capacity of the City's existing groundwater supply system was completed in 2021, which included the following components:

- Current maximum capacity of each individual groundwater supply source; including any constraints to operating at their maximum rate/volume;
- Sustainable capacity of the overall groundwater supply system; and
- Evaluation of potential risks to system operation (i.e., the Security of Supply); including the vulnerability of identified sustainable capacity from both a hydrogeological and operational perspective.

In conjunction with the above, the average (steady-state) capacity of the existing groundwater supply system was also evaluated using the Tier Three Model in an exercise referred to as a Sustainability Assessment (**Appendix B**). This evaluation considered long-term sustainable pumping rates that could be achieved at each well location, assuming that the wells are operated in parallel continuously (i.e., 24 hours per day). The model simulated interference between pumping locations and interaction with surface water features, with the objective of minimizing reductions in surface water baseflows. Results of the Sustainability Assessment are discussed in Sections 4.1.5 and 4.2.

Figure 4-1: Well Locations Considered in Evaluation



4.1 Assessment of Existing Well Capacities

Consistent with previous WSMPs, the City's groundwater supply system has been organized into the following four (4) quadrants for the purposes of this assessment: Southeast, Southwest, Northeast and Northwest. Details of the existing wells are provided in **Table 4-1**. Maximum pumping levels[8] were developed for each well through discussion with City staff, based on a number of considerations, including: well screen elevation, pump intake elevation, depth of water bearing zones, and operational considerations, where applicable.

Historical City records extending from 1997 through to 2019 for each groundwater supply source and quadrant provided daily pumping totals, monthly average of the daily pumping totals, observed groundwater elevations, MECP permitted rates, and maximum pumping elevations. Based on a review of pumping volume and groundwater elevation data, the capacity of each groundwater supply well and the collector system was re-evaluated relative to the 2014 WSMP. This re-evaluation considered:

- Long-term performance history;
- Recently demonstrated specific capacity;
- Response to previous maintenance efforts;
- Input provided by City Water Services staff;
- Review of available groundwater quality data; and
- Results of the Tier Three Study.

The Guelph and Township of Guelph/Eramosa Tier Three Water Budget and Local Area Risk Assessment (Tier Three Study) was completed under the Clean Water Act, 2006, to evaluate sustainability of the City's groundwater supply system from a quantity perspective and to identify potential threats to that sustainability (Matrix Solutions Inc., 2017). The results of this assessment were utilized to evaluate how the system may respond to concurrent pumping at higher rates than the system is currently operated at, and how the system may respond under drought conditions.

8. This is the lowest water level elevation (i.e., the maximum water level depth below ground surface) within a well where the pumping rate is considered sustainable.

Table 4-1: City of Guelph Groundwater Supply Source Details

City Quadrant	Groundwater Supply Source	Year Constructed	Pump House Floor	Well Pump Base Plate	Casing Diameter	Bottom of Casing	Liner Diameter[a]	Bottom of Liner[b]	Pump Intake Elevation	Water Bearing Zone(s)[c]	Maximum Pumping Elevation[d]	Well Depth	Permitted Rate
			(masl)	(masl)	(mm)	(masl)	(mm)	(masl)	(masl)	(masl)	(masl)	(m)	(m^3/day)
Southeast	Arkell Well 1	1966	330.2	330.6	200	321.0	-	-	317.1	321.0	319.1	14.2	3,273
	Arkell Well 6	1963	330.3	330.8	305	320.2	-	-	299.6	298.5	301.6	42.6	28,800
	Arkell Well 7	1963	330.2	330.8	381	306.7	-	-	299.8	292.2 to 286.4	301.8	41.9	
	Arkell Well 8	1963	332.4	333.0	305	320.5	-	-	301.8	295.2 to 294.2 292.2 to 288.1	303.8	42.5	
	Arkell Well 14	2000	334.3	335.1	400	309.2	-	-	306.5	306.3 to 295.7[e]	308.5	40.5	
	Arkell Well 15	2000	319.8	320.6	400	306.7	356/324	297.2	305.3	297.4 to 291.7[f]	307.2	31.9	
	Glen Collector	1908	-	-	-		-	-	-	-	-	-	25,000
	Burke Well	1966	335.6	336.1	300	314.8	-	-	300.4	314.1 to 305.1	313.1	78.9	6,546
	Carter Well 1	1962	324.6	325.0	250	320.4	200	314.9	311.0	313.2	315.0	21.9	6,547
	Carter Well 2	1962	324.6	325.0	250	317.7	-	314.1	306.5	313.0	315.0	20.4	
Southwest	Membro Well	1953	315.6	316.0	254	309.0	200	275.0	277.5	273.3 262.3	275.3	64.6	6,050
	Membro Replacement Well	2016	-	315.7	356	275.4	-	-	-	269.0 to 266.0	272.9	76.2	
	Water Street Well	1953	314.5	315.3	300	308.9	250	283.2	273.9	275.3 to 270.3	275.9	60.1	3,400
	Dean Well	1958	323.3	323.8	330	310.5	250/220	293.3	271.7	276.8 to 269.8	277.8	57.0	2,300
	University Well	1965	329.5	329.9	254	303.1	200	272.8	272.8	274.5 to 265.2	282[g]	64.8	3,300
	Downey Well	1968	317.4	318.1	305	305.3	-	-	280.3	280.6	282.3	73.8	5,237
Northeast	Park Well 1	1937	328.6	329.0	508	319.8	350	285.1	281.8	282.4 to 272.4	286.9	54.7	10,300
	Park Well 2	1947	328.3	328.7	508	319.9	350	286.0	281.4	294.3 286.2 to 270.9	283.4	48.2	
	Emma Well	1931	329.3	329.9	300	325.0	200	286.6	288.9	284.5 to 281.5	291.9	47.3	3,100
	Helmar Well	1966	344.5	345.3	305	332.5	200	317.9	297.9	315.3 293.3 to 287.3	299.9	78.9	3,273
	Clythe Well [h]	1976	326.8	N/A	300	319.4	200	300.0	N/A	304.5 298.4 282.2 to 278.2	N/A	64.0	3,395
Northwest	Paisley Well	1952	322.2	322.6	300	311.1	250	289.4	288.4	288.6	290.4	68.5	3,200
	Calico Well	1976	324.1	324.8	305	306.8		-	288.2	303.7 to 299.7	290.2	64.0	5,237
	Queensdale Well	1970	317.4	317.9	300	307.1	N/A		265.4	269.5	269.9	61.7	5,237

Notes:
a) Multiple values denotes telescoping liner.
b) Elevation of deepest liner provided for telescoping liners.
c) Data sources are as follows: Arkell Well 1 (City of Guelph); Arkell Well 6, 7, 8, 14, 15 (Golder, 2011); Burke Well (LTS, 2018a); Carter Wells 1, 2 (Golder, 2011); Membro Production Well (LTS, 1998); Membro Replacement Well (Stantec, 2016); Water St. Well (LTS, 2017d); Dean Well (LTS, 2016); University Well (Golder, 2011); Downey Well (City of Guelph); Park Wells 1, 2 (Golder, 2011); Emma Well (Golder, 2011); Helmar Well (LTS, 2018d); Clythe Creek Well (Golder, 2011); Paisley Well (LTS, 2007); Calico Well (Golder, 2011); Queensdale Well (Golder, 2011)
d) Values provided by the City of Guelph, exceptions are as follows: Burke Well (LTS, 2018a; Matrix, 2017); Membro Replacement Well (Stantec, 2016); Dean Well (LTS, 2016)
e) Six (6) discrete fracture elevations reported within noted elevation range (Golder, 2011)
f) Five (5) discrete fracture elevations reported within noted elevation range (Golder, 2011)
g) Maximum pumping level is currently maintained at 282 masl to manage interference with University of Guelph Well No. 4
h) Pump not currently installed in the Clythe Creek Well

A discussion regarding the capacity assessment for each groundwater supply source is provided below, including: i) sources with a decreased maximum capacity relative to the 2014 WSMP; and ii) recommendations for activities such as, performance testing, well rehabilitation, and/or mechanical / operational changes to confirm reported well capacity values. A discussion of groundwater quality trends for each groundwater supply source is also included within each quadrant section.

4.1.1 Southeast Quadrant Capacity Assessment

The Southeast Quadrant (SEQ) provides the bulk of the City's groundwater supply, from nine production wells and one groundwater collection system. Total daily production volumes have ranged historically between approximately 10,000 to 50,000 m^3/day. Production rates in 2019 followed this long-term trend, with a minimum daily production rate of approximately 15,400 m^3/day and a maximum of approximately 45,600 m^3/day. Active production wells/systems within the SEQ include:

- Arkell Wells 1, 6, 7, 8, 14 and 15
- Burke Well
- Carter Wells 1 and 2
- Arkell Spring Grounds Collection System (Glen Collector System)

An additional collector system on the Arkell Spring Grounds, known the Lower Road Collector, is currently off-line.

The City operates a seasonally active groundwater infiltration system that takes water from the Eramosa River and discharges it to a pond and trench system, where the water is permitted to infiltrate into the ground, thereby recharging the groundwater system. Upgrades to this system were completed in 2017, in an attempt to increase the volume of water infiltrating into the ground, so as to improve the capture efficiency of recharge water by the Glen Collector. Subsequent to these upgrades, the volume of recharge to the system and production from the Glen Collector has been relatively consistent. Overall, the average daily production rate from the Glen Collector has been nearly identical in the years 2017 to 2019 (approximately 10,500 m^3/day). These rates indicate that the upgrades have been successful when compared to the period of 2011 to 2016 where use of the recharge system and overall collector production were inconsistent.

An assessment was completed to determine the average flow rate from the Glen Collector during January and February – the two-month period with the lowest productivity on an annual basis. Available data for the years 2017, 2018 and 2019 were included in the assessment, as they represent three full years of data where the Glen Collector has operated in its current configuration. The average flow rate during these two months, over the three-year period was approximately 5,100 m^3/day. This value was carried forward within the WSMP Update as the capacity value that the system can reliably produce throughout the year under the operating conditions described above. This represents a decrease from the value of 6,900 m^3/day that was included in the 2014 WSMP.

The Carter Wells are classified as Groundwater Under Direct Influence of Surface Water With Effective In-Situ Filtration (GUDI-EF) and are permitted by MECP for a combined maximum pumping volume of approximately 6,547 m^3/day. Due to concerns related to GUDI water quality impacts, these wells have been used by the City sparingly since 2013. The groundwater quality issues identified in 2013 were attributed to influence from the adjacent Torrance Creek (Stantec, 2019). The results of testing at this site in 2018 indicated that the Carter Wells demonstrate a combined capacity of approximately 6,400 m^3/day with GUDI-EF according to the current MECP GUDI Terms of Reference (TOR). The testing program focused on raw water quality and did not assess fluctuations in water levels and flow conditions within Torrance Creek. There is uncertainty related to optimal operating conditions for the Carter wells while supporting natural creek function. This balance will be assessed by the City through an ongoing testing program that is planned to be completed in 2022. At this time, it is recommended that a conservative capacity value be assigned to the Carter wells of 5,184 m^3/day (60 L/s), representing a reduction to the value of 5,500 m^3/day, as presented in the 2014 WSMP.

Concentrations of key water quality parameters (i.e., chloride, sodium, iron, manganese and nitrate) generally have remained consistent or have decreased with time within the SEQ groundwater supply sources. The exception is the Burke Well, where concentrations of sodium and chloride have increased since 2008, likely as a result of winter road maintenance (salt application) activities in the area. Concentrations of certain metals (iron, manganese) have been variable in the Burke Well since 2017 and

have generally returned to pre-2017 concentrations based on late 2019 and early 2020 sampling results. Higher concentrations may be related to facility upgrades and related well inactivity during the upgrades. Since 2004, the concentration of nitrate in the Carter Wells has gradually decreased from approximately 10 mg/L to less than 8 mg/L and below the Ontario Drinking Water Quality Standard (ODWQS) Maximum Acceptable Concentration (MAC) of 10 mg/L.

Recent detections of Volatile Organic Compounds (VOCs) have only occurred within Arkell Well 1 [Trichloroethylene (TCE), Tetrachloroethylene (PCE) and cis-1,2-Dichloroethlyene (DCE)]. The sporadic nature and low concentrations of VOC detections at Arkell 1 suggest that the groundwater samples may have been affected by a trace source contaminating the samples, rather than a reflection of aquifer water quality. Similar spurious detections of trihalomethanes (THMs) and bromodichloromethane are indicated in the water quality record. The absence of a trend in these detections, as well as those described for Arkell Well 1 suggests that an on-going presence of these parameters should not be expected; however, continued monitoring should be completed by the City to confirm.

4.1.2 Southwest Quadrant Well Capacity Assessment

A total of six production wells are located within the City's Southwest Quadrant (SWQ), including five active wells (Membro Well, Dean Well, Water Street Well, University Well, Downey Well), and one inactive well (Edinburgh Well), as shown in **Figure 4-1**. Mutual drawdown interference is experienced to occur between some of the production wells within SWQ and the nearby River Valley Developments Quarry Site (the Dolime Quarry). Operations at the quarry require pumping of up to approximately 13,750 m^3/day (current PTTW maximum rate). This rate is known to fluctuate in response to seasonal precipitation and operational changes at the City's production wells. The City has proposed a solution to address the groundwater quantity and quality risks related to the quarry that would include the City assuming operational control of groundwater management activities on-site and engineering a system to protect the groundwater supply aquifer from surface contamination. A portion of the groundwater currently removed from the quarry site may potentially be considered for use as a municipal supply. This evaluation of the existing capacity of the SWQ wells assumes continued

operation of the Dolime Quarry water management system at current rates, as proposed future plans for the site are several years from being finalized. Depending on the final solution, well capacities in the SWQ may potentially be increased at some point in the future, and/or the capacity of municipal supply from the quadrant may be increased via direct water taking from the quarry site. Between 2001 and 2010, groundwater pumping from the SWQ wells averaged approximately 11,300 m^3/day. Pumping in the SWQ was reduced in 2011 in response to the commencement of the Arkell Operational Testing Program (OTP). Since 2012, total pumping in the SWQ has gradually increased from a low in 2011 to some of the highest values over the period occurring in 2019 (approximately 12,000 m^3/day).

A replacement well was drilled at the Membro site in 2016 and is referred to as the Membro Replacement Well (or the Rocco Well). This well was drilled to a larger diameter than the Membro Well, which has a liner that limits the size of pump that can be installed. The Replacement Well was constructed to increase the diameter of the well and to allow a pump size that would enable pumping of the well at its permitted rate. Both wells are permitted by MECP for operational use. Testing of the Membro Replacement Well at the time of construction indicated that it possessed a capacity of approximately 5,400 m^3/day, or about 20% higher than the evaluated capacity of the Membro Well (4,500 m^3/day) (Stantec, 2016). In 2020, the City completed long-term testing on the replacement well that demonstrated a sustainable pumping up to a rate of 5,275 m^3/day; however, a degree of drawdown interference within the well field was observed. Given the current maximum pumping level restrictions associated with operation of the quarry water management system and interference within the local well field, the Membro site has been assigned a capacity of 5,200 m^3/day, representing a reduction of 800 m^3/day, as presented in 2014 WSMP. Similarly, a reduced value of 1,901 m^3/day was evaluated for the Water Street Well due to local interference effects, as compared to the 2014 WSMP value of 2,700 m^3/day.

The University Well is located approximately 250 m northwest of the University of Guelph groundwater supply well UoG No. 4. In order to minimize potential interference effects with UoG No. 4, the City maintains a pumping level within the University Well above approximately 282 mASL. Per discussion with City staff, current use of UoG No. 4 by the University of Guelph is unknown. It is recommended that the City discuss the use of UoG

No. 4 with the University to determine if the maximum pumping level of the University Well can be optimized (i.e., lowered).

Groundwater quality monitoring data show increasing concentrations of sodium and chloride within the SWQ wells, with the Dean, University and Membro wells indicating concentrations that exceed the ODWQS Aesthetic Objective for Chloride of 250 mg/L in one or more groundwater samples. To address the rising concentrations of these constituents, the City utilizes best management source protection practices and actively educates residents and business owners about these practices. Other inorganic constituents (i.e., iron, nitrate, manganese) are stable and remain within ODWQS concentration limits.

Low concentrations of VOCs (TCE and DCE[9]) have been reported at the Membro Well, Edinburgh Well and Water Street Well. While the concentrations of these constituents have been decreasing at the Membro Well, observed concentrations in the Water Street Well do not show an apparent trend. Insufficient data are presently available for an Edinburgh Well VOC trend analysis. Although occasional low concentrations of THMs and bromodichloromethane were reported for certain wells, no increasing trends are interpreted in the data.

4.1.3 Northeast Quadrant Well Capacity Assessment

A total of five production wells are located within the City's NEQ, including four active wells (Park 1, Park 2, Emma, and Helmar), and one inactive well (Clythe), as shown in **Figure 4-1**. Since 2011, pumping in the NEQ has generally ranged from 2,000 to 12,000 m^3/day, with an overall average of approximately 6,600 m^3/day during this period.

In 2018, the Helmar well was rehabilitated and tested, as recommended within the 2014 WSMP. In 2019, the well operated at a typical monthly average production total of approximately 700 to 800 m^3/day. A maximum capacity of 800 m^3/day was identified for the Helmar well based on the reviewed response to rehabilitation and recent operational data. This represents a reduction of greater than 50%, as compared to a capacity of 1,500 m^3/day presented within the 2014 WSMP.

9. An ODWQS criteria limit has not been established for DCE.

Concentrations of sodium and chloride have increased to varying degreed within the active NEQ wells over the period of record. Reported concentrations have remained below the ODWQS Aesthetic Objectives, with the exception of chloride at the Park Wells. Similar to the SWQ Wells, the City addresses the rising concentrations of these parameters through best management source protection practices and actively educates residents and business owners about these practices. Other inorganic parameters are generally below ODWQS, with the exception of occasional detections of iron at the Helmar Well above the ODWQS Aesthetic Objective of 0.3 mg/L. It is understood that the City may implement treatment measures to address iron concentrations observed at the Helmar Well. Concentrations of manganese and nitrate (at the Park Wells) have been variable, but consistently remain below ODWQS criteria limits.

Occurrences of VOCs (TCE, PCE and DCE) have been reported at the Emma and Park Wells. At the Park Wells, trace VOC detections (i.e., less than 1 µg/L TCE and PCE) were first reported in 2012, and have remained relatively consistent through to 2019. Concentrations of DCE in these wells have remained consistently below 2 µg/L, with no trend apparent being observed through to 2019.

At the Emma Well, TCE, PCE and DCE detections have been observed since 2006. Since 2011, this well has operated at a relatively consistent rate and concentrations of TCE and PCE have decreased (below 1 µg/L for TCE and non-detect for PCE). Concentrations of DCE have increased over the same period to a maximum of 5 µg/L.

Concentrations of THMs and bromodichloromethane have only been detected in the Park Wells and remain below the ODWQS for THMs (an ODWQS criteria limit does not exist for bromodichloromethane).

4.1.4 Northwest Quadrant Well Capacity Assessment

There are five production wells located within the City's Northwest Quadrant (NWQ), including three active wells (Paisley, Queensdale, and Calico), and two inactive wells (Smallfield and Sacco), as shown in **Figure 4-1**. Since 2014, the combined pumping rate from the NWQ wells has ranged in monthly average production totals from approximately 400 to 3,400 m^3/day. Historically, the maximum pumping in the NWQ was approximately 5,000 m^3/day.

The Calico Well has been off-line since mid-2018 when a casing failure was discovered. The City is presently moving forward with a project to replace the Calico Well with a new well on site. For the purpose of evaluating the existing capacity, the 2014 WSMP capacity of 1,400 m^3/day is assigned to this well, or a subsequent replacement.

The Queensdale well was rehabilitated by the City in 2019, but did not show significant performance improvement in post-rehabilitation testing. The Tier Three Study (Matrix, 2017) predicted that the Queensdale Well would be unable to pump at its allocated rate of 2,000 m^3/day during average climate or drought conditions. A subsequent Threats Management Strategy (Matrix, 2018), completed to assess the options for mitigating the potential water quantity threats, including the Queensdale Well, concluded that this threat could be mitigated by optimizing pumping rates in the municipal production wells, including pumping of this well at a rate of up to 1,100 m^3/day under average and drought climate conditions. Based on these findings, the WSMP rate of 1,100 m^3/day is considered appropriate for the Queensdale Well.

Concentrations of sodium and chloride have increased in the active NWQ wells to varying degrees over the period of record (1991 to 2019). Reported concentrations of sodium and chloride have remained consistently below the ODWQS Aesthetic Objectives. Similar to the SWQ and NEQ wells, the City addresses the rising concentrations of these constituents through best management source protection practices and actively educates residents and business owners about these practices. Other inorganic parameters are generally below ODWQS criteria limits, with the exception of iron at the Queensdale Well, which is above the ODWQS Aesthetic Objective of 0.3 mg/L. Despite increasing concentrations of nitrate at the Paisley Well, it has occurred at a maximum value of 2.19 mg/L, as compared to an ODWQS MAC value of 10 mg/L.

VOCs (TCE, PCE and DCE) have not been detected in the active NWQ Wells. Occasional singular detections of THMs and bromodichloromethane are reported in the monitoring record; however, these detections not any apparent trends.

4.1.5 Summary of Existing Groundwater Supply Capacity

A summary of the individual well capacities evaluated in **Sections 4.1.1** to **4.1.4**, relative to the results for the same wells in the 2014 WSMP are

presented in **Table 4-2**. The total capacity of the City's existing active groundwater sources is interpreted to be approximately 79,422 m^3/day. This represents a decrease in maximum system capacity of approximately 4,414 m^3/day, relative to that reported within the 2014 WSMP. This estimate reflects normal operating conditions (i.e., non-drought conditions), and recognizes interference effects amongst the various groundwater supply sources, as well as other interferences such as that from continued water management activities at the Dolime Quarry. The evaluation also considered other physical constraints, such as well diameter, well condition, etc. that may potentially limit long-term sustainable pumping rates within the groundwater well sources. Recommendations included in the existing capacity assessment section are summarized in **Table 4-3**.

It should be noted that, although the assessment of existing capacity is based on review of an extensive operational record, it is not feasible to field test the City's full groundwater supply system at the estimated maximum capacity due to limitations associated with current requirements for customer demand and available storage capacity within the system. The presented maximum capacity value should be considered achievable over a short-term, but not necessarily sustainable long-term.

Subsequent to the assessment of maximum capacity, an additional modelling analysis was completed to evaluate the long-term average capacity of the existing system (**Appendix B**). This assessment concluded that the average capacity of the system is approximately 67,000 m^3/day when all sources are pumped concurrently and continuously (i.e., 24 hours/day). This result does not directly address the capacity of the groundwater supply system to satisfy maximum day demands, and is considered conservative since experience indicates that modelling results are generally conservative in nature and field testing may not detect impacts to surface water features that are simulated in a model. This said, it does provide an estimate of how the full system may respond to continuous longer term pumping conditions. As additional groundwater sources are added to the City's supply network, detailed field work will be required to assess the sustainability of each new supply; including characterization of raw water quality, potential effects on the natural environment, and drawdown interference with other existing groundwater sources when operating concurrently.

Table 4-2: Updated Capacity Assessment Summary – City of Guelph Groundwater Supply Active Sources

City Quadrant	Groundwater Supply Source	2014 WSMP (m^3/day)	WSMP Update (m^3/day)	Comments on Updated Capacity
Southeast	Arkell Well 1	2,000	2,000	Unchanged
Southeast	Arkell Well 6	28,800	28,800	Unchanged
Southeast	Arkell Well 7	-[b]	-[b]	Unchanged
Southeast	Arkell Well 8	-	-	Unchanged
Southeast	Arkell Well 14	-	-	Unchanged
Southeast	Arkell Well 15	-	-	Unchanged
Southeast	Glen Collector	6,900	5,100	Revised to reflect available capacity with artificial recharge system inactive
Southeast	Burke Well	6,500	6,500	Unchanged
Southeast	Carter Well 1	5,500[c]	5,184[c]	Decreased by 316 m^3/day based on uncertainty of potential impacts to Torrance Creek
Southeast	Carter Well 2	-[c]	-[c]	Decreased by 316 m^3/day based on uncertainty of potential impacts to Torrance Creek
Southwest	Membro[a]	6,000	5,200	Decreased by 800 m^3/day based on preliminary OTP results
Southwest	Water Street Well	2,700	1,901	Decreased by 799 m^3/day based on well field testing that evaluated mutual interference with Membro Replacement Well
Southwest	Dean Well	1,500	1,500	Unchanged
Southwest	University Well	2,500	2,500	Unchanged
Southwest	Downey Well	5,236	5,237	Unchanged[e]
Northeast	Park Well 1	8,000[d]	8,000[d]	Unchanged
Northeast	Park Well 2	-[d]	-[d]	Unchanged
Northeast	Emma Well	2,800	2,800	Unchanged
Northeast	Helmar Well	1,500	800	Decreased by 700 m^3/day based on performance record, rehabilitation results and interference drawdown.
Northwest	Paisley Well	1,400	1,400	Unchanged
Northwest	Calico Well	1,400	1,400	Unchanged[f]
Northwest	Queensdale Well	1,100	1,100	Unchanged
Total	**-**	**83,836**	**79,422**	**-**

Notes: a) Capacity is total for site (Membro Well and Membro Replacement Well)
b) 28,800 m^3/day is the total daily capacity of the Arkell bedrock wells (Wells 6,7, 8, 14, and 15).
c) Total daily capacity of Carter Well 1 and 3.
d) 8,000 m^3/day is the total daily capacity of Park Well 1 and 2.
e) Capacity increased by 1 m^3/day to match PTTW No. 8468-BCVQAN
f) Well is currently off-line due to casing failure, assigned value represents capacity for the site.

Table 4-3: Summary of Recommendations

City Quadrant	Groundwater Supply Source	Recommendation Operational/ Performance Testing	Recommendation Rehabilitation	Recommendation Modifications to Engineering	Comments/Other
Southeast	Arkell Well 1	Evaluation of sand production and overall sustainability above a rate of 1,125 m^3/day	-	-	-
Southeast	Arkell Well 6	-	-	-	-
Southeast	Arkell Well 7	-	-	-	-
Southeast	Arkell Well 8	-	-	-	-
Southeast	Arkell Well 14	-	-	Lower pump, as required in response to PWL[a]	-
Southeast	Arkell Well 15	-	-	-	-
Southeast	Glen Collector	-	-	Increase capacity of Eramosa River taking	-
Southeast	Burke Well	-	-	-	-
Southeast	Carter Well 1	-	-	-	Review pumping and water quality records against updated MECP GUDI TOR, when available. Completed planned assessment of effects on Torrance Creek.
Southeast	Carter Well 2	-	-	-	Review pumping and water quality records against updated MECP GUDI TOR, when available. Completed planned assessment of effects on Torrance Creek.
Southwest	Membro Well	-	-	Connect Membro Replacement Well (Rocco Well) to distribution system	-
Southwest	Water Street Well	-	-	-	-
Southwest	Dean Well	-	-	-	-

City Quadrant	Groundwater Supply Source	Recommendation Operational/ Performance Testing	Recommendation Rehabilitation	Recommendation Modifications to Engineering	Comments/Other
Southwest	University Well	Performance testing when rehabilitated	On regular 3 to 5 year basis	-	Initiate discussion with University of Guelph staff regarding use of University's Well No. 4
Southwest	Downey Well	Monitor during Dolime Quarry OTP for interference[b]	-	Upgrade booster pump at station, as required	-
Northeast	Park Well 1	Conduct OTP in conjunction with Emma	-	-	-
Northeast	Park Well 2	Conduct OTP in conjunction with Emma	-	-	-
Northeast	Emma Well	Conduct OTP in conjunction with Park	-	Lower pump, as required in response to PWL	-
Northeast	Helmar Well	-	-	-	-
Northwest	Paisley Well	Performance testing when rehabilitated	On regular 3 to 5 year basis	-	-
Northwest	Calico Well	-	-	-	Pursue replacement of existing well
Northwest	Queensdale Well	-	-	-	-

Notes: a) PWL: Pumping Water Level
b) Recommendation is in reference to identified potential additional capacity for well – all wells in SWQ should be monitored during the OTP, as well as the Queensdale and Paisley Wells.

The identified long-term average capacity of the existing system is approximately 15% less than the evaluated short-term maximum system capacity (**Table 4-2**). This result is discussed further in the security of supply section.

This total groundwater supply capacity is the basis for evaluating capacity of the City's groundwater supply system to meet projected demand requirements to 2051. Therefore, in **Table 4-4**, the results of the assessment are compared to both current and future projected supply needs, as presented in the Population and Water Supply Demand Forecast technical memorandum (AECOM and Gauley & Associates, 2021).

Table 4-4: Summary of Existing Capacity Assessment and 2051 Water Supply Demand Projection

Evaluation Parameter	2019	2051
Average Daily Demand (m^3/day)[1]	47,015	68,306
Maximum Daily Demand (m^3/day)[1]	58,441	91,530
Existing System Maximum Capacity (m^3/day)	79,422	79,422
Surplus/Deficit (m^3/day)[2]	20,981	-12,108

Notes: 1. Projected demand value for "Reference" growth rate scenario, as provided in the Province of Ontario's August 28, 2020 report A Place to Grow Growth Plan for the Greater Golden Horseshoe.
2. Surplus/deficit relative to maximum daily demand.

The comparison above provides a simple measure of possible future shortfalls if the City were only to meet future needs through new supply facilities, and without consideration of added redundancy to address risks to the system. An evaluation of various potential risks to the system is included in the following section.

4.2 Security of Supply

Task 3 included a review of existing system capacity under various conditions that could potentially reduce overall capacity. This is an important process for understanding potential risks to the City's groundwater supply and distribution system that could reduce the maximum daily system capacity. If the system is unable to meet the projected maximum demand, the City would need to implement immediate emergency water restrictions and customers would be unable to undertake regular, planned water use.

In addition to this review, on an annual basis the City of Guelph reviews and ranks the risk to the Water Supply through their Drinking Water Quality Management System (DWQMS). The purpose of this risk assessment process (Element 7) as it relates to the WSMP is to consider potential hazardous events and associated hazards. These hazards are identified in the MECP document titled "*Potential Hazardous Events for Municipal Residential Drinking Water System*" (2017), which includes long-term impacts from climate change and water supply shortfalls. These two risks continue to be ranked highly for water services through this assessment. In addition to the identification of risks to the water supply, there are also requirements under the DWQMS to identify controls to mitigate the identified risks. One aspect of these mitigative controls relates to incorporating security of supply, where an additional 15% capacity is to be provided in the event of a loss of supply for any reason.

This review also included drought conditions, loss of a well (i.e., a contamination event, equipment failure, structural failure, etc.), regulatory permitting changes, and risks to the well facilities and distribution system. The following sections summarize the assessment of each listed scenario and the associated estimate of system capacity under each.

4.2.1 Drought Conditions

The Tier Three Study (Matrix, 2017) included a groundwater modelling analysis that assessed the capacity of the City's existing groundwater supply system under drought conditions. The results of the final Tier Three Study concluded that operation of the groundwater supply system at an average rate of 73,450 m^3/day (the Tier Three Study Allocated rates) to meet the estimated 2031 average demand of 71,597 m^3/day (RMSi, 2009) could not be sustained during a 10-year drought period, as the groundwater level would be drawn below the maximum pumping level in the Queensdale Well. There also was uncertainty as to whether Arkell Well 1 would have sufficient available drawdown. The subsequent Threats Management Strategy (Matrix, 2018), completed to assess the options for mitigating the identified potential water quantity threats (Arkell Well 1 and the Queensdale Well), concluded that potential threats could be mitigated by optimizing pumping rates in municipal production wells up to the total target pumping rate of 71,597 m^3/day, although this system rate produced a moderate risk to some surface

water features. The average rates assessed in this optimization scenario do not address the maximum pumping rates that can be sustained from the deep confined bedrock aquifer wells on a short term basis to meet maximum day requirements. The potential maximum rates that could be achieved by each existing well in the system was evaluated by reviewing the model estimated available drawdown under drought conditions (Appendix C in Matrix, 2018). A calculation was completed for those wells predicted to have additional available drawdown under drought conditions, such that additional available drawdown was multiplied by the specific capacity estimated for the well to provide an estimate of the short-term maximum rate that could be achieved. The resulting rate was then compared to the recent performance record for each well and, if required, the rate was adjusted for those results that were unrealistically high. The results of this analysis, presented in **Table 4-5**, indicate that a maximum capacity of approximately 71,500 m^3/day can be expected under drought conditions, or an approximate 10% decrease, relative to the total capacity of the City's existing active groundwater sources (79,422 m^3/day).

Subsequent to the above assessment, an additional modelling analysis was completed to evaluate the average capacity of the existing water supply system under both average climate and drought conditions (**Appendix B**). This assessment concluded that the average capacity of the system (approximately 67,000 m^3/day) could be reduced by approximately 14% (or 57,500 m^3/day) under drought conditions. Although this does not directly address the expected drought reduction in maximum day capacity, it provides a range of approximately 10 to 15% for the purposes of planning for security of supply. As noted above, under drought conditions, the rates that may be achieved by the groundwater supply system could pose a moderate risk to the surface water system. It may not be feasible to construct sufficient redundancy (i.e., additional facilities) to address sustainable drawdown within each supply well in the system, and at the same time, mitigate all risks to local surface water systems. As such, there may be a requirement to combine a security of supply allowance within the system with other approaches to system management, such as the GRCA Low Water Response program, which is designed to address drought conditions. This is discussed further in Section 4.2.4.

Table 4-5: Estimated System Capacity Under Drought Conditions

Demand/Capacity	2019	2051
Average Daily Demand (m^3/day)	47,015	68,306
Maximum Daily Demand (m^3/day)	58,441	91,530
Total Existing System Capacity (m^3/day)	79,422	79,422
Total System Capacity with Drought (m^3/day)	71,477	71,477
Surplus/Deficit (m^3/day)	13,036	-20,053

4.2.2 Contamination Event or Loss of Supply Source

The presence of a contaminant in an aquifer that affects a supply well or the loss of a supply well due to long term maintenance activities are risks that must be considered when planning for future water supply requirements. The affect that these risks could have on the capacity of the City's groundwater supply system was evaluated in the 2014 WSMP through a desktop exercise. This exercise considered the potential impact on overall system capacity that loss of the largest producing well within each quadrant would have. One consideration in this assessment was the selection of wells where the lost capacity could not be made up by increased pumping at nearby wells. Four scenarios were considered in the assessment, as follows:

1. Loss of the Burke Well. This well is evaluated to have a capacity of 6,500 m^3/day, one of the highest capacities in the SEQ. This scenario is consistent with the 2014 WSMP.

2. Loss of the Downey Well. This well is rated for slightly higher production than the Membro Well/Membro Replacement Well and does not have a neighbouring well from which additional capacity could be obtained on a short-term basis. In the 2014 WSMP, the Membro Well was selected for the SWQ assessment; however, since 2014, the City has constructed the replacement well and therefore has redundancy on the site[10].

10. Upgrades to the Membro facility (currently underway) are required to bring the Membro Replacement Well on-line as a production well.

3. Loss of the Park Wells. These wells provide the most capacity in the NEQ (i.e., 8,000 m^3/day) and there is limited capacity to recover lost supply from the Emma Well. This scenario is consistent with the 2014 WSMP.

4. Loss of the Calico Well. The well is evaluated to have the same capacity as the Paisley Well and is currently off-line. Review of water levels in the NWQ since the well went off-line indicates that the Paisley and Queensdale Wells are not capable of recovering the lost capacity.

The results of this analysis, as presented in **Table 4-6**, indicates that the loss of the Park Wells in the NEQ would have the largest impact on overall system capacity, with the total capacity being reduced to approximately 71,400 m^3/day, relative to the total capacity of the City's existing active groundwater sources (79,422 m^3/day). This risk is therefore evaluated as being similar to the drought scenario.

Table 4-6: Estimated System Capacity With Well Failure / Contamination Event

Demand/Capacity	2019	2051
Average Daily Demand (m^3/day)	47,015	68,306
Maximum Daily Demand (m^3/day)	58,441	91,530
Total Existing System Capacity (m^3/day)	79,422	79,422
Total System Capacity with Well Loss (m^3/day)	71,422	71,422
Surplus/Deficit (m^3/day)	12,981	-20,108

4.2.3 Changes to Regulatory Approvals

In previous WSMPs completed by the City, an assumption implicit in the assessment of security of supply has been that supply wells with existing permits would remain permitted. Subsequently, the City has submitted applications to the MECP for renewal of existing Permits To Take Water (PTTW) and encountered challenges in obtaining renewed PTTW at the same maximum rates. As the City possesses multiple PTTWs issued by MECP for the various well fields and each PTTW is evaluated as an individual submission according to the expiry timeline of each PTTW, it cannot be

anticipated which of these submissions may be reassessed by MECP over time, potentially resulting in a reduction in the total volume of daily permitted taking. Therefore, an assessment was completed by evaluating the implication of reductions to the maximum PTTW rate for each well of 20% and 30%. These values were selected as the magnitude of reduction that could be contemplated by the MECP based on historical use of a well, maximum pumping requirements, potential interference with other groundwater uses, etc. One exception is the Arkell bedrock wells, which were not included in the assessment. The current permitted taking from these wells was subject to a detailed OTP and Adaptive Management Program (AMP) as a condition of the MECP approval. As the permitted taking from these wells was subject to a rigorous testing program and a wellfield permit, it is not anticipated that MECP would reduce the permitted rates for these wells. Reductions beyond 30% were not considered in this assessment, as it is unlikely that the MECP would request this magnitude of reduction across all City wells.

Where a calculated reduction to the PTTW maximum daily taking did not cause the revised PTTW maximum to drop below the well capacity determined in **Section 4.1**, the estimated existing capacity value was used for that well. The results of this analysis, presented in **Table 4-7**, indicate that, even the 30% reduction scenario would still result in an overall system capacity that is greater than the loss of the Park Wells in the NEQ and the drought scenario.

Table 4-7: Estimated System Capacity With Change in Regulatory Approval

Demand/Capacity	2019	2051
Average Daily Demand (m^3/day)	47,015	68,306
Maximum Daily Demand (m^3/day)	58,441	91,530
Total Existing System Capacity (m^3/day)	79,422	79,422
Total System Capacity with Permit Reduction (m^3/day)	72,801	72,801
Surplus/Deficit (m^3/day)	14,360	-18,729

4.2.4 Other System Risks and Mitigation

In addition to the scenarios assessed in the previous sections, there are a number of risks to the City's groundwater supply and distribution system that should be considered either as part of the WSMP or the Water and Wastewater Servicing Master Plan. In planning for future supply sources, the City could review the potential impact of compounded risks (e.g., loss of a facility during a long term drought). However, in the case of an emergency event, the City could implement demand reductions, such as water use restrictions or temporarily pump above PTTW limits for some wells with permission from MECP.

For completeness, and for the City's further review and planning, some of these risks and possible mitigation measures have been documented below (**Table 4-8**).

A risk management plan to include mitigation and response strategies for the above and any other additional risks should be undertaken by the City to ensure provision of a safe and reliable water supply system now and in the future. This will include current risks to the existing groundwater-based system and may be expanded upon to include additional risks relevant to future water supplies, whether groundwater or surface water based. It is noted that the City reviews the water supply system annually through the DWQMS process. The recommended risk management plan should build on this existing process.

Table 4-8: Potential Additional Risks to Water Supply Capacity, Potential Impacts and Possible Mitigation

Risk to Water Supply Capacity	Potential Impact	Possible Mitigation	Notes
Drought combined with large supply out of service	■ From Task #3, the available max day capacity during drought of 71,500 m^3/day would be reduced further by 7,200 m^3/day if Park wells were removed from service. This represents a reduction in total supply capacity of 19%	■ Consider additional supply sources ■ Implementation of demand management measures to limit max day demands in response to long term drought ■ Emergency level demand management in response to loss of well supply	■ The Grand River Low Water Response Program coordinates and supports the response to low water and may require demand reductions to address drought conditions within the watershed
Maintenance – short term, combined with other risks (e.g., large supply out of service)	■ Regular scheduled maintenance of the facilities is required to complete well rehabilitation, mechanical upgrades, etc.	■ Generally accommodated through scheduling to limit the supplies offline at any given time ■ Consideration is also given to longer term projects to ensure that max day demands can be met in the event of loss of a large supply facility	■ Available excess capacity to accommodate infrastructure upgrades in timeline
Maintenance – long term, combined with other risks (e.g., large supply out of service)	■ Scheduled upgrades to existing facilities may consist of larger construction projects requiring the well supply to be offline for an extended period of time	■ Schedule during higher seasonal production capacity not included in annual sustainable production volume (e.g., collector system)	■ Available excess capacity to accommodate infrastructure upgrades in timeline
Mechanical failures combined with other risks (e.g., large supply out of service)	■ This failure scenario potentially compounds the 'large supply out of service' scenario above, allowing for multiple facilities offline for a short duration	■ Consider additional supply sources ■ Emergency level demand management in response to loss of well supply	
Aqueduct break	■ Loss of the aqueduct could result in the immediate elimination of the southeast supply sources (excluding Burke) representing 41,100 m^3/day	■ Represents catastrophic failure - not reasonable to address through additional supply. Requires plan to provide quick response for repair and emergency demand management measures during downtime	■ Existing recommendation to add secondary connection to system through Arkell should be addressed through the W&WSMP
Watermain breaks	■ Variable loss of supply for short term period	■ Strategy in place to address in short duration – not through added supplies	■ Should be addressed through the W&WSMP – evaluation of risks and mitigative measures
Aquifer contamination	■ Introduction of contaminant to aquifer resulting in impacts to multiple City wells (local or widespread)	■ Managed through source water protection, ongoing water quality monitoring, and by MECP through the Environmental Protection Act, Ontario Water Resources Act, Clean Water Act, Safe Drinking Water Act	■ Multiple wells across City help to mitigate water quality risks in specific areas
Quarry contamination	■ Introduction of contaminant to aquifer resulting in impacts to multiple City wells	■ Managed through maintaining water levels (i.e., groundwater divide with inward gradient to quarry)	
Eramosa River contamination	■ Introduction of contaminant to river resulting in shut down of Arkell recharge system	■ Managed through source water protection (IPZ), ongoing water quality monitoring, and provincial spill response program	

4.2.5 Security of Supply Summary

The assessment presented in Sections 4.2.1 to 4.2.4 indicates that evaluated risks to security of the City's water supply could cause a reduction in available capacity of up to approximately 15%, as compared to the estimated existing system capacity, with a period of prolonged drought being the most impactful event. This assessment is in-line with a similar exercise completed by the City in the 2014 WSMP, where it was concluded that system capacity was vulnerable to a reduction of approximately 10% to 15%. Consideration of other system risks highlights scenarios where lost capacity could exceed 15%. These results indicate that that City should continue on-going monitoring of available system capacity, with the objective of maintaining a system redundancy of 15%. With respect to the existing system, 15% of the existing available water supply system capacity should continue to be reserved for operational challenges which may be experienced in servicing of existing customers; i.e., not available for future growth. This results in an existing firm capacity of 67,509 m^3/day (**Table 4-9**).

Table 4-9: Projected "Reference" Water Demands vs. Required Water Supply Capacity

Demand Type	2021	2026	2031	2036	2041	2046	2051
Average Demand (m^3/day)	49,254	52,429	55,605	58,780	61,955	65,131	68,306
Maximum Day Demand using MDF of 1.34 (m^3/day)	66,000	70,255	74,510	78,765	83,020	87,275	91,530
Existing Firm Capacity (m^3/day)	67,509						
Existing Total Capacity (m^3/day)	79,422						
Estimated Required Future Total Capacity (m^3/day)		80,793	85,687	90,580	95,473	100,366	105,260

Notes: MDF – Maximum Day Factor

The average annual day demand and maximum day demand for the Places to Grow "reference" growth scenario discussed in Section 3, are again provided in **Table 4-9**. Assuming that a safety factor of 15% is applicable to

all future sources (i.e., groundwater based), the required total capacity is calculated as 1.15 times the maximum day demand. This suggests that additional production volume will be needed to satisfy the projected 2026 demand. This short term requirement is anticipated to be addressed by the Clythe Well, which is currently off-line but scheduled to return to service in 2023. In total, a 2051 water supply deficit of approximately 26,000 m^3/day is estimated, relative to the current system total capacity.

4.2.5.1 Future Water Supply Sources

Evaluation of the risks associated with future water supply capacities may differ from those impacting existing supplies depending on the source and other risk factors.

Groundwater based - for additional groundwater supply facilities, the City could continue to plan firm capacity based on incorporating the 15% allowance determined for the existing supply system. However, this should be confirmed with the addition of each supply source to ensure that 15% is sufficient.

Surface water based – typically, for surface water treatment plants and pumping stations, firm capacity is based on pumping and treatment redundancy (i.e., capacity with largest unit out of service). The water supply available to the treatment plant would be based on low flow conditions so would already consider drought conditions encountered within the historical monitoring period. Therefore, as long as sufficient equipment redundancy is included in the design, it may not be necessary to incorporate additional supply capacity for surface water supply sources to determine firm capacity.

The future required municipal water supply firm capacity will be re-assessed with the addition of each new groundwater supply source. A simplistic approach is adopted through this WSMP update to provide general guidance on timeline required for new supply projects and this will be updated through a review of the sufficiency of the water supply surplus after each new water supply is brought on-board. This is in additional to regular (monthly) reviews of the available water supply capacity and required maintenance and upgrade activities.

5. Water Supply Alternatives

5.1 Introduction

Through the 2014 WSMP Update, the following alternatives were evaluated and prioritized with considerable input from the public to develop an implementation plan for the City to ensure sufficient water supply to meet projected demand:

1. Water conservation, efficiency and demand management
2. Groundwater sources inside and outside of the City
3. Aquifer Storage and Recovery (ASR)
4. Local surface water sources
5. Limit community growth
6. Do nothing

During early community engagement events of the WSMP Update, the list of potential water supply alternatives from the 2014 WSMP was reviewed and revised to reflect work completed by the City in the interim, as well as new information. The purpose of this update is to review progress to date and update the status of these alternatives by factoring in new information, innovative technologies, and the most recent public and stakeholder input.

The objective of the WSMP Update is to continue to ensure that the City can provide an adequate, safe and sustainable supply of water to meet the current and future needs of all customers over the next 30 years (i.e., to 2051). As documented in Section 4, the water supply demand forecast, and the existing water supply system capacity assessment concluded that under a "do nothing" scenario with continued growth, in 2051 the City would require an additional water supply capacity of approximately 12,000 m^3/day to satisfy maximum day demand. With a security of supply allowance of 15%, the deficit will be 26,000 m^3/day.

Following the direction of the previous WSMP and incorporating the updates through work completed by the City in the interim, the following alternatives are re-developed and evaluated with respect to their capability to contribute to the total water supply solution. It is acknowledged each does not address the problem statement as a stand-alone alternative. Therefore, each

alternative is discussed and evaluated on its own merit as part of the total solution. Some alternatives are better defined than others and some alternatives either may not deliver, or may exceed the supply capacity estimates presented herein. Therefore, the WSMP may need to present additional alternatives (and more supply capacity) than necessary since some of the alternatives are subject to additional investigations and may not be as feasible or sustainable as are presented in this WSMP.

The following provides an overview of each category of potential water supply alternatives:

1. **Water conservation, efficiency and demand management**

   As recommended in the 2014 WSMP, it is anticipated that water conservation, efficiency and demand management will continue to form part of the preferred sustainable water supply solution (via reductions in water demand) in the future. The WSMP develops high level targets/goals for water supply demand reduction that are subsequently utilized to develop specific programming within the Water Efficiency Strategy (WES). These potential targets were assessed via four scenarios developed to consider the potential reductions associated with various combinations of initiatives in order to set a reasonable and publicly supported reduction target. As stated, the details of the water conservation, efficiency and demand management programming, including the preferred initiatives to be implemented to reach proposed targets will be further developed in the next WES update. The developed scenarios explore the following:

   I. Ceasing non-provincially mandated water efficiency measures (baseline scenario)

   II. Potential reduction through maintaining a level of programming similar to the current water conservation, efficiency and demand management program

   III. Potential reduction through a focus on high water use customers

   IV. Potential reduction through a focus on the current level of programming *and* water reuse initiatives

The estimated reclaimed water supply capacity and cost associated with each of the above initiatives is developed for comparison to the cost to implement new water supply sources.

2. Groundwater sources inside and outside the City

The groundwater supply alternatives considered in the 2014 WSMP are updated and re-stated to provide clarity between various stages of development of future potential supply sources. The following list represents all opportunities in the order established in the original implementation plan.

a. Optimize existing municipal sources
b. Restore off-line municipal sources
c. Develop municipal test wells
d. Develop new wells inside the City
e. Install new Aquifer Storage and Recovery (ASR) wells inside City to optimize available excess Arkell Collector system volumes
f. Develop new wells outside the City – a distance of less than 5 km from the City boundary was applied to meet the desire to maintain local sustainability

For reference, ASR is a strategy where treated (potable) water is stored within an aquifer during periods of water surplus (i.e., when capacity exceeds demand) and subsequently this volume of stored water is recovered during periods of water shortage (i.e., when demand exceeds existing capacity).

The Tier Three Model, described above, was used to review the total sustainable capacity from a natural environment perspective for all of the above alternatives. However, it is recognized that there is no assurance that all of these possible supplies may be developed. The results should therefore be considered as an evaluation of the additional volume of groundwater that may be available before causing unacceptable stress to local watersheds.

In addition to the above sources, existing non-municipal wells are discussed as these present a potential opportunity or conflict should the well owners propose to change the status of the PTTW or well operation. These sources are included as current water takings in the groundwater flow model.

3. **Local surface water sources**

   Local surface water sources evaluated for the WSMP include the Eramosa River and Speed River. These sources are each investigated for their potential to provide a continuous source of water for treatment and supply to the City's distribution system. Also reviewed is the feasibility of developing additional surface water supply through an ASR strategy.

   Of these two options, the Speed River offers the greatest potential due to the presence of Guelph Lake, a man-made reservoir on the Speed River, in Guelph/Eramosa Township. This reservoir was created in 1974 with the construction of the Guelph Lake dam. Guelph Lake is evaluated as a potential location to withdraw water from the Speed River due to the ability of the Grand River Conservation Authority (GRCA) to monitor and control flows to maintain base flow downstream of this dam. This alternative is discussed in detail in Section 5.4.

4. **Limit community growth; and**

5. **Do nothing.**

   Lastly, as a reference for comparison for all of the above alternatives, the potential impacts of developing any of these options are measured against the "limit community growth" alternative and "do nothing".

5.2 Water Conservation, Efficiency and Demand Management

5.2.1 Approach

In previous WSMPs, the utmost importance was placed on water conservation, efficiency and demand management, and as a result, the City of Guelph has become a renowned leader in water conservation, efficiency and demand management in Canada. This effort has proven to be a cost effective initiative that reduces demand within the City and thereby extends the timeline for when new water supply sources are required. Specific programming is identified within the 2016 Water Efficiency Strategy and this will be updated as early as 2022. Examples of programs that have been implemented include Blue Built Home, eMERGE Home Tune-up, greywater reuse, multi-residential water audits, Water Smart Business and municipal facility water audits and upgrades.

As discussed in Section 3.2, the review of per capita water production and demand rates from 2015 to 2019 indicates that customer water demands may be beginning to stabilize after approximately two decades of significant decline. This observation suggests that future per capita customer water demand declines associated with conservation, efficiency and demand management programming and natural water savings may be more difficult to achieve moving forward. This observation is considered in developing the targets for future conservation, efficiency and demand management programming in this section.

The water conservation, efficiency and demand management scenarios developed for the WSMP Update also consider the results of a recent evaluation of the potential to reduce non-revenue water (NRW) rates in the City below their current level (**Appendix C**). This evaluation found that the City's current infrastructure leakage index (ILI) appears to be very similar to its economic level of leakage (ELL). The ELL of a water system is the leakage level where the cost associated with finding and repairing leakage equals the cost associated with producing and distributing the water lost through leakage, i.e., reducing leakage below the ELL is not financially beneficial. As such, the water conservation, efficiency and demand management scenarios assume that the City will continue to implement the current level of water

loss mitigation programming to maintain low NRW to 2051 (i.e., no further reduction in per capita NRW rates).

None of the water conservation, efficiency and demand management scenarios consider the impact of conservation-based water rates on water demands. A study completed for the 2016 WES update evaluated several rate structures to assess their impact on demands: uniform rates, increasing block rates, humpback rates[11], seasonal rates, excess use rates, and water budget rates. While the study found that a very aggressive increasing block rate may be expected to reduce demands by approximately 6%, it also determined that this type of rate was not equitable to all ICI and multi-residential customers. The study concluded that, because of the limited impact on demands and the potential for inequity among customers, the City should not pursue a conservation-based water rate structure at this time.

It should also be noted that the conservation, efficiency and demand management scenarios were developed using pre-pandemic water demand data. In most communities, including in Guelph, pandemic restrictions have resulted in industrial shutdowns, more people working and attending school from home, exercising at home rather than at the gym, preparing meals or getting take-out meals rather than eating in restaurants, etc., and this has resulted in an increase in the average per capita residential water demand and a decrease in the average per capita ICI water demand. The Pacific Institute, a think tank dedicated to global water issues, has stated that the impact of the pandemic on overall water demands is uncertain, with some communities seeing a reduction in total demand and others seeing an increase in total demand depending on their relative proportion of residential and ICI customers and the makeup of their ICI customers[12]. Therefore, the long-term impact of the pandemic on demands is difficult to predict. The current shift in residential and ICI demands may continue or demand patterns may return to their historical pre-pandemic configuration. Because of this uncertainty, it is prudent at this time to project Guelph's future residential and ICI water demands based on long-term historical demand patterns. The City will continue to evaluate the impact of the pandemic on

11. A humpback rate structure uses a combination of increasing and decreasing block rates: rates first increase, then decrease in steps as consumption increases. This approach targets high volume users, and then provides lower rates for high volume users.
12. https://pacinst.org/how-the-coronavirus-pandemic-is-affecting-water-demand/

residential and ICI demands, and the potential long-term effects will be re-evaluated in the next Master Plan Update, as necessary.

Options for consideration in the four scenarios presented herein range from 'do nothing' scenario (i.e., no future conservation, efficiency and demand management efforts beyond those that are provincially mandated), to including water reuse programs in addition to updating current efforts, to include new programs when existing programs are exhausted. In reality, while a 'do nothing' scenario would not incorporate further water conservation, efficiency and demand management programs, some level of natural savings would occur regardless as a function of changes to the Ontario Building Code. Such changes mandate that more efficient plumbing fixtures are installed in new construction and natural replacement cycles of household fixtures and appliances in existing residential homes with newer, more efficient models. It is noted that Guelph's progressive programming to date has leveraged the natural savings opportunities stemming from building code changes and accomplished demand savings under these programs at a higher magnitude and in a shorter period of time than would have occurred naturally. Nevertheless, a 'do nothing' water conservation, efficiency and demand management scenario does not fit with stakeholder feedback nor City Council's commitment to sustainable growth – where the finite supply, if not used efficiently, could result in limiting growth and conflict with Guelph's provincial growth mandate requirements.

5.2.2 Identified Water Conservation, Efficiency and Demand Management Scenarios

Scenario #1 – Static Residential and ICI per Capita Water Demands

This scenario represents the baseline or most conservative case of the four scenarios and assumes the following:

1. the City of Guelph ceases implementing all water efficiency measures that are not provincially mandated; and
2. per capita residential and ICI demands remain static at their average 2015-2019 levels.

An example of provincially mandated programs includes the permit to take water approval process which requires municipalities to demonstrate their

commitment to efficient use of the resources they already have available before expansions or additional permits are given to a permit holder. Schedule 1 for water conservation measures as part of the provincial permit process requires the applicant to demonstrate which tactics are being employed to control water demand, including fixtures, metering, loss prevention and water reuse measures, before expansion is considered. Furthermore, the Water Opportunities and Conservation Act, 2010, requires municipalities to develop water sustainability plans, setting performance indicators and targets. While not yet enacted, the City is positioned to meet the necessary requirements. Lastly, the provincial low water response program, which is watershed-based and is administered by the Grand River Conservation Authority, protects supply throughout peak season, monitoring watershed/ subwatershed conditions and putting restrictions on use, as necessary. This is echoed in and forms part of the basis for the City's Outside Water Use Program.

While per capita water demands under this scenario are not projected to decrease over time, they are also not expected to increase over time despite no further water efficiency programming. This is due to the effort the City has already put into educating and replacing water-using fixtures and systems with the public regarding the importance of water efficiency in a groundwater-based system. As Scenario #1 represents the City ceasing water efficiency programming, there are no associated costs or savings and the values in **Table 5-1** represent the baseline projected 2051 water demands presented in Litres Per Capita Per Day (Lcd).

Table 5-1: Static Per Capita Demands

Demand Type	2020, Lcd	2051, Lcd	2051 Population	2051 Avg. Annual Day Demand, m^3/day
Residential	166.6	166.6	203,000	33,814
Employment	191.0	191.0	116,000	22,155
NRW	60.8	60.8	203,000	12,338
Total	-	-	-	**68,306**

Scenario #2 – Water Demand Reduction of 6.5% by 2051

This scenario represents the City continuing its investment in water efficiency programming with a similar level of effort to that undertaken historically, i.e., the same level of programming budgets and staffing levels. The anticipated level of reduction in demand is based on the historical gross per capita water demand trend between 2015 and 2019. It is expected that the rate of decline in per capita demands will decrease over time as customers become more efficient and there are fewer opportunities for further reductions in demands. It is also expected that the City will continually revise its selection of water efficiency measures as needed in the future with updates to the WES. Programs that become less effective, experience free ridership[13] or that have reached their target savings may be dropped or modified. New programs may be adopted such as rebates for efficient water softeners, implementing Advanced Metering Infrastructure (AMI), and landscape incentives. With employment growth expected to outpace residential growth in the City through to 2051, the City's water efficiency programming may shift to having a greater focus on ICI-based measures.

The savings target identified in Scenario #2 includes savings directly and indirectly resulting from the implementation of City programs as well as 'natural' savings resulting from changes in the Ontario Building Code and continued improvements in the efficiency of water-using fixtures, appliances, products, and processes.

While it is expected that both ICI and residential per capita demands will continue to experience some level of decline over the next 30 years, it is difficult to accurately predict the percentage reduction in each customer class. For the purpose of evaluating this scenario and estimating water efficiency program budgets, we have assumed a similar target reduction for both customer classes. The actual focus and implementation of programs to achieve the overall savings would be addressed through the next WES update.

While customer demands in the City were relatively flat between 2015 and 2019 there was a slight reduction in gross per capita demands (i.e., average

13. Free ridership: a person who would have installed an efficient product or participated in an efficiency program without receiving an incentive.

annual day production rates divided by the serviced population) during this time.

- 2015 Gross per Capita Demand = 348 Lcd
- 2019 Gross per Capita Demand = 331 Lcd

Through a statistical analysis of gross per capita demands between 2015 and 2019, a 2051 gross per capita demand of 315 Lcd and an average day demand of 63,882 m^3/day, are estimated, equating to a reduction of about 6.5% in 2051 average day demand versus Scenario #1.

As stated above, the City is near or at the ELL with respect to NRW and the current per capita NRW rate of 61 Lcd is expected to be maintained at this level until 2051, with active leak detection programs and planned replacement of linear infrastructure which has met its functional life. With no projected reduction in per capita NRW demands, the projected water savings under this scenario are restricted to declines in per capita residential and ICI demands. To achieve an overall reduction in gross demands of 6.5% while maintaining per capita NRW demands at 61 Lcd it is necessary to reduce customer water demands (including both residential and ICI water demands) by 7.9%. The demand projections in **Table 5-2** assume an equivalent reduction in both the residential and ICI customer sectors. It is anticipated that the City will continue to evaluate its ongoing programs and develop new initiatives to target potential savings and ensure success. Scenario #2 will result in the following:

- 7.9% Decrease in Residential Lcd Rates
- 7.9% Decrease in Employment Lcd Rates
- 0% Decrease in NRW Lcd Rates

Table 5-2: 6.5% Reduction in Average Annual Day Demands by 2051

Demand Type	2020, Lcd	2051, Lcd	2051 Population	2051 Avg. Annual Day Demand, m^3/day
Residential	167	153	203,000	31,140
Employment	191	176	116,000	20,404
NRW	61	61	203,000	12,338
Total	-	-	-	**63,882**

Estimated Program Costs

The 2051 water savings in Scenario #2, including direct, indirect, and natural savings is projected at 4,424 m^3/day (in 2051). The total program cost identified in **Table 5-3** of $11.41 million ($380,000 per year for 30 years) is based on an estimated $2021 unit cost of $2,578 per m^3/day of savings.

Table 5-3: Costs and Savings: Scenario #2

Direct Savings, m^3/day	Natural & Indirect Savings, m^3/day	Total Savings, m^3/day	Cost per m^3/day	Total Cost (million $)
1,686	2,739	4,424	$2,578	$11.41

Scenario #3 – Water Demand Reduction of 3.25% by 2051

Although the demand targets expressed in Scenario #2 are based on historical water demand trends, the annual rate of demand reduction has been slowing down – even with the City implementing water efficiency measures during this period. With fewer opportunities to improve efficiency in the future, it is not possible to confirm that the statistical trend in average water demands between 2015 and 2019 will continue for the next 30 years. However, even if overall *average* per capita water demand stabilizes, there will still be an opportunity to focus programming specifically on high water use customers in both the residential and ICI customer sectors. By moving away from broad-based programming to more targeted programming, it is anticipated that the City may achieve a lower demand reduction than Scenario #2 with a corresponding lower budget.

While it is not possible to accurately predict the level of savings that would be achieved under a targeted approach, Scenario #3 is based on achieving 50% of the residential and ICI savings associated with Scenario #2. This results in a 4.0% reduction in both residential and ICI Lcd rates, including natural savings, and a 0% reduction in per capita NRW rates, equating to an overall 3.25% reduction in demands versus Scenario #1 (**Table 5-4**). Scenario #3 will result in the following:

- 4.0% Decrease in Residential Lcd Rates
- 4.0% Decrease in Employment Lcd Rates
- 0% Decrease in NRW Lcd Rates

Table 5-4: 3.25% Reduction in Average Annual Day Demands by 2051

Demand Type	2020, Lcd	2051, Lcd	2051 Population	2051 Avg. Annual Day Demand, m^3/day
Residential	167	160	203,000	32,460
Employment	191	184	116,000	21,288
NRW	61	61	203,000	12,338
Total	-	-	-	**66,086**

Estimated Program Costs

Achieving an average annual day demand of 66,086 m^3/day in 2051 equates to a 3.25% (or approximately 2,220 m^3/day, in 2051) reduction versus Scenario #1. It is assumed that the unit cost of implementing this scenario is 17.3% lower than that of Scenario #2, or $2,132 per m^3/day of savings (**Table 5-5**) and the average program implementation cost for 30 years is estimated at approximately $157,670 per year.

Table 5-5: Costs and Savings: Scenario #3

Direct Savings, m^3/day	Natural & Indirect Savings, m^3/day	Total Savings, m^3/day	Cost per m^3/day	Total Cost (million $)
846	1,374	2,220	$2,132	$4.73

Scenario #4 – Water Demand Reduction of 7.3% Reduction by 2051

This scenario includes the savings targets described in Scenario #2 plus additional savings related to water reuse. Thus Scenario #4 represents the most aggressive option with the highest projected costs and water savings.

It is very difficult to estimate the future impact of water reuse over 30 years. In addition to the water reuse opportunities evaluated within the WSMP process, this topic is a consideration within the Wastewater Treatment and Biosolids master planning process, and an integrated approach to evaluating and executing water reuse must be considered.

It is expected that water reuse will become more attractive over time as technology improves and the availability of high-quality fresh water sources becomes scarcer. The City is currently exploring the potential to use appropriately treated wastewater for sewer flushing, with an estimated potable water savings of 5,678 m^3/year (average of 15.6 m^3/day). At this

time, however, there are still a number of barriers related to the wide-spread acceptance of water reuse, including:

- Community acceptance of using treated wastewater
- Potentially higher unit cost associated with water reuse than with potable water
- Environmental concerns, e.g., reducing the volume of effluent discharged by a WWTP
- Regulatory issues with uncertain permitting and operational standards for reuse options
- City and private property owner based capital investments to develop municipal system and private plumbing upgrades

Water reuse measures are not restricted to municipal programs and may be implemented in both the residential and ICI customer sectors. Previous reports completed for the City on water reuse opportunities have been referenced to estimate total potential reductions. While a number of reuse programs have been identified as part of past City evaluation of reuse opportunities (shared in **Table 5-6**), many of these are seasonal demands some of which may not rely on municipal supply (e.g., municipal irrigation and golf course irrigation) and therefore would have a minimal impact on average annual day demands. Since future water supply infrastructure requirements are based on maximum day demands, measures that don't significantly reduce demands year-round will not reduce future supply capacity requirements. Therefore, the total projected potential potable water savings in this proposed scenario do not include water reuse related to municipal or golf course irrigation.

Table 5-6: Potential Water Reuse Savings (Genivar, 2011)

Measure	Annual Savings, m^3	Average Annual Day Savings, m^3/day
Street sweeping	3,175	8.7
Sewer flushing	11,223	30.7
Urban applications	168,168	460.7
Construction	10,160	27.8
Municipal irrigation	8,800	24.1
Golf course irrigation	147,000	402.7
Total	**348,526**	**955**
Total without Irrigation	**192,736**	**528**

A reduction in potable water demands by 2051 of 528 m^3/day, in addition to the savings identified in Scenario #2, would equate to a savings of 7.3% versus Scenario #1 (**Table 5-7**).

Table 5-7: 7.3% Reduction in Average Annual Day Demands by 2051

Demand Type	2020, Lcd	2051, Lcd	2051 Population	2051 Avg. Annual Day Demand, m^3/day
Residential	166.6	153.4	203,000	31,140
Employment	191.0	175.9	116,000	20,404
NRW	60.8	60.8	203,000	12,338
Total Potable	-	-	-	**63,882**
Estimated Water Reuse Savings	-	-	-	**-528**
Total Potable Minus Reuse	-	-	-	**63,354**

Estimated Program Costs

Achieving an average annual day demand of 63,354 m^3/day in 2051 equates to a 7.3% (or 4,952 m^3/day) reduction versus Scenario #1. For the purpose of estimating the costs associated with this scenario, one must consider that Scenario #4 includes the savings targets described in Scenario #2 plus additional savings related to water reuse.

The American Water Works Association (AWWA) states "reuse system assets, configurations, technologies, and operational considerations are tremendously varied[14]". Without knowing any details regarding the reuse format/ measures the City will undertake in the future or the presence of a constant customer base for such water, it is not possible to accurately estimate the costs associated with implementing water reuse measures. However, to be conservative, a unit cost of $6,875 per m^3/day has been assumed for reuse projects based on the results identified in the publication Cost and Energy Intensity of U.S. Potable Water Re-use Systems[15]. Detailed, program-specific costing will be developed through future updates to the WES, subsequent pilot projects and related research. At this time, the cost to achieve the targeted

14. Water Reuse Cost Allocations and Pricing Survey, May 2019
15. Research on 25 water reuse facilities in the USA with capita cost data found that unit capital costs could be as high as $5,300 per m^3/day of capacity and O&M costs could be as high as $200 per m^3/day, for a total of $5,500 per m^3/day (USD) or approximately $6,875 in Canadian dollars. https://pubs.rsc.org/en/content/articlelanding/2021/ew/d1ew00017a

528 m^3/day of water savings through reuse measures is an estimated $3.63 million (**Table 5-8**:). The total cost of implementing Scenario #4 is estimated to be $15.04 million over 30 years with an average program implementation cost estimated as $501,333 per year.

Table 5-8: Costs and Savings: Scenario #4

Program Type	Direct Savings, m^3/day	Natural & Indirect Savings, m^3/day	Total Savings, m^3/day	Cost per m^3/day	Total Cost (million $)
Water Efficiency Programs	1,686	2,739	4,424	$2,578	$11.41
Water Re-use Programs	528	-	528	$6,875	$3.63
Total	**2,214**	**2,739**	**4,952**	**$3,037**	**$15.04**

Scenario #5 – Blend of Scenarios 2 to 4

An additional blended scenario was identified as an outcome of the Evaluation of Alternatives step, which indicated that a combination of the conservation, efficiency and demand management scenarios may be required to effectively produce demand reductions through the full planning period to 2051. This scenario envisions implementing the current level of programming in the short-term (approximately years 0-10), adjusting the focus to high demand and/or inefficient customers in the mid-term (approximately years 11-20) and incorporating water reuse in the long-term (approximately years 21-30). Using the costs and demand reduction estimates developed for Scenarios 2-4 as a basis, this scenario is estimated to cost an average of $299,792/yr and reduce average day water demand by 3,683 m^3/day.

5.2.3 Water Conservation, Efficiency and Demand Management Summary

The impact of applying the range of proposed conservation, efficiency and demand management scenarios to the projected water demand over the 30-year WSMP Update study period is demonstrated by applying the estimated reductions associated with each scenario to the average and maximum total demands in year 2051 (**Figure 5-1**). It is observed that the range in scenarios depicted provides a significant reduction in the future supply requirements. Also provided below is a summary of the estimated total and

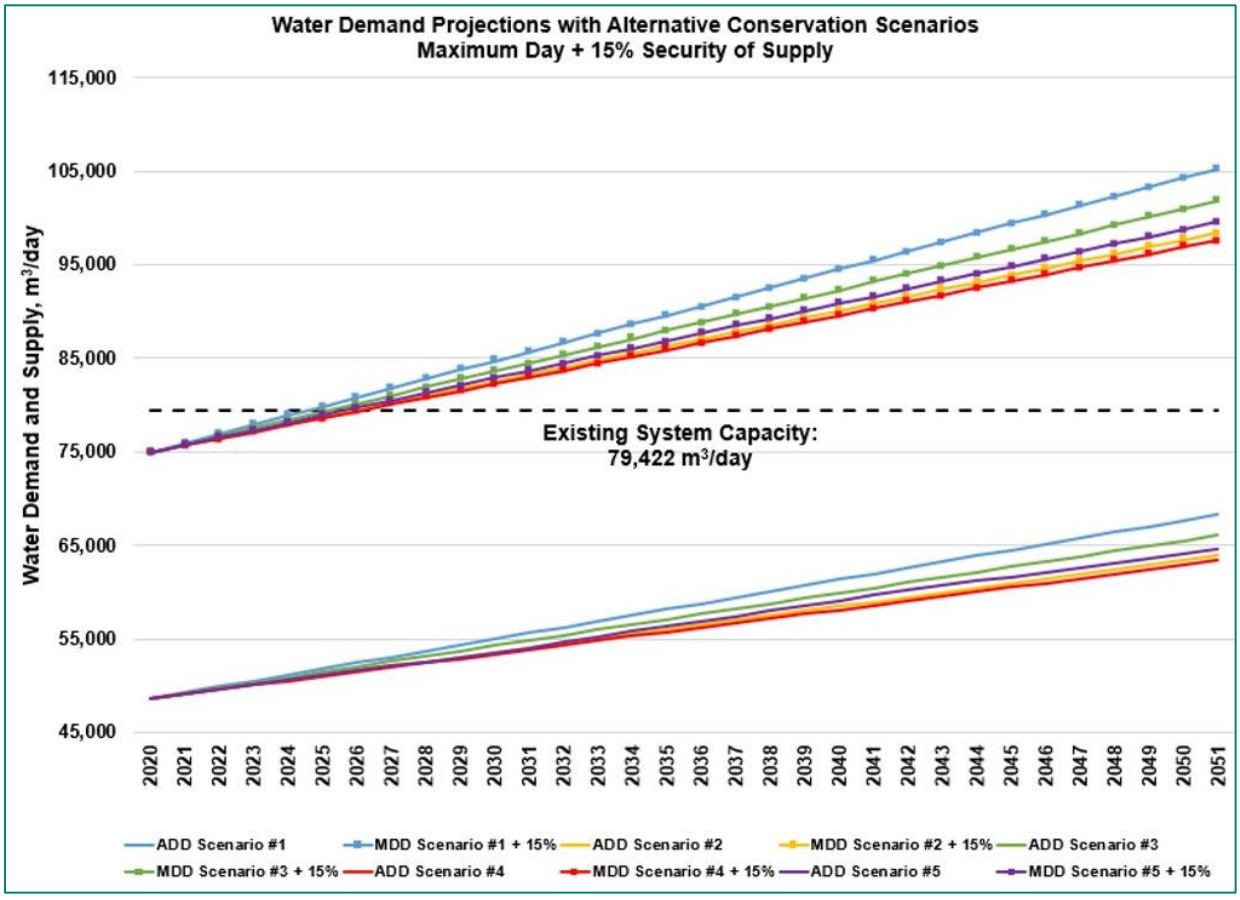
annual program costs for each scenario (**Table 5-9**). The Life Cycle cost is evaluated over a 20-year period in alignment with typical industry practice.

Table 5-9: Summary of Potential Savings and Program Cost Estimates for Each Scenario

Scenario	Projected Reduction in Average Annual Day Demand (m^3/day)	Estimated Program Cost (million $)	Estimated Average Annual Cost ($)	Capital Cost per m^3/day ($)	Life Cycle Cost* – Cost per m^3 avoided ($)
1	-	-	-	-	-
2	4,424	11.41	380,000	2,600	0.53
3	2,220	4.73	157,670	2,100	0.44
4	4,952	15.04	501,333	3,000	0.62
5	3,683	8.99	299,792	2,400	0.50

Notes: * Life cycle cost is the cost per m^3 of avoided capacity over a 20-year period.

Figure 5-1: Water Demand Projections with Conservation, Efficiency and Demand Management Alternative Scenarios



5.3 Expand Existing Groundwater System

The approach undertaken in investigating opportunities for optimizing the City's existing groundwater supplies and developing new sources followed direction provided through the previous WSMP consultation processes (2007 and 2014 update). Public response clearly indicated that the City should consider groundwater opportunities within its municipal boundaries prior to exploring beyond. This mandate was reflected in the prioritization given to projects in the 2014 WSMP implementation plan and in updating the review of groundwater alternatives. As noted in the 2014 WSMP, the development of new groundwater supply sources in surrounding Townships (Guelph/Eramosa and Puslinch) would require concurrence of both the respective Townships and the County of Wellington.

Each quadrant within the City has been studied extensively, with the City undertaking monitoring and groundwater exploration programs in support of the existing operating wells, and in reviewing the feasibility of possible future new groundwater supply sources. Of note here is that potential groundwater sources outside of the City boundaries considered in this WSMP Update are consistent with the 2014 WSMP, where the potential source locations considered were limited to a distance within approximately 5 km of the City limits. This parameter was initially determined with consideration to limiting potential impacts on surrounding municipalities, as well as the practicality of connecting to the City's existing water distribution system. However, if insufficient supply was determined to be available to satisfy projected demands to 2051, this distance could be revisited.

5.3.1 Approach

The first step in the evaluation of groundwater sources was to review the potential sources on a City quadrant basis and identify those that could potentially provide additional capacity. Potential opportunities for expansion of the existing groundwater supply system are grouped into the alternatives below, following the order established in the 2014 WSMP:

- Alternative 2A - Optimize existing municipal sources
- Alternative 2B - Restore off-line municipal sources
- Alternative 2C/D - Develop municipal test wells (includes Dolime Quarry)

- Alternative 2E - Develop new sources inside City
- Alternative 2F - Install new ASR wells inside City to optimize excess Arkell Collector system volumes
- Alternative 2G - Develop new wells outside City

Each groundwater source was evaluated using the updated Tier Three Model and documented in two Technical Memoranda (**Appendix B and D**). The memorandum included in **Appendix B** was initiated in response to updated growth targets provided by the Province in August 2020 within the updated Place to Grow plan ('the Growth Plan') (MMAH, 2020). The amended Growth Plan will place increased pressure on water supply resources available to the City within the 2051 planning horizon. Planning for this growth is complicated by the available capacity in existing and potential wells within the City limits. While additional water (surface water and groundwater) is likely available in the surrounding area, there are significant political challenges associated with developing these water supply sources to service the City. Following the completion of this initial assessment, the second memorandum (**Appendix D**) includes the assessment completed on additional potential sources.

The Tier Three Model is applicable to studying potential impacts from long-term average pumping to determine sustainable system pumping rates. It is acknowledged that pumping at higher short-term rates to meet maximum system demand at a given potential well(s) could be locally sustainable. PTTWs previously issued by the MECP to the City have either been single well permits with a maximum rate for the source, or well field permits that include individual maximum well rates and an overall well field maximum rate (e.g., Arkell Spring Grounds). Applications for these permits have been supported by extensive field testing, often consisting of an Operational Testing Program that evaluates the long-term sustainability within an area of the City surrounding a new source. Based on the current permitting process, a conservative approach was taken for the WSMP Update, wherein the average pumping rate evaluated by the Tier Three Model was considered to be sustainable and identified as the available capacity of a given source that would contribute to the overall system capacity. Using this approach, the additional supply that has been demonstrated by the City through field testing to be locally sustainable would contribute to system redundancy and permit operational flexibility.

The cost estimates developed for the evaluation of alternatives consider the maximum capacity of a given source where it has been demonstrated in the field and the modelled sustainable capacity for the sources where field data are not available (i.e., no redundant supply is assumed for these sources). An example of the latter approach is potential new wells outside of the City, where no field work has yet been completed to assess local hydrogeological conditions. As such, the evaluation of these sources is desktop based. With this approach, the best available information is used to estimate the facility size that will be required and associated costs. Through the completion of individual Class EAs for the identified projects that are pursued by the City, detailed cost estimates will be developed that consider the site-specific information that is developed for each project. Review of this information will consider the cost implications of each alternative with an objective of optimizing the overall system capacity such that it balances the cost of operating existing wells and developing new wells.

5.3.2 Optimize Existing Municipal Sources

In general, 'optimizing' existing wells requires a review of operational and maintenance activities for current facilities to ensure that the potential hydrogeological capacity can be achieved to meet peak demands. The only well identified as possibly having additional capacity available as compared to its current PTTW allocation is the Downey Well, which could potentially pump at a rate of 5,700 m^3/day. Based on preliminary outputs from the 2007 SWQ Class EA study and modelling completed for the current WSMP Update, an estimated additional total long-term capacity of 4,500 m^3/day is available from the SWQ without resulting in potential environmental effects (under historical Dolime Quarry water management conditions).

The City is currently undertaking the Southwest Guelph Water Supply Class EA and associated OTP. An increase to the current PTTW allocation for the Downey Well could form part of the Class EA preferred solution; however, this option would need to be evaluated alongside the other SWQ water supply alternatives. As such, the Downey Well was not evaluated in detail herein, but will be evaluated through the noted Class EA process, which will assess the amount of water available within the SWQ following closure of the quarry.

5.3.3 Restoration of Existing Off-line Municipal Sources

This alternative includes wells that are currently permitted by MECP, but that the City has discontinued their use due to concerns regarding existing water quality issues. In general, these wells require upgrades for water quality treatment and to provide the required disinfection contact time. Most of these facilities will require the completion of Class EA studies to establish recommended treatment systems. The primary method for evaluating the potential sustainable capacity associated with each source was use of the Tier Three Model, as documented in **Appendix B and D**. The potential for future operation of these sources is discussed below.

The Edinburgh and Admiral wells, both permitted by MECP, were considered in the preliminary screening step of the WSMP Update but were not carried forward to the detailed evaluation of alternatives. The future incorporation of these wells into the City system should be reviewed through the Southwest Guelph Water Supply EA and the associated OTP.

Southeast Quadrant

Lower Road Collector

Located on the Arkell Spring Grounds, the Lower Road Collector system extends along the lower slope of the Eramosa Valley wall, eastwards from Watson Road to the northern extent of the Glen Collector System. Groundwater taking from the Lower Road Collector is permitted by the Arkell Spring Grounds collector system PTTW. A review of historical collector production records indicates that the Lower Road Collector produced between 600 and 6,000 m^3/day. Due to GUDI water quality concerns and the related treatment requirements for GUDI sources, the Lower Road Collector System was disconnected in October 2000, coincident with reconstruction of the section of aqueduct along this alignment. The collector would require a full re-build to return to service. The Tier Three Model assessment indicated that a re-built collector could add 4,000 m^3/day to the current minimum collector output. Given the level of calibration of the model to collector flows, this should be considered a screening level result that would require detailed field investigation and feasibility assessment prior to implementation.

Coordination with the on-going Water and Wastewater Servicing Master Plan indicates that the F.M. Woods UV system has sufficient capacity for the total flows from Arkell. Limitations, that may be partially addressed through infrastructure upgrades, have been identified for flow rates associated with the combined maximum capacity of the Arkell wells and collector PTTW maximum (C3, 2018). This was completed on a preliminary basis and would require confirmation through a groundwater modelling assessment. As an element of the additional work required to define this alternative, consideration may be given to design aspects that could improve the in-situ water quality such as the use of a sand filter bed at the collector intake (i.e., perforated pipe).

The Arkell Collectors are located near the Eramosa River and Eramosa River Blue Springs Creek Provincially Significant Wetland complex. As this is a previously permitted water source and an increase to the PTTW maximum[16] for the system is not being proposed, it is not anticipated that future operation of the Lower Road Collector would cause an impact to the natural environment. As the system has been offline since 2000, a review of existing conditions would be required to confirm this interpretation.

It is assumed that a Schedule B Class EA would be required to reconstruct the collector as the project would require a review of potential environmental impacts and consideration of treatment requirements.

Modelling was also completed to assess the potential for increasing the capacity of the artificial recharge system on site. This system pumps water from the Eramosa River under a surface water PTTW that allows pumping at variable rates from mid-April to mid-November when there is sufficient flow at specified downstream flow gauges. The pumped water is discharged to an open-bottom pond and trench system (the infiltration system). The water then infiltrates into the overburden and follows the natural groundwater flow direction towards the river. The Glen Collector intercepts a portion of this additional water (estimated to be approximately 50%; C3 Water Inc., 2019), while the balance is likely naturally discharged back to the river. The current pump that draws water from the river limits the maximum discharge to the infiltration system to about 8,640 m^3/day or about 27% of the PTTW

16. The Glen and Lower Road Collectors are included on a single PTTW with a maximum permitted flow rate of 25,000 m^3/day.

maximum (31,795 m^3/day). The modelling assessment indicated that increasing the capacity of the artificial recharge system would not significantly increase the annual minimum Glen Collector flows; however, an increase to the peak flows was simulated. As additional productivity from the Arkell site provides the City with flexibility in terms of how the overall system is managed and could contribute to a future ASR system, it is recommended that system upgrades be pursued. Further, re-construction of the Lower Road Collector could potentially improve the overall efficiency of the artificial recharge system. These upgrades would generally consist of: i) pump replacement with a single double-stage vertical turbine pump with a variable frequency drive; ii) replacement of the pump support platform within the river; and iii) installation of a concrete slab at the riverbed to prevent excess sediment from entering the pump. Planning for these upgrades should consider re-construction of the Lower Road Collector, such that the recharge system provides a maximum benefit to both collector systems. The cost estimate to develop the Lower Road Collector alternative is based on a capacity of 4,000 m^3/day (**Table 5-10**)[17].

Northeast Quadrant

Clythe Well

The Clythe Well is a municipal supply that was taken offline in 1999 due to naturally occurring water quality issues. In 2018, the City completed the Clythe Well Upgrade Municipal Class EA and determined that the well could be brought back into service with the construction of a new water treatment facility. Construction of this new facility is anticipated to be completed in 2023. The Clythe Well has a PTTW with a maximum daily rate of 3,395 m^3/day.

The modelling assessment estimated a sustainable capacity for the Clythe Well with consideration of potential effects on the natural environment. The well is located near Clythe Creek and the Clythe Creek Provincially Significant Wetland (PSW) and under long-term pumping conditions the modelling assessment indicated the potential for a greater than 10% baseflow reduction to Clythe Creek. Although the creek has historically been

17. Supply chain issues related to the COVID-19 pandemic have introduced uncertainty into the cost estimating process. Certainty is highest for short-term projects where recent project budgets are available for review and are factored into the estimates presented herein. Cost estimates for medium and long-term projects will be refined through future updates to the WSMP.

identified as a coldwater feature, current temperature monitoring suggests that the middle and lower reaches of the creek, in the vicinity of this well, are no longer coldwater. With respect to the modelling results, the Tier Three Study (Matrix, 2017) noted that insufficient data were available to calibrate the model to shallow conditions locally. As such, the results presented herein should be considered preliminary and further evaluated along with future field data, such as that associated with on-going City investigations designed to build on the understanding of the potential for interaction between the well and natural environment. The cost estimate to develop the Clythe Well alternative is based on the upper range of the steady-state modelled capacity of 1,180 m^3/day and the field tested rate of 3,370 m^3/day (**Table 5-10**). It is anticipated that the modelled capacity value is conservative with respect to the potential for impacts to the natural environment.

Northwest Quadrant

Sacco and Smallfield Wells

Two municipal groundwater supply sources (Sacco and Smallfield) are currently permitted for operation; however, these wells remain inactive and off-line since about 1994 due to groundwater quality concerns. The groundwater source from the Smallfield Well has been adversely impacted and has consistently contained TCE concentrations that exceed the ODWQS maximum acceptable concentration (MAC) of 5 μg/L. Low level concentrations of PCE, 1,1-dichloroethylene, 1,1,1-Trichloroethane, dioxin and furans, and 1,4-dioxane have also been detected in the well, and chloride has been reported above the ODWQS Aesthetic Objective of 250 mg/L.

The sources of groundwater contamination have been identified as comprising several industrial properties in the area of the Smallfield Well, where TCE concentrations have been reported as high as 4,000 times the ODWQS MAC. At the request of MECP, investigations of these sites have been ongoing since about 1994; however, no active groundwater remediation has taken place and the aquifer targeted by the Smallfield Well remains unchanged from when the well was shut down in 1994. The City has engaged in ongoing discussions with MECP regarding the status of the contaminated sites and the need for actions to address groundwater contamination and its impact on the City's drinking water sources.

Groundwater quality at the Sacco Well has indicated detectable levels of TCE that remain consistently below the ODWQS MAC and low levels of PCE and 1,1-dichloroethylene.

Potential well capacities for the Smallfield and Sacco well are 1,408 and 1,150 m^3/day, respectively, as concluded in a rehabilitation and performance assessment completed by the City in 2008. However, due to groundwater contamination that is known to exist in the NWQ, operation of the Sacco Well has the potential to re-distribute existing contamination within the bedrock aquifer, resulting in further water quality impacts. With continued pumping of the Sacco Well, there is the potential that groundwater from contaminated sites in the area may be drawn into the capture zone of the well, thereby resulting in further water quality impacts.

The modelling assessment estimated a sustainable additional capacity for the NWQ of 1,275 m^3/day, which would include pumping from the Sacco, Smallfield and Hauser Wells. Testing completed by the City in 2009 (Stantec, 2009) has demonstrated a capacity of 1,150 m^3/day for the Sacco Well and 1,408 m^3/day for the Smallfield Well. Additional capacity developed from these wells would contribute to system redundancy. In 2014, the City completed a treatment study for these wells that provided cost estimates for four options to return the wells back to service that included manganese dioxide oxidation-filtration followed by granular activated carbon treatment (Gamsby and Mannerow Ltd., 2014). For the purpose of this assessment, it is assumed that the option of constructing a water treatment facility at the City-owned Smallfield Well site would be implemented, as additional property would be required to construct a treatment facility on the Sacco Well site. Currently the Sacco well is not contained within a well house. The cost estimate presented below assumes that the well would be outfitted with a submersible pump and electrical panel to pump water to the Smallfield site via a raw watermain. This strategy is accounted for in the associated cost estimate, which is developed based on the full potential capacity of these wells of 2,560 m^3/day (**Table 5-10**).

The sources of contamination in the NWQ have been identified as several industrial properties in the Smallfield Well Head Protection Area which were assessed as conditions resulting from past activities in the Grand River Source Protection Area Assessment Report (2019). The aquifer targeted by the Smallfield Well remains as contaminated today as when it was taken

offline in 1994. The extent of contamination on adjacent properties, the potential liability associated with re-distributing groundwater contamination and lack of remediation or source control are considered to be significant impediments to the development of these wells or other water supply sources in the NWQ. Since the City has limited authority to implement actions related to groundwater contamination on private property, further source investigations and source control/remediation, to be led by MECP, will be required to develop these wells.

For the return to service of these wells, there remains great uncertainty and risk for the City in the design of a treatment system with respect to the maximum raw water contaminant concentrations, the concentration trend with time, the duration of treatment, and the potential liability of pulling contaminated groundwater across areas which are not yet impacted. To that end, the City is proposing to de-prioritize these already permitted water supply sources through the WSMP Update, until such time as the sources of groundwater contamination in the area have been remediated. However, these wells should remain as part of the WSMP as future drinking water sources (i.e., post-2051, or until source remediation occurs).

Summary

The sustainable additional quantity of groundwater that has been determined to be available from these sources through the modelling assessment is 6,030 m^3/day. **Table 5-10** summarizes the cost estimate for capital works for preliminary investigations, design, land acquisition[18] (where required), construction of new wells and treatment systems, and approvals. In addition to the capital costs, operating and maintenance costs were also estimated including labour, maintenance and energy costs.

18. Land acquisition cost estimates, where required, are based on current market values and will be updated in subsequent WSMP Updates to reflect land values estimates at that time.

Table 5-10: Summary of Cost Estimates for Off-Line Municipal Sources

Description	Clythe Well	Smallfield/ Sacco Wells	Lower Road Collector
Potential Capacity Range [m^3/day]	1,180 – 3,370	850 – 2,560	4,000
Capital Cost (incl. contractor overhead)	**$4,717,000**	**$8,394,000**	**$9,478,480**
Estimating Contingency	$1,356,000	$2,623,125	$2,585,040
Engineering and Construction Service	$707,550	$2,098,500	$1,809,528
GRAND TOTAL^	**$6,781,000**	**$13,116,000**	**$13,874,000**
Cost per m^3/day	$2,012	$5,127	$3,469

Notes: *Included in above cost.
^Total values are rounded.

5.3.4 Develop Existing Municipal Test Wells

An extensive review and assessment of existing municipal test wells was undertaken to determine potential well yields and water quality treatment requirements. Test wells/ observation wells for which modelling has indicated potential capacities are shown in **Figure 4-1**. It is noted that these wells are located in areas both within and outside the City's boundary. The Fleming and Logan wells are located immediately east of the City boundary on Eastview Road, on City-owned property. Based on the information available from previous studies including pumping tests and water quality testing of the test wells, there is generally more certainty regarding these alternatives in regard to location, potential yields and treatment requirements. The City can more readily move toward next steps including Class EA, treatability studies and permitting, should these be included as part of the recommended solution.

Southwest Quadrant

Steffler, Ironwood, and Guelph South (GSTW1-20)

Through the 2007 SWQ Class EA study, two large diameter test wells (named 'Ironwood' located in University Village Park and 'Steffler' located in Steffler Park; **Figure 4-1**) were installed and tested over an extended period

at capacities of 8,000 and 3,600 m^3/day, respectively, to determine potential capacities and to monitor potential effects on other municipal supply wells, private wells, and surface water features. The SWQ Class EA study was put on hold by the City in 2010 due to groundwater quality and quantity concerns related to operations at the Dolime Quarry. Since that time, the City has worked with the quarry owners (River Valley Developments; RVD) to identify a viable solution to protect the drinking water source. Now agreed-upon by both parties, this three-fold strategy includes: i) closing the quarry; ii) bringing the quarry property into the municipal boundary; and iii) controlling the quarry pond water level via an on-site water management system operated by the City (referred to as Pond Level Management; PLM). The PLM strategy will be evaluated as a source protection strategy within the Southwest Guelph Water Supply Class EA (a continuation of the SWQ Class EA). The water supply opportunity is associated with the use of municipal and/or test wells to capture of some of the water currently pumped to the Speed River as part of the dewatering operations of the quarry.

In 2019, the City initiated the Guelph South Groundwater Supply investigation to assess the capacity of test well GSTW1-20, located in the Hanlon Creek Business Park in southwest Guelph (**Figure 4-1**). This work indicated that the test well has a capacity of approximately 4,320 m^3/day (based on a 30-day pumping test). This project is on-going, and this well will be considered within the Southwest Guelph Water Supply Class EA and this WSMP Update.

A total objective for additional groundwater supply from Southwest Guelph of 4,500 m^3/day may be available through new municipal wells (i.e., Ironwood, Steffler, GSTW1-20) alone, or through a combination of new wells plus optimizing existing wells including reactivating existing off-line wells requiring treatment. The ongoing Southwest Guelph Water Supply Class EA will aim to fulfill two main objectives: i) to manage the operation of existing and new wells in Southwest Guelph to sustainably capture as much groundwater locally as possible thereby minimizing the inflow of groundwater to the quarry; and ii) to manage the level of the quarry pond through pumping to the Speed River to minimize the potential for quarry water influx to the groundwater aquifer, thereby keeping the municipal supply safe. Subject to the technical assessment process, the Class EA may consider the feasibility of an additional alternative of capturing groundwater

directly from the quarry as a potential future source. It is noted that the additional capacity identified in Southwest Guelph of 4,500 m^3/day was under historical quarry operating conditions and that the OTP being completed may determine that additional capacity is available to the surrounding wells through quarry PLM.

As it is assumed that the City will move forward with the Council-approved plan to bring the quarry site into the municipal limits, this alternative is considered alongside those within the City.

Consistent with previous work, the Tier Three Model assessment concluded that these wells could contribute an additional capacity of 4,500 m^3/day to the overall system capacity under current quarry dewatering conditions. These wells have demonstrated individual well capacities above this combined capacity of 3,600, 8,000, and 4,320 m^3/day for Steffler, Ironwood and Guelph South, respectively. Therefore, additional capacity developed from these wells would contribute to system redundancy. Baseflow reduction of >10% was simulated using the Tier Three Model for Hanlon and Irish Creeks, although there is uncertainty with the results for Irish Creek due to its proximity to the model boundary. These test wells will be further assessed through a detailed Operational Testing Program being completed for the Southwest Guelph Water Supply Class EA, including monitoring of surface water features for baseflow reductions and potential effects to municipal and non-municipal wells. This testing will also further assess the presence of antimony in the groundwater, which was detected in previous testing at the Ironwood and Steffler Wells but deemed to be spurious.

The Ironwood and Steffler Wells are located in municipal parks with sufficient area for well house facilities. The Guelph South Well site also has sufficient available land for a well facility.

The cost estimates for these test wells are presented in **Table 5-11** and are based on the noted individual well capacities of 3,600, 8,000, and 4,320 m^3/day for Steffler, Ironwood and Guelph South, respectively.

Table 5-11: Summary of Cost Estimates for Municipal Test Wells

Description	Fleming/ Logan	Guelph South	Steffler	Ironwood	Hauser	Dolime
Potential Capacity Range [m^3/day]	4,180 – 4,700	2,250 – 4,320	2,250 – 3,600	2,250 – 8,000	425 - 900	1,000 - 3,000
Capital Cost (incl. contractor overhead)	**$6,902,500**	**$3,279,100**	**$4,231,700**	**$3,501,300**	**$3,984,200**	**$13,399,800**
Estimating Contingency (30%)	$1,882,500	$894,300	$1,154,100	$954,900	$1,086,600	$3,485,400
Engineering and Construction Service (15%)	$1,317,750	$626,010	$807,870	$668,430	$760,620	$2,091,240
GRAND TOTAL*	**$10,103,000**	**$4,800,000**	**$6,194,000**	**$5,125,000**	**$5,832,000**	**$18,976,440**
Cost per m^3/day	$2,150	$1,111	$1,721	$640	$6,480	$6,325

Notes: * Total values are rounded.

Dolime Quarry

Significant dewatering occurs within the Dolime Quarry on an on-going basis to maintain the water level within the quarry pond (i.e., to prevent flooding of the quarry). Groundwater inflow into the quarry occurs primarily through the Gasport Formation, the main source of municipal groundwater supply. Historically, dewatering in the quarry has occurred up to the PTTW maximum for the site of 13,750 m^3/day; however, the dewatering rates are influenced by municipal pumping patterns at the surrounding wells. Recent dewatering rates, as reported by the quarry owners (RVD), have typically ranged from 8,000 to 11,000 m^3/day. The agreement in place between the City and RVD includes, in part, the City assuming control of water management, thereby controlling the groundwater elevation within the quarry at a level below the surrounding area, resulting in groundwater inflow to the quarry pond (via a hydraulic gradient). At some distance away from the quarry, a maximum groundwater level would occur and represent a flow divide. On either side of the divide, groundwater would flow in opposite directions (i.e., into the quarry on one side and toward the municipal wells on the other). This strategy will be evaluated as a potential alternative within the on-going Southwest Guelph Water Supply Class EA. The Class EA will include an Operational Testing Program that will evaluate the strategy outlined above with a goal of maximizing the amount of water that is captured by the surrounding municipal wells and test wells (above the 4,500 m^3/day

additional capacity estimated with active dewatering), while at the same time minimizing the amount of groundwater that flows into the quarry.

Through this process, the City will determine the pumped flow from the quarry necessary to protect the water supply and, subject to the technical assessment process, the Class EA may consider the feasibility of an additional alternative of capturing groundwater directly from the quarry as a potential future source. In terms of the volume of water that could be available directly from the quarry, it is anticipated that it would be less than the 8,000 to 11,000 m^3/day typically pumped in the 2019 to 2020 period, as a portion of this would be captured by existing and new wells. The groundwater modelling assessment reported daily groundwater discharge to the quarry that ranged from approximately 3,400 to 6,100 m^3. Acknowledging the uncertainty in assigning a potential volume that could be available from the quarry under Pond Level Management, a conservative range of 1,000 to 3,000 m^3/day was carried forward for costing and evaluation purposes. There is little water quality information available for the quarry discharge; for evaluation purposes it is assumed that this source may be considered surface water and therefore would require filtration and enhanced disinfection.

The cost estimate for the Dolime Quarry water treatment facility, provided in **Table 5-11**, is based on a capacity of 3,000 m^3/day. The cost for a full scale water treatment facility is high and will be refined through the Southwest Guelph Water Supply Class EA and associated Operational Testing Program. For example, the primary objective of this testing is to develop a strategy for protecting groundwater quality within the Gasport aquifer, while optimizing the volume of water available to the existing municipal supply wells and potential new supply wells (test wells). Capture of this water through the well network would result in a substantially lower cost, as the bulk of the associated cost is included in the cost estimates for development of the individual test wells. The cost presented in **Table 5-11** should be considered a conservative value that will be refined through the noted process.

Northeast Quadrant

Logan and Fleming

The City has previously installed test wells in the area of Eastview Road and Watson Road; referred to as the Logan and Fleming Wells, respectively. Both

wells are located on City-owned property outside of the municipal limits and within Guelph/Eramosa Township.

The Tier Three Model assessment concluded that these wells could contribute an additional capacity of 4,180 m^3/day, similar to the 2014 WSMP result of 4,700 m^3/day. In 2020, testing was completed at the Logan well to assess its integrity and to evaluate water quality within both the shallow and deep aquifer (Well Initiatives, 2020). Based on this testing, the City has initiated a project to reconstruct the Logan Test Well to target the Gasport aquifer by drilling out the existing borehole to below the Vinemount Member (regional aquitard) and installing a new casing. This project will include an assessment of potential effects on surrounding private wells and the natural environment. As this test well is located on City-owned property outside of the City, there is a higher density of active private wells. The test well is also located near the Guelph Northeast PSW and a tributary of the Speed River. The property on which this test well is located is anticipated to be large enough for a future facility. Consultation with Guelph/Eramosa Township will be required to develop the Logan supply. The cost estimate presented in **Table 5-11** is based on a capacity of 4,700 m^3/day.

If the City pursues a potential municipal water supply the Fleming site in the future, a new well would be required as the original test well has been converted to a multi-level monitoring well.

Northwest Quadrant

Hauser

The City possesses a former test well in the NWQ referred to as the Hauser Well. A potential issue within this area of the City is the presence of known contamination (TCE), as discussed in relation to the Smallfield Well.

The groundwater modelling assessment estimated a sustainable additional capacity for the NWQ of 1,275 m^3/day, which would include pumping from Sacco, Smallfield and Hauser. The estimated capacity of a well at this site is approximately 900 m^3/day; however this requires significant study for verification. Additional studies would be required to determine if water quality impacts would occur from long-term pumping due to known contaminated sites in the Smallfield Well area located 2.2 km to the northeast. Future work should also focus on potential effects to the local natural environment, which

includes Ellis/ Chilligo Creek and the Ellis Creek PSW Complex. A new well would be required to develop this alternative. For costing purposes, it is assumed that iron and manganese treatment would be required for this well, as water quality data are not available for the test well. This estimate is presented in **Table 5-11** and reflects a capacity of 900 m^3/day.

Summary

The total increase in a potential quantity available from these wells is 12,105 m^3/day; including 4,500 m^3/day from SWQ wells and 3,000 m^3/day from the Dolime Quarry. **Table 5-11** summarizes the cost estimate for capital works for preliminary investigations, design, land acquisition (where required), construction of new wells and treatment systems, and approvals. In addition to the capital costs, operating and maintenance costs were also estimated including labour, maintenance and energy costs.

5.3.5 Develop New Wells Outside City Boundaries

Guelph Southeast

A potential test well area, located southeast of the City (east of Victoria Road, on Maltby Road) within the Mill Creek catchment area was modelled in the completed assessment. This location, within Puslinch Township, was established through a review of the Tier Three Model parameters, and a nearby municipal monitoring well (MW08-T3-09). No detailed testing or site-specific information is available, and the estimated capacity result is based solely on model interpretation. The rationale for this location is its proximity to an area with high transmissivity within the Gasport Formation bedrock aquifer and limited local groundwater usage (i.e., nearby golf course well operating at 660 m^3/day seasonally). The estimated available sustainable capacity of a modelled groundwater supply well in this general area is 1,600 m^3/day on an average basis with a low potential for impacts to baseflow within Mill Creek. Groundwater quality from a source in this area is unknown and therefore it is conservatively assumed that iron and manganese treatment would be required. The cost estimate for the Guelph Southeast Well is included in **Table 5-12** and is based on the modelled capacity value of 1,600 m^3/day.

Guelph North

A second potential test well area, located north of the City (the western limit of Conservation Road) within the Marden Creek catchment area was modelled in the completed assessment. This location was established through a review of the Tier Three Model parameters, and no detailed testing or site-specific information is available. The estimated capacity result is based solely on model interpretation. The rationale for this location is its proximity to an area with high transmissivity within the Gasport Formation bedrock aquifer and limited local groundwater usage (i.e., two Guelph/Eramosa Township community wells with a combined permitted rate of 2,022 m^3/day). The estimated available sustainable capacity of a modelled groundwater supply well in this general area is 2,935 m^3/day on an average basis. A baseflow reduction greater than 10% was modelled for Marden Creek. Groundwater quality from a source in this area is unknown and therefore it is conservatively assumed that iron and manganese treatment would be required.

Future work associated with the Guelph Southeast and North locations would require a detailed assessment of potential impacts on surrounding private wells and the natural environment after specific potential well locations are identified. As these well areas are located outside of the City, there is a higher density of active private wells. New property would be required for test wells and future well facilities. Consultation and collaboration with Puslinch Township (Southeast) and Guelph/Eramosa Township (North) would be required in advance of initiating these projects.

The cost estimate for this alternative is included in **Table 5-12** and is based on a capacity of 2,935 m^3/day.

Summary

The total modelled sustainable increase in overall capacity related to these hypothetical well locations is 4,535 m^3/day. **Table 5-12** summarizes the cost estimate for capital works for preliminary investigations, design, land acquisition (where required), construction of new wells and treatment systems, linear distribution and approvals. In addition to the capital costs, operating and maintenance costs were also estimated including labour, maintenance and energy costs.

Table 5-12: Summary of Cost Estimates for New Wells Outside of City

Description	Guelph SE	Guelph N
Potential Capacity (average) [m^3/day]	1,600	2,935
Capital Cost (incl. contractor overhead)	**$4,688,200**	**$8,772,940**
Estimating Contingency (30%)	$1,278,600	$ 2,392,620
Engineering and Construction Service (15%)	$895,020	$ 1,674,834
GRAND TOTAL*	**$6,862,000**	**$12,841,000**
Cost per m^3/day	$4,289	$4,375

Notes: * Total values are rounded.

5.3.6 Arkell Collector System ASR Wells

Review of the current Glen Collector system and off-line Lower Road Collector system flows indicates high seasonal variability, with elevated flows in the spring (April, May, June), which do not correspond to a period of high demand that traditionally occur during the summer months. As a result, this water may not be available to the distribution system and these flows cannot be considered as part of the maximum system daily supply capacity. ASR is a strategy where excess flows from the collector systems would be treated (potable) and then stored within an aquifer during periods of water surplus (i.e., when capacity exceeds demand) and subsequently this volume of stored water would then be recovered during periods of water shortage (i.e., when demand exceeds existing capacity). For this assessment, the Guelph Innovation District Lands were assessed as a potential location for ASR injection and recovery wells.

The advantage of this ASR alternative is that a surface water treatment plant may not be required as it would be if water were to be taken directly from the Eramosa River (the Eramosa River was determined to have insufficient capacity to support additional surface water pumping). The additional seasonal volumes from the collector systems would be discharged to the existing aqueduct to combine with other Arkell wellfield supplies for disinfection at the Woods PS through the UV system as they are currently. Treatment requirements would need to be confirmed through water quality testing and consideration of MECP's pending, revised GUDI TOR. Through coordination with the Water and Wastewater Servicing Master Plan, it was determined (on a preliminary basis) that the aqueduct and the F.M. Woods

facility have sufficient design capacity to accommodate the additional flows contemplated in this alternative, but this would require verification through a detailed assessment of the infrastructure capacity. Limitations, that may be partially addressed through infrastructure upgrades, have been identified for flow rates associated with the combined maximum capacity of the Arkell wells and collector PTTW maximum (C3, 2018).

The excess volume available to the ASR system would be pumped into the distribution system and delivered to the ASR well locations, similar to a large customer demand, for dechlorination, injection and storage in the aquifer.

In concept, the ASR system would consist of a series of wells arranged in one or more wellfields that would inject treated water for storage in the deep bedrock (i.e., injection mode) when excess water is available. When water is required from storage, the same wells would be used to recover the water (i.e., extraction mode). The water recovered from the ASR wells would require disinfection prior to distribution. Depending on the configuration of the system, the wells could pump to reservoirs prior to distribution or directly into the distribution system. Extensive studies are required to evaluate the feasibility of this alternative with respect to excess water available from the Arkell collector systems as well as appropriate areas to install wells to ensure optimal hydrogeological properties. Another important consideration is the location of the system and number of wells needed to ensure the most advantageous input into the distribution system from an operational perspective to facilitate additional supply scenarios. However, from a feasibility perspective, the Gasport Formation bedrock aquifer is known to have high transmissivities and cavernous porosity in areas as well as being confined at depth by the Eramosa Formation, all of which make the aquifer ideal for ASR. While testing would still be required, the Gasport Formation bedrock is considered to be highly feasible for ASR.

To assess the feasibility of an alternative that captures a portion of the excess flow available from the Arkell collector systems, the modelling output for the Lower Road Collector replacement scenario was reviewed. This provided an estimate of combined Glen Collector and Lower Road Collector flows. If upgrades to the artificial recharge system are pursued, excess water above that described herein would be available during the spring period.

The estimated excess flow available from the collectors for ASR in April to June was determined by first removing the volume that would be required to address daily customer demand (i.e., assumed to flow directly to distribution). The remaining monthly volume (451,000 m^3) is that which is excess and available to inject into the ASR system. For the remaining months of the year (July to March), the ASR system would operate in extraction mode for a total extraction of 451,000 m^3 (**Table 5-13**).

Table 5-13: Summary of Estimated Arkell Spring Grounds Flows Available for ASR

Month	Excess Collector Flow (m^3/mo.)	Estimated System Demand (m^3/mo.)	Volume to ASR (m^3/mo.)	Volume from ASR (m^3/mo.)
Jan	0	49,600	0	49,600
Feb	0	51,000	0	51,000
Mar	0	51,700	0	51,700
Apr	93,900	50,600	43,300	0
May	195,100	51,200	143,900	0
June	317,500	53,700	263,800	0
July	0	52,200	0	52,200
Aug	0	50,800	0	50,800
Sept	0	52,100	0	52,100
Oct	0	49,000	0	49,000
Nov	0	48,800	0	48,800
Dec	0	45,800	0	45,800
TOTAL	**606,500**	**606,500**	**451,000**	**451,000**

The ASR system was simulated with six ASR extraction/injection wells located within the Guelph Innovation District Lands (**Appendix D**). Local hydrogeological conditions within the Tier Three Model (high hydraulic conductivity zone) suggest the potential for developing an ASR system in this area. Further, the Eramosa River passes through the site and is less vulnerable to potential baseflow impacts than smaller creeks within the Study Area. The modelling output suggests that the ASR wells should be operated at 60% of the target extraction rates tested in the model, while the existing municipal wells are operated at baseline rates (i.e., system total of 53,551 m^3/day). These were the rates identified to accomplish extraction at the ASR wells, while allowing the existing municipal wells to continue operating sustainably.

It was noted in the modelling results that some existing municipal wells have considerable available head and therefore there is likely an opportunity to

increase pumping rates at those wells to capture more of the injected water. This is supported by other completed model scenarios that indicate sustainable total system pumping rates up to 82,370 m^3/day. The simulations showed that the influence of the injections caused increased groundwater level elevations in the surrounding area that extended as far as 10 km away from the ASR system. This indicates that the influence of the injection is dissipating far from the injection site and the injected volume is unlikely available to be extracted locally in its entirety within the Guelph Innovation District Lands. Further evaluation to optimize the efficiency of the system is recommended should the City wish to pursue ASR as a future water supply option. It is recommended that additional work focus on the potential to site ASR wells that maximize the ability for existing municipal wells to form part of this alternative, thereby greatly reducing the associated cost.

In order to plan and design a full-scale ASR facility, pilot testing is required. Further, there is a need to evaluate site specific issues including water quality, known significant drinking water threats, geochemical reactions, aquifer hydraulics, recharge/ recovery capacity of individual wells, maximum feasible storage volume, maximum possible storage time, an optimal recovery strategy with respect to utilization of existing wells, and treatment requirements.

The Arkell Collectors produce high quality groundwater that is consistent with groundwater produced elsewhere in the City and is not anticipated to affect the feasibility of ASR. However, the design process must consider ASR geochemistry, which can be complex. It is necessary to study potential impacts of recharge water which could result in a decrease in the ability to transmit water into aquifer storage due to clogging of aquifers (i.e., reduction in the hydraulic conductivity of the aquifer matrix). Subsurface chemical reactions will depend on the water chemistry of the source water and native groundwater and the mineral composition of the aquifer materials; reactions are also a function of the temperature of the recharge water and injection pressure. Injection of water with a different geochemistry will establish a new equilibrium which can cause precipitation of minerals, and therefore lead to clogging of the aquifer and reduction in recharge rates; and can also cause increases in concentrations of dissolved minerals to levels above drinking water limits. Injection of ASR water has the potential to improve groundwater quality as in the case of dilution of impacted groundwater resulting from existing land use within urban areas.

There are considerable studies to confirm the feasibility of ASR with respect to water quality issues. There are many existing case studies that demonstrate the feasibility of ASR in a number of different geological and hydrogeological settings, and the investigation process is well defined.

The intent of ASR is that on an annual basis, the ASR facility represents zero net withdrawal – therefore, no decline in groundwater levels within the aquifer and subsequently negligible environmental impacts. The completed modelling work indicates that system optimization would be required to develop a specific ASR strategy that best utilizes the existing municipal pumping network to fully capture the injected water. With an optimized strategy, a net zero injection/ withdrawal water balance would be achieved and significant interference effects on existing groundwater dependent natural features or users are not anticipated.

During further development of this alternative consideration should be paid to the possibility of using excess flows from the collector(s) during period of high seasonal flow to service customer demands while resting wells within the system. This strategy could potentially allow for recovery within the groundwater system, thereby allowing for pumping at higher rates when overall system demands are higher, but collector flows are lower during annual dry periods. This strategy may require flexibility within the City's PTTW to reflect variable maximum pumping rates throughout the year. Further, testing would be required to determine whether a strategy of resting wells would realize sufficient water level recovery to impact the maximum rate that a given well could operate at. This should be considered alongside further work to evaluate the ASR strategy, as there is a possibility that this could off-set the high anticipated costs of developing an ASR network.

Summary

The total potential additional system capacity from the Arkell ASR, subject to additional optimization evaluation, is 1,170 m^3/day (in consideration of the 60% extraction constraint). With optimization of both the artificial recharge system and the injection/ extraction strategy, it is anticipated that additional capacity is possible. This total capacity includes the combined direct to distribution volume and ASR extraction volumes averaged on an annual basis. The cost estimate for capital works for preliminary investigations, and design, land acquisition where required, construction of new wells,

dechlorination and rechlorination systems, and approvals are provided in **Table 5-14**. In addition to the capital costs, the operating and maintenance costs were also estimated including labour, maintenance, and energy costs. The total cost presented is very high in comparison to other water supply alternatives and illustrates the need to further develop this alternative through an optimization strategy that maximizes the capacity available through ASR, minimizes the number of new ASR wells required for the system and utilizes existing municipal supply wells as part of the injection/extraction process.

Table 5-14: Arkell ASR Cost Estimate

Item Description	Total Cost
Capital Cost (incl. contractor overhead)	**$17,274,400**
Estimating Contingencies on Subtotal (30%)	$4,711,200
Engineering Design and Construction Services on Total (15%)	$3,297,840
GRAND TOTAL*	**$25,284,000**
Cost per m^3/day	$21,610

Notes: * Total values are rounded.

5.3.7 Non-Municipal Groundwater Supply Sources

The Tier Three Study documented non-municipal groundwater-takings within the study area that are permitted through MECP (Matrix, 2017), as operation of these sources affect the overall water balance within the WSMP Update study area. Should use of any of these groundwater sources be discontinued in future, this could present a potential opportunity to the City to incorporate the well/source into the municipal supply system, and/or optimize existing municipal wells to increase production accordingly. An example of this is the Dolime Quarry, which is discussed in detail within this document. Should any of the identified or new non-municipal groundwater source owners/operators seek to initiate or increase production, this could potentially pose a negative impact on the total capacity of the City's municipal sources within the area. Any new or increased permitted maximum(s) for non-municipal groundwater sources would be completed through the MECP approval process, which allows the City to review and comment on the application.

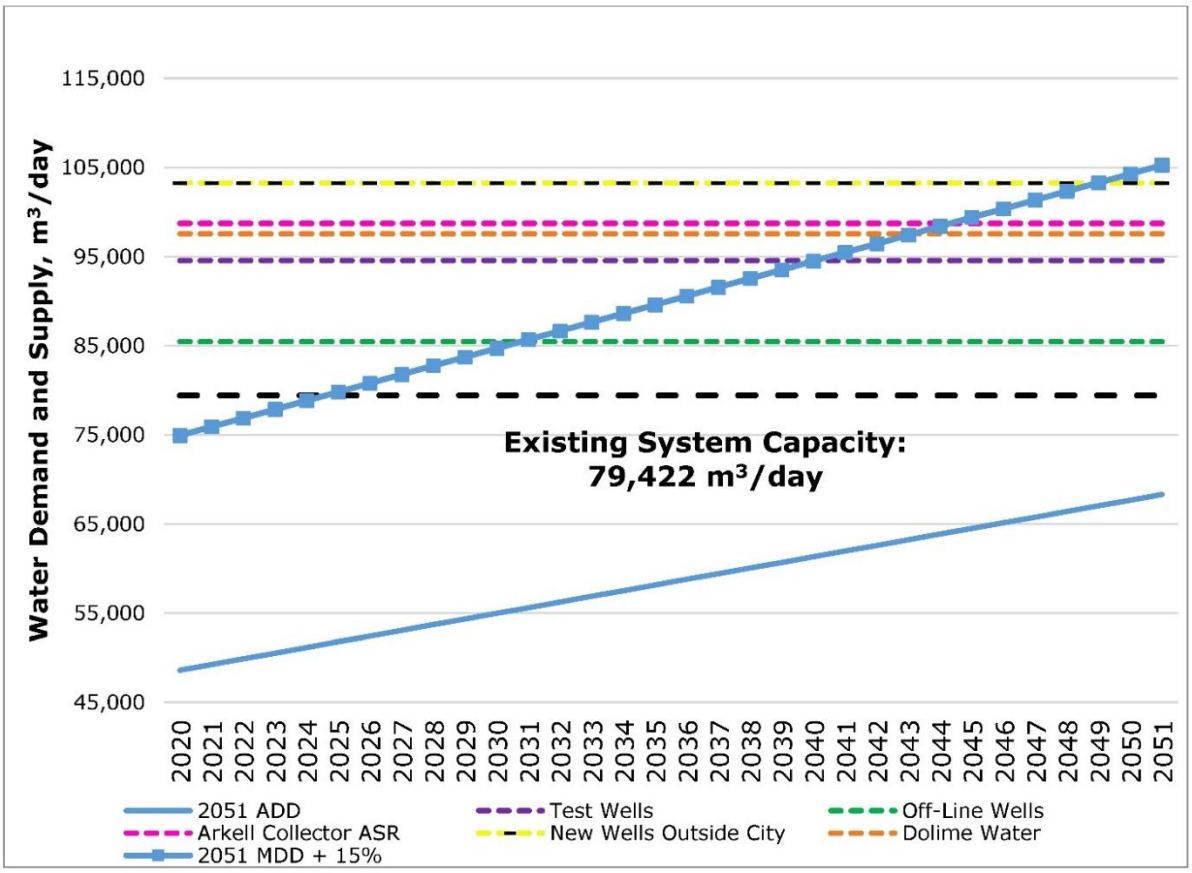
5.3.8 Groundwater Alternatives Summary

The evaluation of groundwater alternatives followed a conservative approach toward identifying potential additional system capacity. The Tier Three Model was used to determine a flow rate that could be achieved on a sustainable basis (average, long-term flow rates), while supporting pumping at existing and new municipal sources and affecting minor to moderate reductions to surface water baseflow.

As with any model, the Tier Three Model is a representation of the system and has associated uncertainties that must be acknowledged when reviewing the output. Previous modelling studies completed by the City indicate that the modelling results are typically conservative and field studies are required to further assess surface water and groundwater conditions with direct measurements and associated interpretation. These field studies would aid in reducing uncertainties and would likely support higher capacities from the evaluated sources. However, the Tier Three Model is the best planning tool available to the City for development of the Master Plan and the results of the modelling assessment have been used to develop a conservative assessment of the sustainable rate that each supply will add to the overall system capacity. A total of approximately 16,000 m^3/day of additional supply capacity from groundwater wells (off-line municipal wells, test wells, and new wells) was identified on an average day basis. This result was utilized in conjunction with available field testing to identify a potential range in capacity that may be achieved by each source. Similarly, other groundwater-based sources (Lower Road Collector, Dolime Quarry PLM, Arkell system optimization, and Arkell ASR strategy) were evaluated in the model to have an average capacity of approximately 8,000 m^3/day of additional flow. Capacity values are also presented for these sources as a range using the model results and available field information. Although individual sources included in the assessment may be able to provide higher short term capacity to meet maximum day demands, the summarized results provide an estimate of the additional available long-term sustainable capacity of groundwater sources within the WSMP Update study area. The work completed indicates that sufficient water supply sources are available to support planned growth within the City (when combined with conservation, efficiency and demand management programs – see Section 8); however, there are limits to the resource. Each detailed study completed to support resource development must assess both the local and City-wide sustainability of the source.

The resulting totals for the groundwater alternatives are shown in **Figure 5-2**, indicating the ability of identified sources to provide a portion of the required water supply capacity to meet the projected 2051 demand.

Figure 5-2: Water Demand Projection with Groundwater Alternatives



5.4 Establish New Surface Water Supply

During completion of the previous master plan updates, public response to the proposed alternatives clearly provided the direction to consider only local surface water as a feasible alternative in the City's goal to grow as a sustainable community. As such, the technical work completed in support of the WSMP Update included two possible local surface waters for assessment of volume available for taking water on a continuous or seasonal basis including the Speed River (at Guelph Lake) and the Eramosa River (at the Arkell Spring Grounds). The preliminary stage of the assessment indicated that the Eramosa River has sufficient flow to support the permitted Arkell

taking in support of the artificial recharge system but does not have sustained excess flow that would support a local surface water supply. Therefore, only the Speed River/Guelph Lake option was carried forward to the detailed evaluation stage. The evaluation presented herein is based on results presented in the 2020 GRCA Technical Memorandum on the Surface Water Analysis for City of Guelph Long Term Water Supply Plan (**Appendix E**).

To contribute to the available supply capacity, surface water must either be treated to provide a continuous flow into the distribution system, or alternatively, excess water can be taken from the surface water when available, treated and stored underground in aquifers. This option is referred to as an Aquifer Storage and Recovery (ASR) system. The rate available from this source on a continuous basis is equal to the volume taken from surface water when available, treated and injected within a year, and removed over the period of a full year (i.e., seasonal use) or multiple years (i.e., banked storage).

For both continuous flow and ASR approaches, construction of a water treatment plant (WTP) is required to fully treat the surface water to meet Ontario Drinking Water Quality Standards (prior to distribution/ ASR injection). In the first option (no ASR), the WTP is sized to treat a continuous input to the plant with direct discharge to the City's distribution system. In the second option (with ASR), the WTP would be required to treat varying flows ranging from the continuous flow requirement to the maximum design capacity based on high seasonal river flows.

To evaluate potential quantity available through this alternative, the GRCA provided their expert opinion on the volume of surface water available in this managed watershed, utilizing historical flow information (1951 to 2019 period of record) and modeling tools. Through this evaluation, a base level water taking was established which would be available year-round, while maintaining minimum flows in the river and minimizing potential environmental impacts of reducing total river flows. The GRCA also reviewed historical records to establish the reliability of taking additional volumes during times of higher river flows. This was an iterative process which resulted in capping this higher flow rate at a level which would be reasonable for modular construction and operation of a WTP, such that it would be operating at three capacity levels each for a minimum period in any given year: a conservative scenario consisting of a municipal base taking of 150 L/s

100% of the time and two incremental steps (with regards to treatment capacity) of 300 L/s and 500 L/s was used as a starting basis to construct a stepped taking scenario. (Note that river flows are typically presented in units of Litres per second, L/s. For conversion to m^3/day, 150 L/s = 12,960 m^3/day, 300 L/s = 25,920 m^3/day, and 500 L/s = 43,200 m^3/day).

The stream inflow supplying flow through the Guelph dam is not constant. It varies within the year and across years. Based on the taking scenarios described above, a chart of the daily inflow probability at the Guelph Dam for the 1950 to 2019 period was constructed which was used to determine which periods of the year were most likely to yield potential for the taking of 500 L/s and 300 L/s. The number of days for each of these takings was placed into different periods of the year that would yield the highest probability of the taking being available. The chart presented as **Figure 5-3** illustrates the inflow probability and the periods of the year when takings of 500 L/s and 300 L/s would most likely be available.

Figure 5-3: Stepped Surface Water Takings from Guelph Dam (GRCA, 2021)

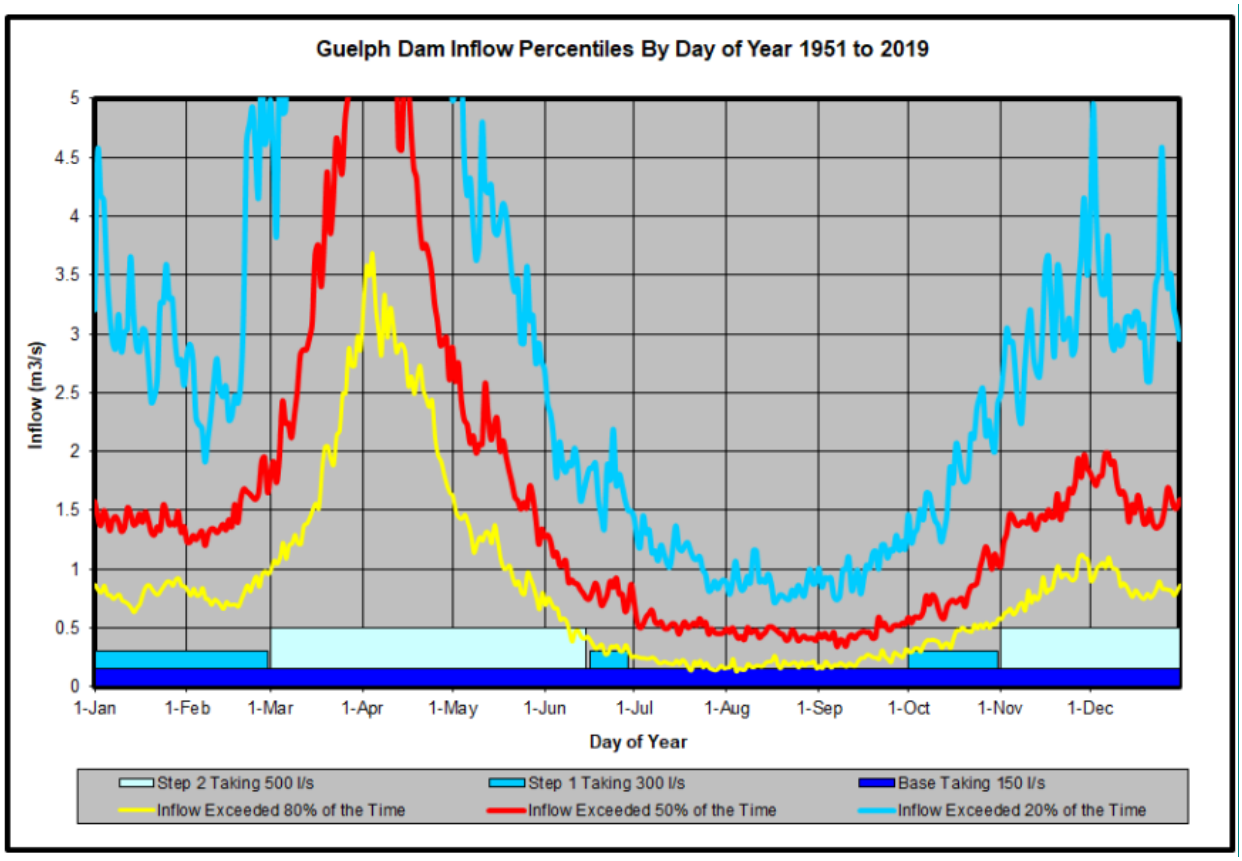


Figure 5-3 illustrates that a 500 L/s taking is most likely available in the March through May period and the November and December period. A 300 L/s taking is most likely available in the January through June and October through December period of the year. During the summer period, only the base taking (150 L/s) is reliably available. The availability of taking will vary depending on the watershed conditions and may not be guaranteed in some years.

Based on the above, rules were set up for the reservoir yield model to represent a two staged taking. First the 500 L/s taking was assumed to occur any month of the year provided the storage in in the Guelph Lake reservoir equaled or exceeded 95% of the upper rule curve storage. This ensured there was ample water to meet downstream low flow augmentation requirements and provided flexibility to accommodate an ASR taking. Next the 300 L/s taking was assumed to occur if the storage in in the Guelph Lake reservoir equaled or exceeded 50% of the upper rule curve storage. The 300 L/s taking was not allowed to occur between July 1st and September 1st but allowed during other periods of the year provided the storage requirements were met. The 150 L/s taking was assumed to occur if storage in in the Guelph Lake reservoir exceeded the lower rule curve storage.

Based on the above scenarios, the reliability of stepped taking was modelled. The reservoir yield modelling assumed the existing permitted Eramosa taking at Arkell was maximized and that downstream low flow targets upstream of the Guelph wastewater treatment plant were achieved 100% of the time. The results provide the reliability of ASR takings which closely follows the inflow reliability. The detailed results are provided in the supporting technical memo (**Appendix E**). In summary, the results indicated that there is a potential for the proposed stepped taking (150 and 300 L/s), but the step to 500 L/s was dismissed. It is not deemed practical to build a WTP for the incremental step to 500 L/s when the reliability is high for only three months. Furthermore, it is anticipated that from a hydrogeological perspective, this flow cannot be injected in a reasonable number of ASR wells.

Therefore, further analysis was completed based on the base taking of 150 L/s and an increase to 300 L/s for a minimum of nine months of the year assuming it is not available for three months (approximately from mid-June to mid-September). This resulted in an identified 940,000 m^3 of water available annually for ASR (**Table 5-15**).

Table 5-15: Calculation of Guelph Lake Annual Volume (for ASR)

Month	Days	Monthly Water Taking at Base Flow Rate (m^3)[1]	Additional Monthly Water Taking When Available (m^3)[2]	Total Volume from Guelph Reservoir (m^3/month)	Base Volume from Guelph Reservoir (m^3/month)	Vol > base from Guelph Reservoir (m^3/month)	Estimated Demand[3] (m^3/month)	Flow minus Demand (m^3/month)	Volume to ASR (m^3/month)	Volume from ASR (m^3/month)
Jan	31	401,760	401,760	803,520	401,760	401,760	688,700	114,820	114,800	
Feb	28	362,880	362,880	725,760	362,880	362,880	639,600	86,160	86,200	
Mar	31	401,760	401,760	803,520	401,760	401,760	718,800	84,720	84,700	
Apr	30	388,800	388,800	777,600	388,800	388,800	680,100	97,500	97,500	
May	31	401,760	401,760	803,520	401,760	401,760	711,400	92,120	92,100	
June	30	388,800	388,800	777,600	388,800	388,800	721,600	56,000	56,000	
July	31	401,760		401,760	401,760	0	725,800	-324,040		324,040
Aug	31	401,760		401,760	401,760	0	705,900	-304,140		304,140
Sept	30	388,800		388,800	388,800	0	701,100	-312,300		312,300
Oct	31	401,760	401,760	803,520	401,760	401,760	680,800	122,720	122,700	
Nov	30	388,800	388,800	777,600	388,800	388,800	656,500	121,100	121,100	
Dec	31	401,760	401,760	803,520	401,760	401,760	637,800	165,720	165,700	
Total	**365**	**4,730,400**	**3,538,080**	**8,268,480**	**4,730,400**	**3,538,080**	**8,268,100**	**380**	**940,800**	**940,480**
Daily pump rate to distribution (m^3/day)	**-**	**-**	**-**	**22,653**	**12,960**	**9,693**	**22,652**	**1**	**-**	**-**

Notes: 1 – Base flow rate is 150 L/s
2 – Total flow rate of 300 L/s (additional 150 L/s) when available.
3 - Assumed annual demand pattern to reflect seasonal fluctuations.
General – Alternative would include a water intake within Guelph Lake; however, source of water is a portion of the total Speed River discharge flowing through lake.

5.4.1 Surface Water Treatment

Water quality information available for the Speed River was referenced to determine treatment processes required to achieve drinking water quality. Conventional treatment for surface water is proposed with treatment for taste and odour on a seasonal basis, as needed. The proposed WTP has been sized to accommodate the following alternatives at Guelph Lake:

- continuous taking of 150 L/s – Base Taking
- maximum taking of 300 L/s – ASR option

For the purposes of evaluating the alternatives, cost estimates were provided for (1) a surface water treatment plant sized to treat a maximum day capacity of 150 L/s on a continuous basis, as well as (2) a modular plant which would treat 150 L/s on a continuous basis as well as 300 L/s during nine months of the year. It is assumed that the treatment required would consist of those processes found at the Brantford WTP which draws from the Grand River, for costing purposes:

- screening
- pre-treatment (Dissolved Air Floatation with Coagulant, Flocculation)
- Intermediate Ozonation
- Biologically Active Carbon Filtration
- Chlorination
- Space Allowance for Future UV Disinfection
- residuals management (equalization, thickening, discharge to sewer)
- allowance for connection to ASR with re-chlorination

Depending on pilot scale testing, recharge injection quality may require pH adjustment, and other processes to ensure no chemical reactions occur in the aquifer. Further analysis of surface water and groundwater will be required to determine whether it is suitable for injection. It is anticipated that groundwater recovered from the aquifer would only require disinfection prior to distribution.

It is assumed that the intake at Guelph Lake would be upstream of the Guelph dam with an intake crib (assumed 100 m). A low lift pumping station would be required to draw water from the lake into the WTP. A high lift pumping station would be required to pump treated water to the distribution system.

Summary

The total increase in potential quantity available from surface water treatment based on after treatment flows is 12,312 m^3/day[19] (i.e., continuous taking from Guelph Lake of 150 L/s). The cost estimate for providing a WTP at Guelph Lake is provided in **Table 5-16**.

Table 5-16: Cost Estimate for Guelph Lake WTP

Item Description	Total Cost
Capital Cost (incl. contractor overhead)	**$35,064,128**
Estimating Contingencies on Subtotal (30%)	$9,562,944
Engineering Design and Construction Services on Total (15%)	$6,694,061
GRAND TOTAL*	**$51,322,000**

Notes: * Total values are rounded.

5.4.2 Aquifer Storage Recovery

As discussed under the Arkell ASR alternative, an ASR strategy consists of the storage of treated drinking water in underground aquifers during periods of water surplus (i.e., when capacity exceeds demand) and subsequent recovery of this volume of stored water during periods of water shortage (i.e., when demand exceeds existing capacity).

Aquifer storage provides the advantage of enormous storage volumes compared to conventional distribution system storage in elevated or underground storage tanks. Depending on the availability of surface water for treatment, it may be possible to continuously store water in excess of annual requirements resulting in carry-over storage for future needs or to meet needs in years where the surface water may not be available (e.g., low river flows). This point may apply particularly to the initial years of a WTP construction or expansion where capacity exceeds demand; the WTP could

19. This value assumes that 5% of the total feed water is lost during the treatment process.

be operated to treat excess volumes to be stored in aquifers for future recovery. The concept discussed in this section, in relation to the capture of excess water from Guelph Lake, is similar to the approach applied in the Region of Waterloo at the Mannheim WTP to maximize the supply capability of the Grand River, which is subject to seasonal streamflow limitations, while minimizing downstream impacts.

The Arkell ASR alternative evaluated a potential ASR wellfield within the Guelph Innovation district. The 2014 WSMP evaluated two options related to the Guelph Lake strategy:

- ASR system located at Guelph Lake
- ASR system located in area of Park & Emma wells

The 2014 WSMP concluded that ASR wells in the area of the Park and Emma Wells would require fewer wells and could be accomplished all within the City boundary. As such, this strategy was re-evaluated using the updated Tier Three Model. The furthest north simulated ASR well was placed approximately 300 metre north of the Helmar well and the furthest south simulated ASR well was placed approximately 500 metre north of Park and Emma wells. Due to the proximity to the Helmar well, the Helmar well was turned off in this scenario. The remaining four wells were placed along an interpreted linear higher hydraulic conductivity zone simulated in the Middle Gasport Formation of the Tier Three Model between the Helmar and Park wells.

Similar to the Innovation District scenario, the modelling output suggested that the ASR wells should be operated at 60% of the injection rates, while the existing municipal wells operated at baseline rates (i.e., system total of 53,551 m^3/day), in order to maintain hydraulic heads above low water level thresholds at existing municipal wells. It was noted that some existing municipal wells have considerable available head and therefore there is likely an opportunity to increase pumping rates at other municipal wells to capture more of the injected water. This is supported by other completed scenarios that indicate sustainable total system pumping rates up to 82,370 m^3/day. The injection simulations showed that the influence of the injections, that is increased water level elevations in the surrounding area, extended as far as 10 km away from the ASR system. This indicates that the water level increase resulting from the injected groundwater is dissipating far from the

injection site and a water level "mound" is not maintained around the injection wells. The model shows that the water levels recover relatively quickly, and the water flows away from the injection sites; therefore not all of the water is available to be extracted locally within the area of the Emma/ Park Wells. Further evaluation to optimize the efficiency of the system is recommended should the City wish to pursue ASR as a future water supply option. Additional work should focus on the potential to site ASR wells that maximize the ability for existing municipal wells to capture injected water.

The recommendations for significant further work provided in the Arkell ASR alternative section also apply to the Guelph Lake ASR alternative. Assumptions included in this evaluation include:

- Allowance for 6 injection/extraction wells for ultimate supply;
- Cost for ASR system includes costs to upgrade WTP to 300 L/s capacity; and
- Approximately 1.2 km of pipeline to connect WTP discharge and/or ASR wells/High Lift Pumping Station to the City system.

Summary

The total increase in potential quantity available from surface water treatment and ASR systems based on after treatment flows is 25,825 m^3/day (i.e., a continuous taking from Guelph Lake of 150 L/s and a step taking of 300 L/s and a 5% loss at the WTP). **Table 5-17** summarizes the cost estimate for capital works for preliminary investigations, and design, land acquisition, construction of a WTP, and approvals. In addition to the capital costs, the operating and maintenance costs were also estimated including labour, maintenance and energy costs and were used to calculate the Life Cycle Costs for each alternative (see Section 6.2).

Table 5-17: Cost Estimate for Guelph Lake ASR

Item Description	Total Cost
Capital Cost (incl. contractor overhead)	**$39,136,900**
Estimating Contingencies on Subtotal (30%)	$10,673,700
Engineering Design and Construction Services on Total (15%)	$7,471,590
GRAND TOTAL*	**$57,283,000**

Notes: * Total values are rounded.

5.4.3 Surface Water Alternatives Summary

The estimated volume from the surface water alternatives is applied to the demand projections in **Figure 5-4** and all alternatives are shown in **Figure 5-5**. **Figure 5-5** indicates that the groundwater alternatives, along with water conservation, efficiency and demand management are anticipated to provide the required water supply capacity to meet projected 2051 demand. **Figure 5-5** assumes that all groundwater alternatives are first constructed and that surface water alternatives are implemented subsequently, if required to meet future demands.

As there is uncertainty about the water supply capacity that each potential source will yield, as the City progresses with implementation of the projects, the water supply deficit will subsequently be evaluated, and the implementation plan (Section 8) will be revised as necessary. This process may result in additional projects falling outside of the planning period.

Figure 5-4: Water Demand Projections with Surface Water Alternatives

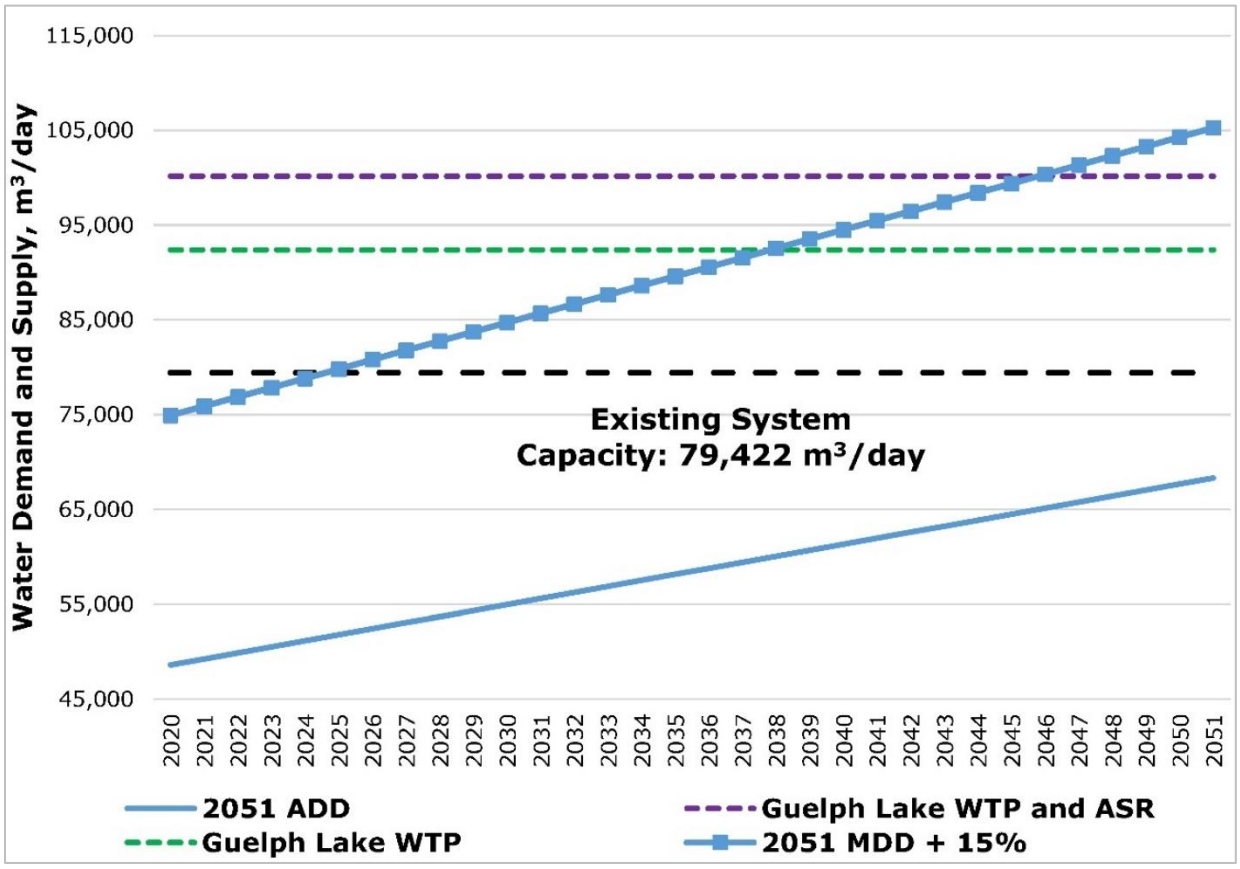
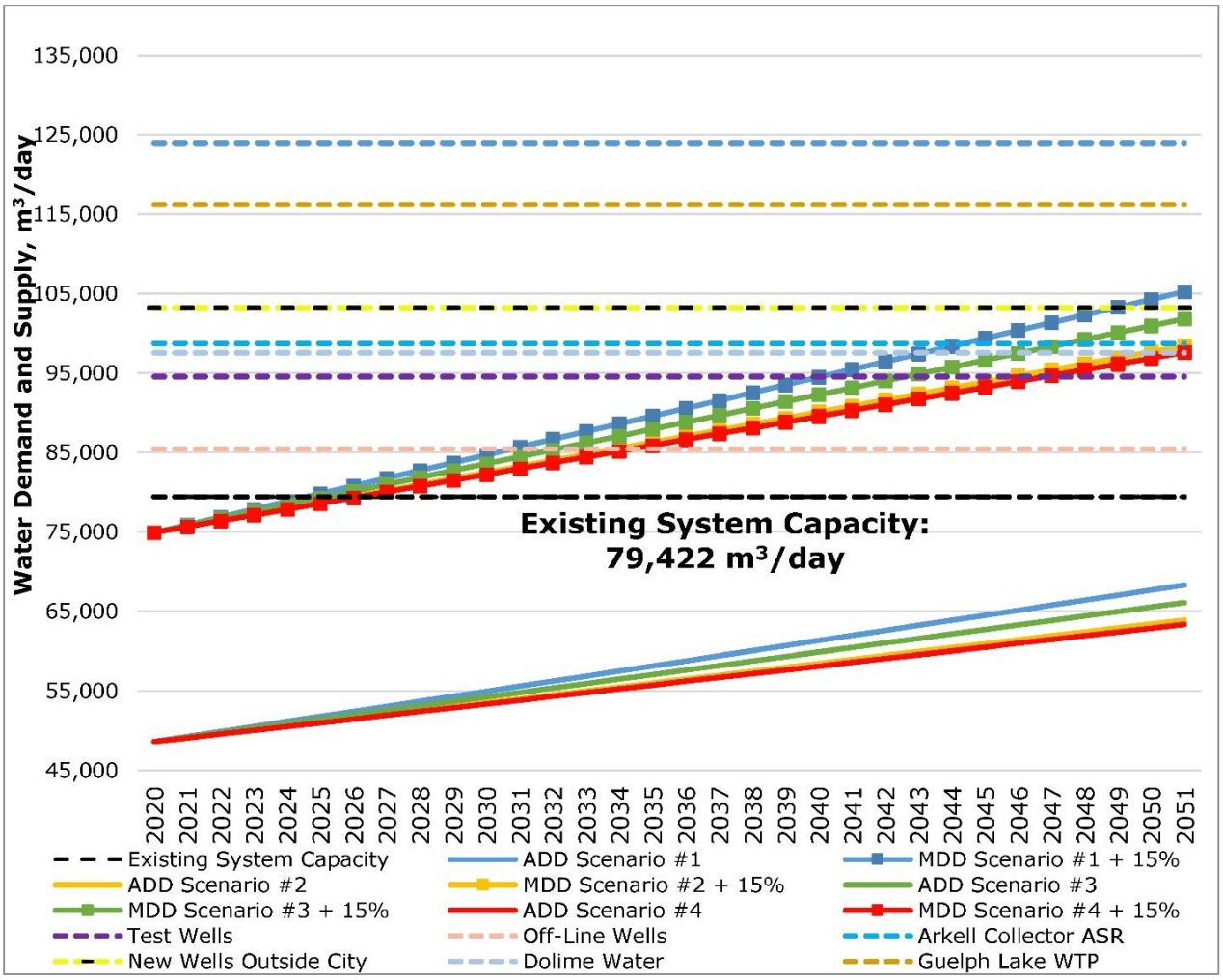


Figure 5-5: Water Demand Projections with All Water Supply Alternatives



5.5 Limit Community Growth

This option consists of reduction in future water supply needs by limiting the extent, density, type and/ or location of future residential, industrial, commercial, and institutional growth in the City below levels identified in recent planning studies. Implementation of this alternative would require changes to municipal planning documents which would not meet Provincial growth targets. Subject to the required future testing identified in this report, the technical work completed indicates that the identified alternatives can be sustainably developed to meet the forecasted future water supply

demands. In consideration of this finding and as this alternative does not meet the Purpose Statement for the project, it is not carried forward as part of the preferred alternative.

5.6 Do Nothing

The Do Nothing alternative is that in which no improvements or changes would be undertaken to address present and long-term water supply requirements. This would have a significant impact on the growth potential for the City. The "Do Nothing" alternative represents what would likely occur if none of the alternative solutions were implemented.

6. Environmental Assessment Evaluation Criteria and Process

6.1 Environmental Assessment (EA) Evaluation Criteria

Preliminary EA criteria and a proposed evaluation process were first presented to the project team, agencies and municipalities, Community Liaison Group and the general public between November 2019 and February 2020. The proposed criteria and processes were revised, incorporating the comments received, and then confirmed via the Community Liaison Group and agencies and municipalities through meetings in July and September 2021.

Evaluation criteria were developed based on the environmental components that address the broad definition of the environment described in the Environmental Assessment Act, as summarized in **Table 6-1**.

Table 6-1: Evaluation Criteria Components Summary

Component	Criteria
Effect on Indigenous values, culture, and Traditional use	■ An evaluation of the effect on Indigenous values, culture, and Traditional use. Key themes shared with the Project Team that help guide the evaluation include: – valuing and respecting the agency of water – understanding the spirit and personhood of water, – good stewardship of the connected ecosystem including protection of water's pureness, – consideration of First Nations, Métis and Inuit Peoples culture and worldview in aspects of the evaluation.
Technical Considerations	■ Constructability ■ Potential productivity and reliability ■ Water treatment requirements ■ Approval requirements
Natural Environmental	■ Effect of construction and operation on aquatic and terrestrial species and habitat ■ Effect on surface water quantity and quality

Component	Criteria
Built Environment	■ Effect on existing and/or planned residences, businesses, community, institutional or recreational facilities ■ Effect on private and municipal wells
Social/Cultural Environment	■ Ability to meet municipal and provincial growth targets ■ Public acceptance ■ Effect of noise/vibration on sensitive receptors ■ Effect on cultural heritage landscapes and built heritage resources ■ Effect on potential archaeological resources
Legal/Jurisdictional Considerations	■ Location inside versus outside of City boundaries
Financial Considerations	■ Estimated capital costs; capital cost per capacity ■ Estimated operation and maintenance costs ■ Life cycle cost (per volume produced)

An additional objective of the evaluation consists of consideration of First Nations, Métis and Inuit Peoples culture and worldview in aspects of the evaluation. The intent is to assess the potential effect of each alternative on Indigenous values, culture, and Traditional use.

This category is not intended to be a comprehensive assessment of how the alternatives could affect Indigenous Peoples in the identified communities. Rather it is a summary of what the Project Team has learned about the perspective of individual First Nations, Métis and Inuit Peoples living in Guelph. Key themes shared with the Project Team that help guide the evaluation include:

- valuing and respecting the agency of water
- understanding the spirit and personhood of water,
- good stewardship of the connected ecosystem including protection of water's pureness, and
- consideration of First Nations, Métis and Inuit Peoples culture and worldview in all aspects of the evaluation.

The categories and associated evaluation criteria in **Table 6-1** meet the definition of the environment as defined in the Environmental Assessment Act. Indicators, presented in **Table 6-2**, were further detailed for each criterion which provides further information about the how the criteria are applied. These criteria and their indicators reflect input received from a very

broad and diverse range of Master Plan study participants. For example, during the Community Liaison Group meetings, Agency and Municipality workshops, and at Township Council meetings, participants from the Townships expressed the need to consider the effects of future Source Water Protection policies on growth and land use and potential well interference (i.e., lowering of water levels in domestic wells and potential affecting the well yields) on the landowners in the vicinity of possible future wells located outside the City. This is consistent with feedback received during the 2014 WSMP Update process and underscores the importance of communication and collaboration with the Townships as the City proceeds with implementation of the Master Plan.

Table 6-2: Evaluation Criteria Indicators Summary

Component	Criteria	Indicator
Technical Considerations	■ Water Treatment	■ Review of Wellhead Protection Areas to identify any potential future treatment and monitoring requirements by identifying any risks in accordance with Source Water Protection standards of the *Clean Water Act*.
Built Environment	■ Effect on Existing and/or Future Planned Residences, Businesses, and / or Community, Institutional and/or Recreational Facilities	■ Future planned, or approved land uses, including those affected by the addition of new Wellhead Protection Areas. These may include but are not limited to existing and future agricultural operations and Environmental Protection Areas.
Legal/ Jurisdictional Considerations	■ Location Inside vs. Outside City boundaries	■ Requirement for Townships to implement Source Water Protection requirements within their jurisdiction.

6.2 Environmental Assessment (EA) Evaluation Process

Each potential alternative is assessed using a consistent approach and evaluation criteria along with specific indicators for each. The completed evaluation is qualitative – not a numerical ranking system – and considers

the suitability of alternative solutions and strategies based on significant advantages and disadvantages. Comparisons and trade-offs are made between alternatives and form the rationale for the identification of the preferred solution or water supply strategy.

The alternatives evaluation is presented in **Table 6-3** to **Table 6-8**, which include a summary table for each group of alternatives and a detailed table that presents the comparison of each alternative relative to other alternatives. The summary versions of these tables were provided in draft format at the Community Liaison Group meeting and Agency and Municipality workshop in September 2021, as well as the second Community Open House, for comment. Comments received, including those noted below, were incorporated into the assessment process:

- Strong support for conservation, efficiency and demand management, including minimizing system leakage
- Preference for groundwater over surface water
- Strong recommendation to maximize water supply potential within the City's boundaries before going into Townships
- Questions regarding effects on the surrounding land uses/owners from Source Water Protection policies on new wells and surface water taking
- Questions regarding how climate change could impact water supply sources in the future
- Questions about how the Dolime Quarry will be managed, associated potential environmental impacts and water supply opportunity
- Concern expressed about Aquifer Storage and Recovery, in particular the injection of water into the aquifer

As mentioned above, a review of the natural environment considerations was undertaken in detail and is presented in a support technical memorandum in **Appendix A**. The results from this review are incorporated into the summary evaluation tables.

The summary of the evaluation was then further considered with respect to application in the short-, mid- and long-term to address the City's water supply needs. This is discussed further in **Section 7.10** as a proposed implementation strategy.

Table 6-3: Summary of Evaluation of Water Supply Alternatives – Conservation, Limit Growth, Do Nothing

Category of Consideration	Conservation – Cease Programs	Conservation – Current Level of Effort	Conservation – Focus on High Demand Customers	Conservation – Current Level of Effort With Reuse	Limit Growth	Do Nothing
First Nations, Métis and Inuit Peoples Category - Effect on Indigenous values, culture, and Traditional use ***This category is not intended to be a comprehensive assessment of how the alternatives could affect the Peoples in the identified communities. Rather it is a summary of what the Project Team has learned about the perspective of individual First Nations, Métis and Inuit Peoples living in Guelph***	■ Ceasing current conservation and efficiency programs does not reflect good stewardship of the resource	■ Continuing water conservation and efficiency efforts reflects a respect for and good stewardship of the resource; alternative achieves medium water savings	■ Continuing water conservation and efficiency efforts reflects a respect for and good stewardship of the resource; alternative achieves the least water savings	■ Continuing water conservation and efficiency efforts reflects a respect for and good stewardship of the resource; alternative achieves the most water savings	■ Limiting growth would effectively reduce demand for the resource and therefore reflect a respect for the resource and good stewardship of the connected ecosystem	■ Doing nothing does not reflect good stewardship of the resource
Technical Category	■ Does not achieve demand reductions	■ Moderately preferred for achieving reduction	■ Least preferred for achieving reduction	■ Most preferred for achieving reduction	■ Does not result in added capacity or demand reduction	■ Does not result in added capacity or demand reduction
Natural Environment Category	■ No impact	■ No impact	■ No impact	■ No impact	■ Limits potential for impact to natural environment	■ Limits potential for impact to natural environment
Built Environment Category	■ No impact	■ Minor changes to existing & planned building	■ Minor changes to existing & planned building	■ Minor changes to existing and planned buildings, moderate impact to WWTP infrastructure ■ Each reuse option to be evaluated on its own merits, risks and costs	■ High impact to planned growth (does not meet growth targets)	■ High impact to planned growth (does not meet growth targets)
Social/Cultural Environment Category	■ Does not contribute to meeting future demands; low public acceptance	■ Contributes to meeting future demands; high public acceptance	■ Contributes to meeting future demands; high public acceptance	■ Contributes to meeting future demands; moderate public acceptance – some reuse options may require public education to gain acceptance	■ Does not meet growth targets; mixed public acceptance	■ Does not meet growth targets; mixed public acceptance

Category of Consideration	Conservation – Cease Programs	Conservation – Current Level of Effort	Conservation – Focus on High Demand Customers	Conservation – Current Level of Effort With Reuse	Limit Growth	Do Nothing
Legal/Jurisdictional Category	■ In City – no impact	■ In City – no impact	■ In City – no impact	■ In City – no impact ■ Some reuse options may require regulatory approvals including review by Health Unit for potential public health considerations (e.g., irrigation on sports fields, etc.)	■ May drive growth to Townships	■ May drive growth to Townships
Financial Category	■ No associated costs	■ Low to moderate costs as compared to supply alternatives	■ Low costs as compared to supply alternatives	■ Moderate to high costs as compared to supply alternatives	■ Not evaluated; does not address problem statement	■ Not evaluated; does not address problem statement
Overall Results	■ **Not preferred**	■ **Preferred as part of short-term strategy**	■ **Preferred as part of mid- to long-term strategy**	■ **Reuse preferred as part of long-term strategy**	■ **Not preferred**	■ **Not preferred**

Table 6-4: Assessment and Evaluation of Water Supply Alternatives - Conservation, Limit Growth, Do Nothing

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Conservation – Cease Programs	Conservation – Current Level of Effort	Conservation – Focus on High Demand Customers	Conservation – Current Level of Effort With Reuse	Limit Growth	Do Nothing
First Nations, Métis and Inuit Peoples Category	-	-	-	-	-	-	-
Effect on Indigenous values, culture, and Traditional use ***This category is not intended to be a comprehensive assessment of how the alternatives could affect Indigenous Peoples in the identified communities. Rather it is a summary of what the Project Team has learned about the perspective of individual First Nations, Métis and Inuit Peoples living in Guelph***	■ An evaluation of the effect on Indigenous values, culture, and Traditional use. Key themes shared with the Project Team that help guide the evaluation include, – valuing and respecting the agency of water – understanding the spirit and personhood of water, – good stewardship of the connected ecosystem including protection of water's pureness, – consideration of First Nations, Métis and Inuit Peoples culture and worldview in all aspects of the evaluation.	■ Ceasing current conservation and efficiency programs does not reflect good stewardship of the resource	■ Continuing water conservation and efficiency efforts reflects a respect for and good stewardship of the resource; alternative achieves medium water savings	■ Continuing water conservation and efficiency efforts reflects a respect for and good stewardship of the resource; alternative achieves the least water savings	■ Continuing water conservation and efficiency efforts reflects a respect for and good stewardship of the resource; alternative achieves the most water savings	■ Limiting growth would effectively reduce demand for the resource and therefore reflect a respect for the resource and good stewardship of the connected ecosystem	■ Doing nothing does not reflect good stewardship of the resource
Technical Category	-	■ Does not achieve demand reductions	■ Moderate potential for demand reductions	■ Minimal potential for demand reductions	■ High potential for demand reductions	■ Does not result in added capacity or demand reduction	■ Does not result in added capacity or demand reduction
Constructability	■ An evaluation of the proposed water supply location, based on: 1. Ability to use existing infrastructure 2. Site access 3. Constructability (geotechnical, proximity to adjacent buildings, etc.) 4. Proximity to municipal distribution system/ large diameter watermains 5. Proximity to sanitary collection system for building and process drainage 6. Future expandability	■ No impact	■ New infrastructure required by customer	■ New infrastructure required by smaller customer base	■ New infrastructure required by City and customers	■ No impact	■ No impact
Potential Productivity and Reliability	■ An evaluation of the productivity potential of the water supply alternative based on: 1. Total available supply quantity 2. Aquifer thickness & available drawdown; transmissivity 3. Surface water flows & seasonal reliability	■ No demand reduction	■ Potential demand reduction/ available capacity to service demand = 4,424 m^3/day	■ Potential demand reduction/ available capacity to service demand = 2,220 m^3/day	■ Potential demand reduction/ available capacity to service demand = 4,952 m^3/day	■ No associated capacity	■ No associated capacity
Water Treatment Requirements	■ An evaluation of the raw water quality and review of treatment requirements; based on: 1. Preliminary or estimated water quality results, based on available historical water quality data;	■ None	■ None	■ None	■ Some treatment post-WWTP may be required, depending on end use	■ None	■ None

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Conservation – Cease Programs	Conservation – Current Level of Effort	Conservation – Focus on High Demand Customers	Conservation – Current Level of Effort With Reuse	Limit Growth	Do Nothing
	2. Consideration to be given to difficulty of treatment, operational requirements and associated costs; 3. Ability to respond to change in regulatory treatment requirements 4. Review of Wellhead Protection Areas to identify any potential future treatment and monitoring requirements by identifying any risks within that zone in accordance with Source Water Protection standards of the *Clean Water Act*.						
Approval Requirements	■ An evaluation of the approval requirements specific to a proposed location, based on consideration of: 1. Municipal approvals (site plan approval, building permit) 2. Ministry of Environment, Conservation and Parks (Permit to Take Water, Environmental Compliance Approval/Drinking Water License); 3. Grand River Conservation Authority (GRCA). ■ Ability to respond in change in permitting requirements	■ None	■ None	■ None	■ Non-potable reuse options may require MECP approvals, Health review etc.	■ Changes to Official Plan to revise growth targets	■ Changes to Official Plan, as growth targets could not be met
Natural Environment Category	-	■ No impact to natural environment	■ No impact to natural environment	■ No impact to natural environment	■ No significant impact to natural environment	■ Limits potential for impact to natural environment	■ Limits potential for impact to natural environment
Effect of Construction and Operation of Alternative on Aquatic and Terrestrial Species and Habitat	■ An evaluation of the effects of construction of the well facility or surface water treatment facility on aquatic species and habitat, based on: 1. Presence of aquatic and terrestrial species potentially affected temporarily and/or permanently, including Species at Risk, (Endangered, Threatened, Special Concern), species of provincial, regional and local conservation concern, native and invasive species, and area-sensitive species; 2. Area of temporary or permanent loss of aquatic and terrestrial features or categorical loss of habitat functions by type – including Provincially Significant Wetland, Locally Significant Wetland, Environmentally Significant Areas, Areas of Natural and Scientific Interest, watercourses by sensitivity type, and others.	■ No impact	■ No impact	■ No impact	■ No impact	■ No impact	■ No impact

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Conservation – Cease Programs	Conservation – Current Level of Effort	Conservation – Focus on High Demand Customers	Conservation – Current Level of Effort With Reuse	Limit Growth	Do Nothing
Effect on Surface Water Quantity & Quality	■ An evaluation of temporary and/or long-term change in quantity or quality of surface water bodies due to: 1. Construction or operation. 2. Groundwater drawdown during operation of the well.	■ No impact	■ No impact	■ No impact	■ Minor reduction in WWTP effluent flows	■ No impact	■ No impact
Built Environment Category	-	■ No impact	■ Minor changes to existing and planned buildings	■ Minor changes to existing and planned buildings	■ Minor changes to existing and planned buildings, moderate impact to WWTP infrastructure	■ High impact to planned growth	■ High impact to planned growth
Effect on Existing and/or Future Planned Residences, Businesses, and / or Community, Institutional and/or Recreational Facilities	■ An evaluation of the effects on existing or future planned property & buildings, based on: 1. Displacement and/or temporary or permanent disruption to residences, businesses, and / or community, institutional, and recreational facilities; 2. Future planned, or approved land uses, including those affected by the addition of new Wellhead Protection Areas. These may include but are not limited to existing and future agricultural operations and Environmental Protection Areas. 3. Effect on Property (ownership, size, and willingness of property owner)	■ No impact	■ Potential changes in requirements for existing and future buildings	■ Potential changes in requirements for existing and future buildings	■ New distribution infrastructure at WWTP for non-potable uses	■ High impact to planned community	■ High impact to planned community
Effect on Private and Municipal Wells (groundwater quality and quantity)	■ An evaluation of effects on private and municipal wells, based on: 1. Proximity to and number of private and municipal wells in the vicinity of proposed alternative; 2. The distance to other permitted takers	■ No impact	■ No impact	■ No impact	■ No impact	■ No impact	■ No impact
Social/Cultural Environment Category	-	■ Does not contribute to meeting future demands ■ Low public acceptance	■ Contributes to meeting future demands ■ High public acceptance	■ Contributes to meeting future demands ■ Moderate public acceptance	■ Contributes to meeting future demands ■ Highest public acceptance	■ Will not meet growth targets ■ Mixed public acceptance	■ Will not meet growth targets ■ Low public acceptance
Ability to Meet Municipal and Provincial Growth Targets	■ An evaluation of the water supply alternative to partially or fully meet the future 30-year demands	Partial	Partial	Partial	Partial	Will not meet targets	Will not meet targets
Public Acceptance of Alternative	■ An evaluation of the opportunities for Water Conservation Education through the implementation of the alternatives ■ Expected public acceptance	■ No opportunity for public education ■ Anticipated low public acceptance based on current	■ Significant opportunity for education through current programming ■ Higher public acceptance based on	■ Moderate opportunity for education as included customer base is reduced ■ Moderate public acceptance based on	■ Significant opportunity for education through current programming and addition of reuse	■ None ■ Mixed public acceptance	■ None ■ Low public acceptance

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Conservation – Cease Programs	Conservation – Current Level of Effort	Conservation – Focus on High Demand Customers	Conservation – Current Level of Effort With Reuse	Limit Growth	Do Nothing
		public support for programming	current public support for programming	current public support for programming	■ Highest public acceptance based on current public support for programming and focus on non-potable reuse		
Effect of Noise/Vibration on Sensitive Receptors	■ An evaluation of effects on noise sensitive receptors, based on: 1. Presence of sensitive receptors and duration of construction schedule; 2. Disruption during the operations phase.	■ None	■ None	■ None	■ Potential construction requirements at WWTP to support reuse opportunities	■ Reduction in construction within City	■ Reduction in construction within City
Effect on Cultural Heritage Landscapes and Built Heritage Resources	■ An evaluation of effects on cultural heritage resources, based on: 1. Presence of cultural heritage landscapes; 2. Presence of built heritage resources.	■ None	■ None	■ None	■ None; WWTP is previously disturbed site	■ Reduction in construction within City	■ Reduction in construction within City
Effect on Potential Archaeological Resources	■ An evaluation of effects on archaeological resources, including: 1. Presence of areas with archaeological potential (i.e., lands with potential archaeological resources) affected.	■ None	■ None	■ None	■ None; WWTP is previously disturbed site	■ Reduction in construction within City	■ Reduction in construction within City
Legal/Jurisdictional Category	-	■ In City – no impact	■ In City – no impact	■ In City – no impact	■ In City – no impact	■ City would not meet targets potentially driving growth to Townships	■ City would not meet targets potentially driving growth to Townships
Location Inside vs. Outside City boundaries	■ An evaluation of need to work with adjacent Townships for land requirements for facility and utility easements. ■ Requirement for Townships to implement Source Water Protection requirements within their jurisdiction.	■ Solution within the City	■ Solution within the City	■ Solution within the City	■ Solution within the City	■ Lack of allowable growth in City could drive growth to Townships	■ Lack of allowable growth in City could drive growth to Townships
Financial Category	-	■ Low cost but with low benefit	■ Low compared to supply alternatives	■ Low compared to supply alternatives	■ Highest of conservation/efficiency alternatives	■ Not evaluated	■ Not evaluated
Capital Costs (Life cycle cost per m^3)	■ An evaluation of the capital and operation & maintenance costs, including: 1. Estimated Capital Cost of all works in category 2. Capital Cost per Capacity ($/$m^3$/day) 3. Life Cycle Cost (20 year) – Cost per m^3 produced based on average pumping rate	■ No cost associated with alternative	■ Capital cost = $11.41 Million ■ Capital cost per capacity = $2600 per m^3/day of avoided capacity ■ Life cycle cost: $0.53 per m^3 avoided	■ Capital cost = $4.73 Million ■ Capital cost per capacity = $2100 per m^3/day of avoided capacity ■ Life cycle cost: $0.44 per m^3 avoided	■ Capital cost = $15.04 Million ■ Capital cost per capacity = $3000 per m^3/day of avoided capacity ■ Life cycle cost: $0.62 per m^3 avoided (need to fully consider life cycle cost of each reuse option)	■ Cost not evaluated ■ Does not meet growth targets	■ Cost not evaluated ■ Does not meet growth targets

Table 6-5: Summary of Evaluation of Water Supply Alternatives - Groundwater Sources

Category of Consideration	2B – Groundwater - Existing Municipal Off-line Sources (Clythe, Sacco, Smallfield, Lower Road Collector)	2C – Groundwater - Municipal Test Wells (Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])	2D - Groundwater – Dolime Quarry	2F - Arkell Collectors & ASR	2G – Groundwater - New Wells Outside City (Guelph North; Guelph Southeast)
First Nations, Métis and Inuit Peoples Category - Effect on Indigenous values, culture, and Traditional use ***This category is not intended to be a comprehensive assessment of how the alternatives could affect the Peoples in the identified communities. Rather it is a summary of what the Project Team has learned about the perspective of individual First Nations, Métis and Inuit Peoples living in Guelph***	■ Optimizing use of existing resources and treating impacted water reflects good stewardship of the resource; must be done in a way that protects the ecosystem.	■ Adding new wells to the system increases the amount of water being pumped and the risk of impacting the ecosystem. This alternative must be done in a way that protects the ecosystem.	■ This alternative reflects the use of water that is currently taken from the aquifer and discharged to the Speed River. Use of this water as supply reflects good stewardship of the resource.	■ Optimizing use of existing resources (Lower Collector) reflects good stewardship of the resource. Injection of water into the aquifer must be done following detailed study so that it is done in a way that protects water purity.	■ Adding new wells to the system increases the amount of water being pumped and the risk of impacting the ecosystem. Spreading out the pumping across a larger area helps to reduce this risk. This alternative must be done in a way that protects the ecosystem.
Technical Category	■ Highest potential capacity due to level of available information regarding quantity, quality; existing facilities with connections to system ■ Prioritization of sources based on ease of implementation and treatability challenges, as follows: – Clythe – Lower Road Collector seasonal variability; uncertainty regarding base flows; potential for optimization with Glen Collector; modelling results require verification – Sacco/Smallfield – investigation into source and nature of TCE contamination plume; contaminant source uncertainties will complicate treatment processes; liability issue if contaminants are re-distributed; return to service not currently feasible if contaminated sites not addressed	■ Moderate to high potential capacity depending on source ■ Prioritization of sources based on ease of implementation and approvals requirements, as follows: – Ironwood/Steffler/Guelph South – based on outcome of Guelph Southwest Water Supply Class EA – Logan/Fleming – need to drill large diameter test wells and complete testing/approvals (underway at Logan) – Hauser – lower capacity well; contamination exists within NWQ	■ High potential for additional capacity within or around quarry ■ Proposed strategy, ease of implementation and approvals requirements, based on outcome of Guelph Southwest Water Supply Class EA; available new capacity could be captured through existing/new municipal wells or alternatively via direct pumping/treatment from Dolime Quarry, or a combination thereof	■ Moderate potential – depends on Lower Rd. re-construction; significant ASR feasibility study required	■ Moderate potential for new capacity due to limited site-specific information ■ Prioritization of new wells outside Guelph lower compared to known sources inside Guelph

Category of Consideration	2B – Groundwater - Existing Municipal Off-line Sources (Clythe, Sacco, Smallfield, Lower Road Collector)	2C – Groundwater - Municipal Test Wells (Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])	2D - Groundwater – Dolime Quarry	2F - Arkell Collectors & ASR	2G – Groundwater - New Wells Outside City (Guelph North; Guelph Southeast)
Natural Environment Category	■ Existing municipal sources – sustainable pumping established historically with effects within catchments accounted for – City conducting additional study for Clythe Well ■ Further study required to understand contaminant source(s) around Smallfield site and potential for re-distribution of contaminants	■ Sustainable pumping rates are conservatively assessed through modelling by evaluating potential reduction to baseflow in local surface water ■ Test wells near or adjacent to natural heritage features must be investigated to assess potential effects resulting from modelled reduction in baseflow	■ Dolime site is previously disturbed; artificial discharge to Speed River would be reduced ■ Sustainable pumping rates from existing/new wells to be assessed to optimize water pumped from quarry; risks to natural environment considered low with optimized system as quarry dewatering has occurred for decades	■ Capturing excess collector system flows has minimal impacts – system is previously permitted; specific ASR locations require significant study	■ Sustainable pumping rates are conservatively assessed through modelling by evaluating potential reduction to baseflow in local surface water. ■ New wells near or adjacent to natural heritage features must be investigated to assess potential effects resulting from modelled reduction in baseflow
Built Environment Category	■ Temporary disruption on neighbouring residents during construction due to need for expansion to accommodate treatment requirements ■ Existing WHPAs	■ Temporary disruption on neighbouring residents during construction due to need for water supply infrastructure ■ New WHPAs may affect current and future land use	■ Source water protection restrictions may affect current and future land use	■ Property acquisition required for ASR wells inside City ■ New WHPAs may affect current and future land use	■ Property acquisition required in areas outside City ■ New WHPAs may impact current and future land use
Social/ Cultural Environment Category	■ Moderate ability to meet future demand ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Technical cultural heritage studies (e.g. heritage and/or archaeological assessment) will be undertaken as early as possible during preliminary design and prior to any ground disturbing activities. Recommendations from these studies will be followed.	■ Moderate to high ability to meet future demand ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction	■ Moderate to high ability to meet future demand in conjunction with surrounding wells/ test wells ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction	■ Low ability to meet future demand ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction	■ Moderate ability to meet future demand; extensive study required to explore potential source ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction
Legal/ Jurisdictional Category	■ Potential legal/ liability issues related to re-distribution of contamination around Smallfield site ■ No jurisdictional issues	■ Ironwood/Steffler, Guelph South, Hauser – in City of Guelph; Potential interaction with Region of Waterloo wells must be studied ■ Logan/Fleming well in Guelph/Eramosa Township	■ Council has approved quarry annexation; Provincial approval required	■ No jurisdictional issues	■ Guelph North well in Guelph/Eramosa Township ■ Guelph Southeast well in Puslinch Township
Financial Category	■ Low to moderate costs depending on source capacity	■ Lowest costs due to high capacity wells (except Hauser)	■ High cost for new WTP; OTP to assess availability of water through surrounding wells rather than within quarry	■ Very high costs due to seasonal availability, low average production year-round, and number of modelled ASR wells	■ Moderate to high costs due to assumed Fe/Mn treatment and location outside of City (high infrastructure costs)
Overall Results	■ **Preferred as part of overall solution (Clythe, Lower Rd); additional investigation/ remediation of Sacco/ Smallfield source of contamination required; additional work required to assess feasibility of Lower Road Collector**	■ **Preferred as part of overall solution; recommended investigations and Class EA studies proceed to confirm feasibility**	■ **Preferred as part of overall solution; feasibility based on outcome of Southwest Guelph Water Supply Class EA**	■ **Preferred as part of overall solution; additional modelling and hydrogeological studies required to assess efficiency and confirm required infrastructure and costs**	■ **Preferred as part of overall solution; commence communication with Townships regarding project feasibility, followed by groundwater investigation phase to assess feasibility and assess effects**

Table 6-6: Assessment and Evaluation of Water Supply Alternatives - Groundwater Sources

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	2B – Groundwater - Existing Municipal Off-line Sources *(Clythe, Sacco, Smallfield, Lower Road)*	2C – Groundwater - Municipal Test Wells *(Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])*	2D - Groundwater – Dolime Quarry	2F – Arkell Collectors & ASR *(Central)*	2G – Groundwater - New Wells Outside City *(Guelph North – Conservation Rd. W.; Guelph Southeast – Victoria& Maltby)*
First Nations, Métis and Inuit Peoples Category	-	-	-	-	-	-
Effect on Indigenous values, culture, and Traditional use ***This category is not intended to be a comprehensive assessment of how the alternatives could affect the Peoples in the identified communities. Rather it is a summary of what the Project Team has learned about the perspective of individual First Nations, Métis and Inuit Peoples living in Guelph***	■ Key themes shared with the Project Team include, valuing and respecting the agency of water, understanding the spirit and personhood of water, good stewardship of the connected ecosystem including protection of water's pureness, consideration of First Nations, Métis and Inuit Peoples culture and worldview in all aspects of the evaluation.	■ Optimizing use of existing resources and treating impacted water reflects good stewardship of the resource; must be done in a way that protects the ecosystem.	■ Adding new wells to the system increases the amount of water being pumped and the risk of impacting the ecosystem. This alternative must be done in a way that protects the ecosystem.	■ This alternative reflects the use of water that is currently taken from the aquifer and discharged to the Speed River. Use of this water as supply reflects good stewardship of the resource.	■ Optimizing use of existing resources (Lower Collector) reflects good stewardship of the resource. Injection of water into the aquifer must be done following detailed study so that it is done in a way that protects water purity.	■ Adding new wells to the system increases the amount of water being pumped and the risk of impacting the ecosystem. Spreading out the pumping across a larger area helps to reduce this risk. This alternative must be done in a way that protects the ecosystem.
Technical Category	-	■ Highest potential due to level of available information regarding quantity, quality; existing facilities with connections to system	■ Moderate to high potential depending on source	■ High potential for additional capacity within or around quarry; significant infrastructure requirements	■ Moderate potential – depends on Lower Rd. re-construction; significant ASR feasibility study required	■ Moderate potential due to limited site-specific information
Constructability	■ An evaluation of the proposed water supply location, based on: 1. Ability to use existing infrastructure; 2. Site access; 3. Constructability (geotechnical, proximity to adjacent buildings, etc.); 4. Proximity to municipal distribution system/ large diameter watermains; 5. Proximity to sanitary collection system for building and process drainage; and 6. Future expandability.	■ All off-line sources are existing facilities located in the City or on the Arkell Spring Grounds; improvements to existing infrastructure can be accommodated; combined treatment for Sacco/Smallfield required ■ Connections to distribution system exist; close proximity to sanitary sewer where required ■ Lower Road – major infrastructure upgrades required	■ Ironwood/ Steffler – new facilities would be in municipal parks; close proximity to distribution system and sanitary services ■ Logan/ Fleming – requires well reconstruction with consideration of wetland; subject to investigation; just east of City boundary; about 1.5 km from distribution and sanitary system ■ Hauser – in City; about 1.0 km from distribution and sanitary system ■ Guelph South - in City; close proximity to distribution system and sanitary services (Hanlon Creek Business Park development)	■ Groundwater would be captured by surrounding municipal wells/ test wells or on-site facility (subject to Operational Testing Program) ■ Constructability evaluation for off-site capture is assessed under previous column; Off-site groundwater capture would require pond level control pumping station within quarry footprint ■ Council has approved annexation of Site into City; on-site pumping and treatment facility would require connection to distribution system and sanitary in close proximity to site	■ Reliant on reconstruction of Lower Road collector system (Alternative 2B) ■ Takes advantage of existing infrastructure – aqueduct; Woods UV system and PS; distribution system ■ New ASR wells required – location dictated by areas with high hydraulic conductivity (potentially around Park & Emma/ Guelph Innovation District) – requires land acquisition ■ Requires ASR well facilities for dechlorination and disinfection/ rechlorination systems	■ New areas located southeast and north of City – no existing infrastructure; would require connection to nearest large diameter watermain and sanitary sewer in City ■ Land acquisition for well site and utilities required

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	2B – Groundwater - Existing Municipal Off-line Sources *(Clythe, Sacco, Smallfield, Lower Road)*	2C – Groundwater - Municipal Test Wells *(Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])*	2D - Groundwater – Dolime Quarry	2F – Arkell Collectors & ASR *(Central)*	2G – Groundwater - New Wells Outside City *(Guelph North – Conservation Rd. W.; Guelph Southeast – Victoria& Maltby)*
Potential Productivity and Reliability	■ An evaluation of the productivity potential of the water supply alternative based on: 1. Total available supply quantity (field results, modelling studies) 2. Known and modelled aquifer conditions 3. Surface water flows & seasonal reliability	■ Clythe – known available quantity; system-wide sustainable quantity evaluated with Tier Three Model ■ Sacco – known available quantity; system-wide sustainable quantity evaluated with Tier Three Model ■ Smallfield – known available quantity; system-wide sustainable quantity evaluated with Tier Three Model ■ Lower Road – seasonal variability; uncertainty regarding base flows; potential for optimization with Glen Collector; modelling results require verification	■ Ironwood/ Steffler/ Guelph South – pumping tests indicate high volumes available; may be limited by possible baseflow reductions in Hanlon/ Irish Creek per Tier Three Model evaluation ■ Logan/ Fleming – City to reconstruct Logan well; productivity subject to investigation ■ Hauser – low volume available	■ Historical quarry dewatering information available, varies seasonably and in response to municipal pumping; reliability of volume available within quarry versus surrounding wells uncertain and subject to Operational Testing Program	■ Reliability of excess flows during peak seasons to be confirmed; model output of 50,500 m3/month available from combined Glen and Lower Road Collectors for 3 months included in feasibility assessment of ASR	■ Guelph North – area with high model transmissivity in Gasport aquifer; site-specific field confirmation required ■ Guelph Southeast - area with reasonably high model transmissivity in Gasport aquifer; site-specific field confirmation required
Water Treatment Requirements	■ An evaluation of the raw water quality and review of treatment requirements; based on: 1. Preliminary or estimated water quality results, based on available historical water quality data; 2. Consideration to be given to difficulty of treatment, operational requirements and associated costs; 3. Ability to respond to change in regulatory treatment requirements 4. Review of Wellhead Protection Areas to identify any potential future treatment and monitoring requirements by identifying any risks within that zone in accordance with	■ Clythe – iron & manganese, H2S (conceptual treatment design completed in 2018 EA); existing WHPA ■ Sacco – TCE & VOCs below ODWQS; VOC concentrations may increase with return to service; existing WHPA ■ Smallfield – TCE above ODWQS; extent and range of concentrations of groundwater contamination is unknown; design of treatment system is uncertain; feasibility of return to service is uncertain; existing WHPA ■ Lower Road – historical bacteria issues can be addressed through infrastructure upgrades and UV disinfection at	■ Ironwood/ Steffler – good quality; Sb noted; treatment not anticipated subject to additional testing; WHPA delineation required ■ Logan/ Fleming – Fe noted at Logan, below ODWQS; WHPA delineation required; potential impacts to existing land uses (e.g., agricultural, commercial) ■ Hauser – iron & manganese treatment assumed; WHPA delineation required ■ Guelph South – good quality based on available water quality data; treatment not anticipated subject to review of additional data; WHPA delineation required; potential impacts to existing land uses (e.g., agricultural)	■ Treatment requirements depend on evaluation of groundwater versus surface water source and GUDI status; ■ Costing assumes WTP consists of following processes: – Low lift pumping station – Screening – Filtration (dual media) – Chlorination – Residues Management – assume direct to WWTP ■ Need to consider source protection requirements depending on EA evaluation	■ Arkell wellfield aqueduct flows through UV disinfection at Woods, and secondary chlorination before distribution; preliminary assessment indicates existing UV system sufficient for added flows (to be confirmed) ■ Dechlorination required prior to ASR injection; disinfection required after recovery prior to distribution ■ WHPAs to be considered for any new ASR wells in the City; potential effects to existing land use depending on well location(s)	■ Guelph North – assumed iron & manganese treatment ■ Guelph Southeast – assumed iron & manganese treatment ■ WHPAs to be developed for new wells outside City; potential impacts to existing land uses (e.g., agricultural)

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	2B – Groundwater - Existing Municipal Off-line Sources *(Clythe, Sacco, Smallfield, Lower Road)*	2C – Groundwater - Municipal Test Wells *(Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])*	2D - Groundwater – Dolime Quarry	2F – Arkell Collectors & ASR *(Central)*	2G – Groundwater - New Wells Outside City *(Guelph North – Conservation Rd. W.; Guelph Southeast – Victoria& Maltby)*
	Source Water Protection standards of the *Clean Water Act*.	Woods PS; located in existing WHPA				
Approval Requirements	■ An evaluation of the approval requirements specific to a proposed location, based on consideration of: 1. Municipal approvals (site plan approval, building permit) 2. Ministry of Environment, Conservation and Parks (Permit to Take Water, Environmental Compliance Approval /Drinking Water License); 3. Grand River Conservation Authority (GRCA). ■ Ability to respond in change in permitting requirements	■ All existing municipal off-line sources have current PTTWs ■ Requirement for treatment to be studied in Schedule B Class EAs ■ Amendments to City DWL ■ Municipal permits required for new/expanded source facilities ■ Consultation with MECP for Smallfield to address existing contaminated sites; Consultation with GRCA for Lower Road replacement	■ All test wells require all approvals for new production wells, including: – Class EA – Schedule B – Municipal – City and Guelph/Eramosa Township (Logan/ Fleming) – PTTW – ECA/ DWL – GRCA (Logan/ Fleming)	■ Approval requirements subject to groundwater versus surface water designation: – Class EA – Schedule B or C (GW/ SW) – Municipal – City and Township (subject to property annexation) – PTTW (Surface water or groundwater) – ECA/ DWL – GRCA	■ New ASR wells require hydrogeological investigation phase; all approvals for new production wells, including: – Class EA – Schedule B or C – Municipal – City – PTTW – ECA/ DWL – GRCA (Depending on proximity to regulated area)	■ New municipal wells require hydrogeological investigation phase; all approvals for new production well, including: – Class EA – Schedule B – Municipal: Township of Puslinch (southeast); Guelph/Eramosa (north) – PTTW – ECA/ DWL – GRCA (Depending on proximity to regulated area)
Natural Environment Category	-	■ Existing municipal sources – sustainable pumping established historically with impacts within catchments accounted for – City conducting additional study for Clythe Well	■ Test wells near or adjacent to natural heritage features must be investigated to assess potential effects resulting from reduction in surface water and wetland water levels	■ Site is previously disturbed; artificial discharge to Speed River would be reduced	■ Capturing excess collector system flows has minimal impacts – system is previously permitted; specific ASR locations require significant study	■ New wells near or adjacent to natural heritage features must be investigated to assess potential effects resulting from reduction in surface water and wetland water levels
Effect of Construction and Operation of Alternative on Aquatic and Terrestrial Species and Habitat	■ An evaluation of the effects of construction of the well facility or surface water treatment facility on aquatic species and habitat, based on: 1. Presence of aquatic and terrestrial species potentially affected temporarily and/or permanently, including Species at Risk, (Endangered, Threatened, Special Concern), species of provincial, regional and	■ All wells in category have existing PTTW and previously evaluated potential impacts; further evaluation to be completed through individual Class EAs ■ Clythe – close to Clythe Creek and Clythe Creek PSW (Class EA complete) ■ Sacco & Smallfield – Speed River catchment; close proximity to Ellis/ Chilligo Creek; near Marden South PSW Complex; Smallfield near a significant woodland	■ Further evaluation of potential impacts to be completed through individual Class EAs ■ Steffler/ Ironwood/ Guelph South - near Hanlon Creek Swamp PSW ■ Logan/ Fleming – near Guelph Northeast PSW Complex; new well required ■ Hauser – close proximity to Ellis/ Chilligo Creek; near Ellis Creek PSW Complex; new well required	■ Further evaluation of potential impacts to be completed through upcoming Class EA ■ Site is adjacent to Speed River and Speed River PSW Complex; quarry lands are previously disturbed	■ Further evaluation of potential impacts to be completed through specific Class EA ■ Specific locations of ASR wells not yet determined, to be reviewed and evaluated through EA process	■ Further evaluation of potential impacts to be completed through individual Class EAs ■ Guelph North – near the Marden South PSW Wetland Complex; new well required ■ Guelph Southeast - near Arkell Bog PSW Complex and Mill Creek Puslinch PSW Complex; new well required

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	2B – Groundwater - Existing Municipal Off-line Sources *(Clythe, Sacco, Smallfield, Lower Road)*	2C – Groundwater - Municipal Test Wells *(Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])*	2D - Groundwater – Dolime Quarry	2F – Arkell Collectors & ASR *(Central)*	2G – Groundwater - New Wells Outside City *(Guelph North – Conservation Rd. W.; Guelph Southeast – Victoria& Maltby)*
	local conservation concern, native and invasive species, and area-sensitive species; 2. Area of temporary or permanent loss of aquatic and terrestrial features or categorical loss of habitat functions by type – including Provincially Significant Wetland (PSW), Locally Significant Wetland, Environmentally Significant Areas, Areas of Natural and Scientific Interest, watercourses by sensitivity type, and others.	■ Lower Road – near Eramosa River and Eramosa River Blue Springs Creek PSW Complex				
Effect on Surface Water Quantity & Quality	■ An evaluation of temporary and/or long-term change in quantity or quality of surface water bodies due to: 1. Construction or operation; 2. Groundwater drawdown during operation of the well.	■ Existing PTTWs – flows accounted for in Tier Three Model and therefore, impacts to watersheds incorporated into combined takings	■ Ironwood/ Steffler/ Guelph South – pumping rate(s) to be established to avoid impacts to Hanlon/ Irish Creek baseflow; system-wide sustainable quantity evaluated with Tier Three Model, identified potential baseflow reduction >10% ■ Logan/ Fleming – Speed River catchment, close to tributary; potential effects to surface water; testing of new well will assess surface water/ groundwater interaction; system-wide sustainable quantity evaluated with Tier Three Model, identified potential baseflow reduction >10% to Clythe Creek ■ Hauser – close proximity to Ellis/ Chilligo Creek; low capacity well; potential effects to be assessed through detailed testing; system-wide sustainable quantity evaluated with Tier Three Model, baseflow impacts not identified	■ Currently, water within quarry is pumped and discharged to Speed River. Developing new wells in area will reduce in-flow to quarry and reduce artificial discharge to Speed River. If water within quarry is utilized for supply, artificial discharge would be further reduced. Not considered an impact to surface water as this input to river is not natural.	■ Excess flows from collector systems discharge to Eramosa River; excess flows proportional to seasonality of river flows so no reduction in baseflows ■ ASR wells in high conductivity areas, designed to re-capture injected flow; impacts not anticipated	■ Guelph North – pumping rate(s) to be established to mitigate effects on Marden Creek baseflow; system-wide sustainable quantity evaluated with Tier Three Model, identified potential baseflow reduction >10% ■ Guelph Southeast – pumping rate(s) to be established to mitigate effects on Mill Creek baseflow; system-wide sustainable quantity evaluated with Tier Three Model, baseflow impacts not identified

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	2B – Groundwater - Existing Municipal Off-line Sources *(Clythe, Sacco, Smallfield, Lower Road)*	2C – Groundwater - Municipal Test Wells *(Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])*	2D - Groundwater – Dolime Quarry	2F – Arkell Collectors & ASR *(Central)*	2G – Groundwater - New Wells Outside City *(Guelph North – Conservation Rd. W.; Guelph Southeast – Victoria& Maltby)*
Built Environment Category	-	■ Disruption on neighbouring residents due to need for expansion to accommodate treatment requirements at Clythe, Sacco/ Smallfield ■ Existing WHPAs	■ New WHPAs may affect current and future land use	■ New WHPA may affect current and future land use	■ Property acquisition required for ASR wells inside City ■ New WHPAs may affect current and future land use	■ Property acquisition required in areas outside City ■ New WHPAs may affect current and future land use
Effect on Existing and/or Future Planned Residences, Businesses, and / or Community, Institutional and/or Recreational Facilities	■ An evaluation of the effects on existing or future planned property & buildings, based on: 1. Displacement and/or temporary or permanent disruption to residences, businesses, and / or community, institutional, and recreational facilities; 2. Future planned, or approved land uses, including those affected by the addition of new Wellhead Protection Areas. These may include but are not limited to existing and future agricultural operations and Environmental Protection Areas. 3. Effect on Property (ownership, size, and willingness of property owner)	■ Clythe – City owns required property for well and treatment facility; existing WHPA ■ Sacco – expansion of facility for treatment requires new property; evaluation assumes use of space at Smallfield site; existing WHPA ■ Smallfield – sufficient area for expansion of facility for treatment; existing WHPA ■ Lower Road – no property required; existing WHPA	■ Ironwood/ Steffler – planned locations in municipal parks; potential disruption to park use; historical concern regarding property value from adjacent residents; new WHPAs to consider nearby existing land use (minimal impacts anticipated) ■ Logan/ Fleming – City owns required land at Logan site for new well facility; new WHPA may affect current and future land uses (potential impacts to agricultural/ commercial land use) ■ Guelph South – City owned property; new WHPA to consider nearby existing land use (potential effects on agricultural/ commercial land use) ■ Hauser – City owned property; new WHPA to consider nearby existing land use (potential effects on agricultural/ industrial land use)	■ Required infrastructure within quarry will be incorporated into quarry development plan; new WHPA to consider nearby existing and planned land uses (minimal impacts anticipated)	■ New ASR wells in the City will require property – either private or municipal land. These wells will also result in new WHPAs which may affect current and future uses.	■ Guelph North – land required; new WHPA may affect current and future land use including agricultural ■ Guelph Southeast – land required; new WHPA may affect current and future land use including agricultural
Effect on Private and Municipal Wells (groundwater quality and quantity)	■ An evaluation of effects on private and municipal wells, based on: 1. Proximity to and number of private and municipal wells in the vicinity of proposed alternative; 2. The distance to other permitted takers	■ Existing sources – interference with other municipal wells already considered in establishing available capacity when system pumped at maximum rate; system-wide sustainable quantity evaluated with Tier Three Model	■ Test wells - system-wide sustainable quantity evaluated with Tier Three Model; field investigations have evaluated potential for private well interference at Ironwood/ Steffler/ Guelph South; future testing will evaluate this for Hauser/ Logan/ Fleming	■ Pond Level Management pumping is an established activity; will be optimized to protect municipal wells	■ New ASR wells in the City require future investigations to review potential interference with municipal wells; low risk of interference with private wells	■ Guelph North – potential effects anticipated to municipal and private wells; to be evaluated through Class EA ■ Guelph Southeast – potential effects anticipated to private wells; to be evaluated through Class EA

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	2B – Groundwater - Existing Municipal Off-line Sources *(Clythe, Sacco, Smallfield, Lower Road)*	2C – Groundwater - Municipal Test Wells *(Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])*	2D - Groundwater – Dolime Quarry	2F – Arkell Collectors & ASR *(Central)*	2G – Groundwater - New Wells Outside City *(Guelph North – Conservation Rd. W.; Guelph Southeast – Victoria& Maltby)*
Social/Cultural Environment Category	-	■ Moderate ability to meet future demand ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction	■ Moderate to high ability to meet future demand ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction	■ Moderate to high ability to meet future demand in conjunction with surrounding wells/ test wells ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction	■ Low ability to meet future demand ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction	■ Moderate ability to meet future demand; extensive study required to explore potential source ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction
Ability to Meet Municipal and Provincial Growth Targets	■ An evaluation of the water supply alternative to partially or fully meet the demands to 2051	■ Existing sources – total available sustainable capacity of 6,030 m^3/day	■ Test wells – total available sustainable capacity of 9,105 m^3/day	■ Dolime Quarry – estimated 3,000 m^3/d available; subject to Southwest Guelph Class EA; water from surrounding wells or directly from quarry	■ New ASR wells total – available minimum capacity of 1,170 m^3/day	■ New Wells outside the City – total available sustainable capacity of 4,535 m^3/day
Public Acceptance of Alternative	■ An evaluation of the opportunities for Public Education through the implementation of the alternatives ■ Expected public acceptance based on health and safety concerns	■ Public will be educated regarding treatment requirements through Class EA; ■ Clythe – evaluated through Class EA, preferred alternative identified and accepted by public ■ Sacco & Smallfield – potential issues with public acceptance due to treatment requirements for TCE, PCE, VOCs; ■ Lower Road – anticipated high public acceptance based on good water quality	■ Public will be educated regarding new wells and treatment requirements through individual Class EAs ■ Ironwood/ Steffler – anticipated high public acceptance based on good water quality; some concerns related to use of park land, property value implications ■ Logan/ Fleming – anticipated high public acceptance based on good water quality ■ Hauser – anticipated high public acceptance based on good water quality (field testing/ confirmation required)	■ Public consultation occurred through Our Community, Our Water initiative; strong public acceptance of high-level plan for City to annex quarry property and manage on-site water; future consultation related to site will occur through Southwest Guelph Water Supply Class EA ■ No identified health and safety concerns with this source.	■ Public will be educated regarding ASR strategy through Class EA ■ Non-traditional water source, public education required to communicate other successful applications of technology and extensive water quality study that will occur during feasibility and design stages	■ Public will be educated regarding new wells outside City through Class EA ■ Guelph North – assumed good water quality to be confirmed through future testing; Township residents may oppose ■ Guelph Southeast – assumed good water quality to be confirmed through future testing; Township residents may oppose

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	2B – Groundwater - Existing Municipal Off-line Sources *(Clythe, Sacco, Smallfield, Lower Road)*	2C – Groundwater - Municipal Test Wells *(Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])*	2D - Groundwater – Dolime Quarry	2F – Arkell Collectors & ASR *(Central)*	2G – Groundwater - New Wells Outside City *(Guelph North – Conservation Rd. W.; Guelph Southeast – Victoria& Maltby)*
Effect of Noise/Vibration on Sensitive Receptors	■ An evaluation of effects on noise sensitive receptors, based on: 1. Presence of sensitive receptors and duration of construction schedule; 2. Disruption during the operations phase.	■ Existing sources – construction of new treatment systems and expansion of source facility will have temporary effects ■ Operations phase will have similar impacts to previous historical operation	■ Ironwood/ Steffler – temporary impacts from construction to adjacent residents and park users; operations phase noise and disruption to be mitigated through design considerations ■ Logan/ Fleming – rural setting minimizes number of adjacent residents during construction and operation ■ Hauser – temporary impacts from construction to adjacent residents (low density locally); operations phase noise and disruption to be mitigated through design considerations ■ Guelph South - temporary impacts from construction to adjacent residents (low density locally); operations phase noise and disruption to be mitigated through design considerations	■ Site is relatively isolated, noise related to construction and operations less than that of operating quarry	■ New ASR wells in the City - locations to be determined; temporary impacts from construction to adjacent residents; operations phase noise and disruption to be mitigated through design considerations	■ Guelph North – to be determined for specific location; anticipate minimal impacts due to rural locations ■ Guelph Southeast – to be determined for specific location; anticipate minimal impacts due to rural locations
Effect on Cultural Heritage Landscapes and Built Heritage Resources	■ An evaluation of effects on cultural heritage resources, based on: 1. Presence of cultural heritage landscapes; 2. Presence of built heritage resources. (Technical cultural heritage studies (e.g. heritage and/or archaeological assessment) will be undertaken as early as possible during preliminary design and prior to any ground disturbing activities. Recommendations from these studies will be followed.)	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	2B – Groundwater - Existing Municipal Off-line Sources *(Clythe, Sacco, Smallfield, Lower Road)*	2C – Groundwater - Municipal Test Wells *(Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])*	2D - Groundwater – Dolime Quarry	2F – Arkell Collectors & ASR *(Central)*	2G – Groundwater - New Wells Outside City *(Guelph North – Conservation Rd. W.; Guelph Southeast – Victoria& Maltby)*
Effect on Potential Archaeological Resources	■ An evaluation of effects on archaeological resources, including: 1. Presence of areas with archaeological potential (i.e., lands with potential archaeological resources) affected.	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities
Legal/Jurisdictional Category	-	■ No jurisdictional issues	■ Logan/Fleming well in Guelph/Eramosa Township	■ Council has approved quarry annexation	■ No jurisdictional issues	■ Guelph North well in Guelph/Eramosa Township ■ Guelph Southeast well in Puslinch Township
Location Inside vs. Outside City boundaries	■ An evaluation of need to work with adjacent Townships for land requirements for facility and utility easements ■ Requirement for Townships to implement Source Water Protection requirements within their jurisdiction.	■ All proposed upgrades at existing City facilities/ property; existing WHPAs ■ Smallfield – potential legal liabilities associated with re-distribution of contaminated groundwater	■ All proposed wells are inside City except new well in area of Fleming/Logan just east of City on Eastview Rd. Within G-E Township jurisdiction – effects with respect to WHPA, utility easements. ■ WHPA for Guelph South/ Hauser could extend into surrounding Township	■ City Council and G-E Township/ Wellington County have approved annexation plan. Provincial approval of annexation required. New WHPA may affect surrounding properties (including in G-E Township)	■ Proposed ASR wells are inside City.	■ Proposed wells outside City will require land for facilities and easements for utilities as well as consultation during Class EAs ■ Within G-E and Puslinch Township jurisdictions – effects with respect to WHPAs
Financial Category	-	■ Low to moderate costs depending on source capacity	■ Lowest costs due to high capacity wells (except Hauser)	■ High cost for new WTP; OTP to assess availability of water through surrounding wells rather than within quarry	■ Very high costs due to seasonal availability & low average production year-round	■ Moderate to high costs due to assumed Fe/Mn treatment and location outside of City
Capital Costs (Life cycle cost per m^3)	■ An evaluation of the capital and operation & maintenance costs, including: 1. Estimated Capital Cost of all works in category 2. Capital Cost per Capacity ($/$m^3$/day) 3. Life Cycle Cost (20 year) – Cost per m^3 produced based on average pumping rate and capital plus O&M cost	■ Capital cost = $6.78 to 13.87 Million ■ Capital cost per capacity = $2,012 to 5,127 per m^3/day ■ Life cycle cost: $0.58 to $1.24 per m^3 produced	■ Capital cost = $4.8 to 10.1 Million ■ Capital cost per capacity = $640 to 6,480 per m^3/day ■ Life cycle cost: $0.19 to $1.86 per m^3 produced	■ Capital cost = $18.9 Million ■ Capital cost per capacity = $6,325 per m^3/day of total capacity ■ Life cycle cost: $1.71 per m^3 produced	■ Capital cost = $25.3 Million ■ Capital cost per capacity = $21,610 per m^3/day of total capacity ■ Life cycle cost: $4.79 per m^3 produced	■ Capital cost = $6.8 to 12.8 Million ■ Capital cost per capacity = $4,289 to 4,375 per m^3/day ■ Life cycle cost: $1.11 to $1.22 per m^3 produced

Table 6-7: Summary of Evaluation of Water Supply Alternatives - Surface Water Source

Category of Consideration	3A - Surface Water – Guelph Lake WTP	3B - Surface Water - Guelph Lake WTP & ASR
First Nations, Métis and Inuit Peoples Category - Effect on Indigenous values, culture, and Traditional use ***This category is not intended to be a comprehensive assessment of how the alternatives could affect the Peoples in the identified communities. Rather it is a summary of what the Project Team has learned about the perspective of individual First Nations, Métis and Inuit Peoples living in Guelph***	■ Pumping surface water for water supply must be done in a way that protects the connected ecosystem at Guelph Lake and downstream in the Speed River.	■ Pumping surface water for water supply must be done in a way that protects the connected ecosystem at Guelph Lake and downstream in the Speed River. Injection of water into the aquifer must be done following detailed study so that it is done in a way that protects water purity.
Technical Category	■ Subject to investigation and feasibility studies ■ Complex Surface WTP to operate	■ Subject to investigation and feasibility studies ■ Complex Surface WTP & ASR system to operate
Natural Environment Category	■ Impacts to natural environment features to be assessed and mitigated	■ Impacts to natural environment features to be assessed and mitigated
Built Environment Category	■ Potential disruption to recreational use of Guelph Lake & Speed River. ■ Potential effects to agricultural operations from new Source Water intake protection zone	■ Potential disruption to recreational use of Guelph Lake & Speed River. ■ Potential effects to agricultural operations from new Source Water intake protection zone
Social/ Cultural Environment Category	■ High ability to meet future demand ■ Noise impacts to be mitigated	■ Highest ability to meet future demand ■ Noise impacts to be mitigated
Legal/ Jurisdictional Category	■ WTP intake upstream of Guelph Lake dam east of City boundary ■ WTP south side of Guelph Lake in or outside City	■ WTP intake upstream of Guelph Lake dam east of City boundary ■ WTP & ASR wells options in or outside City
Financial Category	■ Moderate to high cost	■ Moderate to high cost
Overall Results	■ **Preferred as part of overall solution; commence preliminary treatability studies and ecological effects investigations to identify constraints and mitigation required; identify stakeholders and property acquisition requirements**	■ **Preferred as part of overall solution; additional modelling and hydrogeological studies required to assess efficiency and confirm required infrastructure and costs**

Table 6-8: Assessment and Evaluation of Water Supply Alternatives - Surface Water Source

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Surface Water – Guelph Lake	Surface Water & ASR – Guelph Lake/City
First Nations, Métis and Inuit Peoples Category	-	-	-
This category is not intended to be a comprehensive assessment of how the alternatives could affect the Peoples in the identified communities. Rather it is a summary of what the Project Team has learned about the perspective of individual First Nations, Métis and Inuit Peoples living in Guelph	■ Key themes shared with the Project Team include, valuing and respecting the agency of water, understanding the spirit and personhood of water, good stewardship of the connected ecosystem including protection of water's pureness, consideration of First Nations, Métis and Inuit Peoples culture and worldview in all aspects of the evaluation.	■ Pumping surface water for water supply must be done in a way that protects the connected ecosystem at Guelph Lake and downstream in the Speed River.	■ Pumping surface water for water supply must be done in a way that protects the connected ecosystem at Guelph Lake and downstream in the Speed River. Injection of water into the aquifer must be done following detailed study so that it is done in a way that protects water purity.
Technical Category	-	■ Complex WTP to operate	■ Complex WTP and ASR System to operate
Constructability	■ An evaluation of the proposed water supply location, based on: 1. Ability to use existing infrastructure; 2. Site access; 3. Constructability (geotechnical, proximity to adjacent buildings, etc.); 4. Proximity to municipal distribution system/ large diameter watermains; 5. Proximity to sanitary collection system for building and process drainage 6. Future expandability	■ Able to use Guelph Lake as a reservoir with level control via Guelph Lake dam ■ Requires new infrastructure at Guelph Lake consisting of intake, WTP, large diameter watermain to distribution system in Guelph; sewer connection to NE City collection/PS for WTP residuals ■ Build for base continuous flow of 150 L/s, expandable to 300 L/s for future ASR	■ Able to use Guelph Lake as a reservoir with level control via Guelph Lake dam ■ Requires new infrastructure at Guelph Lake consisting of intake, WTP, large diameter watermain to distribution system in Guelph; sewer connection to NE City collection/PS for WTP residuals ■ Build in modules of 150 L/s to 300 L/s for future ASR ■ Two options for locating ASR wells: 1. Injection wells in area of Guelph Lake + recovery wells around Park & Emma (assessed in 2014 WSMP) 2. Full ASR wells in Park & Emma area ■ Use of existing municipal wells to maximize recovery to 100% subject to further study and field testing
Potential Productivity and Reliability	■ An evaluation of the productivity potential of the water supply alternative based on: 1. Total available supply quantity 2. Known and modelled aquifer conditions 3. Surface water flows & seasonal reliability	■ Surface water availability determined by GRCA through assessment of decades of data - base flow of 150 L/s determined to be available at a reliability of 100% at any given time	■ Surface water availability determined by GRCA through assessment of decades of data -base flow of 150 L/s determined to be available at a reliability of 100% at any given time; additional flow of 150 L/s (to a total of 300 L/s) also very reliable; conservative assumption that is available 9 months of the year avoiding takings from June to August
Water Treatment Requirements	■ An evaluation of the raw water quality and review of treatment requirements; based on: 1. Preliminary or estimated water quality results, based on available historical water quality data; 2. Consideration to be given to difficulty of treatment, operational requirements and associated costs; 3. Ability to respond to change in regulatory treatment requirements 4. Review of Drinking Water Source Protection Areas to identify any potential future treatment and monitoring requirements by identifying any risks within that zone in accordance with Source Water Protection standards of the *Clean Water Act*.	■ SW requires increased treatment; assumes WTP consists of following processes: – Low lift pumping station – Screening – Pre-treatment (Dissolved Air Floatation with Coagulant, Flocculation) – Intermediate Ozonation – Biologically Active Carbon Filtration – Chlorination – Space Allowance for Future UV Disinfection – Residuals management (equalization, thickening, discharge to sewer) ■ Need to consider Drinking Water Source Protection Area for surface water taking	■ SW requires increased treatment; assumes WTP consists of following processes: – Low lift pumping station – Screening – Pre-treatment (Dissolved Air Floatation with Coagulant, Flocculation) – Intermediate Ozonation – Biologically Active Carbon Filtration – Chlorination – Space Allowance for Future UV Disinfection – Residuals management (equalization, thickening, discharge to sewer) – Allowance for connection to ASR with re-chlorination ■ Need to consider Drinking Water Protection Area for surface water taking

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Surface Water – Guelph Lake	Surface Water & ASR – Guelph Lake/City
Approval Requirements	■ An evaluation of the approval requirements specific to a proposed location, based on consideration of: – Municipal approvals (site plan approval, building permit) – Ministry of Environment, Conservation and Parks (Permit to Take Water, Environmental Compliance Approval/Drinking Water License) – Grand River Conservation Authority (GRCA) – Ability to respond in change in permitting requirements	■ New Surface WTP require extensive approvals, including: – Class EA – Schedule C – Municipal – City and Township – PTTW (Surface Water) – ECA/DWL – GRCA	■ New Surface WTP and ASR system require extensive approvals, including: – Class EA – Schedule C – Municipal – City and Township – PTTW (Surface water and groundwater) – ECA/DWL – GRCA
Natural Environment Category	-	■ Impacts to natural environment features to be assessed and mitigated	■ Impacts to natural environment features to be assessed and mitigated
Effect of Construction and Operation of Alternative on Aquatic and Terrestrial Species and Habitat	■ An evaluation of the effects of construction of the well facility or surface water treatment facility on aquatic species and habitat, based on: 1. Presence of aquatic and terrestrial species potentially affected temporarily and/or permanently, including Species at Risk, (Endangered, Threatened, Special Concern), species of provincial, regional and local conservation concern, native and invasive species, and area-sensitive species; 2. Area of temporary or permanent loss of aquatic and terrestrial features or categorical loss of habitat functions by type – including Provincially Significant Wetland, Locally Significant Wetland, Environmentally Significant Areas, Areas of Natural and Scientific Interest, watercourses by sensitivity type, and others.	■ Area affected includes Guelph Lake and its associated wetland and aquatic features, i.e., Guelph Northeast PSW and Speed River ■ Impacts mitigated by keeping existing water capacity at base levels; however taking of surface water may affect surface water and wetland water levels with potential impacts of: – Reduction in viable fish/amphibian habitat within lake and river systems – Alteration of plant community composition through change of riparian/emergent and submergent zones – Alteration of sensitive species habitat/range – Alteration of overall water temperatures (i.e., shallower waters result in higher temperature regimes) ■ Investigation and approvals would require field investigations and assessment to determine mitigation measures addressing impacts related to water drawdown	■ Area affected includes Guelph Lake and its associated wetland and aquatic features, i.e., Guelph Northeast PSW and Speed River ■ Impacts mitigated by keeping existing water capacity at base levels; however taking of surface water may affect surface water and wetland water levels with potential impacts of: – Reduction in viable fish/amphibian habitat within lake and river systems – Alteration of plant community composition through change of riparian/emergent and submergent zones – Alteration of sensitive species habitat/range – Alteration of overall water temperatures (i.e., shallower waters result in higher temperature regimes) ■ Investigation and approvals would require field investigations and assessment to determine mitigation measures addressing impacts related to water drawdown
Effect on Surface Water Quantity & Quality	■ An evaluation of temporary and/or long-term change in quantity or quality of surface water bodies due to: 1. Construction or operation; 2. Groundwater drawdown during operation of the well.	■ Reduced water quantity; possible temperature effects per above	■ Reduced water quantity; possible temperature effects per above ■ ASR wells in high conductivity areas, designed to re-capture injected flow; impacts not anticipated
Built Environment Category	-	■ Disruption to recreational use of Guelph Lake and Speed River ■ Potential impact to agricultural operations from new Source Water intake protection zone.	■ Disruption to recreational use of Guelph Lake and Speed River ■ Potential impact to agricultural operations from new Source Water intake protection zone.
Effect on Existing and/or Future Planned Residences, Businesses, and / or Community, Institutional and/or Recreational Facilities	■ An evaluation of the effects on existing or future planned property & buildings, based on: 1. Displacement and/or temporary or permanent disruption to residences, businesses, and / or community, institutional, and recreational facilities; 2. Future planned, or approved land uses, including those affected by the addition of new Wellhead Protection Areas. These may include but are not limited to existing and future	■ Reduction in surface water flow and water levels could affect recreational uses at Guelph Lake and along Speed River upstream of the WWTP (where discharge would be increased proportional to water taking) ■ WTP siting may disrupt use of Guelph Lake area recreational use depending on location ■ Addition of new Source Water protection area around intake (IPZ) may affect existing and future agricultural use in area	■ Reduction in surface water flow and water levels could affect recreational uses at Guelph Lake and along Speed River upstream of the WWTP (where discharge would be increased proportional to water taking) ■ WTP siting may disrupt use of Guelph Lake area recreational use depending on location ■ Addition of new Source Water protection area around intake (IPZ) and new WHPAs for ASR wells may affect existing and future agricultural use in area

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Surface Water – Guelph Lake	Surface Water & ASR – Guelph Lake/City
	agricultural operations and Environmental Protection Areas. 3. Effect on Property (ownership, size, and willingness of property owner)		
Effect on Private and Municipal Wells (groundwater quality and quantity)	■ An evaluation of effects on private and municipal wells, based on: 1. Proximity to and number of private and municipal wells in the vicinity of proposed alternative; 2. The distance to other permitted takers	■ No impacts anticipated on private and municipal wells	■ No impacts anticipated on private and municipal well; potential benefit from ASR
Social/Cultural Environment Category	-	■ High ability to meet future demand ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction	■ Highest ability to meet future demand ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction
Ability to Meet Municipal and Provincial Growth Targets	■ An evaluation of the water supply alternative to partially or fully meet the future 25-year demands	■ Available takings of 150 L/s; provides maximum capacity of approx. 12,300 m^3/day after WTP treatment losses ■ Provides significant source to partially meet future 2051 max day demand	■ Available takings of 150 to 300 L/s; provides maximum capacity of approx. 25,800 m^3/day after WTP treatment losses ■ Provides significant source to fully meet future 2051 max day demand
Public Acceptance of Alternative	■ An evaluation of the opportunities for Water Conservation Education through the implementation of the alternatives ■ Expected public acceptance based on health and safety concerns	■ Large volume available may deter conservation efforts ■ Moderate public acceptance	■ Large volume available may deter conservation efforts ■ Moderate public acceptance
Effect of Noise/Vibration on Sensitive Receptors	■ An evaluation of effects on noise sensitive receptors, based on: 1. Presence of sensitive receptors and duration of construction schedule; 2. Disruption during the operations phase.	■ Significant disruption during construction ■ Minimal impact during operation due to remote location	■ Significant disruption during construction ■ Minimal to moderate impact during operation due to remote location of WTP; location of ASR wells in City temporary impacts from construction to adjacent residents; operations phase noise and disruption to be mitigated through design considerations
Effect on Cultural Heritage Landscapes and Built Heritage Resources	■ An evaluation of effects on cultural heritage resources, based on: 1. Presence of cultural heritage landscapes; 2. Presence of built heritage resources.	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities
Effect on Potential Archaeological Resources	■ An evaluation of effects on archaeological resources, including: 1. Presence of areas with archaeological potential (i.e., lands with potential archaeological resources) affected.	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities
Legal/Jurisdictional Category	-	■ WTP intake upstream of Guelph Lake dam east of City boundary; WTP south side of Guelph Lake in or outside City	■ WTP intake upstream of Guelph Lake dam east of City boundary; WTP south side of Guelph Lake in or outside City ■ Two options for ASR include inside and outside City
Location Inside vs. Outside City boundaries	■ An evaluation of need to work with adjacent Townships for land requirements for facility and utility easements	■ WTP intake just east of City boundary; land requirement could be within City by extending raw water transmission main; land outside City could be mitigated through discussions with GRCA; utility easements along Victoria Road in City	■ WTP intake just east of City boundary; land requirement could be within City by extending raw water transmission main; land outside City could be mitigated through discussions with GRCA; utility easements along Victoria Road in City

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Surface Water – Guelph Lake	Surface Water & ASR – Guelph Lake/City
	■ Requirement for Townships to implement Source Water Protection requirements within their jurisdiction.		■ Two options for ASR include combination of ASR wells inside and outside City; or all wells inside City
Financial Category	-	■ Moderate to High Cost	■ Moderate to High Cost
Capital Costs (Life cycle cost per m^3)	■ An evaluation of the capital and operation & maintenance costs, including: 1. Estimated Capital Cost of all works in category 2. Capital Cost per Capacity ($/$m^3$/day) 3. Life Cycle Cost (20 year) – Cost per m^3 produced based on average pumping rate	■ Capital cost = $51.3 Million ■ Capital cost per capacity = $3,960 per m^3/day of total capacity ■ Life cycle cost: $1.16 per m^3 produced	■ Capital cost = $77.1 Million ■ Capital cost per capacity = $4,420 per m^3/day of total additional capacity ■ Life cycle cost: $0.75 per m^3 produced

6.3 Evaluation Summary

6.3.1 General Approach

The alternatives considered through this WSMP Update do not represent stand-alone solutions to meeting the City's future water supply needs. The preferred solution will consist of several of the available alternatives that, in combination, will satisfy future water demands as well as a contingency for security of supply.

Potential projects were identified earlier in the WSMP process and reviewed from a technical and natural environment (i.e., effects on to surface water baseflow) perspective through modelling. Those that were found to have some merit were carried forward for further evaluation. The potential projects are grouped by type – i.e., conservation, groundwater, surface water etc., due to the common characteristics and impacts, and evaluated against environmental assessment criteria for the purpose of comparing the level of impacts within the context of the categories of natural, social, cultural, and built environments, and regulatory, technical and financial considerations in order to achieve the following:

- To determine whether a project should be recommended for implementation on the basis of acceptable impacts with mitigation; or recommended for additional investigation prior to potential implementation to further assess potential impacts, mitigation measures and technical feasibility; or recommended against further consideration on the basis of unacceptable impacts that cannot be mitigated;
- To prioritize projects with the least potential impacts for immediate implementation;
- To prioritize projects within the City first versus outside the City following input from the public and stakeholders in previously completed iterations of the WSMP;
- To identify projects with potential future water supply capacity subject to additional investigation; outlining data gaps and areas of uncertainty;

- To identify mitigation measures to reduce potential impacts to the natural, social, and cultural environments;
- To identify considerations for future Class EA Schedule B and C projects including required studies and stakeholders to be consulted; and
- To consider cost of implementation to allow for future budgeting and management.

Furthermore, as described above, an additional objective of the evaluation consists of consideration of First Nations, Métis and Inuit Peoples culture and worldview in aspects of the evaluation. The intent is to assess the potential effect of each alternative on Indigenous values, culture, and Traditional use. Through the draft evaluation of alternatives, this category was used as a guide for how subsequent categories have been evaluated with consideration of the feedback and key themes that were communicated to the City through the process.

It is acknowledged that climate change is an important consideration when evaluating potential impacts to the natural environment, the sustainability of a water supply source and the reliability of a source over a long-term planning period. However, in the case of the alternatives evaluated for the WSMP Update, climate change was not considered to be a criterion that would distinguish between the alternatives being considered. Based on climate change modelling, conducted as part of the Tier Three Water Budget and Local Area Risk Assessment, it is expected that future changes to the climate will have a more acute impact to surface water resources due to their exposure to extreme weather events and drought that could result from a changing climate. Groundwater drawn from deep bedrock aquifers is afforded the buffering capacity of the overlying rock and sediments and is expected to experience variable recharge that results from extreme weather events and more frequent melting events in winter. As the preference to prioritize groundwater sources within the City in previous master plans was carried forward to this WSMP Update, the potential for surface water resources to be affected by climate change does not cause a change in the evaluation process. Despite this, it is recommended that the City continue to study the ways in which climate change will impact the municipal water supply system and apply, as necessary, future climate models and

projections of weather patterns to each water supply project that is pursued in the future.

6.4 Alternatives – Key Findings of Evaluation

Water Conservation and Efficiency Programs – in evaluating the various scenarios developed for water conservation, there are a few considerations worth noting:

- There is a clear preference in the Guelph community to have an active conservation and efficiency program, as opposed to the 'do nothing' scenario
- The level of effort applied to water efficiency programs should be determined by the success and life span of the individual programs – over time, each will reach a point where the cost is not warranted as compared to its benefits; at which point it should cease or alternatively be replaced by a more effective program
- The cost per m^3 reduction varies with program type (direct vs indirect) and whether reuse is implemented; if the unit cost is being compared to the unit cost of implementing new water supply this is also subject to change over time as the supply sources changes from more readily available water, to water requiring treatment, to surface water options.
- Therefore it is recommended that the water efficiency program be viewed as a flexible strategy with the following considerations:
  - Continuation of the current program (Scenario #2) in the short term, winding down programs that are found to be less effective
  - New programming based on a more targeted approach (Scenario #3) that has a higher benefit to cost (more direct accountability) – and lower cost per m^3 reduction
  - Long term consideration and implementation of water reuse programs that provide year-round reliable reductions (Scenario #4) with added public education and acceptance and as cost per m^3 reduction becomes more favourable against more expensive future water supply options

Groundwater Sources – as a groundwater-based community, Guelph is committed to optimizing the available local groundwater supply first within the City, and then within a reasonable distance of the City boundary, prior to pursuing local surface water supply. The City is very cognizant of determining the quantity that can be withdrawn from the aquifer in a sustainable way. Sustainability is assessed through use of the Tier Three Model which is able to quantify the impact of varying well capacities on local surface water features. Therefore, the proposed capacities for each individual well supply, whether existing or proposed, is based on the model outputs. However, while the model uses the best available information, the modelling approach contains some conservativeness that must be considered in the interpretation of the results. The evaluation against environmental criteria as well as review of technical and financial considerations was completed against the various categories of groundwater projects grouped by similar aspects. Additional considerations for each potential project are identified below:

2B – Groundwater – Existing Municipal Off-line Sources

In the 2014 WSMP, the category of existing municipal off-line sources was prioritized as more information was known about these wells, some have current approvals, and they are located on City owned land with existing infrastructure; therefore there is greater certainty about capacity and feasibility for implementation. However, each has challenges that will need to be addressed in the next phase of implementation:

- Clythe Well – Schedule B Class EA completed; property acquisition adjacent to well site for treatment facility completed; next steps include design and construction
- Sacco & Smallfield Wells – known groundwater contamination from anthropogenic sources; there remains great uncertainty and risk for the City in the design of a treatment system with respect to the maximum raw water contaminant concentrations, the influent concentration trend with time, the duration of treatment, and the potential liability of pulling contaminated groundwater across areas which are not yet impacted; therefore this potential source has less certainty about next steps; it remains part of the preferred solution but timing delayed until investigation/ contaminant source control undertaken with agency involvement

- Lower Road Collector - uncertainty regarding base flows and variability; requires additional modelling and study to verify potential and feasibility for implementation

2C – Groundwater – Municipal Test Wells

In the 2014 WSMP, the category of municipal test wells was also assigned high priority; while approvals are still required (i.e., PTTW), there is sufficient information available about these wells to provide a high degree of certainty about capacity and feasibility for implementation. Each has unique challenges that will need to be addressed in the next phase of implementation:

- **Ironwood/ Steffler Test Wells** – Previous assessment of these wells indicated that operations at the Dolime Quarry impacted the quantity of water available at these locations. Both of these sources will be considered through the Southwest Guelph Water Supply Class EA. These wells are located within municipal parks and must be developed in a manner that minimizes impact to community use of the parks and disruption to the surrounding residences. Optimization of pumping within southwest Guelph is a critical aspect of managing the overall water balance between groundwater extraction, groundwater protection and surface water ecology.
- **Logan/ Fleming Test Wells** – The City is proceeding with reconstructing and testing the Logan Well to further characterize the well as a future water supply source, evaluate the potential for interaction with the natural environment, and assess the potential effects to other groundwater users. Consultation with Guelph/Eramosa Township will be required to address the jurisdictional aspects of this City-owned property located outside of the City boundary. Future work will address the delineation of a WHPA and the associated land use management through the Source Water Protection process.
- **Hauser Test Well** – This well is anticipated to be relatively low capacity and is located in close proximity to the Sacco and Smallfield Wells, which have been impacted by anthropogenic contaminants. Development of this alternative requires the drilling of a test well, evaluation of local water quality and the potential for interaction with the natural environment.

- **Guelph South [GSTW1-20] Test Well** – This test well will also be evaluated through the Southwest Guelph Water Supply Class EA. The operation of this well is anticipated to reduce baseflow on the same surface water features (Hanlon Creek, potentially Irish Creek) as the other test wells and municipal wells in southwest Guelph. Similar to previous OTP work completed by the City, detailed testing and field data collection will be completed to critically evaluate the response within the system to pumping at varying rates and varying locations, in order to arrive at an optimized solution.

2D – Groundwater – Dolime Quarry

Subsequent to the City's successful discussions with the owners of the Dolime Quarry regarding a preferred methodology to protect the exposed aquifer that supplies the City's potable water during the 2014 WSMP, the City has undertaken a Class EA study to develop a Pond Level Management strategy that may result in added water available for supply. Operational testing and modelling will indicate whether additional water may be pumped through municipal wells or from the Dolime quarry directly while maintaining a pond level that protects the aquifer.

More information will be available through the Guelph Southwest Water Supply Class EA study to be completed prior to the next update of the WSMP.

2F – Arkell Collectors & ASR (Central)

ASR has been reviewed at a conceptual level to determine whether it warrants further consideration. There are several potential opportunities for locating ASR injection and recovery wells across the City, combined with maximizing existing City wells for optimized extraction.

This particular ASR option takes advantage of the highly seasonal flows in the Arkell collectors (Glenn and Lower Road) and existing available infrastructure including:

- In-situ filtration of shallow groundwater on site
- Available capacity for higher flows in aqueduct to convey flows to Woods PS
- Use of available disinfection capacity in the Woods UV system

- Use of existing distribution system
- Construction of injection wells in highly permeable areas of City (injected directly from distribution system)
- Use of existing municipal wells for extraction

Use of the Tier Three Model identified some limitations of this possible alternative. Therefore, it is recommended that it be carried forward for additional investigation and review by the City to examine its efficiency, infrastructure requirements, and costs and ultimately its long-term feasibility.

2G – Groundwater – New Wells Outside City

In the 2014 WSMP, the category of new wells outside the City was assigned a lower priority for a couple of reasons; the primary reason was that public and stakeholders provided clear direction to maximize sources within the City first, and coordination and approvals will be required from neighbouring Townships; and secondly there is little information available regarding the site-specific geology and hydrogeology in these areas to provide a strong recommendation regarding capacity and feasibility. This previous recommendation is carried forward in this WSMP Update – these potential sources will not be pursued until after the groundwater alternatives within the City and on City-owned land. Groundwater investigation programs are required to identify locations and to conduct test well drilling and testing to evaluate impacts.

- **Guelph North** – Conservation Rd. W: This general well area is located within Guelph/Eramosa Township and will require consultation and coordination with the Township. Significant work will be required to assess the potential baseflow reductions in surface water features. Municipal supply is available to some residents living outside of the City; however, the instance of active private well use is also more common and must be evaluated with respect to the potential for impacts.
- **Guelph Southeast** – Victoria & Maltby: This alternative has the same key aspects outline above and would also require consultation and coordination with Puslinch Township.

Surface Water Source

The proximity of Guelph Lake and dam that provides the opportunity for an intake to a WTP makes this a very possible alternative for the City. Due to its higher cost (compared to groundwater) and location outside the City boundary, it is assigned a lower priority in the overall timeline; however, it is recommended that the City allow for a minimum ten year time period to complete preliminary studies in order to refine the details such as ecological impacts, treatment requirements, property acquisition needs and requirements for connection to the existing distribution system in advance of the eventual Schedule C Class EA study.

- **3A – Surface Water – Guelph Lake WTP:** Development of this source would require significant water quality characterization, evaluation of the local natural environment and ecosystem function, consultation with GRCA, treatability studies, land acquisition, etc. Public education is another important element as this would be the first surface water source developed for direct use by Guelph residents, who have a long history of groundwater-based supply. Downstream conditions were considered in the evaluation of this alternative but would require further review as the WWTP capacity expands in response to City growth and more related data are available for review.
- **3B – Surface Water – Guelph Lake WTP & ASR:** In addition to the above considerations, the development of ASR is a new concept to the residents of Guelph and would require extensive communication and education to generate public approval. However, ASR is a known technology with decades of practical applications including at the Region of Waterloo's Mannheim facility. From a technical perspective, development of this alternative would require a long implementation period to assess feasibility, improve model predictions, develop an optimized system that efficiently injects and captures excess water, and geochemical studies to ensure that the alternative could be implemented long-term without changing the in-situ aquifer characteristics.

7. Engagement and Consultation

7.1 Overview

The WSMP Update follows the requirements of Phases 1 and 2 of the Municipal Class Environmental Assessment in accordance with Approach #1 of the Master Plan Process described in the Municipal Class Environmental Assessment Manual (amended in 2015) by the Municipal Engineers Association. The WSMP will be updated at approximately five-year intervals. This 2021 update will be co-ordinated with the City's future Official Plan update and will contain plans for development of individual projects consisting of Schedule A, B and C Class Environmental Assessment activities.

Community input is an essential part of the Water Supply Master Plan Update process. People care about where their water comes from, and they want to see a safe and sustainable supply maintained for present and future generations, and residents, councils, agencies, stakeholders and Indigenous Peoples from Guelph and the surrounding Townships and County were engaged throughout the project. This report provides a summary of the engagement process and the feedback received for the Water Supply Master Plan Update.

With this in mind, Phase 1 engagement activities included:

- newspaper advertising and electronic mailing to inform people about the start of the Water Supply Master Plan Update;
- a project website to provide useful information, including links to the previous 2014 Water Supply Master Plan Update, contact information and invitations to online and in-person engagement opportunities;
- online engagement through the City's online community engagement site, Have Your Say Guelph, linked through the project website and promoted via the electronic mailing list, social media and a monthly Have Your Say newsletter;
- establishment of an inclusive and diverse Community Liaison Group to advise and provide feedback to the Project Team throughout the process;

- a municipal and agency workshop to provide crucial inputs from a government and approval agency perspective;
- electronic mailing, newspaper and community-wide advertising about the first community open house;
- one community open house (with two time slots) to introduce the Water Supply Master Plan Update, giving community members an opportunity to discuss the project with experts and provide comments;
- one stakeholder meeting with Guelph Wellington Development Association and Guelph and District Home Builder's Association; and
- co-ordination with other related master plan updates (i.e., Water and Wastewater Servicing Master Plan, Wastewater and Biosolids Master Plan, Stormwater Master Plan and the Municipal Comprehensive Review / Official Plan Update).

Phase 2 engagement activities included:

- continued update of the project website to provide useful information, including links to key documents, contact information and invitations to online engagement opportunities;
- online engagement through the City's online community engagement site, Have Your Say Guelph, linked through the project website and promoted via the electronic mailing list, social media and a monthly Have Your Say newsletter;
- the second and third Community Liaison Group workshops to continue updating interested stakeholders and collecting feedback;
- a second municipal and agency workshop to share an update of the project, and collect additional inputs from the government and approval agency perspective;
- two meetings with the Water Conservation and Efficiency Public Advisory Committee
- one meeting with Mississaugas of the Credit First Nation;
- one meeting with Six Nations of the Grand River;
- meetings held with Councils of the Township of Puslinch and Township of Guelph Eramosa; and

- co-ordination other related master plan updates (i.e., Water and Wastewater Servicing Master Plan, Wastewater and Biosolids Master Plan, Stormwater Master Plan and the Municipal Comprehensive Review / Official Plan Update).

90-day review engagement activities included

- updating the project website to provide the latest updates, access to the Draft Final Water Supply Master Plan, relevant resources and contact information;
- online engagement through Have Your Say Guelph, linked through the project website and promoted via the electronic mailing list and social media;
- newspaper advertising and electronic mailings to invite participation in the review period;
- four meetings with the representatives from the Township of Puslinch, Township of Guelph/Eramosa and County of Wellington; and
- a meeting with Ministry of the Environment, Conservation and Parks.

7.1.1 Approach to Public Engagement

At the start of the project, a community engagement and communications plan was developed to guide the implementation of the engagement process for the Water Supply Master Plan Update consistent with the Municipal Class EA process and the City's Community Engagement Framework.

The City's Community Engagement Framework (guelph.ca/plans-and-strategies/community-engagement-framework/) is referenced in the plan, and the Water Supply Master Plan Update aims to embrace the guiding principles for community engagement outlined in the framework including inclusive, early involvement, access to decision making, coordinated approach, transparent and accountable, open and timely communication, mutual trust and respect, evaluation and continuous improvement.

As the project progressed, a virtual approach to engagement was adopted to provide a safe and convenient forum for the Project Team, participants, and stakeholders during the COVID-19 pandemic.

7.1.2 Engagement and Communication Goals

During the development and implementation of the 2021 Water Supply Master Plan Update, the Project Team set out with engagement and communication goals to:

- engage the Guelph community to develop a shared vision for managing the City's water supply;
- generate a broad awareness of the Water Supply Master Plan and opportunities for participation;
- obtain an understanding of the community's aspirations and concerns relating to water management;
- keep key stakeholders informed of Water Supply Master Plan activities, and communicate in a timely and clear manner; and
- affirm the City's commitment to community engagement and open planning processes and demonstrate the impact of engagement efforts on the Master Plan Update and the Class Environmental Assessment process.

7.1.3 Engagement and Communication Objectives

Engagement and communication objectives were also established to

- ensure diverse opportunities for local municipalities, Indigenous Peoples, government agencies, non-governmental organizations, institutions, businesses, community groups / associations, and residents to participate;
- educate community members and groups about the study - why it's important, what's included, how key elements relate to stakeholders, the process that will be followed and how decisions will be made;
- inform and educate stakeholders about the 2021 Water Supply Master Plan Update, and any related studies or initiatives like the Tier Three Water Budget and Water Quantity Risk Assessment, the Outdoor Water Use By-law Update, Water Efficiency Strategy, the "Our Community, Our Water" (the Dolime Quarry Revitalization plan), and the Clean Water Act Source Protection Plan;

- develop plain language communication materials that support the goals of the project and encourage participation;
- consider all feedback provided and document that it has been considered during the development of water supply alternatives by the Project Team; and
- meet the consultation requirements of the Municipal Class Environmental Assessment for Master Plans.

7.1.4 Presentation Materials

Clear, easy-to-understand and engaging materials (including notices, presentations for the Community Liaison Group, agency workshops and the virtual community open house, display boards, survey, a web page and Have Your Say online community engagement site) were developed for the public for Phases 1 and 2.

The topics addressed during Phase 1 included:

- an overview of why the Water Supply Master Plan is being updated, including a draft problem and opportunity statement;
- an overview of the Municipal Class Environmental Assessment process, including a timeline of major milestones;
- the Water Supply Master Plan Update steps including forecast of future population and water needs, assess existing water supply capacity, develop and evaluate water supply alternatives and update the Water Supply Master Plan;
- the personhood of water as it is understood in the Indigenous worldview of Indigenous Peoples in the Guelph community;
- a closer look at Guelph's current groundwater supply system;
- estimates of our future water supply requirements – i.e., how Guelph's population is expected to grow by 2051 and the water supply it will need;
- challenges related to the City's water supply, including water security, climate change and extreme weather events, contaminated sites and surface water effects;

- proposed water supply alternative solutions being considered and / or updated, including demand management / efficiency programs, groundwater sources in and outside of the city, local surface water sources, and do nothing;
- evaluation criteria and how the proposed alternative solutions will be evaluated, including natural environment, social and cultural (including archeological) resources, economic and financial considerations, legal / jurisdictional considerations and technological considerations;
- other water-related master planning projects that are currently underway at the City; and
- ways to build authentic, long-standing, community-based relationships by reaching out.

The topics addressed in Phase 2 included:

- review of Phase 1 topics;
- a detailed review of Guelph's existing water supply (namely the 25 production wells, the Arkell Spring Grounds and the Eramosa River intake and recharge system);
- reviewing the water supply requirements to accommodate the 2051 population forecast based on population and water demand projection based on average day demand, maximum day demand and system security of supply (i.e., system redundancy);
- a detailed assessment of the water supply alternatives (water conservation and demand management / water reuse programs; optimizing and expanding on existing groundwater systems; establishing new surface water supply sources; and limiting population growth / doing nothing); and
- preliminary evaluation of the water supply alternatives and results.

The topics addressed through presentations during the 90 day review included:

- an overview of the Water Supply Master Plan Update Report including water supply requirements, a detailed assessment of the water supply alternatives, and the preferred supply alternatives and results.

7.1.5 Engagement topics

The Project Team identified key engagement topics related to Phases 1 and 2 of the Water Supply Master Plan. Stakeholders and the public were invited to provide their input and feedback to these engagement topics through the various engagement tools and activities. During the 90 day review period, the engagement topics were identified according to the received review comments.

Phase 1 engagement focused on gathering feedback and input into:

- changes or additions to the draft problem and opportunities statement;
- unique challenges that Guelph faces and should be considered regarding our water supply;
- additional water supply alternatives that should be considered; and
- additional evaluation criteria that should be included.

Phase 2 engagement focused on gathering feedback and input into:

- results of the technical work including the future population targets, water supply demand forecasts, and the existing water supply capacity assessment;
- results of the technical assessment and preliminary evaluation of the water supply alternatives, including additional factors or considerations that are missing; and
- prioritization and public acceptance of the preliminary preferred water supply alternatives.

90-day public review engagement focused on gathering feedback and input into

- ensuring adequate water supply for the City and adjacent Townships;
- ensuring enough water to allow for growth both within the City and the Townships, including allowances for population growth and new industry and employment opportunity considerations;
- reviewing required approvals for water taking by industries;

- ensuring key areas where water might be taken are/will be protected, at both new and existing wellheads;
- clarification of when Wellhead Protection Area Modeling should be performed;
- the recommendation to continue utilizing and improving conservation, efficiency and demand management programs to meet and surpass targets;
- the recommendation to consider climate change specifically as it impacts agriculture;
- jurisdictional concerns regarding source protection and the installation of wells outside of the City of Guelph; and
- continuing cooperation and consultation efforts with surrounding Townships and establishment of a regional water management framework.

7.2 Feedback

7.2.1 Phase 1 Feedback

7.2.1.1 Introduction

The feedback received during Phase 1 through the various engagement tools and activities indicates that there is a continued interest from community members and stakeholders about water supply in Guelph. Several themes emerged related to the key engagement topics of this phase, including:

- prioritizing conservation;
- protecting the natural environment;
- managing growth and development;
- controlling groundwater impacts from large water users;
- monitoring emerging contaminants;
- limiting impacts to aquatic and terrestrial wildlife; and
- valuing the agency of water.

Each section below includes content that was presented in relation to the consultation questions. All comments and questions received during Phase 1 engagement are summarized in the subsections below and are provided in **Appendix F**.

7.2.2 Draft Challenge and Opportunity Statement

The public was invited to comment on any suggested changes or additions to the following draft problem and opportunity statement:

- The City of Guelph is committed to managing population growth as it continues to develop strategies for ensuring adequate water supply. The goal is to develop a reliable and sustainable supply of water to meet the current and future needs of all residential, industrial, commercial and institutional customers. The 2014 Water Supply Master Plan confirmed that the existing water supply capacity will not meet future demands and set out a strategy for meeting these future needs. It is important to update the water demand forecast, the existing water system capacity and the status of ongoing water supply projects and make adjustments to the plan as required. The proposed implementation strategy must deliver through to 2051, an adequate amount of water in a safe and cost-effective manner and ensure that environmental sustainability is not compromised.

Comments received about the draft problem and opportunity statement were based on the topics of water supply, conservation, capacity and growth, aquifer recharge, infrastructure, wastewater and other. Summaries of themed responses are outlined below. See all comments received in **Appendix F**.

- **Water supply:**
  It was suggested that groundwater cannot be controlled or developed, therefore, the word 'develop' should be removed from the statement or rephrased to water supply infrastructure being developed. Another suggestion was to focus on adequate water supply (without summer restrictions) before population growth.
- **Conservation:**
  Individuals noted that watershed protection and conservation efforts should be the main priorities.

- **Capacity and growth:**
  Concerns were expressed regarding 2041 as too short of a planning horizon and to first determine the future capacity of water supply before determining how to limit growth.
- **Aquifer recharge:**
  One comment suggested recharging aquifers with wetlands, stormwater and treated wastewater.
- **Infrastructure:**
  One comment suggested exploring costs of more rapidly upgrading infrastructure to reduce system losses, and another comment suggested building a pipe to a lake.
- **Wastewater:**
  One comment suggested including wastewater disposal as part of the Water Supply Master Plan process.
- **Other:**
  Several respondents agreed with the draft problem and opportunity statement. One comment suggested declaring that water-taking is not an approved land use.

7.2.3 Unique challenges

There are a number of unique challenges that Guelph faces and will be taken into consideration during the Water Supply Master Plan Update. These challenges include:

- a Tier Three Water Budget and Local Area Risk Assessment identified the City's water supply as having a 'significant risk level' of not meeting the 2031 water demand under drought conditions;
- whether a 10 per cent 'system redundancy' allowance is sufficient for ensuring security of our water supply;
- understanding impacts from climate change and extreme weather events to our water supply;
- the existing Smallfield and Sacco wells are affected by contaminated sites and may need to be removed from consideration as City water supply options;

- Dolime Quarry – a proposal to close the quarry ahead of schedule and transfer water management to the City is under consideration; and
- how surface water baseflows could be impacted if we pump more groundwater.

When asked about whether there are other unique challenges that Guelph faces and should be considered with regard to the water supply, a wide variety of comments were received. The following six themes summarize the responses provided. See all comments received in **Appendix F**.

- **Development and growth**:
  Several respondents expressed concerns about developers and impacts of their land use, the impacts of Clair-Maltby developments on Carter 1 and 2 well sites and overpopulation. One comment suggested the City should challenge growth targets set by the provincial government. Another comment expressed concerns that condominium owners may lack understanding about water use and efficiency because water is paid for through condominium fees and they don't see information related to water conservation on bills.
- **Industrial and commercial water use**:
  Several respondents expressed concerns about large industrial and commercial water users (e.g., quarries and aggregate pits, breweries bottled water and meat packing companies) and their impacts on local aquifers.
- **Rates**:
  One comment suggested mirroring off-peak electricity rates by reducing water usage rates during off-peak hours and implement higher rates during peak times.
- **Contamination and treatment**:
  Several respondents were concerned about contaminants entering the water supply, including microplastics, perfluorooctanesulfonic acids, hormones and pharmaceuticals. One respondent was concerned about the increased use of salt during winter and suggested education campaigns for property managers. Another individual questioned the use of adding fluoride and removing calcium from the water supply. One respondent was concerned about offline wells with unknown contaminants and potential

impacts to nearby residents. There was also a comment about a potential contaminated groundwater plume and a suggestion to address former industrial waste and garbage dumping sites in addition to ongoing contamination of surrounding rivers.

- **Environmental impacts**:
  Two respondents wanted to know how climate change may impact the model and one respondent would like to see how aquatic and terrestrial wildlife would be impacted by any of the City's proposals.
- **Other:**
  One respondent added water-taking from adjacent aquifers (e.g., Erin, Aberfoyle) as an additional unique challenge. Three respondents agreed with the unique challenges listed.

7.2.4 Proposed Alternative Solutions

The following water supply alternatives were considered in Phase 1 for meeting Guelph's drinking water supply needs.

- **Demand management, efficiency and water reuse programs**
  - Maintain commitment to our water conservation initiatives and 2016 Water Efficiency Strategy
  - Determine range of realistic goals and cost for implementation
  - Develop means to measure for effectiveness
- **Groundwater sources in and outside of city**
  - Improve and optimize the existing well supply system
  - Restore offline wells with treatment
  - Identify new potential water supply areas
  - Consider Dolime Quarry as a source of municipal water supply
- **Local surface water sources**
  - Establish feasibility / risks of surface water alternatives including aquifer storage and recovery system
  - Assessment areas include: Guelph Lake / Speed River and Eramosa River

- **Do nothing**
  - Undertake no improvements or changes
  - Significant impact on the growth potential for the City would be expected with this alternative

Members of the public were asked if any proposed alternative solutions were missed. There were several comments received on the existing proposed alternatives solutions in addition to new suggestions. See all comments received in **Appendix F**.

Additional feedback on the alternative solutions was provided in Phase 2 and is referenced below.

- **Demand management, efficiency and water reuse programs**:
  A few respondents questioned the need for growth and suggested limiting population increase and challenging growth targets. One respondent suggested revising the 2016 Water Efficiency Strategy to better reflect extreme weather events, infrastructure deficiencies and contamination. Another respondent would like to see more water conservation initiatives and increasing the use of grey water for residential, commercial and industrial water users.
- **Groundwater sources in and outside of city**:
  The majority of comments related to groundwater were about Nestle and the impacts of water extraction for bottled water companies. One respondent suggested quantifying the impact of Nestle on the water supply to show financial implications for residents.
- **Local surface water sources**:
  There was one suggestion to look at potential sources of water outside of the watershed.
- **Other**:
  Other proposed alternative solutions included contamination risk management, using stormwater and wastewater to help aquifer restoration, establishing urban rooftop water collection systems and considering how to adapt in the case of extreme floods. Three respondents agreed with the proposed alternative solutions.

7.2.5 Preliminary Evaluation criteria

The following initial evaluation criteria were put forward as potential criteria to be used to evaluate new drinking water sources in the Water Supply Master Plan Update and were subsequently revised based on feedback received and other technical considerations.

- **Public health and safety**
  - Ability to meet provincial water quality requirements
- **Natural environment**
  - Potential effects to natural environment
  - Potential impacts to water resources
  - Potential impacts to natural heritage features
  - Environmental management planning considerations
- **Social and cultural resources**
  - Land use impacts
  - Short-term construction impacts
  - Potential impacts from operations
  - Implications of new / expanded Source Protection areas
- **Economic and financial considerations**
  - Estimated capital costs
  - Estimated operations and maintenance costs, including energy consumption
- **Legal / jurisdictional considerations**
  - Location of facility relative to city boundaries
  - Land requirements
  - Implementation of Source Protection Policies
- **Technological considerations**
  - Ability to implement and meet peak demand
  - Constructability, schedule and timing, and maintaining operations during construction
  - Water quality
  - Allowance for future treatment needs
  - Expandability
  - Ability to respond to changes in regulations
  - Ability to utilize existing infrastructure

- **Additional considerations**
  - Alignment with City 2050 Net Zero Carbon emissions target
  - Impacts on Indigenous peoples and values
  - Climate adaptability and resiliency

The public were asked if there are additional evaluation criteria that should be considered. There were additions to existing 'natural environment', 'economic and financial considerations' and 'additional considerations' categories. See all comments received in **Appendix F**.

- **Natural environment**:
  Comments related to the natural environment include prioritizing the protection of the environment above all else, considering how Clair-Maltby is a recharge area and how development in this area will impact water availability and recharge, and a request to see a breakdown of how any Water Supply Master Plans would impact aquatic and terrestrial wildlife.
- **Economic and financial considerations**:
  There were a range of comments related to economic and financial considerations, including the potential creation of local jobs, socio-economic benefits from managing groundwater and forestry and the economic impacts of current and future scenarios of not having water. One respondent asked who will pay for new water supply and treatment in light of new residential developments, and another respondent asked how much it will cost to bring water to Guelph in 2041 if there isn't enough local supply.
- **Additional considerations**:
  One respondent suggested listening to and understanding Indigenous People's approach to water. Another respondent added the ability to respond to unpredictable climate events as an important consideration.
- **Other**:
  One respondent suggested considering long-term groundwater and surface water impacts of any new facility – both during operation and after being closed. Two respondents agreed with the evaluation criteria.

Additional feedback on the evaluation criteria was provided in Phase 2 and is outlined below.

7.2.6 Questions

During Phase 1, questions were received from the general public, both at the in-person community open house and online via the Q&A tool on Have Your Say. Questions related to the Water Supply Master Plan ranged from overall process, timelines and next steps to projected water demands, development and large water users. Several questions were unrelated to the Water Supply Master Plan, including wastewater and stormwater questions. All questions and responses are captured in **Appendix F**.

7.3 Phase 2 Feedback

7.3.1 Introduction

The feedback received during Phase 2 through the various engagement tools and activities indicates that agencies, municipal representatives and interested community members were invested in Guelph's water supply and the work being undertaken. Feedback was generally requested in these three discussion areas:

- results of the technical work including the future population targets, water supply demand forecasts, and the existing water supply capacity assessment
- results of the assessment and preliminary evaluation of the water supply alternatives, including additional factors or considerations that are missing
- prioritization and public acceptance of the preliminary preferred water supply alternatives

Each section below includes content that was presented in relation to the consultation topics. All comments and questions received during Phase 2 engagement are summarized in the subsections below and are provided in **Appendix F**.

7.3.2 Future population targets and water supply demand forecasts

The Province of Ontario's August 28th, 2020 report **A Place to Grow Growth Plan for the Greater Golden Horseshoe** (P2G) was utilized to identify future population growth to 2051 and combined with a review of past water use patterns to quantify the future water supply requirements. The 2051 population is projected to be 203,000 residential and 116,000 employment. Guelph's current water supply is estimated to provide a maximum of approximately 79,000 cubic metres per day, however by 2051 it is anticipated that we will need an additional 26,000 cubic metres per day to meet the needs of the future population.

Stakeholders were invited to comment on the analysis completed regarding the City's population in 2051 and the water supply capacity needed in order to support the anticipated demand. Some of the feedback from participants who attended the open house included:

- The uncertainty of future water supply demands and forecasts due to climate change was identified. The potential for decreased rainfall was mentioned with concern for what the water demand would be during a drought, and how farmers might need to increasingly rely on irrigation systems. Another comment identified the possibility of increased rainfall in the future due to climate change.
- The price of water was also questioned in terms of how a change in supply and demand would affect residential prices, and if there was a pricing strategy in place for moderating water usage and encouraging conservation efforts.
- One participant mentioned that the anticipated water taking for 2051 coincides with the actual water taking from 2001, and that over 50 years there was enough water conservation to keep the City well supplied. The City clarified that while the water taking numbers may appear similar, water conservation efforts and programs were responsible for ensuring that the City had enough water at an affordable rate.

Phase 2 largely focused on assessing the potential water supply capacity of the alternatives. Each of the water supply alternatives was evaluated against several criteria to identify potential impacts. The evaluation criteria included: First Nations, Metis, and Inuit Peoples, Technical (ability to achieve demand and reduction), Natural Environment, Built Environment, Social / Cultural Environment, Legal / Jurisdictional, and Financial.

Stakeholders and interested community members provided their feedback on the results of the water supply alternatives assessment and evaluation.

Water conservation, efficiency and water reuse programs

Four water conservation, efficiency and reuse program scenarios were presented, and each forecasted the demand reduction that could be achieved by 2051. Guelph has a history of leveraging strong water conservation efforts in order to reduce water demand requirements. As a result, there were fewer suggestions for this alternative, but the ones provided considered at how these conservation efforts could be enhanced. Feedback included:

- Suggestions for enhancing water conservation initiatives included: non-revenue water reduction, grey water usage and incentives for increased usage, water recycling programs, and halting major water taking. While some of these initiatives are currently underway, promoting them to a wider audience and incentivizing them would help to increase conservation efforts.
- Suggestions for stormwater clean up and sewage water recycling practices were also provided.

Groundwater sources

Six categories of potential groundwater projects were shared: optimizing existing operating municipal sources, restoring existing off-line municipal sources, developing existing municipal test wells, installing new wells inside City boundaries, installing new wells outside City boundaries, and installing new Aquifer Storage and Recovery wells inside the City. Some of the feedback on the groundwater alternatives included:

- The Dolime Quarry was frequently mentioned during the engagement phase. Some concerns included whether an assimilative capacity study had been conducted as it relates to the

City's wastewater treatment plant and discharge from the quarry, how the aquifer was being protected and maintained in case dewatering were to stop, and potential impacts to dewatering as a result of annexation.

- The well locations were also a point of interest, including why some locations inside the City, such as the Clair Maltby area, were not selected for well locations.
- Water quality concerns and a recommendation for further study to determine the viability of remediating or adding treatment to the current off-line wells were raised. Water quantity concerns were raised regarding the potential impacts to the baseflow of surrounding waterbodies with restoring offline wells (e.g., impacts to Clythe Creek from restoring and pumping the Clythe well).
- Legal and jurisdictional implications of installing new wells outside of the City (in the surrounding townships) was also brought forth including growth and land use restrictions related to expanded source water protection areas, fair compensation (including for costs related to source water protection policy implementation), potential well interference, water use restrictions and employment opportunities. The Townships were concerned that their water supply would be taken to accommodate Guelph's growing population without fairly and duly consulting the Townships.

Surface water

Guelph Lake was reviewed as a potential source of surface water for direct treatment and distribution and as a potential source for an Aquifer Storage Recovery system to capitalize on peak flow.

- An additional surface water suggestion was to connect to the water supply from the Grand River and Lake Erie.

7.3.3 Prioritization and public acceptance of the preliminary preferred water supply alternatives

Based on the evaluation, a preliminary preferred solution was identified that recommended implementation of all water supply alternatives (except for the 'do nothing' alternative) in the short-, medium- and long-term over a thirty-year period (i.e., between 2021 and 2051) (see **Table 7-1**).

Stakeholders and interested community members were asked to provide their feedback on the preliminary preferred solution.

- No objections to the preliminary preferred solution were raised, however there were some questions and concerns regarding the implementation timelines and the prioritization of the water supply alternatives – particularly for the development of new wells outside of the City. While the townships were generally supportive of the preliminary preferred solution, they were also concerned that developing wells in their jurisdiction for Guelph's use could limit the amount of residential and employment growth in the townships and impose source water protection land use constraints.

Table 7-1: Preferred Water Supply Alternatives

Alternative	Timeline	Projects
1A – Conservation, Efficiency & Demand Management	Throughout	■ Blended Conservation Scenario
2B – Groundwater: Restore Off-line Municipal Wells	Short-term	■ Clythe Well (completion in 2023)
2B – Groundwater: Restore Off-line Municipal Wells	Mid-term	■ Lower Road Collector (completion in 2037)
2C/D – Groundwater: Develop Municipal Test Wells	Short-term	■ Ironwood/Steffler (completion in 2027) ■ Guelph South (completion in 2028) ■ Dolime Quarry (pumping station component completed to align with Ironwood/ Steffler) ■ Logan/ Fleming (completion in 2030)
2C/D – Groundwater: Develop Municipal Test Wells	Long-term	■ Hauser (completion in 2047)
2F – Groundwater: Arkell Collectors & ASR Wells	Long-term	■ Arkell ASR (completion in 2045)
2G – Groundwater: Develop New Wells Outside City	Long-term	■ Guelph North (completion in 2048)

7.3.4 Consultation

Consultation has been a vital part of collecting feedback to inform the Water Supply Master Plan. Various parties were interested in additional

engagement sessions and reached out for opportunities to stay informed and involved.

- Several individuals including members of the public, municipal representatives, and interested stakeholders asked how they could remain involved with the project.
- A concern was voiced that there was not enough consultation with the Townships over the course of the project. It should be noted that the City offered several opportunities for engagement to the Townships during the study including providing notices on the Master Plan Update, representation on the Community Liaison Group, participation in the municipal and agency workshops and offers to present to Township Council. The Townships of Puslinch and Guelph-Eramosa opted to invite the Project Team to their respective Council meetings to learn more about the progress and provide feedback. The presentation and corresponding resolutions for the two sessions can be found in **Appendix F**.

7.3.4.1 Agency and Municipality Workshop #2 – Additional Feedback

Additional feedback about the materials presented at the Agency and Municipality Workshop #2 was received from the County of Wellington, Township of Puslinch and Township of Guelph/Eramosa. This written feedback and the subsequent City response is included in Appendix F.

7.4 90-Day Public Review Feedback

7.4.1 Introduction

The feedback received during the 90-day public review through the various engagement tools and activities indicates that there is continued interest in being involved in the process of updating the Water Supply Master Plan.

Comments were received from Townships, Wellington County, local businesses, organizations, ministries of the provincial government and the public during the 90-Day Review period. Key themes that emerged from the feedback included

- ensuring adequate water supply for the City and adjacent Townships;

- ensuring enough water to allow for growth both within the City and the Townships, including allowances for population growth and new industry and employment opportunity considerations;
- clarification of how the City determined the existing system capacity and that the existing sources are optimized and will continue to be
- reviewing required approvals for water taking by industries;
- ensuring key areas where water might be taken are/will be protected, at both new and existing wellheads;
- clarification of when Wellhead Protection Area modeling would be completed;
- discussion regarding Source Protection land use concerns and the existing Significant Water Quantity risk designation;
- the recommendation to continue utilizing and improving conservation, efficiency and demand management programs to meet and surpass targets and continue to evaluate and address system leakage and non-revenue water;
- clarification that a Lake Erie pipeline was not considered in the list of potential alternatives;
- the recommendation to consider climate change specifically as it impacts agriculture;
- jurisdictional concerns regarding source protection and the installation of wells outside of the City of Guelph;
- discussions about the Class EA process and how/when consultation occurs; and
- continuing cooperation and consultation efforts with surrounding Townships/County and establishment of a regional water management framework.

A complete summary of the feedback received during the review period is provided in Appendix F.

7.5 Community engagement tools and activities

As part of the communication and engagement strategy for the Water Supply Master Plan Update, a number of activities were undertaken to notify the Guelph and area community, provide up-to-date information, seek input on the current phase of the study and answer any questions or concerns.

7.5.1 Notifications

7.5.1.1 Notice of Commencement

A formal notice of study commencement was issued on October 31, 2019 to provide an overview of the Water Supply Master Plan Update, an explanation of the master plan process, engagement opportunities and contact information.

Engagement opportunities included joining the Community Liaison Group, attending an open house, reading about progress on the project web page (click here for the City of Guelph's Water Supply Master Plan), joining the electronic mailing list and following the conversation on Facebook (facebook.com/cityofguelph) and Twitter (twitter.com/cityofguelph).

The notice was advertised through:

- the project website guelph.ca/plans-and-strategies/water-supply-master-plan/;
- the City's website guelph.ca/2019/10/notice-of-study-commencement/;
- traditional newspapers including the Guelph Mercury Tribune (City news section), Wellington Advertiser and Milton Champion;
- an initial project email list including agencies, municipalities, Indigenous Peoples and the original contact list from the 2014 Water Supply Master Plan mailing list (over 70 recipients during the week of November 28, 2019);
- organic social media posts on Facebook (facebook.com/cityofguelph) and Twitter (twitter.com/cityofguelph); and
- internal City staff including the Executive team, the Mayor and council, and all Water Services staff and other City Master Plan Project Managers.

The notice of commencement and associated advertisements are included in **Appendix F**.

7.5.1.2 Invitation to Community Open House #1

A formal invitation to the first community open house on February 13, 2020 was published on January 23, 2020 and distributed through:

- the project website guelph.ca/plans-and-strategies/water-supply-master-plan/;
- the City's website guelph.ca/2020/01/join-us-february-13-for-the-first-water-supply-master-plan-open-house/;
- a project email list (53 recipients on January 30, 2020);
- social media posts on Facebook (facebook.com/cityofguelph) and Twitter (twitter.com/cityofguelph);
- Internal City staff including the Executive team, the Mayor and council, and all Water Services staff and other City Master Plan Project Managers; and
- paid advertisements with
  - Guelph Mercury Tribune (print, September 23, 2021)
  - guelphtoday.com.

The community open house invitation is included in **Appendix F**.

7.5.1.3 Invitation to Community Open House #2

A formal invitation to the second community open house on September 29, 2021 was published on September 16, 2021 and distributed through:

- the Project website guelph.ca/plans-and-strategies/water-supply-master-plan/;
- the City's website guelph.ca/2021/09/join-us-september-29-to-talk-about-the-future-of-drinking-water-in-guelph/;h
- Have Your Say newsletter list;
- social media posts on Facebook (facebook.com/cityofguelph) and Twitter (twitter.com/cityofguelph)
  - https://twitter.com/cityofguelph/status/1438500050246774787
  - https://twitter.com/cityofguelph/status/1439937666842337282

  - https://twitter.com/cityofguelph/status/1442867081955868688
  - https://www.facebook.com/permalink.php?story_fbid=10159680867733156&id=90034568155;
- Internal City staff including the Executive team, the Mayor and council, and all Water Services staff and other City Master Plan Project Managers; and
- paid advertisements with
  - Guelph Mercury Tribune (print, September 23, 2021)
  - guelphtoday.com

The community open house invitation is included in **Appendix F**.

7.5.1.4 Notice of Completion

A Notice of Completion was issued on January 10, 2022 to conclude Phase 2 of the project. A copy of the notice and the distribution details are provided in Appendix F.

7.5.2 Project website

A page on the City's website (click here for the City of Guelph's Water Supply Master Plan) was published in November 2019. The purpose of the web page is to help build awareness for the Water Supply Master Plan Update, share updates and engagement opportunities, as well as useful information. The web page provides an up-to-date source of comprehensive and timely information and is linked to Have Your Say for online engagement. Information found on the web page includes:

- notices and latest updates;
- engagement opportunities;
- background and process information;
- resources, including downloads from open houses and the 2014 Water Supply Master Plan final report;
- mailing list subscription link; and
- contact information.

From the launch to October 14, 2021, the project web page has had 2,110 page views, including 926 page views from unique visitors. The average time spent on the web page was more than one minute (1:22).

7.5.3 Social Media

City of Guelph Facebook (facebook.com/cityofguelph) and Twitter (twitter.com/cityofguelph) accounts were used to complement the project web page to reach a larger audience who may otherwise be less engaged in traditional in-person engagement methods, and to share information about the Water Supply Master Plan Update. Social media posts were developed to engage online stakeholders throughout Phases 1 and 2 and helped to invite interested individuals or groups to attend the open houses and take part in online engagement (i.e., the online survey) and provide links to the web page and Have Your Say.

Since the launch there has been five Facebook posts shared organically and combined they reached 10,270 Facebook users. One paid Facebook ad reached 11,500 Facebook users. A total of 11 Tweets have resulted in 22,661 impressions, 30 re-tweets, 22 likes and 32 clicks to the web page.

Social media posts related to the Water Supply Master Plan update can be found in **Appendix F**.

7.5.4 Community Open House #1

The purpose of the first community open house was to provide an opportunity for the public to share feedback to help inform how the City will manage the water supply as the community grows. It was also an opportunity for the public to share what is important to them for the future so that the City can continue to provide excellent drinking water service to Guelph residents.

Logistics for community open house #1:

- **Where:** Marg MacKinnon Community Room, City Hall, 1 Carden Street
- **When:** February 13, from 2:00 p.m. to 4:00 p.m. and 6:00 p.m. to 8:00 p.m.

Topics presented on twelve display boards included:

- the objectives and overview of the Water Supply Master Plan Update;
- the City's current drinking water supply;
- proposed alternatives for meeting our drinking water supply needs;
- proposed criteria and methodology for evaluating new drinking water sources;
- the agency of water/personhood of water/water is life; and
- the next steps as we update the Water Supply Master Plan.

Upon arriving at the open house, attendees were greeted and encouraged to sign-in at the welcome table. A survey was provided for attendees to submit their comments before they left, or they could send in responses via email or complete the online version on Have Your Say. Display boards were situated along the edge of the room with various experts available to answer questions. Printed copies of a map of Guelph Water Services Municipal Wells were available.

The City's water conservation staff also had a booth set-up to answer questions about water conservation and efficiency. Desktop computers were available for attendees to sign-up real-time to the online engagement platform, Have Your Say.

Seventeen attendees signed in, including several students from a university class. Many City staff stopped by without signing in and some attendees entered through the back door and missed the welcome table. Eight people completed the survey in-person.

Display boards, the survey and map are provided in **Appendix F**. Feedback from the open house is available in the feedback section (Section 7.2) of this report.

7.5.5 Community Open House #2

The purpose of the second open house was for the public and interested stakeholders to learn about and share their thoughts on the potential alternative water supply sources that were identified, the detailed evaluation

of the alternatives and the preferred solutions that were identified. The open house was hosted virtually due to the COVID-19 pandemic and restrictions for in-person gathering.

Logistics for community open house #2:

- **Where:** Online via Microsoft Teams
- **When:** September 29 from 6:30 p.m. – 8:30 p.m.

Attendees were reminded of the Water Supply Master Plan Update objectives, the challenge and opportunity statement, the municipal class Environmental Assessment process what was it involved in the update. An overview of Phase 1 consultation and engagement was provided, including feedback that was shared. Technical content focused on:

- the population forecasted to 2051 and the anticipated demand for water;
- the potential alternative water supply sources that have been identified and the benefits and considerations for why the alternative is being added to the overall solution;
- the detailed evaluation of the alternatives measured against seven evaluation criteria; and
- the preferred solutions.

After the presentation, a question and answer period was held.

Six attendees joined, along with three representatives from AECOM, and four representatives from the City of Guelph.

At the end of the session, a survey link to Have Your Say was provided for attendees to submit their comments by October 13, 2021.

The presentation and the survey are provided in **Appendix F**. Feedback from the open house is included in the feedback section (Section 7.3) of this report.

7.5.6 Phase 1 Online Engagement

During the first phase of the study, online engagement was used to gather public input related to the Water Supply Master Plan Update. Have Your Say,

the City of Guelph's online community engagement platform featured a Water Supply Master Plan page so that the public can share ideas and help shape decisions (haveyoursay.guelph.ca/wsmp). The Water Supply Master Plan Update page includes information about the project, an online survey associated with the open house, a Q&A tool available at any time, key dates, project lifecycle, contact information for 'who is listening', document library and a Have Your Say newsletter subscription.

The Have Your Say page was published February 10, 2020. Since being published, the page received 218 total visits. Twenty-three visitors filled out the online survey and one visitor asked a question with the Q&A tool.

February 2020 and March 2020 newsletters were distributed through the entire Have Your Say Guelph subscribers highlighting the community open house #1 and the online survey. The newsletters are available in **Appendix F**.

7.5.7 Phase 2 Online Engagement

Online engagement continued to be used to gather public input related to the Water Supply Master Plan Update (haveyoursay.guelph.ca/wsmp). The Water Supply Master Plan Update page included updated information about the project, an online survey associated with the second open house, a video recording of the second open house, the results of the survey associated with the first open house, a question and answer tool available at any time, key dates, project lifecycle, contact information for 'who is listening', document library and a Have Your Say email subscription.

Including results from Phase 1, as of October 14, 2021 the online engagement page received 733 total visits. One person filled out the online survey for the second community open house and four people asked a question with the Q&A tool.

7.6 Indigenous engagement

7.6.1 First Nations, Métis, Inuit Peoples living in Guelph

There are Indigenous Peoples—First Nations, Métis and Inuit Peoples–living in Guelph who are working with the City and contributing to the development of the Water Supply Master Plan Update. Specifically, through

the Community Liaison Group, Indigenous Peoples shared their perspectives on the spirit of water and the importance of respecting the agency of water. This involved conversations during the first Community Liaison Group meeting; contribution at the first open house where Indigenous knowledge on water relations was shared with members of the public; and on-going dialogue with the Water Supply Master Plan Project Team around ways the relationships can be enhanced through working with the diversity of local Indigenous voices, on Water Supply Master Plan Update and other water-related projects and initiatives.

Details regarding meetings held with Indigenous communities regarding the Water Supply Master Plan Update are further outlined below.

7.6.2 Duty to Consult

The Crown has a legal duty to consult Indigenous Peoples when it has knowledge of potential project impacts on Indigenous or treaty rights. The Crown may delegate procedural aspects of the duty to consult to project proponents, and the Ministry of the Environment, Conservation and Parks has delegated the procedural aspects of rights-based consultation to the City, as noted in a letter dated November 5, 2019.

Ministry of the Environment, Conservation and Parks notified the Project Team of the Indigenous communities to contact regarding the Water Supply Master Plan Update and included Six Nations of the Grand River, Haudenosaunee Confederacy Chiefs Council and Mississaugas of the Credit First Nation. The Project Team is following the steps outlined in the "Code of Practice for Consultation in Ontario's Environmental Assessment Process". Where the Water Supply Master Plan Update may affect Indigenous and treaty rights, Ministry of the Environment, Conservation and Parks will determine additional consultation-related steps that may be taken.

These contacts were provided with a formal letter, the notice of commencement and invitation to the workshop with agencies and other municipalities, and the notice and invitation to the first community open house. Follow-up with the communities was conducted by the City to determine if there is any specific consultation format that is preferred in addition to the tools and activities utilized to date. In addition, the City conducted general communication and consultation with the Indigenous

communities identified above with the intent to improve relationships with the communities and to share information with respect to the City's Municipal Comprehensive Review and updating of a number of the City Master Plans[20]. These contacts resulted in some meetings to discuss the City's general master planning processes and the Water Supply Master Plan Update in particular.

7.6.2.1 Six Nations of the Grand River

One meeting and presentation was held with the Six Nations of the Grand River on July 6, 2021. This meeting was for the purpose of providing a briefing of the water-related master plan projects at the City. A presentation was delivered and included the following topics:

- overview of the Water Supply Master Plan
- overview of the existing water supply system
- how much water Guelph currently has
- how much water Guelph will need in the future
- water supply alternatives
- overview of engagement conducted to-date

A briefing note was provided to supplement the presentation and the City responded to pre-submitted questions from Six Nations. A meeting summary was also provided.

Following the presentation, there was a question and answer session that provided additional information on the City's water supply, source protection programs and water conservation and efficiency programs.

As an action item from the meeting, the City indicated they would share the draft final Water Supply Master Plan Update Report as part of the 90-day review period and prior to being approved by City Council.

All meeting materials are available in **Appendix F**.

[20] Communications with the Haudenosaunee Confederacy Chiefs Council were unsuccessful during Phase 2 of the project due to a change in email contact information resulting in undelivered email and unsuccessful phone call attempts (voicemail box was at capacity per recorded message).

7.6.2.2 Haudenosaunee Confederacy Chiefs Council

Efforts were made by the City to contact the Haudenosaunee Confederacy Chiefs Council regarding the Water Supply Master Plan Update.

Communications were directed to the Haudenosaunee Confederacy Chiefs Council, as noted above, to inquire about interest in a one-on-one meeting to discuss the Water Supply Master Plan Update. However, formal contact was not established, and meetings were not conducted.

7.6.2.3 Mississaugas of the Credit First Nation

As noted above, communications were initiated with the Mississaugas of the Credit First Nation on to inquire about interest in a one-on-one meeting to discuss the WSMP Update. A subsequent meeting took place on October 6, 2021.

A presentation was delivered and included the following topics:

- overview of the Water Supply Master Plan
- overview of the existing water supply system
- how much water Guelph currently has
- how much water Guelph will need in the future
- water supply alternatives
- overview of engagement conducted to-date

A briefing note was provided to supplement the presentation and a written follow-up to pre-submitted questions regarding conservation and efficiency programs was also provided.

The Mississaugas of the Credit First Nation confirmed that they do not need to review additional materials for the WSMP Update, however, they did request annual updates on all water-related master plans and would like to be involved in new projects from the outset.

All meeting materials are available in **Appendix F**.

7.7 Additional stakeholder meetings and presentations

Meetings and presentations with key stakeholders were encouraged during Phase 1 and Phase 2 so that organizations and groups could learn about the Water Supply Master Plan Update and be kept informed on how they might specifically be impacted by updates. Meetings were held predominantly in-person for Phase 1 and virtually for Phase 2.

7.7.1 Guelph Wellington Development Association and Guelph and District Home Builders' Association

On November 7, 2019, the City Staff Technical Liaison Committee met with the Guelph Wellington Development Association and Guelph and District Home Builders' Association. Dave Belanger from the Water Supply Master Plan team was invited to present an overview of the Water Supply Master Plan update, including the process for updating the 2014 Water Supply Master Plan.

After the meeting, the Water Supply Master Plan Project Team invited both organizations to participate in the Community Liaison Group.

Meeting minutes and the presentation are available in **Appendix F.**

7.7.2 Our community, our water open house

The City hosted a community open house on November 26, 2019 at Holiday Inn regarding a proposed solution between the City and the owners of the Dolime Quarry. The City's concerns about the Dolime Quarry revolve around how operations at the quarry could affect Guelph's drinking water.

The WSMP Project Team was invited to bring an overview display board about the WSMP Update to the open house. The display board is available in **Appendix F**.

7.7.3 Water Conservation and Efficiency Public Advisory Committee

On September 16, 2020 and on September 28, 2021 the Water Supply Master Plan team presented at the Water Conservation and Efficiency Public Advisory Committee meeting.

The first presentation discussed the 2014 WSMP Preferred solution, conservation and demand management efforts underway, the 2016 Water Efficiency Strategy, potential enhanced water conservation program successes / challenges and the demands projections for the WSMP update. The session also provided an opportunity to ask questions and collect feedback.

The second presentation discussed the summary of water supply requirements to 2051, an overview of water supply alternatives, the environmental assessment evaluation criteria, preliminary preferred solution and opportunity for questions and feedback.

A copy of the presentation is available in **Appendix F**.

7.7.4 Puslinch Township

On December 2, 2019 the City provided an overview presentation of the Water Supply Master Plan Update project to the Township Supervisor of Public Works and Parks. This included an overview of the MCEA process, the draft Problem and Opportunity Statement, a review of the Water Supply Master Plan work plan and the schedule and next steps for the project.

Subsequently, in late 2019 and early 2020, the City offered on several occasions to provide a similar overview presentation to Township Council. Additional offers of meetings and presentations to staff and/or Council on the Water Supply Master Plan Update were provided in mid-2020 (July to September) associated with Water Supply Master Plan field work related to the Guelph South Groundwater Supply Feasibility Project.

Township of Puslinch identified the Mayor and a Councillor as the designated representatives for the Community Liaison Group. Invitations to the meetings as well as presentations and survey forms were provided to the Mayor and Councillor.

Representatives from Township of Puslinch attended the agency meetings on November 28, 2019 and on September 14, 2021 and, while verbal comments were provided at the meetings, written comments were not provided to the City following the meetings.

On October 13, 2021 the Water Supply Master Plan team met with Township of Puslinch's Council to provide an overview of the project and a shortened version of the presentation that was presented at the second agency and municipality workshop. The agency meeting presentation from September 14, 2021 was sent to Puslinch Council in advance of the meeting. Following the presentation the Project Team responded to questions from Council. Feedback generally focused on the following topics:

- concerns about source protection areas and land use constraints particularly with respect to impacts on the Township;
- concerns about potential well interference effects with existing wells particularly with respect to impacts on the Township;
- prioritizing supply within the City before considering sources within Township;

In follow-up to the meeting, Township of Puslinch sent a Council Resolution dated October 13, 2021 to the City (and to the Township of Guelph/Eramosa) which included several requests:

- confirming that the City extended the Township's commenting deadline on the Agency and Municipality Workshop #2 presentation slides from October 22, 2021 to November 5, 2021 despite a request for further extension
- Township staff and consultants review the Water Supply Master Plan Update when made available and provide comments at the November 24, 2021 Puslinch Council meeting
- that the City of Guelph Council provide the opportunity for Puslinch Council to provide comments in advance of the draft report being adopted by City of Guelph Council
- that the City of Guelph Council acknowledge receipt of the Township comments and provide a response
- that the City of Guelph Council authorize the release of the draft report to Puslinch staff in advance of the City of Guelph council meeting

A copy of the presentation and final Council Resolution are available in **Appendix F**. A copy of the meeting minutes can be accessed online at https://puslinch.ca/wp-content/uploads/2020/11/November-3-2021-Council-Agenda.pdf.

City staff responded to Township of Puslinch staff clarifying that feedback from Township was being sought for content in the agency and municipality workshop #2, not on the draft final report of the Water Supply Master Plan Update. The City extended the timeframe to submit comments on the September 14 agency presentation to November 5, 2021, providing a seven-week commenting period. It was noted that the draft final report, under development at the time of the meeting, will be released for public review and will be accompanied by a formal public review period in early 2022. City staff clarified that it was soliciting comments from the Township in order to incorporate Township feedback into the draft final Water Supply Master Plan Update Report. Formal comments were not received prior to completion of the draft final report; however, subsequent feedback was incorporated into the final report.

7.7.5 Township of Guelph/Eramosa

The Township of Guelph Eramosa had representation by a Councillor at all three of the Community Liaison Group meetings, and a Public Works representative at the first Agency / Municipality workshop. Communication was primarily verbal, with email correspondence from a Township of Guelph/ Eramosa citizen seeking additional information after the second CLG meeting.

On October 20, 2021 the Water Supply Master Plan team met with Township of Guelph/Eramosa Council to provide an overview of the project and a shortened version of the presentation that was presented at the second agency and municipality workshop. Following the presentation, the Project Team responded to questions from Council. Feedback generally focused on the following topics:

- Location of the Logan test well and primary direction of groundwater drawdown
- Leakage from the City's water distribution network and how it is managed

- The Eramosa River artificial recharge system and opportunities to improve the system efficiency
- How the Guelph Lake alternative could function and details of the GRCA capacity analysis
- The City's experience supporting the installation of residential greywater systems
- Possibility of collaborating on use of Cross-Creek water supply system to help meet future City demands

In a follow-up to the meeting, the Township of Guelph/Eramosa sent a Council Resolution dated October 27, 2021 which included a number of statements and requests:

- that the Township of Guelph/Eramosa has concerns with the City of Guelph's November 5, 2021 deadline for comments regarding the Water Supply Master Plan 2021 Update
- that the City of Guelph Council authorize the release of the draft report to Guelph/Eramosa staff in advance of the City of Guelph's council meeting
- that council direct Township staff and Township consultant(s) to review the City of Guelph Water Supply Master Plan Update correspondence and draft report, when available, and to provide comments for Council's consideration at a subsequent Township of Guelph/Eramosa Council meeting
- that the City of Guelph Council provide the opportunity for Guelph/Eramosa Council to provide comments in advance of the draft report being adopted by City of Guelph Council
- that the City of Guelph Council acknowledge receipt of the Township comments and provide a response
- that the resolution be forwarded to the City of Guelph and the Township of Puslinch

A copy of the presentation and final Council Resolution are available in **Appendix F**.

City staff similarly responded to the Township of Guelph Eramosa staff clarifying that feedback was being sought for content in the agency and

municipality workshop #2, not on the draft final report of the Water Supply Master Plan Update. The City extended the timeframe to submit comments on the September 14 agency presentation to November 5, 2021. It was noted that the draft final report will be released for public review and will be accompanied by a formal public review period in early 2022. The purpose of the review period is to solicit commentary and incorporate feedback from the Township into the final Water Supply Master Plan Update Report. Formal comments were not received prior to completion of the draft final report; however, subsequent feedback was incorporated into the final report.

7.8 Community Liaison Group

An aspect of the WSMP Update included consultation with a Community Liaison Group. The purpose of this group was to inform and provide an opportunity for input on specific issues related to the WSMP Update. Three meetings were planned at key milestones:

1. Introduction of the master plan and gain feedback
2. Update on alternative solutions and evaluation criteria and gain feedback
3. Present draft master plan update and gain feedback

A Community Liaison Group was created during the 2014 Water Supply Master Plan update, and this membership was used as a foundation for the 2021 Community Liaison Group membership. Participants from 2014 were invited to take part again, in addition to new groups and the broader community (invited through the Notice of Commencement and direct emails). The Community Liaison Group included members from a wide cross-section of the community:

- business/ industry (two members);
- environmental organizations (two members);
- agriculture (one member);
- land development (one member);
- community or social organizations (two members);
- academia (three members);
- the Guelph community-at-large (Guelph) (three members);

- the community-at-large outside of Guelph (two members); and
- the Anishinaabe (one member representing the local Indigenous community).

7.8.1 Meeting #1

The first Community Liaison Group meeting was held in-person on December 4, 2019 to share stakeholder and community ideas and perspectives on the Water Supply Master Plan Update. The purpose of the first Community Liaison Group meeting was to review and provide input on key aspects of the Master Plan and the Class Environmental Assessment, including:

- the objectives and scope of the Master Plan Update;
- issues and opportunities to be addressed;
- alternative solutions to be assessed; and
- the draft evaluation criteria to be applied.

For the first meeting there were 13 participants, along with four City staff and three AECOM consultants. The format of the workshop included a presentation and opportunities for discussion and reflection.

A full meeting summary, in addition to presentation and discussion guide is provided in **Appendix F**.

Responses to questions in the discussion guide are presented in the feedback table in **Appendix F.**

7.8.2 Meeting #2

The second Community Liaison Group meeting was held virtually on July 27, 2021 to continue sharing stakeholder and community ideas and perspectives on ways to improve the Water Supply Master Plan Update. The purpose of the second Community Liaison Group meeting was to review and provide input on major technical task progress related to the Master Plan and the Class Environmental Assessment, including:

- consultation conducted to-date;
- population targets and water supply demand forecasts;

- existing water supply capacity assessment;
- technical assessment of alternatives to-date; and
- environmental assessment evaluation criteria.

For the second meeting there were nine participants, along with three City staff and three AECOM consultants. The format of the workshop included a presentation and opportunities for discussion and reflection.

A full meeting summary and the presentation (including discussion questions) is provided in **Appendix F**.

7.8.3 Meeting #3

The third Community Liaison Group meeting was held virtually on September 21, 2021 to provide a final opportunity for sharing stakeholder and community ideas and perspectives on ways to improve the Water Supply Master Plan Update. The purpose of the third Community Liaison Group meeting was to review and provide input on major technical task progress related to the Master Plan and the Class Environmental Assessment, including:

- water supply requirements
- work completed since meeting #2
- assessment of water supply alternatives
- evaluation of water supply alternatives

For the third meeting there were twelve (12) participants, along with six (6) City staff and three (3) AECOM consultants. The format of the workshop included a presentation and opportunities for discussion and reflection.

A full meeting summary and the presentation (including discussion questions) is provided in **Appendix F**.

7.9 Agency and municipality workshop

Part of the WSMP Update included two workshops to bring Municipalities and Agencies together, providing a forum to discuss plans for the 2021 WSMP Update and to gather input.

In addition to select City of Guelph staff, organizations that were invited to participate included:

- Grand River Conservation Authority;
- Guelph/Eramosa Township;
- Haudenosaunee Confederacy Chiefs Council;
- Ministry of the Environment, Conservation and Parks;
- Ministry or Natural Resources and Forestry;
- Mississaugas of the Credit First Nation;
- Region of Waterloo;
- Six Nations of the Grand River First Nation;
- Town of Milton;
- Township of Centre Wellington;
- Township of Puslinch;
- Wellington County;
- Wellington Source Water Protection; and
- Wellington-Dufferin-Guelph Public Health.

7.9.1 Workshop #1

The first workshop was held on November 28, 2019 with 10 participants from six organizations, along with four City staff and four AECOM consultants. The purpose of the first workshop was to review and provide input on key aspects of the Master Plan and the Class Environmental Assessment, including:

- the objectives and scope of the Master Plan Update;
- issues and opportunities to be addressed;
- alternative solutions to be assessed; and
- the draft evaluation criteria to be applied.

The format of the workshop included a presentation and opportunities for discussion and reflection. A full meeting summary, in addition to presentation and discussion guide is provided in in **Appendix F**.

Responses to questions in the discussion guide are presented in the feedback table in **Appendix F.**

7.9.2 Workshop #2

The second workshop was held virtually on September 14, 2021 with 11 participants from five organizations, along with six City staff and three AECOM consultants. The purpose of the second agency workshop was to gather feedback and concerns from agency and municipality representatives after reviewing progress related to the Master Plan and the Class Environmental Assessment, including:

- water supply requirements;
- work completed since meeting #2;
- assessment of water supply alternatives; and
- evaluation of water supply alternatives.

The format of the workshop included a presentation and opportunities for discussion and reflection. A full meeting summary and the presentation (including discussion questions) are provided in **Appendix F**.

7.10 90 Day Public Review Period

The draft final Water Supply Master Plan was posted in accordance with the requirements of the Municipal Class Environmental Assessment process for review as of January 10, 2022. The published report was available both online (project webpage and on https://www.haveyoursay.guelph.ca/wsmp) and in person at the main branch of the Guelph Public Library.

The purpose of the 90 day review was to gather feedback from the public, agencies, municipalities and other stakeholders after reviewing the draft final Waster Supply Master Plan update documents. Received comments can be found in **Appendix F.**

During this time, additional and ongoing engagement was held with the surrounding municipalities and other government agencies as outlined below.

7.11 County and Township Meetings

Four virtual meetings were held with representatives of Wellington County and the Townships of Puslinch and Guelph/Eramosa between December 2021 and March 2022. The purpose of the meetings and topics of discussion were as follows:

- a review and discussion of staff / consultant memos providing comments on the materials presented at Agency and Municipality Workshop #2 and the subsequent City response to the comments;
- a discussion of Township Council comments from October 2021;
- a presentation and discussion of the County of Wellington's Official Plan Amendment which addressed the County's plans for growth;
- a presentation and discussion of the Water Supply Master Plan Update Report from the City;
- discussion about the preliminary County/Township questions/ comments on the draft final Water Supply Master Plan Update Report; and
- a review of the timeline to submit formal comments, and clarifying dates.

A representative of Wellington County Source Protection chaired the meetings and provided meeting minutes. The presentations, meeting minutes and other documents outlined above are provided in **Appendix F**.

7.12 Township Council Meetings

The Township of Puslinch held a council meeting on April 13, 2022 and discussed the staff comments on the draft final Water Supply Master Plan Update Report. The WSMP Update review comments, related Council resolution, and the City's responses can be found in **Appendix F.** A copy of the council meeting minutes can be accessed online at: https://puslinch.ca/calendar/.

The Township of Guelph/Eramosa held a council meeting on April 19, 2022 and discussed the staff comments on the draft final Water Supply Master Plan Update Report. The WSMP Update review comments, related Council resolution, and the City's responses can be found in **Appendix F.** A copy of

the council meeting minutes can be accessed online at: https://www.get.on.ca/township-services/committee/mayor-and-council/meetings.

7.13 Ministry of the Environment, Conservation and Parks Meeting

A meeting was held virtually on March 22, 2022 with 20 participants, including five City staff and two AECOM consultants. The purpose of the meeting was to present the draft final Water Supply Master Plan update to staff from the Ministry of the Environment, Conservation and Parks and to provide them with the opportunity to address their questions and concerns. The topics of the presentation for this meeting included

- the objectives and scope of the Master Plan Update;
- issues and opportunities to be addressed;
- population and water supply demand projections;
- existing water supply system capacity;
- assessed alternative solutions;
- the applied evaluation criteria;
- engagement and consultation completed; and
- implementation recommendations.

The format of the meeting included a presentation and opportunities for discussion and reflection. The presentation is provided in **Appendix F.**

8. Implementation Recommendations

8.1 Financial Evaluation Approach

Based on the evaluation outputs for each of the alternatives, a priority was established for the proposed water supply projects that determines how the City will proceed to develop its water supply over time to meet future needs. This implementation strategy is to ensure that there will always be sufficient supply including an additional allowance for security of supply in place prior to approving growth.

The timeline for this plan is dependent on the water conservation scenarios. For example, a more aggressive conservation strategy would result in lower demands for the same population thereby deferring the schedule for new water supplies which results in some cost savings; however, the more aggressive conservation strategy comes at a higher cost. Therefore, a financial evaluation was carried out to determine the optimal water conservation scenario when viewed in the context of cost, impact on demand and the resulting timeline and costs for all of the water supply projects.

This section provides an overview of the financial evaluation approach including the inputs regarding timeline and budget established for implementing the preferred projects.

The analysis takes into consideration the following:

- Timeline and costs associated with each alternative – including technical investigations, water quality analysis, environmental impact studies, land acquisition, preliminary and detailed design, and construction and commissioning. The timeline allowed in advance of water supply availability is as follows:
  - Groundwater - 5 year timeline
  - Arkell Collector ASR wells – 8 year timeline
  - Surface Water – 10 year timeline
- The exception to the above is that the investigative phase for the test wells and inside-City groundwater options is scheduled to occur early in the implementation timeline so that the City has sufficient information to determine whether the alternative is feasible, to

identify any constraints, and to confirm capacity and treatment requirements prior to the next WSMP Update; the groundwork would then be in place in order to implement the remaining tasks in a timeline such that the supply would be in place as required. For the proposed wells outside the City, budget is allocated in the short- to mid-term for additional modeling work to update and substantiate the estimated capacities and potential effects related to the Guelph North and Guelph Southeast alternatives for use in the next two WSMP Updates.

- An assumed order of groundwater projects is presented in **Table 8-1** and is based on the prioritization of alternatives identified in Section **6.4**. It is important to note that the assumptions made in the prioritization of projects were for the purpose of determining the requirement for new supplies against the demand curve in comparison to varying conservation scenarios. Most of these projects would be in investigation and design phases concurrently and the schedule for each would be a function of constraints and ease of implementation.
- Schedule for implementation such that new water supply projects will be brought online when required capacity reaches 90% of system capacity to ensure sufficient capacity for proposed development commitments, and industrial / commercial applications, as well as to respond to large increases in demand by current customers, in particular major industries or ICI consumers. This flexibility is important to address growth needs or demands that do not follow the planned demand projection. This 90% trigger is to be compared to the calculated maximum day demand and not the redundancy and security of supply allowance which is included in addition to the maximum day demand. The additional 15% added onto the actual maximum day factor in determining the required water supply capacity is intended to provide sufficient volume at any given time to address transitory events such as a short-term loss of supply and drought conditions, or to provide the necessary firm capacity to allow for wells to be off-line for short durations for maintenance or upgrades.

Table 8-1 lists the assumed order of project implementation. The timing for these proposed projects is determined by establishing the need for the water being supplied through each individual source to meet demand, which is a function of which conservation scenario is applied. Detailed descriptions of the individual projects are included as project sheets within **Appendix G**. These expand on the implementation requirements for each project including technical investigations, water quality analysis, environmental impact studies (including Class EA, where required), land acquisition, preliminary and detailed design, and construction and commissioning.

Table 8-1: Assumed Order of Project Implementation

Order of Implementation	Project Name	Project Type
Project 1	Clythe Well	Offline Wells
Project 2*	Ironwood/ Steffler Well	Test Wells
Project 3*	Guelph South Well	Test Wells
Project 4*	Dolime Quarry	Optimization of existing and test wells / potential direct supply source
Project 5	Fleming/ Logan	Test Wells
Project 6	Lower Road Collector	Offline Wells
Project 7	Arkell Collector ASR Wells	Arkell Collector
Project 8	Hauser test well	Test Wells
Project 9	Guelph North	New Wells Outside City
Project 10	Guelph Southeast	New Wells Outside City
Project 11	Guelph Lake WTP	Surface Water
Project 12	Smallfield/ Sacco Wells	Offline Wells
Project 13	Guelph Lake WTP and ASR wells	Surface Water

Notes: *Project implementation subject to outcome of on-going Southwest Guelph Water Supply EA

8.2 Recommended Water Conservation, Efficiency and Demand Management Strategy

From a water supply planning perspective, water conservation, efficiency and demand management programming can help to delay the requirement to implement high cost water supply projects to meet demand. Although it is anticipated that the current level of programming can achieve per capita

demand reduction in the short-term, as Guelph continues with initiatives to incrementally reduce water usage, programming will need to be adjusted to align with any opportunities for further reductions. In order to fully understand the trade-offs between demand management and the need for additional water supply, a comparison of water conservation scenarios is appropriate. This comparison needs to forecast the future costs of both water conservation and water supply and compare it to the corresponding reductions in water consumption.

Through the WSMP Update, conservation scenarios were explored to establish the cost associated with different approaches to future programming. As outlined in Section 5.2, four scenarios were developed to represent a range of possible target reductions and associated costs. These programs are forecasted to range in cost from $0/year to approximately $501,333/year, and reduce average day water demand by 0 m^3/day to 4,952 m^3/day. An additional blended scenario was identified as an outcome of the Evaluation of Alternatives step, which indicated that a combination of the conservation, efficiency and demand management scenarios may be required to effectively produce demand reductions through the full planning period to 2051. This scenario envisions implementing the current level of programming in the short-term (approximately years 0-10), adjusting the focus to high demand and/or inefficient customers in the mid-term (approximately years 11-20) and incorporating water reuse in the long-term (approximately years 21-30). Using the costs and demand reduction estimates developed for Scenarios 2-4 as a basis, this scenario is estimated to cost an average of $299,792/yr and reduce average day water demand by 3,683 m^3/day. Each of the water conservation scenarios explored will delay the need to implement proposed projects for increasing the water supply, assuming that conservation is successfully implemented to achieve the desired targets.

While many of the water conservation projects explored have a relatively low capital cost, they do have an annual operating cost. However, water conservation will delay the capital costs associated with new water supply projects as well as their incremental operating costs. This statement is due to the fact that as per capita demand is reduced, overall demand will also be reduced, delaying the occurrence of having water demand equal water supply. If water conservation projects are not put in place, water supply

projects will need to be implemented sooner in the schedule. This analysis looked at the range of possible water conservation, efficiency and demand management scenarios which are described in Section 5.2, along with the blended Scenario 5 (**Table 8-2**).

At a high level, each scenario addresses a different strategy for implementation of conservation, efficiency and demand management programming moving forward, as follows:

Scenario 1: No further reductions - ceasing non-provincially mandated water efficiency measures (baseline scenario)

Scenario 2: Potential reduction through maintaining a level of programming similar to the current water conservation, efficiency and demand management program

Scenario 3: Potential reduction through a focus on high water use customers

Scenario 4: Potential reduction through a focus on the current level of programming *and* water reuse initiatives

Scenario 5: A blend of Scenarios 2 to 4

Table 8-2: Water Conservation Scenarios

Scenario	Reduction in Average Day Demand (m^3/day)	Est. Total Program Cost (Non-Discounted; million $)
1	-	-
2	4,424	11.41
3	2,220	4.73
4	4,952	15.04
5	3,683	8.99

This analysis compares the forecasted impacts of the five scenarios on: the demand for potable water, the timing of the City's proposed water supply projects, and the City's capital spending and operating expenditure on water supply projects and water conservation.

For each of the scenarios, the stream of total annual costs (i.e., capital, operating and conservation costs) for each scenario is discounted to a

present value using a 3.5% discount rate. Applying a net present value (NPV) calculation to each scenario's unique cost stream is an effective way to compare them in today's dollars. More specifically, expenditures delayed by conservation measures are valuable to the City from a financial management perspective.

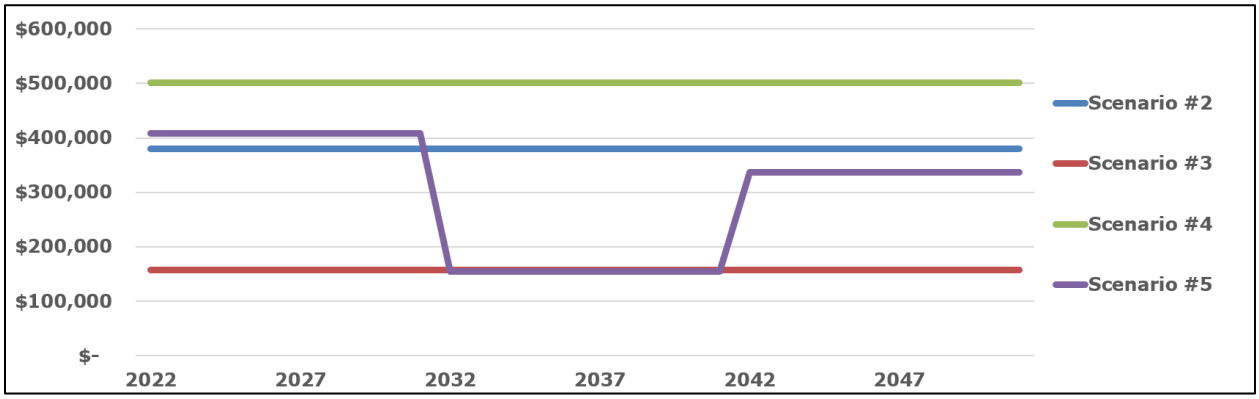
The forecasted timing of proposed water supply projects under the different scenarios is presented in **Table 8-3**. Included in each project expenditure is the preceding timeline for work and associated costs outlined in the assumptions. The annual estimated conservation, efficiency and demand management program costs that trigger the differences in capital and operating costs for each scenario is presented in **Figure 8-1**. **Table 8-3** presents a summary illustration to compare the total annual capital and operating costs by scenario.

Table 8-3: Timing of Proposed Water Supply Projects Under Different Conservation Scenarios

Order of Implementation	Project Name	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Project 1	Clythe Well	2023	2023	2023	2023	2023
Project 2*	Ironwood/ Steffler Well	2027	2027	2027	2027	2027
Project 3*	Guelph South Well	2028	2030	2028	2030	2030
Project 4*	Dolime Quarry	2031	2032	2031	2032	2032
Project 5	Fleming/ Logan	2033	2036	2034	2037	2036
Project 6	Lower Road Collector	2037	2042	2038	2042	2040
Project 7	Arkell Collector ASR Wells	2041	2047	2044	2047	2045
Project 8	Hauser test well	2042	2049	2045	2049	2047
Project 9	Guelph North	2043	2049	2046	2050	2048
Project 10	Guelph Southeast	2046	Post-2051	2048	Post-2051	Post-2051
Project 11	Guelph Lake WTP	2048	Post-2051	2051	Post-2051	Post-2051
Project 12	Smallfield/ Sacco Wells	Post-2051	Post-2051	Post-2051	Post-2051	Post-2051
Project 13	Guelph Lake WTP and ASR wells	Post-2051	Post-2051	Post-2051	Post-2051	Post-2051

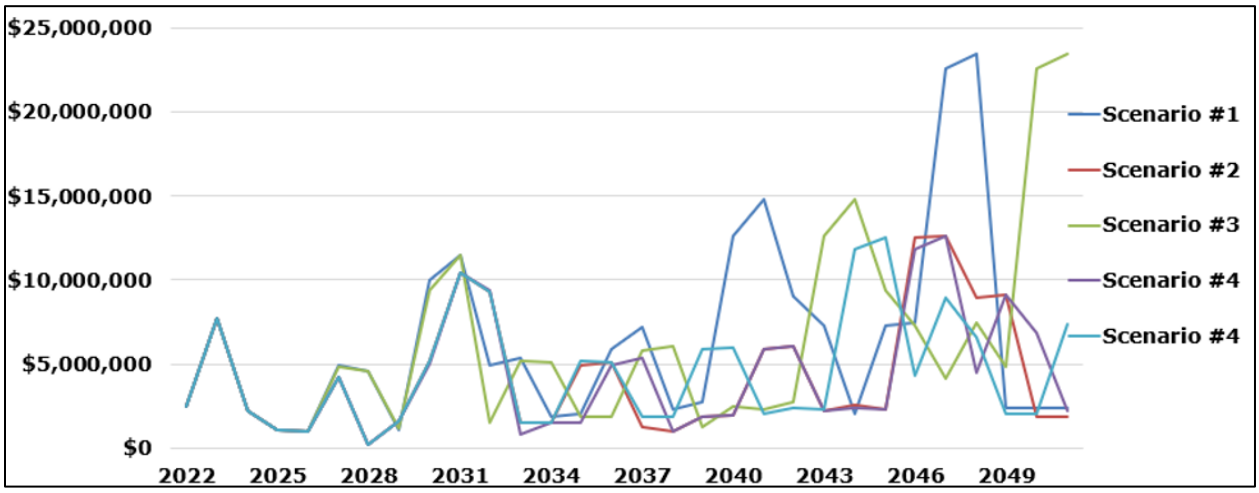
Notes: *Project implementation subject to outcome of on-going Southwest Guelph Water Supply EA

Figure 8-1: Annual Estimated Conservation Program Costs for Scenarios 2-5 (Undiscounted)



Of note in **Figure 8-2** is the difference in timing and magnitude of total capital and operating expenditures over time for each scenario.

Figure 8-2: Total Annual Capital and Operating Costs (Undiscounted) by Scenario



The net consequence of the evaluated scenarios linked to their capital and operating cost impacts over time yields an interesting picture when the cost streams are discounted to present value (**Table 8-4**). The discounted capital (Capx) plus operating (Opx) costs range from approximately $74.4 million (Scenario 4) to as high as $107.2 million (Scenario 1). These savings are incurred by deferring the need for new water supply projects (i.e., demand reduction). As the projects get increasingly expensive over time, as new supplies are more difficult to implement due to distance from the serviced

population, smaller quantity sources are developed, etc., the deferral of these projects represents a direct financial benefit to the City.

Table 8-4: Comparison of Alternative Conservation Scenario Discounted Costs and Savings

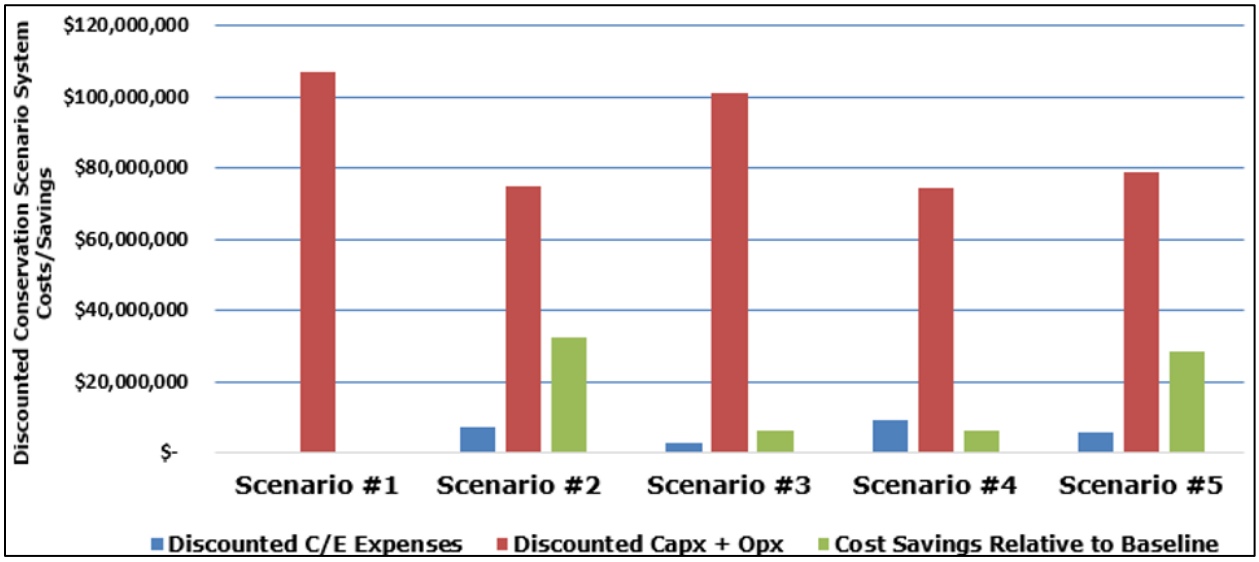
Financial Parameter	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Discounted Annual Capital Cost	91,951,961	63,170,785	87,263,622	62,705,967	66,914,343
Discounted Annual Operating Costs	15,239,422	11,709,923	13,535,273	11,715,192	11,709,923
Discounted Conservation Expenses	0	6,988,977	2,899,874	9,220,539	5,713,115
Discounted Capx + Opx	107,191,383	74,880,707	100,798,896	74,421,159	78,624,266
Savings Relative to Scenario 1	0	32,310,676	6,392,487	6,392,487	28,567,117
Ratio of Savings to Conservation Expenses	0	4.6	2.2	0.7	5.0

When the cost savings relative to the baseline (Scenario 1) are considered (i.e., the difference between Scenarios 2-5 discounted Capx + Opx cost relative to the baseline) we see that the highest cost savings are achieved with Scenarios 2 and 5, respectively (**Figure 8-3**). However, since the estimated conservation, efficiency and demand management program costs for the blended Scenario 5 is lower than Scenario 2 by more than $1 million (discounted), it generates a slightly more favorable cost/benefit ratio of 5.0 to 4.6 (**Table 8-4**).

Based on the completed analysis AECOM recommends implementing the blended strategy, Scenario 5. This scenario will result in a target for reduction in average day demand of 3,683 m^3/day by 2051.

While this analysis has been system focused, the full water system has not been considered. This analysis has included system costs associated with water supply and water conservation. Previous studies have included wastewater treatment in the consideration of system cost, which could be analyzed further in the future. In previous studies, the delay and avoidance of expanded wastewater treatment projects resulted in relatively lower costs for scenarios with higher water conservation. Adding wastewater treatment into the consideration of system costs would not increase the cost of water conservation programs but would increase the benefit from infrastructure avoidance.

Figure 8-3: Comparison of Alternative Financial Scenarios Relative to Baseline



8.3 Preferred Water Supply Alternative

The preferred water supply alternative consists of the blended conservation scenario as well as Projects 1 through 9 listed in **Table 8-1.** These are all groundwater projects included in the preferred alternatives in the evaluation process, consisting of existing municipal off-line wells, existing municipal test wells, Dolime Pond Level Management, Arkell ASR, and a new well (Guelph North) outside of the City.

8.3.1 Recommended Water Supply Alternative Implementation

For completion of the financial analysis undertaken to determine the preferred conservation scenario in the previous section, assumptions were made regarding timeline and costs associated with the individual projects that make up the supply alternatives (**Table 8-3**). This serves as a basis for demonstrating the savings that could be achieved through the conservation, efficiency and demand management programming; however, project timelines are routinely affected by factors exterior to those considered in a implementation schedule built on an ideal timeline.

The detailed implementation schedule for the identified water supply projects was prepared through discussion with the City and considers

progress that has been made to date with on-going project work and reflects anticipate timelines to complete the short-term projects where there is the most certainty with respect to timing and potential results. The subsequent projects that fall in the mid- and long-term portions of the 2051 timeline are established based on anticipated requirements stated previously:

- Groundwater – 5 year timeline
- Arkell Collector ASR wells – 8 year timeline
- Surface Water – 10 year timeline

The order and timing of the individual water supplies will be determined as the City moves through development of each. However, an initial timeline was determined to provide a schedule for implementation of each water supply project, with estimated costs for each phase of development based on a portion of the overall capital cost: in reality many of these projects would be in investigation and design phases concurrently and the schedule for each would be a function of constraints and ease of implementation.

Also noted above is the recommendation that regardless of the required timeline for new water supply, the investigative phase for the groundwater options inside the City is scheduled to occur in the short term (2022-2025) so that the City has sufficient information to determine whether the alternative is feasible, to identify any constraints, and to confirm capacity and treatment requirements prior to the next WSMP Update; the groundwork would then be in place in order to implement the remaining tasks for any given project such that the supply would be in place as required.

For the purpose of illustrating the timeline of project development and capital expenditures, the estimated budgets for each project are provided along with the proposed timeline developed for the recommended implementation plan (**Table 8-5**). This table includes the costs for a permanent pumping station at the Dolime Quarry property ($3.3M) that is required for protection of the groundwater resource *regardless of which new water supply projects are implemented in southwest Guelph*. As such, this cost was not included in the financial analysis.

Table 8-5: Capital Cost Forecast

Project	1 Clythe	2 Ironwood	3 Guelph South	4 Dolime Quarry	5 Fleming/Logan	6 Lower Collector	7 Arkell Collector ASR	8 Hauser	9 Guelph North	10 Guelph Southeast	11 Guelph Lake	12 Smallfield/Sacco	Total Capital Cost for Water Supply Projects	Cumulative Annual Operating Costs	C/E Costs Blended
Min. Capacity (m^3/d)	1,180	2,250	2,250	3,000	4,180	4,000	1,170	425	2,935	1,600	12,312	850	-	-	-
O&M Cost	$100,000	$111,000	$109,000	$135,000 + $521,000	$126,000	$125,000	$99,000	$96,000	$111,000	$105,000	$900,000	$180,000	-	-	-
2021	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2022	$707,550	$157,729	$157,729	$157,729	$232,000	$420,000	$570,000	$0	$0	$0	$0	$87,500	$2,490,238	$0	$ 408,165
2023	$6,073,450	$157,729	$157,729	$157,729	$100,000	$290,000	$570,000	$82,000	$0	$0	$0	$0	$7,588,638	$100,000	$ 408,165
2024	$0	$157,729	$157,729	$157,729	$112,500	$1,480,000	$0	$0	$148,200	$0	$0	$0	$2,213,888	$100,000	$ 408,165
2025	$0	$157,729	$157,729	$157,729	$112,500	$30,000	$120,000	$0	$337,500	$0	$0	$0	$1,073,188	$100,000	$ 408,165
2026	$0	$668,430	$0	$495,000	$0	$0	$0	$0	$0	$235,000	$0	$0	$1,398,430	$100,000	$ 408,165
2027	$0	$3,667,570	$626,010	$2,805,000	$658,875	$0	$0	$0	$0	$338,000	$0	$0	$8,095,455	$346,000	$ 408,165
2028	$0	$0	$3,384,990	$0	$658,875	$0	$0	$0	$0	$0	$0	$0	$4,043,865	$455,000	$ 408,165
2029	$0	$0	$0	$0	$4,114,125	$0	$0	$0	$0	$0	$0	$0	$4,114,125	$455,000	$ 408,165
2030	$0	$0	$0	$0	$4,114,125	$0	$0	$0	$0	$0	$602,000	$0	$4,716,125	$581,000	$ 408,165
2031	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,520,000	$0	$1,520,000	$581,000	$ 408,165
2032	$0	$0	$0	$0	$0	$250,000	$0	$0	$0	$0	$0	$0	$250,000	$581,000	$ 154,693
2033	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$581,000	$ 154,693
2034	$0	$0	$0	$0	$0	$904,764	$0	$0	$0	$0	$0	$0	$904,764	$581,000	$ 154,693
2035	$0	$0	$0	$0	$0	$904,764	$0	$0	$0	$0	$0	$0	$904,764	$581,000	$ 154,693
2036	$0	$0	$0	$0	$0	$4,797,236	$0	$0	$0	$0	$0	$0	$4,797,236	$581,000	$ 154,693
2037	$0	$0	$0	$0	$0	$4,797,236	$0	$0	$0	$0	$0	$0	$4,797,236	$706,000	$ 154,693
2038	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$706,000	$ 154,693
2039	$0	$0	$0	$1,045,620	$0	$0	$150,000	$0	$0	$0	$0	$0	$1,195,620	$706,000	$ 154,693
2040	$0	$0	$0	$1,045,620	$0	$0	$150,000	$0	$0	$0	$0	$87,500	$1,283,120	$706,000	$ 154,693
2041	$0	$0	$0	$8,442,600	$0	$0	$1,099,280	$0	$0	$0	$0	$0	$9,541,880	$706,000	$ 154,693
2042	$0	$0	$0	$8,442,600	$0	$0	$1,099,280	$200,000	$0	$0	$0	$0	$9,741,880	$1,227,000	$ 336,519
2043	$0	$0	$0	$0	$0	$0	$1,099,280	$0	$125,000	$0	$0	$0	$1,224,280	$1,227,000	$ 336,519
2044	$0	$0	$0	$0	$0	$0	$10,213,080	$380,310	$125,000	$0	$0	$0	$10,718,390	$1,227,000	$ 336,519
2045	$0	$0	$0	$0	$0	$0	$10,213,080	$380,310	$837,417	$0	$0	$0	$11,430,807	$1,326,000	$ 336,519
2046	$0	$0	$0	$0	$0	$0	$0	$2,394,690	$837,417	$0	$0	$0	$3,232,107	$1,326,000	$ 336,519
2047	$0	$0	$0	$0	$0	$0	$0	$2,394,690	$5,215,233	$125,000	$0	$0	$7,734,923	$1,422,000	$ 336,519
2048	$0	$0	$0	$0	$0	$0	$0	$0	$5,215,233	$125,000	$0	$0	$5,340,233	$1,533,000	$ 336,519
2049	$0	$0	$0	$0	$0	$0	$0	$0	$0	$447,510	$200,000	$0	$647,510	$1,533,000	$ 336,519
2050	$0	$0	$0	$0	$0	$0	$0	$0	$0	$447,510	$200,000	$0	$647,510	$1,533,000	$ 336,519
2051	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,571,990	$3,347,030	$0	$5,919,020	$1,533,000	$ 336,519

It will be important for the City to closely track the success of the water conservation and efficiency program to ensure that the predicted reductions are being achieved, and to be able to trigger the initial phases of supply projects noting the lengthy lead-in time to complete all of the necessary investigations, approvals and design such that the water is available when needed. This is particularly important for the mid- and long-term projects as there are five supplies scheduled to come online in the 2022 to 2031 portion of the timeline. The City may decide to take a more conservative approach to complete more of the preliminary steps in advance to allow for a shorter final implementation time required for final construction and commissioning once triggered. This would also assist in identifying project issues early, and also securing land requirements.

In reviewing the preceding tables, it can be seen that depending on the conservation scenario, there are projects for which costs are falling within the study period although the water supply capacity is not required until post-2051. This points to the need to look beyond 30 years to better understand potential future requirements to determine when preliminary work must take place in preparation for the following years.

The presented costs include capital expenditures required to develop the identified water supplies and estimated operating costs associated with each constructed facility (i.e., materials, power, labour, maintenance, etc.). There are additional costs that the City must plan for in order to implement the projects identified in this plan, such as:

- Project management and coordination costs. It is estimated that the current City water supply projects can be implemented by two full time project managers; however, as the water supply system grows and the number of projects in various stages of development increase, up to four full time employees could be required.
- Regular model upgrades. Each of the identified projects will include a modelling component as part of the impact analysis. The model will require regular upgrades to incorporate new information collected in the field for each project and City-wide updates on a regular basis to calibrate to the updated regional dataset. It is estimated that the City-wide updates could cost approximately $500,000, commencing in 2023 and being completed on an approximate five year cycle.

8.4 Recommendations

The WSMP Update has been completed according to the Municipal Class EA process and the WSMP Update Report can be used as a plan to implement the preferred solutions to address the anticipated water supply deficit to 2051. As part of this project the following recommendations have been developed.

8.4.1 Individual Project Implementation

Detailed descriptions of the individual projects are included as project sheets within **Appendix G**. These project sheets provide a summary of the required investigations, Class EA Schedule, other approvals, and infrastructure needs in order to implement each. Also indicated are the total estimated costs for each major phase of implementation taken from the cost summaries provided in Section 5, with the estimated timing for each determined through the above analysis based on the blended water conservation, efficiency and demand management programming scenario.

8.5 General Program Recommendations

1. The City of Guelph relies on groundwater sources for its drinking water. The investigations completed as part of this WSMP Update and other studies have indicated that the water supply sources proposed in this plan are sustainable under the current conditions and sufficient groundwater is available to meet the proposed growth targets proposed by the Provincial Places to Grow. However, the groundwater supply is finite, and Guelph may reach a limit in the future whereby additional groundwater extraction may be unsustainable. Future growth outside of Guelph may also affect the available water supply. As a result, as each new supply source is developed, it is recommended that the total water budget be re-evaluated as compared to the conditions at the time of assessment to ensure that additional groundwater extraction does not result in adverse environmental or well interference impacts.

2. Sustainable groundwater supplies will require careful monitoring of surface waters and wetlands as these ecosystems are the most

sensitive to increasing groundwater extraction. As each new water supply project is developed, it is recommended that additional monitoring programs be put in place to monitor for potential environmental effects to adapt the water takings to mitigate impacts, if necessary. Since water taking effects may extend outside of the City, collaboration with the GRCA and the Townships may be required to implement programs outside of the City.

3. Groundwater modelling is recommended as an important tool to assess potential cumulative effects and environmental impacts. It is recommended that the City's groundwater flow model be continuously updated and maintained for application in the various WSMP projects.

4. A basic premise of the WSMP Update is that the existing supply system is protected, and the City does not lose supply through contamination events or as a result of other non-municipal water takings. Therefore, it is important that the City enhance/maintain its source protection programs, particularly with respect to contaminated sites and to support, and in some cases, sponsor source protection programs outside of the City to provide equal protections. In addition, it is recommended that the preferred solution (i.e., future drinking water sources) in this WSMP Update be incorporated into the City's Source Protection Program for protection of water quantity of existing and future drinking sources as required by the purpose of the Clean Water Act and the objective of the Source Protection Plan.

5. In comparison to the 2014 WSMP Update, capital and unit costs for the development of new groundwater supplies have increased. This is primarily due to the addition of treatment costs, particularly for new sources on the east side of the City that have been known to required iron and manganese treatment. Pandemic-related, supply-chain issues have been identified in developing cost estimates but there is uncertainty if some of the increased material and service costs will persist into the future. With Guelph City Council's direction of growth paying for the cost of growth, it is recommended that cost estimates in the WSMP Update be updated as part of Class EA projects once additional design details are available and with each subsequent WSMP Update (approximately every five years in frequency).

6. The Master Plan approach within the Municipal Class EA process addresses Phase 1: Identify and describe the problems and opportunities to be addressed; and Phase 2: Identify and evaluate alternative solutions and establish the preferred solution(s). Subsequent projects will address the remaining phases of the Class EA process. It is recommended, as part of feasibility studies or the Class EA process, that each potential new source of water supply require additional field work and environmental impact assessments, particularly with respect to water budget and sustainability issues.

7. Through the WSMP Community Engagement Plan, the Project Team heard concerns from adjacent municipalities on source protection and land use constraints as well as potential impacts to domestic wells from well interference. While some concerns, such as well interference, can be addressed with technical/operational measures (i.e., lowering of well pumps, deepening of wells), land use and water rights concerns associated with municipal growth are more difficult to address. It is recommended that future programs have a focus on enhanced engagement and development of intergovernmental relations with the goal to promote more regional water resources management, to support water supply needs for all affected municipalities and to address attendant environmental effects with the support of provincial agencies (i.e., Ministry of the Environment, Conservation and Parks) to meet provincial growth targets.

8. The recommendations provided in **Table 4-3** should be implemented in order to maintain and optimize the existing water supply sources.

9. The City should continue its existing raw water quality sampling program at each active water supply source.

10. It is recommended that the City build on the existing DWQMS process by developing a risk management plan that includes mitigation and response strategies. This will include current risks to the existing groundwater-based system and may be expanded upon to include additional risks relevant to future water supplies, whether groundwater or surface water based.

11. The future incorporation of the Edinburgh and Admiral wells into the water supply system should be reviewed through the Southwest Guelph Water Supply EA and the associated OTP.

12. The results presented for the Clythe Well should be considered preliminary and further evaluated along with future field data, such as that associated with on-going City investigations designed to build on the understanding of the potential for interaction between the well and natural environment.

13. As additional productivity from the Arkell site provides the City with flexibility in terms of how the overall system is managed and could contribute to a future ASR system, it is recommended that upgrades to the artificial recharge system be pursued.

14. Further development of the Arkell ASR alternative should consider the possibility of using excess flows from the collector(s) during period of high seasonal flow to service customer demands while 'resting' wells within the system (i.e., extended period with well off-line). This strategy may require flexibility within the City's PTTW to reflect variable maximum pumping rates throughout the year. Further, testing would be required to determine whether a strategy of resting wells would realize sufficient water level recovery to impact the maximum rate that a given well could operate at.

15. The feasibility of both the Arkell and Guelph Lake ASR alternatives should be further developed, and this process should include an optimization study to evaluate the placement of ASR wells that best utilize the existing municipal supply wells to efficiently recover injected water.

8.5.1 Water Supply Planning Recommendations

The estimated water supply demand in any given future year is based on the projected residential population and employment numbers for that year multiplied by design values for unit consumption. Actual demand averaged over time generally follows a similar linear trend. In reality, however, required water supply capacity is subject to planning applications for developments which may require commitment of a large volume at one time regardless of the timeline for construction or when the demand will be

realized, and proposals from industries which may require a large volume in a short period of time. These planning obligations present challenges for infrastructure planning as they can result in expediting water supply projects and the associated budgets to bring water supply on-line prior to when it is actually needed, or conversely use up available capacity on an accelerated schedule that was intended for future growth. This can be partially addressed by including a conservative trigger for bringing on-line new supply capacity (e.g., at demand/supply of 90%). However, optimizing the schedule for water supply capacity planning may also be addressed through appropriate planning policies that ensure the City has suitable lead-time and budgets in place for required water supplies. As such, it is recommended that the City continue to review on an annual basis, its planning and approvals process for managing allocation of water supply capacity.

Future City policies addressing water supply will address these challenges as follows:

- Build on the current process and guidelines for review of applications from new large volume users (e.g., industry), which considers a balance of employment and water use. Future projections are based on allocated amounts dedicated to the residential and ICI sectors, where the volume for ICI relates to a specified employment number. If high volume water users are not coupled with high employment, water demand projections will need to be revisited to establish a revised schedule for new water supply without jeopardizing the needs of planned growth.
- Investigate more robust policies for supply capacity allocation for both new and existing customers that take into account the relatively large capital expenses and lengthy timelines required to fully commission new water supply facilities. These policies would ensure maximum value to the City for supply capacity allocated to both new and existing customers.
- Complete an update of the 2016 Water Efficiency Strategy, commencing as early as 2022, based on the blended water conservation, efficiency and demand management scenarios presented through the WSMP (Scenario 5). This will include evaluation of non-potable reuse options in alignment with the City's other water-related Master Plans.

- Continue, and refine as necessary, the tracking system that closely monitors sectoral demand management (i.e., conservation and efficiency programs) and optimization successes and whether results are in-line with the forecasted demand for the preferred scenario and is achieving the goals of the Water Efficiency Strategy. Trends must be monitored with a long-term view recognizing that the effect of some direct programs may be more immediate, resulting in short-term deviations from the forecast.
- Consider time limits on development commitments such that water capacity is not 'held' for long periods of time. Review possible mechanisms to synchronize approvals of significant capacity increases with the proposed timing of new supplies in accordance with the master planning schedule.
- Assess the Development Charges planning process for the ability to provide flexibility in funding in relation to COVID cost increases.
- Review land acquisition requirements for all projects, both short- and long-term, to ensure future flexibility when implementing alternatives. Consider delegation of authority to staff to execute strategic land procurement requirements for future water supply provided property values fall within 20% of study estimates, subject to the approval of the DCAO and City solicitor.

8.5.2 Supply Capacity Management Recommendations

The supply capacity in any given year is dependent on the existing water supply system to deliver the optimal capacity from each of the municipal wells or collector system. Maintaining the system for optimal capacity requires regular reviews of system capacity and consideration of potential threats in quantity and quality. The City's Source Protection Program under the Clean Water Act is designed to protect and improve the quality and quantity aspects of the existing water supply system. The following are recommendations to maintain the water supply capacity:

- Water Services should conduct annual reviews of each component of the water supply system to determine the supply capacity and to identify any changes in the capacity from previous years or any constraints in delivering the optimal supply capacity.

- Based on the annual reviews of water supply capacity, Water Services should develop programs and implement maintenance and upgrades to the water supply system so that the system can deliver its optimal supply capacity.
- To protect water quantity and to mitigate potential impacts on quantity from other water takings, the City should consider implementing a municipal by-law to prohibit new private groundwater supply wells in the City as well as other areas where municipal water services are present.

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