NORFOLK COUNTY

WATER SUPPLY OPERATIONAL STRATEGY

INTER-URBAN WATER SUPPLY

JANUARY 28, 2021

WATER SUPPLY OPERATIONAL STRATEGY

INTER-URBAN WATER SUPPLY

NORFOLK COUNTY

VERSION 1.2

PROJECT NO.: 181-09161-00
CLIENT REF:PW-E-17-78
DATE: JANUARY 28, 2021

WSP
100 COMMERCE VALLEY DRIVE WEST
THORNHILL, ON, CANADA L3T 0A1

WSP.COM

January 28, 2021

Jason Godby
General Manager, Public Works
Public Works Division, Norfolk County
183 Main Street of Delhi,
Delhi, ON
N4B 2M3

Subject: Inter-Urban Water Supply - Water Supply Operational Strategy Report (FINAL)

Client ref.: PW-E-17-78

Dear Jason:

We are pleased to provide you with the Water Supply Operational Strategy Report (Final Report) as part of the overall Inter-Urban Water Supply study for servicing Norfolk County. This version of the report has incorporated comments and feedback received from review of the Draft report by the County.

Should you have any questions please do not hesitate to contact the undersigned.

Yours sincerely,

Mazahir Alidina, Ph.D., P.Eng,
PMP
Project Manager

cc: RW, MA
WSP ref.: 181-09161-00

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EXECUTIVE SUMMARY

Norfolk County is a single-tier municipality that provides municipal drinking water to the following communities:

- Port Dover
- Simcoe
- Waterford
- Delhi and Courtland
- Port Rowan and St. Williams

These communities all have independent water supplies, except for Courtland and St. Williams which are supplied via transmission mains from Delhi and Port Rowan, respectively. Simcoe, Delhi, and Waterford have groundwater supplies, whereas Port Dover and Port Rowan are serviced by Lake Erie.

In 2016, the County finalized its Integrated Sustainable Master Plan (ISMP) study, which was initiated to address long-term planning for essential community services including potable water strategies to facilitate growth to 2041. The ISMP considered an inter-urban water supply (IUWS) system, wherein all communities would be interconnected. This option was not recommended at the time due to cost. However, given the projected growth and existing constraints in each community, the County has decided to re-evaluate the IUWS option. The purpose of this project is to identify water quantity and quality issues, develop alternatives to mitigate these issues, and provide recommendations on next steps to provide the County with a secure, inter-urban water supply servicing strategy.

EXISTING INFRASTRUCTURE AND SYSTEM DEFICIENCIES

A summary of the supply surplus/deficiency of each system under maximum day demand (MDD) conditions is shown in Table E- 1. Installed capacity refers to the nominal rated capacity per the Drinking Water Works Permit (DWWP), which in some cases, is lower than the rated capacity of the Permit To Take Water (PTTW). For groundwater systems, 'installed capacity' is the sum of DWWP rated capacity of all groundwater wells. Operational capacity refers to typical operating capacities provided by the County staff.

Firm capacity of a water treatment plant (WTP) is calculated as the capacity of the plant with the largest unit of a single process out of service (excluding clarification units). For groundwater systems, the firm capacity is calculated as the sum of operational capacities with the largest well out of service. The firm capacity of a community's system should be equal to or greater than the community's projected MDD. The projected MDD is a reflection of anticipated population increase, or development.

Note that capacities in Table E- 1 refer to the volume that a system is *capable* of producing, not the volume that a system *needs* to produce. That is, capacity is independent of demand and may not match historic water production data.

PORT DOVER – HIGH-HIGH RISK

Port Dover is supplied by the Port Dover Water Treatment Plant (PDWTP) and has one (1) elevated tank. Port Dover was assigned the highest risk rating of all communities as it does not have sufficient firm (2,500 m^3/d) nor installed capacity (5,000 m^3/d) to meet current max day demands (5,700 m^3/d). This is a result of limitations in unit processes, disinfection issues, and insufficient high lift pumping capacities. Currently, the MDD is met by drawing down the Port Dover elevated tank using the emergency supply. The elevated tank also cannot be taken offline as it provides the backwash water for the Port Dover filters. Due to water supply challenges, Norfolk Council has implemented a "development freeze" in Port Dover as of September 2019.

Previously, it was identified that the highest risk was associated with PDWTP's single old clarifier that was expected to reach end of service life by 2022. WSP began a project to replace the clarifier with dissolved air flotation units (DAFs) in 2020 with construction anticipated to begin in 2021. This will allow the

clarification capacity to meet the projected 2041 MDD, however, the WTP will still be limited by the high lift pumping capacity. Additionally, the County has experienced structural challenges with the existing media filters. The estimated 2041 MDD deficiency is 4,800 m^3/d.

SIMCOE – HIGH RISK

Simcoe is supplied by multiple groundwater wells which generally cannot operate at rated capacity due to water quality concerns, low water levels, aging infrastructure, and operational complexities. Several wells are at risk of contamination from agricultural activities or high iron levels, and some have already been taken out of service for water quality reasons. Efforts to find new groundwater supplies have generally been unsuccessful, and Simcoe is at a high risk of having insufficient water supply. At the time of writing, the County was in the process of conducting 7-day pump testing on new test wells drilled in the north-east of Simcoe, but production yields had not yet been confirmed.

Simcoe currently has sufficient firm supply capacity to meet its average day demand (ADD). However, during maximum day demand (MDD) situations, the County is required to draw into the emergency supply in the Simcoe storage reservoir to meet its demands. In 2020, Simcoe has a firm capacity of 7,200 m^3/d, with an MDD supply deficiency of 1,000 m^3/d. It is assumed that all wells which are at risk or subject to operational concerns will be removed from service by the end of 2022. This will reduce Simcoe's firm capacity to 3,700 m^3/d in 2023. Using the 2023 firm capacity as the base value, Simcoe is projected to have a production deficiency of 5,400 m^3/d by 2041.

WATERFORD – MEDIUM-HIGH RISK

Waterford is supplied by two (2) groundwater wells that draw from the same GUDI (groundwater under influence of surface water) aquifer. The wells are located close together, and there is a risk that surface runoff may result in contamination of both wells. This would reduce Waterford's supply capacity to zero. Currently, Waterford has a firm capacity of 2,000 m^3/d and supply surplus of 200 m^3/d. The system is projected to have a deficiency of 200 m^3/d in 2041.

DELHI & COURTLAND – LOW RISK

The Delhi/Courtland system is considered to be at low-risk. This system currently has four (4) operational groundwater wells, two (2) of which were commissioned in 2020, and one surface water treatment plant (Delhi Surface WTP). The Delhi Surface WTP will be decommissioned in the near future due to water quality concerns, mechanical challenges, and age of infrastructure. However, the Delhi system will have a supply surplus in both 2020 (1,500 m^3/d) and 2041 (1,400 m^3/d) with all four (4) groundwater wells operational.

There are two (2) transmission mains that connect the groundwater wells to the Delhi distribution system, but only one (1) transmission main supplying Courtland from Delhi. Failure of this transmission main would put Courtland's supply at risk, however, the ISMP did not recommend twinning this transmission main as there is sufficient storage in Courtland.

PORT ROWAN & ST. WILLIAMS – MEDIUM RISK

Port Rowan and St. Williams are both supplied by the Port Rowan WTP which is sourced from Lake Erie. Based on the DWWP, the Port Rowan WTP has a firm capacity of 1,633 m^3/d (rounded to 1,700 m^3/d) and a rated capacity of 3,040 m^3/d. The plant's production capacity is limited by its shallow intake and several treatment related factors. High turbidity levels resulting from changes in lake levels causes the filters to plug faster and the filters require multiple backwashes each day. The ISMP also noted that algae blooms have caused issues for the plant and limits its capacity. If these issues are resolved and the plant can operate at its DWWP rated capacity of 3,040 m^3/d, the Port Rowan & St Williams system will not have any deficiencies in 2041. For the purposes of this study, Port Rowan is assumed to have a deficiency of 600 m^3/d in 2041 and is rated medium risk. The St. Williams community is supplied by a single transmission main from Port Rowan. Failure of this transmission main would result in loss of supply to the St. Williams community. The County recently inspected the watermain and is working on replacing a portion of the main in Port Rowan, with plans to replace and upsize the remainder of the main in the future.

Table E- 1 Water Supply Deficiencies

HORIZON BASE YEAR 2020 2020 2041

Communities	Capacity			Demands	Surplus or (Deficiency)[1]	Demands	Surplus or (Deficiency)[5]	Concerns / Issues	Risk
Unit: m3/d	**Installed**	**Operational**	**Firm**	**MDD**		**MDD**			
Simcoe	17,000	9,900	7,200 (3,700 in Year 2023)[2]	8,200	(1,000)	9,100	(5,400)[2]	Groundwater/aquifers are at risk of contamination and/or operational difficulties. Some wells have already been taken out of service to ensure water quality and safety. Existing wells have limited capacity. Historically, the County has been unsuccessful in finding additional groundwater supplies. There is also potential for significant demand increase in Simcoe.	**High**
Port Dover	5,000	5,000	2,500[3]	5,700	(3,200)	7,300	(4,800)[3]	Port Dover WTP operates below rated capacity (2.5 MLD vs 7.5 MLD) due to limitations in unit process capacity and disinfection issues. Backwash water is provided by the elevated tank. If the elevated tank is shut down, Port Dover system capacity would also drop to zero. There have also been structural challenges with the existing filters. Development Freeze - in effect as of 2019.	**High-High**
Waterford	5,875	3,900	2,000	1,800	200	2,200	(200)	Both wells draw from one aquifer which is at risk of contamination from surface runoff. If aquifer becomes contaminated, Waterford supply capacity would be zero. There is also potential for significant demand increase in Waterford.	**Medium-High**
Delhi & Courtland	7,900	6,800[4]	4,500[4]	3,000	1,500	3,100	1,400	Existing Delhi Surface WTP to be decommissioned.	**Low**
Port Rowan & St. Williams	3,300	3,300	1,700	1,800	(100)	2,300	(600)	Shallow intake impacts WTP performance and limits its capacity. Algae is also a growing concern.	**Medium**
Total	**39,075**	**28,900**	**17,900**	**20,500**	**(2,600)**	**24,000**	**(12,100)**	**County-wide system does not meet current or future demands.**	

1 Although deficiency in supply has been identified in Simcoe, Port Dover & Port Rowan based on MDD, it is important to note that for those days the County is required to draw from the available storage facilities. However, in case of a fire incident, or watermain break on the same day, the community would be at risk of not having sufficient water supply (as described above).
2 It is assumed that by 2023, only Cedar Street Wells 3,4,5 and Northwest Wells 2 and 3 will remain in service. Firm capacity is calculated as the sum of the operational capacities of the aforementioned wells minus Northwest Well 3 (this well has the largest operational capacity). The other wells (Chapel Street, Cedar Street Infiltration Gallery, Cedar Street Well 2A) are assumed to be removed from service as these wells have historically had water quality, mechanical, and/or water level challenges and there is concern that these wells are at risk of future contamination and/or operational difficulties.
3 Port Dover's firm capacity is limited by its disinfection and high lift pumping capacity.
4 Operating capacities of Delhi Wells 3A and 3B were assumed to be the same as rated capacity as these had just been commissioned at the time of writing. The firm capacity is calculated as the operational capacities of all four (4) wells minus the capacity of Well 3B.
5 Surplus (Deficiency) = Firm Capacity in 2020 – MDD in 2041. Numbers shown in parentheses represent deficiency in supply. With respect to Port Dover & Simcoe, their firm capacity in 2023 was used.

PROPOSED SERVICING ALTERNATIVES

Servicing alternatives were developed in three (3) major groups. Alternative 1 variations involve Norfolk County providing its own supply through lake based systems. Alternative 2 variations involve purchasing water from Haldimand County, located immediately to the east of Norfolk County. Haldimand County owns and operates the Nanticoke WTP, which is a Lake Erie based WTP currently rated at 13,636 m^3/d. The Nanticoke WTP can potentially expand to a maximum firm capacity of 43,000 m^3/d and supply Norfolk County in addition to Haldimand County. Alternative 3 considered purchasing water from Elgin County, located to the west of Norfolk County. However, purchasing water from Elgin County is cost prohibitive due to transmission main lengths and this option was not considered further.

The key assumptions made in development of alternatives are shown below.

Norfolk Capacity

- Simcoe's firm capacity will decrease to 3,700 m^3/d in 2023 because groundwater sources at risk or subject to water quality concerns, low water levels, or low reliability are assumed to be taken offline. This includes the Cedar Street Infiltration Gallery, Cedar Street Well No. 1A and 2A, and the Chapel Street Well.

Nanticoke WTP Capacity

- The Nanticoke WTP in Haldimand County has a rated capacity 13,636 m^3/d.
- Upgrades at Nanticoke WTP are expected to provide a maximum possible firm capacity of 43,000m^3/d.
- Haldimand County indicated that its projected 2041 MDD is 22,000 m^3/d, which includes 20,000 m^3/d for Haldimand proper (Jarvis, Hagersville, Caledonia, Cayuga and the Lake Erie Industrial Park) and a new 2,000 m^3/d connection to Six Nations. The timeline for the new connection and annual projected demand increases were not provided.
- The Nanticoke WTP can supply 2,800 m^3/d to Norfolk County from 2021 until upgrades are completed at the Nanticoke WTP (estimate 2028).

Cost

- The level of cost estimate: Rough Order of Magnitude (ROM).
- Costs of water quality and corrosion control studies were not included as they should be performed for all alternatives. These studies are estimated to be in the range of $20,000 each.
- The ISMP recommends $9M in Storage Upgrades and $6 in Local Distribution System upgrades (2016 dollars). It is assumed these upgrades must be performed regardless of whether the County chooses to proceed with an interurban system. Therefore, these costs ($15M in 2016 dollars, or about $17M in 2020 dollars total) have not been included in the cost estimate for this study.
- Distribution system related operating costs (flushing, sampling etc.) are not included as they will be required regardless of alternative selected.
- Based on the rate study conducted by Watson, Norfolk County will pay for 72% of capital costs associated with Nanticoke WTP expansion, and 100% of costs associated with transmission mains and booster stations associated with bringing water from Nanticoke to Norfolk County (including infrastructure located within Haldimand County borders).
- Based on the Watson report, the total estimated cost for Nanticoke WTP upgrades to maximum capacity (43 MLD) is $20.25M, including contingency and engineering (20% each). Norfolk County will pay $14.58M capital costs and Haldimand County will pay the remainder.

- Based on the Watson rate study, Norfolk County is estimated to pay:
  - $1.74 per cubic meter of treated water prior to Nanticoke WTP upgrades (i.e. when Haldimand County provides 2,800 m3/d to Norfolk County). This includes $1.52 per cubic meter paid to Haldimand (purchase rate) plus $0.22 per cubic metre debt payment.
  - $1.99 per cubic meter of treated water after Nanticoke WTP undergoes upgrades (i.e. when Haldimand County provides 21,600 m3/d to Norfolk County. This includes $1.64 per cubic meter paid to Haldimand (purchase rate) plus $0.35 per cubic metre debt payment.
  - The debt payment includes the capital costs for Nanticoke WTP upgrades and transmission mains located within Haldimand County borders, thus the capital costs of these items have not been accounted for separately. Debt payments are calculated over a 20-year term at 3% interest.
- Operational (treatment) costs:
  - Port Dover WTP: $0.60/$m^3$. This was calculated by dividing Port Dover's annual Operations Cost (2017- 2019) by Port Dover WTP's firm capacity of 2,500 m^3/d. This was also verified by performing the same calculation using 2017 – 2019 production data, which resulted in costs approximately $0.55 to $0.60 per cubic metre treated water.
  - Port Rowan WTP: Assumed same as Port Dover
  - Groundwater Wells: 0.45/m^3 (based on similar projects)

An initial evaluation was undertaken to determine alternatives that warranted further analysis. The following alternatives were rejected as they were technically or financially infeasible, or do not provide inter-urban connection which is one of the key objectives of this study:

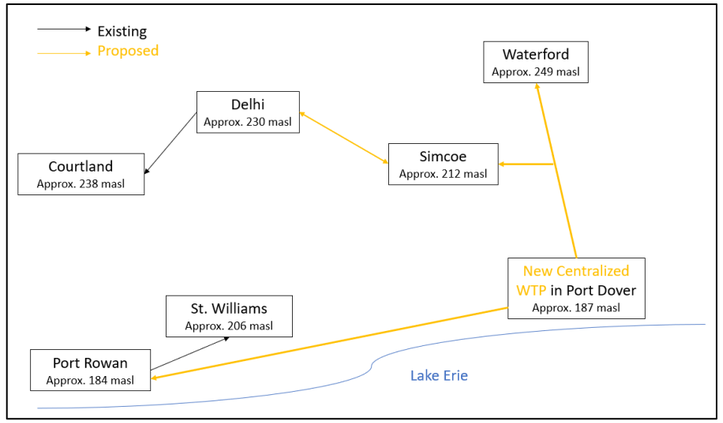
- → Alternative 1.0: Conduct local upgrades
- → Alternative 2.0: Purchase raw water from Haldimand County
- → Alternative 2.5: Supply entire Norfolk County from Haldimand County
- → Alternative 3 variations: Supply from Elgin County

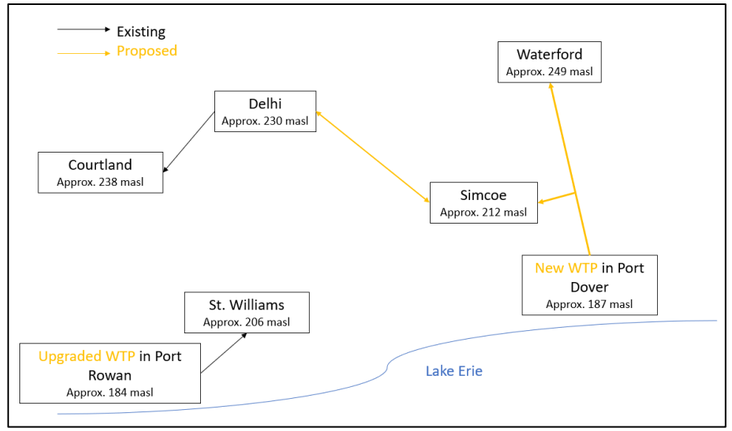
The shortlisted alternatives are shown in Table E- 2. CAPEX NPV refers to the net present value of the capital costs over a period of 21 years (2020 – 2041), and OPEX NPV refers to the net present value of operating costs over 21 years.

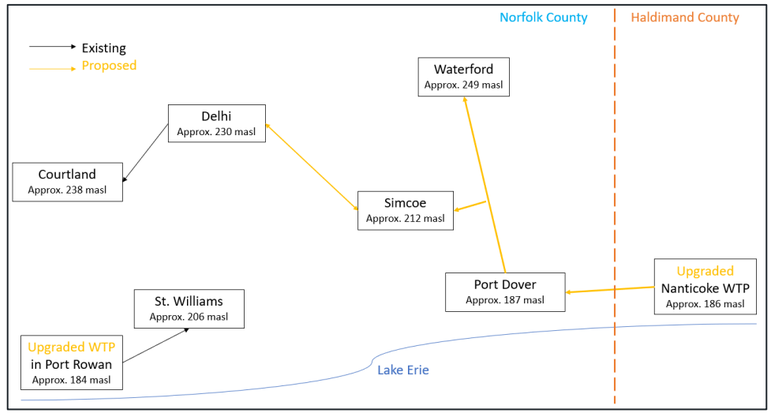
All alternatives involve supplementing Simcoe from Delhi in the short term, which will require Simcoe to use a blended water supply. Blending can change chemical equilibrium and introduce water quality challenges, although blending sources of the same type (ex. groundwater with groundwater) is generally less likely to introduce water quality challenges than blending sources of different types (ex. groundwater with surface water). For this reason, WSP typically recommends avoiding blending where possible, particularly if treated water is blended in the distribution system pipes as this reduces the operator's control over water quality. However, because Simcoe currently has a supply deficit (based on firm capacity) and there is a potential for significant demand increase, supplementing Simcoe from Delhi can be done as a short term solution until the permanent solution is implemented. Further, because both communities use groundwater and cursory review indicates that similar treatment processes are employed at groundwater wells of both communities, WSP anticipates limited water quality challenges when supplementing Delhi with Simcoe. However, the County is still recommended to undertake a water quality study before introducing a new source into the Simcoe system.

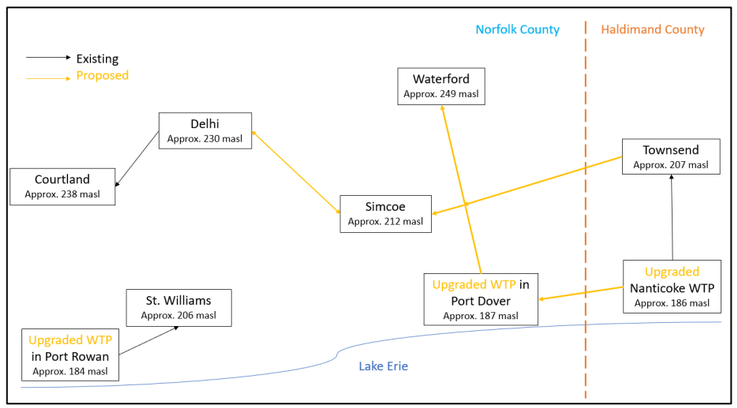
Table E- 2 Description of Proposed Alternatives

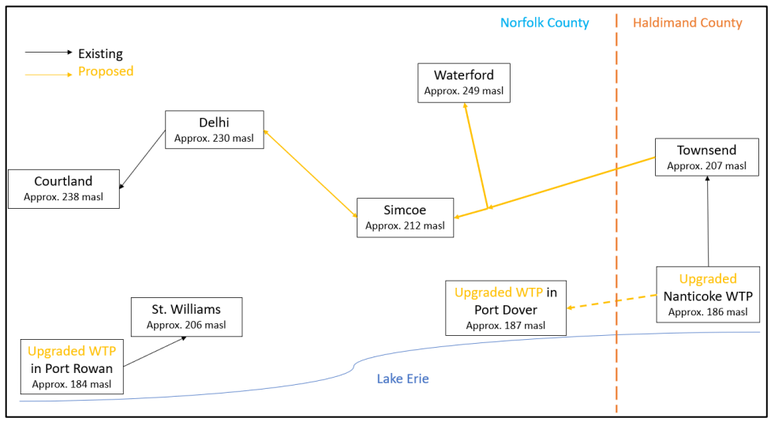
ALTERNATIVE	DESCRIPTION	HIGH LEVEL SCHEMATIC	CAPITAL COST	CAPEX NPV	OPEX NPV	TOTAL NPV

ALTERNATIVE 1.2
Centralized WTP
	• Construct new 24 MLD WTP (including new intake) in Port Dover to supply the entire Norfolk County's 2041 MDD
	• Construct new interconnection from Delhi to Simcoe to provide supplementary supply, as Delhi currently has surplus capacity.Decommission all existing groundwater wells and surface WTPs
	• Supply Simcoe using only surface water once Centralized WTP is complete.
	• Inter-connect all communities
	• Estimated timeline:
	  • 2025: Simcoe supplemented by Delhi
	  • 2027: Completion of Centralized WTP
	  • 2028: Port Dover and Simcoe supplied by Centralized WTP
	  • 2030: Waterford supplied by Centralized WTP
			$129,356,000	$120,750,000	$75,890,000	**$196,640,000**

ALTERNATIVE 1.3
Two lake based WTP
	• Construct new 21 MLD WTP (including new intake) in Port Dover to supply all communities except Port Rowan and St Williams.
	• Construct new interconnection from Delhi to Simcoe to provide supplementary supply, as Delhi currently has surplus capacity.Decommission all existing groundwater wells and surface WTPs
	• Supply Simcoe using only surface water once Centralized WTP is complete.
	• Upgrade Port Rowan WTP including treatment process upgrades and constructing a new intake.
	• Decommission all existing groundwater wells and existing Port Dover WTP.
	• Inter-connect all communities except Port Rowan and St. Williams
	• Estimated timeline:
	  • 2025: Simcoe supplemented by Delhi
	  • 2027: Port Rowan WTP upgrades, construction of new Port Dover WTP complete
	  • 2028: Port Dover and Simcoe fully supplied by new Port Dover WTP
	  • 2030: Waterford supplied by new Port Dover WTP
			$109,680,000	$104,150,000	$75,890,000	**$180,030,000**

ALTERNATIVE 2.2
Supply from Nanticoke with one Connection (Port Dover)
	• Purchase treated water from Nanticoke WTP
	• Upgrade Nanticoke WTP (to 43 MLD) to service Port Dover, Simcoe, Waterford.
	• Construct new interconnection from Nanticoke WTP to Port Dover. This connection can be constructed prior to Nanticoke upgrades as Nanticoke currently has surplus capacity that can be used immediately by Port Dover.
	• Construct new interconnection from Delhi to Simcoe to provide supplementary supply, as Delhi currently has surplus capacity.
	• Construct new interconnections from Port Dover to Simcoe, Waterford and Delhi. These communities will also be supplied by Nanticoke WTP through the connection with Port Dover.
	• Decommission groundwater wells in Simcoe and Waterford. Supply Simcoe using only surface water.
	• Upgrade Port Rowan WTP including treatment process upgrades and constructing a new intake.
	• Estimated timeline:
	  • 2025: Port Dover supplemented by Nanticoke WTP, Simcoe supplemented by Delhi
	  • 2027: Port Rowan WTP and Nanticoke WTP upgrades complete
	  • 2028: Port Dover and Simcoe fully supplied by Nanticoke WTP
	  • 2031: Waterford fully supplied by Nanticoke WTP
			$78,890,189	$73,460,000	$163,030,000	**$236,480,000**

ALTERNATIVE 2.3
Supply from Nanticoke with two Connections (Port Dover and Simcoe)
	• Purchase treated water from Nanticoke WTP
	• Upgrade Nanticoke WTP (to 43 MLD) to service Port Dover, Simcoe, Waterford.
	• Construct new interconnection from Nanticoke WTP to Port Dover and from Nanticoke WTP to Simcoe through Townsend. The Port Dover connection should be built first as Nanticoke WTP currently has surplus capacity that can be used immediately by Port Dover.
	• Construct new interconnection from Delhi to Simcoe to provide supplementary supply, as Delhi currently has surplus capacity.
	• Construct interconnection from Simcoe to Waterford. These communities will also be supplied by Nanticoke WTP.
	• Decommission groundwater wells in Simcoe and Waterford. Supply Simcoe using only surface water.
	• Upgrade Port Rowan WTP including treatment process upgrades and constructing a new intake. Upgrade Port Rowan WTP including treatment process upgrades and constructing a new intake.
	• Estimated timeline:
	  • 2025: Simcoe supplemented by Nanticoke WTP
	  • 2027: Port Rowan WTP and Nanticoke WTP upgrades complete
	  • 2028: Port Dover, Waterford, Simcoe fully supplied by Nanticoke WTP
			$69,690,189	$66,250,000	$166,020,000	**$232,270,000**

ALTERNATIVE 2.4
 	
Upgrade Port Dover WTP, two connections to Nanticoke
	• Upgrade Port Dover WTP to 7.3 MLD (local 2041 MDD)
	• Upgrade Nanticoke WTP to 43 MLD to supply Simcoe, Waterford, and Port Dover in the future.
	• Construct new interconnection from Nanticoke WTP to Simcoe through Townsend and from Delhi to Simcoe. Simcoe can receive supplementary supply from both these sources in the short term.
	• Construct interconnection from Simcoe to Waterford. These communities will also be supplied by Nanticoke WTP. Decommission groundwater wells in Simcoe and Waterford.
	• Construct a second connection from Nanticoke WTP to Port Dover. This connection would provide Port Dover and interurban system additional redundancy. This connection was included in the cost estimate but is not a high priority as Port Dover will be self sufficient.
	• Decommission groundwater wells in Simcoe and Waterford. Supply Simcoe using only surface water.
	• Upgrade Port Rowan WTP including treatment process upgrades and constructing a new intake. .
	• Estimated timeline:
	  • 2025: Simcoe supplemented by Nanticoke WTP and Delhi wells
	  • 2026: Port Dover WTP upgrades complete
	  • 2027: Port Rowan WTP and Nanticoke WTP upgrades complete
	  • 2028: Simcoe and Waterford fully supplied by Nanticoke WTP
			$81,150,189	$76,950,000	$169,490,000	**$246,440,000**

RISK ANALYSIS

A risk analysis was conducted to determine potential risks that could impact the success and viability of each shortlisted alternative. Risk categories included financial, environmental, public health, regulatory, and social and cultural risks. Each risk item was assigned a 'likelihood' and 'severity' to determine which risks were critical, high, medium, or low. Mitigation measures were then developed to reduce the severity and/or likelihood.

For all alternatives, funding for capital costs was considered to be a major risk. If Norfolk Council does not approve required capital budget for infrastructure upgrades, water supply issues would likely continue. This risk was considered higher for alternatives with higher capital costs (Alternatives 1.2 and Alternative 1.3) than for alternatives with lower capital costs. To reduce this risk, it is recommended to increase communication with Council and stakeholders, and ensure that there is buy-in for the selected solution.

In general, Alternatives 1.2 and 1.3 have more critical risks and high risks than Alternatives 2.2 – 2.4, both before and after mitigation measures are applied. The critical and high risks of Alternatives 1.2 and 1.3 primarily stem from construction of a new intake and water treatment plant in Port Dover. In particular, siting a new intake in Lake Erie can be difficult as the Lake is relatively shallow, and presence of storm water or wastewater treatment plant runoffs will limit the number of available locations. A new intake is also more prone to delays in permitting as extensive planning and consultation is required. To address these risks, the County should initiate discussions with appropriate regulating authorities and Council early on, and keep them involved throughout the Class Environmental Assessment process. If these risks are not addressed, project implementation may be delayed. Because both these alternatives involve greenfield construction, there is no opportunity for phasing and communities would need to rely on existing supplies until construction of the new WTP is completed. It should be noted here that a new intake in Port Rowan WTP is also recommended for Alternatives 1.3, and Alternatives 2.2 – 2.4. However, there is an option to deepen the existing Port Rowan intake and/or upgrade treatment processes to allow the Port Rowan WTP to be more resilient to poor raw water quality if construction of a new intake is not feasible. Additionally, Port Rowan WTP would only impact two communities, thus the risks associated with a new Port Rowan intake are considered to be lower than with a new Port Dover intake.

The other risks of Alternatives 2.2 – 2.4 relate to the jurisdiction of facilities and the potential increase in water rates with time. Jurisdiction would impact the division of costs for future capital upgrades. Additionally, the purchased water rate was found to be the most sensitive factor in the total NPV of Alternatives 2.2 – 2.4. If the purchased water rate increases, the operating cost for Norfolk County would increase as well. To mitigate these risks, Norfolk County should maintain open communication with Haldimand County throughout the planning process.

Water quality was considered a risk for all shortlisted alternatives as they all involve changing groundwater systems to surface water supplies, and supplementing Simcoe from Delhi for a period. Separate water quality studies, corrosion control studies, and bench testing should be performed to determine the extent of these challenges and appropriate mitigation measures. In general, water quality challenges should be anticipated during the initial transition from groundwater to surface water. These can potentially be mitigated through increased flushing. Alternative 2.4 is anticipated to have the highest risk relating to water quality as Simcoe will be supplied by a blend of groundwater and surface water for a few years before Nanticoke WTP upgrades are complete.

EVALUATION AND RECOMMENDATION

An evaluation matrix was developed to determine how well each alternative performed against a set of pre-determined criteria. The criteria covered four (4) major categories: Natural Environment, Technical Environment, Social and Cultural Environment, and Financial Environment. In general, alternatives that had the following characteristics were preferable:

- Less impact on aquatic and terrestrial ecosystems, surface water and groundwater quality
- Less impact on archaeological features and First Nations Land

- Multiple sources of supply or multiple connections with Nanticoke WTP
- Allows Norfolk County to have good control over supply volume, including potential to expand supply capacity
- Allows Norfolk County to have good control over water quality
- Lower construction difficulty and fewer permitting requirements
- Easier to maintain and operate
- Shorter timeline to achieve MDD supply in either Port Dover or Simcoe
- Lower total 21-year NPV (capital and operating cost)

The purpose of this project is to identify a secure water servicing strategy for the entire Norfolk County. However, it is also recognized that Port Dover is in immediate need of water and that the County would like to lift the development freeze at the earliest date possible, and there is potential for significant demand increase in both Simcoe and Waterford. Following completion of the risk analysis and completion of the evaluation matrix, two (2) different preferred alternatives were recommended based depending on the County's priorities.

If timeline is the greatest concern, Alternative 2.4 would be the preferred option. This alternative involves upgrading Port Dover WTP to meet its local 2041 MDD. Simcoe would be supplemented by both Delhi and Nanticoke WTP in the short term, and would eventually be fully supplied by Nanticoke WTP. Waterford would also be supplied by Nanticoke WTP.

An additional connection from Nanticoke to Port Dover has also been included for 2029 to provide additional supply redundancy, however, it is not urgent and could be delayed to a later date.

Advantages:

- Shortest timeline to lift Port Dover development freeze
- Simcoe will receive supplementary supply from Nanticoke WTP and Delhi in the short term
- The connection from Nanticoke to Simcoe can also be rapidly utilized by Waterford
- Port Rowan WTP upgrades can occur independently of Nanticoke WTP upgrades
- Good supply security

Disadvantages:

- Most expensive option (highest total NPV)
- Most difficult operation
- Potential water quality issues in Simcoe
- Norfolk has less control over water rate, water supply capacity, and water quality
- Least preferred from a County wide perspective based on evaluation matrix

From a more balanced perspective reflected in the evaluation matrix(i.e. timeline is not the greatest concern), Alternative 2.3 would be the preferred option. This option involves supplying Port Dover, Simcoe, and Waterford from an upgraded Nanticoke WTP. Two (2) connections, one from Nanticoke to Port Dover, and one from Townsend to Simcoe, are recommended. Port Dover would be receive supplementary capacity from Nanticoke WTP in the short term. A Simcoe-Delhi connection would allow Simcoe to be supplemented by Delhi, and Simcoe would eventually be fully supplied by Nanticoke WTP. Port Rowan WTP would be upgraded independently.

Advantages:

- Avoids risks and uncertainties associated with a new intake in Port Dover
- Potential to phase infrastructure upgrades
- Good supply security
- Provides immediate/short term supplementary capacity to both Port Dover and Simcoe
- Ease of operation

Disadvantages:

- Longer timeline to lift Port Dover development freeze
- Second most expensive option
- Norfolk has less control over water rate, water supply capacity, and water quality

1 INTRODUCTION

1.1 STUDY PURPOSE

Norfolk County is a large rural, single-tier municipality that was formed in 2001 with the dissolution of the Regional Municipality of Haldimand-Norfolk. Norfolk County provides municipal drinking water to the following communities:

- Simcoe
- Port Dover
- Delhi & Courtland
- Waterford
- Port Rowan & St. Williams

Each of the above noted communities have independent water supplies, except for Courtland and St. Williams that are supplied via transmission mains from Delhi and Port Rowan, respectively. Simcoe, Delhi and Waterford have groundwater supplies, whereas Port Dover and Port Rowan are serviced by surface water (source: Lake Erie) In 2016, the County finalized its Integrated Sustainable Master Plan (ISMP) study, which was initiated to address long-term planning for essential community services including potable water strategies and facilitate the growth to 2041.

Given the existing constraints and in recognition of projected growth in each community i.e. increase in water demands, the County initiated the Inter-Urban Water Supply (IUWS) project to determine the preferred long-term approach to accommodate future development and demands, while addressing the issues with the existing system. This technical feasibility study evaluates the alternatives designed to address the water supply challenges. The ISMP data will be used as a basis to develop the alternatives for the Inter-Urban Supply Water Supply study, unless otherwise noted. Decisions made as a part of this project may identify a different long-term water solution for the County and may potentially impact the design of the Port Dover WTP (WTP) and/or Port Rowan Water Treatment Plant, their expansion, and pressure zone boundaries within the system.

1.2 STUDY APPROACH

The methodology of this study is broken into the following distinct phases:

- Review of the existing background information to determine the known and potential water quality and quantity challenges – Gap Analysis
- Develop alternatives to mitigate threats and address challenges – Long List of Alternatives
- Review of all alternatives - Development of Short-list of Alternatives
- Evaluation of short-listed alternatives based on pre-determined criteria
- Sensitivity and Cost Analysis
- Risk Analysis to identify most significant threats associated with each alternative
- Evaluation and recommendations on next steps

This approach allows a more thorough analysis of the County's existing system and understanding of the County's challenges. Upon conclusion of the study, the County can implement the recommendations to provide a secure and reliable water supply to all communities.

2 BACKGROUND

2.1 NORFOLK COUNTY

Norfolk County is located on the north shore of Lake Erie between Elgin County and Haldimand County, in southwestern Ontario. It is a single tier municipality that provides municipal drinking water to a few small communities: Simcoe, Port Dover, Delhi, Courtland, Waterford, Port Rowan, and St. Williams.

2.2 STUDY AREA

The study area is defined by the Norfolk County's municipal limits, which is shown in Figure 2-1.

2.3 REGULATORY FRAMEWORK

The regulatory framework includes various acts, regulations, guidelines and policies that govern water supply, collection and treatment, as well as the pattern of development for which these systems will be expanded to service. This regulatory framework is overseen by three main bodies: the Ontario Ministry of the Environment, Conservation and Parks (MECP), the Ontario Ministry of Natural Resources, and the Federal Government.

2.3.1 SAFE DRINKING WATER ACT, 2002

The *Safe Drinking Water Act, 2002* provides the legislative framework for municipal drinking water systems. It establishes a set of province-wide standards, rules and regulations to ensure the population has access to safe and reliable drinking water. The Act specifies requirements for drinking water systems, testing services and the certification of system operators and water quality analysts including regulatory water quality standards and mechanisms for compliance.

2.3.2 CLEAN WATER ACT, 2006

The *Clean Water Act, 2006* aims to ensure that Ontarians get access to safe drinking water through the protection of existing and future sources of drinking water. In the multi-barrier approach, protecting water at its source by preventing its contamination is the first step. The Act requires communities to assess the existing and potential threats to their water sources and take the corresponding actions to reduce or eliminate the threats. In addition, it empowers communities to take action by requiring public participation in local source protection planning, and by requiring that all plans and actions be based on sound science.

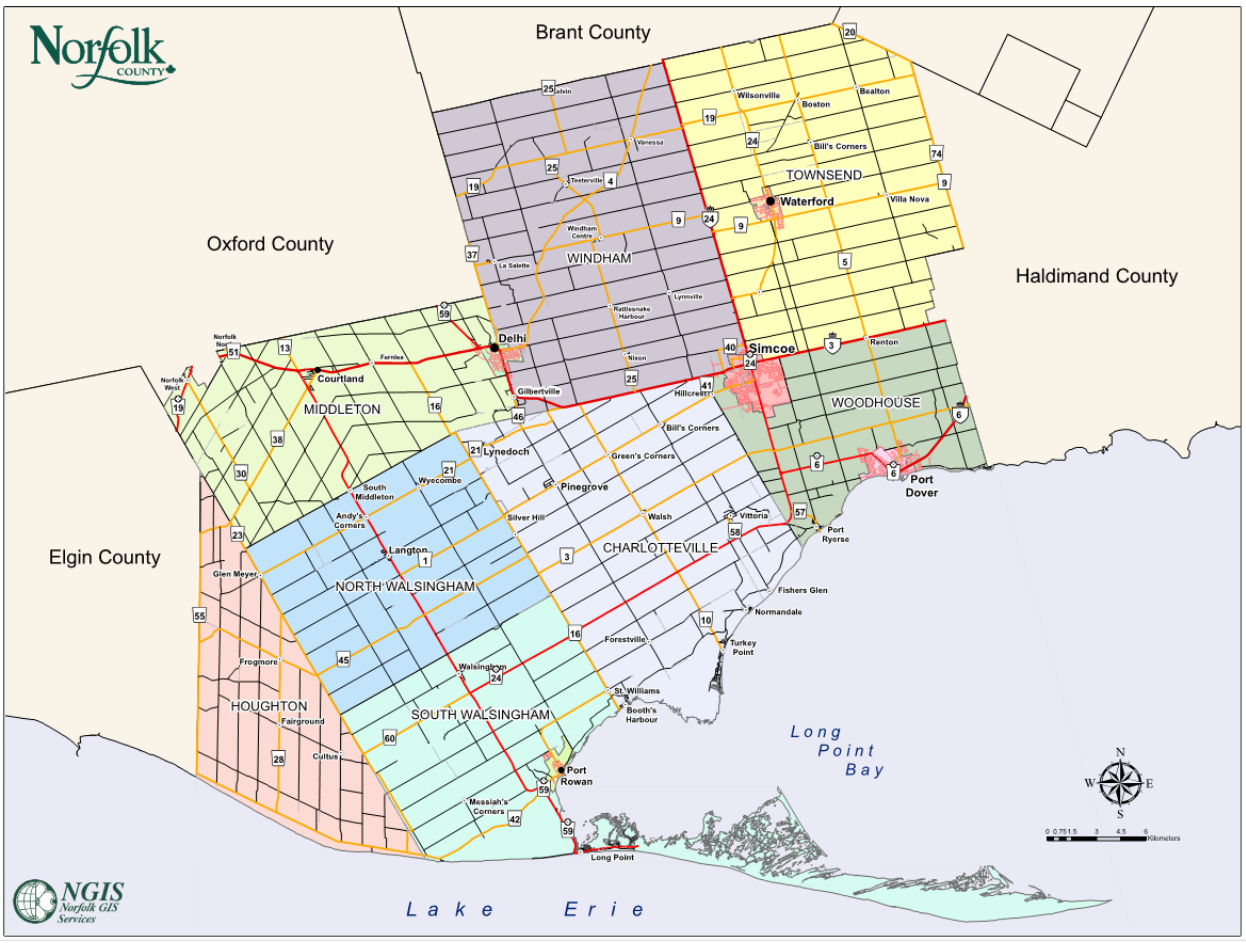


Figure 2-1 Norfolk County Study Area

2.3.3 WATER OPPORTUNITIES ACT, 2010

The *Water Opportunities Act, 2010* provides a framework for the economic development of water resources while conserving and sustaining them in the long-term. The Act seeks to foster innovative technologies, services and practices in the private and public sectors for water, wastewater, and storm water. Another key objective is the creation of opportunities for economic development and clean-technology jobs.

2.3.4 PROVINCIAL POLICY STATEMENT, 2014

The Provincial Policy Statement (PPS), 2014, is issued by the Province from time to time under the authority of Section 3 of the *Planning Act*. The PPS contains provides policy direction on matters relating to land use planning and development and applies to any land use planning decisions made under the *Planning Act* by municipal councils, local boards, planning boards, provincial ministers, provincial government and agency officials, including the Ontario Municipal Board. Municipal planning decisions are to be consistent with the policies of the PPS.

The PPS includes policies relevant to water and wastewater infrastructure planning including the requirement that infrastructure be provided in a coordinated, efficient and cost-effective manner. Additional requirements under the 2014 PPS include:

- These systems are to be sustainable, feasible, financially viable and comply with all regulatory requirements, as well as protect human health and the natural environment (PPS-Section 1.6.6.1.b)
- That water and wastewater infrastructure will be integrated at all stages of land use planning and implementing processes (PPS-Section 1.6.6.1.d)
- The 2014 PPS also states that settlement areas will be serviced by municipal water and wastewater systems, with intensification and redevelopment within these areas provided by municipal water services wherever feasible (PPS-Section 1.6.6.2).

2.4 PREVIOUS STUDIES

2.4.1 DEFINITION OF TERMS

The table below presents the definitions of the terminology used in this report.

Table 2-1 Definition of Terms

TERM	DEFINITION
Installed Capacity	For groundwater systems and pumping stations, it is the sum of all the treated water pumps' rated capacity per the DWWP. In the case of water treatment plants, the installed capacity is determined by the limiting process (low lift pumping, clarification filtration, disinfection steps, or high lift pumping). The limiting process is the one with the lowest capacity.
Operational Capacity	Sum of the operational capacity of all treated water pumps per feedback from the Norfolk County operation staff.
Firm Capacity	Installed capacity with the largest unit of a single process out of service (excluding clarification units). For groundwater sources, this was assumed to be the largest well out of service.
HLP	High lift pumps
MLD	Million Litres per Day. 1 MLD = 1000 m^3/d
ADD	Average Day Demand
MDD	Maximum Day Demand
MDD + FF	Maximum Day Demand plus Fire Flow Demand
ODWQS	Ontario Drinking Water Quality Standards
GUDI	Groundwater under the direct influence of surface water. GUDI wells are more prone to contamination compared to non-GUDI wells.

GUDIWEF	GUDI with effective in-situ filtration.
WHPA	Well head protection area, an area around a municipal well where land activities may negatively impact groundwater quality or quantity.
MECP	Ministry of Environment, Conservation and Parks
MAC	Maximum allowable concentration as stipulated by ODWQS
DNAPL	Dense non-aqueous phase liquids, chemical compounds regulated by O.Reg 287/07.
TCE	Trichloroethylene, a chemical compound regulated by ODWQS
THM	Trihalomethane, a disinfection by-product formed when chlorine reacts with organic materials
PTTW	Permit to Take Water
DWWP	Drinking Water Works Permit
EA	Municipal Class Environmental Assessment
WTP	Water treatment plant
WWTP	Wastewater treatment plant
Masl	Metres above sea level

2.4.2 INTEGRATED SUSTAINABLE MASTER PLAN SUMMARY (2016)

In 2016, Norfolk County completed an ISMP consistent with environmental planning processes for Master Plans under the current Municipal Class Environmental Assessment. The ISMP is a comprehensive plan to address their long-term planning for water, wastewater, transportation and active transportation infrastructure needs for the County. The ISMP used the Population Projection Study (2014) prepared by Hemson Consulting as the basis for long-term forecasts of population and housing. The ISMP adopted a 2041 planning horizon.

The following is a summary of its findings:

1 **Simcoe**: There are multiple well fields in the community of Simcoe to supply water to its residents. However, many of them are at risk of failure (mechanical, aquifer contamination or screen failure). Some of the wells have already been taken out of service due to contamination in the aquifer (mainly due to agricultural activities and old industries). The ISMP indicates that although the Permit to Take Water for this community allows for **19,362 m^3/d**, the practical firm capacity of the system is **10,563 m^3/d.** The ISMP also notes that the groundwater nearby Cedar Street Wells and Infiltration Gallery had contamination in early 2016 which may put these wells in danger and cause their failure. In this case, they limit the firm capacity of Simcoe to 5,379 m^3/d. The projected 2041 maximum daily demand is **9,039 m^3/d**. Due to the high risk of well failure and lack of water source reliability, Simcoe is ranked

as a high risk community that is in need to additional water sources. This community also has insufficient water storage and will have an estimated deficiency of 3,751 m^3 in 2041. However, the ISMP has proposed some pumping upgrades at the in-ground reservoirs in Simcoe which can resolve the issue with storage.

2 **Port Dover**: This community is supplied by the Port Dover WTP, which draws water from Lake Erie. The plant requires major repairs, replacements and upgrades. The only existing clarifier at the WTP was taken out of service for repairs in 2017, and water demands in the community were supplied by a temporary membrane system. After its refurbishment, the clarifier was placed back into service and was expected to operate reliably for a five year period from the date of the 2017 inspection. [Note: WSP initiated a clarifier replacement project with construction anticipated to begin in 2021.] However, the high lift pumping station does not have redundancy, limiting the firm capacity of the plant to **2,454 m^3/d**. The elevated tank cannot be taken out of service for maintenance since it also provides backwash water to the filters at the Port Dover WTP. The ISMP estimated that the 2041 maximum daily water demand for this community is **7,341 m^3/d,** which is lower than its rated capacity of **9,677 m^3/d** as noted in the Plant's license and Drinking Water Work Permit (DWWP). Port Dover does not appear to have storage deficiency at the moment, and in 2041, its deficiency is only 333 m^3, which is negligible. However, ISMP defines the "usable" volume as the volume that can be drawn down plus the top 10 m of any gravity storage, including elevated tanks. Based on the Port Dover elevated tank's shop drawing, the tank was designed for a useable volume of 5,000 m^3. This needs to be confirmed by Norfolk County staff, since there could be additional storage availability at the tower (approximately 500 m^3, when comparing with the proposed firm capacity in ISMP).

3 **Delhi & Courtland**: Delhi WTP is practically unusable due to the presence of contamination in the Lehman Dam (contamination arises from runoff from road and agricultural activities) and mechanical issues. Therefore, the Delhi community is mainly supplied by two wells, which are prone to failure due to either mechanical issues or contamination. In 2016, WSP conducted a treatability study for two new wells in the proximity of the existing ones to evaluate the option of potentially connecting them to the Delhi water system. A capital project was approved to decommission the WTP following the commissioning of additional well supplies in 2020. The new wells are expected to mitigate the risks associated with Delhi's water supply capacity. It should be noted that the Courtland community is also supplied by the Delhi water system through a single water transmission main, which is at risk of watermain break. However, ISMP did not recommend installing a second main between Delhi and Courtland as the existing reservoir in Courtland can provide substantial time for watermain break repair. The ISMP recommends developing an enhanced response plan to watermain break. The alternative to add a new main can be re-evaluated only if additional development occurs in this community. Delhi currently has insufficient water storage and in 2041, its deficiency is estimated to be 1,994 m^3. It was recommended to install a pump at the Delhi standpipe to use the "unusable" capacity and therefore eliminate the need for a new storage tank. Courtland does not have any storage deficiency.

4 **Waterford:** Waterford is supplied by two shallow groundwater wells in the same well field. The firm capacity of Waterford's water system (considering both wells are operational) is **2,933 m^3/d,** according to the ISMP and DWWP. Based on the analysis completed as part of the ISMP, the community's 2041 maximum daily demand would be **2,207 m^3/d**, and therefore it appears that Waterford has a surplus capacity of 726 m^3/d. The well fields in this community are at high risk of contamination due to its proximity to sanitary sewers and septic tanks and therefore, a secure water source is required. Waterford currently has insufficient water storage and in 2041, its storage deficiency is estimated to be 1,327 m^3. The ISMP resolves this issue by increasing the pumping capacity at the Waterford standpipe.

5 **Port Rowan and St. Williams:** These communities are supplied by the Port Rowan WTP, which draws water from Lake Erie. The plant requires repairs, replacements and upgrades. According to its DWWP, the plant is rated for **3,040 m^3/d**, however due to operational constraints e.g. shallow intake, severe algae bloom in the raw water and the need for frequent filter backwash, its firm capacity is limited to **1,765 m^3/d**. The ISMP has estimated that the 2041 maximum daily water demand for this community

is **2,300 m^3/d.** The plant is currently meeting the community needs. However, the ISMP recommended to upgrade the plant with new technologies, which would require building expansion, and deepening the existing intake. It appears that Port Rowan will not have any storage deficiency in 2041. It should be noted that one of the solutions of ISMP was to construct a new intake at the Long Point location with a low lift pump station and a watermain.

To meet Norfolk County's future demands, the ISMP explored three main alternatives:

1. **County-Wide Water System**
2. **Purchase Water from an Adjacent Community**
3. **Local-System Alternatives (Multiple Upgrade Option)**

The ISMP concluded that although the County-Wide Water System has multiple benefits, Local-System Upgrades would address the needs of the County at a lower cost. Therefore, the County-Wide alternative was not recommended at the time due to its capital costs. The Multiple Upgrade option, which is made up of a series of local system upgrades, was selected as the preferred water supply solution for Norfolk County, with consideration to implement the County-Wide alternative in the future. The Local-System upgrades has also included interconnection between service areas and provided short, medium and long terms recommendations for each community.

The recommendations for connecting the communities in the Local-System Upgrades included:

- Interconnecting Simcoe and Port Dover: this is based on the assumption that the Port Dover WTP would be restored to its full DWWP rated capacity of 9.6 MLD as part of the "Short-Term" solutions, however the required upgrades are not presented in detail. It is also noted that although this option would have a great value for Simcoe, Port Dover can also benefit from having an emergency back-up supply if Simcoe had sufficient capacity. The potential issues arising from blending groundwater and surface water was not discussed.
- Interconnecting Delhi and Simcoe: this connection would provide emergency back-up supply for the Delhi Wells (assuming Simcoe has sufficient capacity) and vice versa.
- Interconnecting Waterford and Simcoe: this connection can address the significant risk associated with Waterford well field and introduces a new water source of supply to Simcoe. This connection assumes Simcoe has surplus capacity and can provide supply to Waterford in case both wells fails at the same time.
- No additional interconnection with other communities was proposed, i.e. Port Rowan/St. Williams was not part of the interconnection.

2.4.3 NANTICOKE GRAND VALLEY AREA WATER SUPPLY

In 2009, Genivar Ontario Inc. (now WSP) completed a feasibility study on the Nanticoke Grand Valley Area Water Supply (NGVAWS). The purpose of this study was to assess and explore the possibility and viability of using Nanticoke Water Supply System (Nanticoke WTP) to supply industrial and potable water to the following communities, collectively referred to as Partners (Figure 2-2):

- Haldimand County
- Norfolk County
- The Mississauga of New Credit First Nation
- Six Nations of the Grand River Territory
- The City of Brantford
- The County of Brant

- The Region of Waterloo

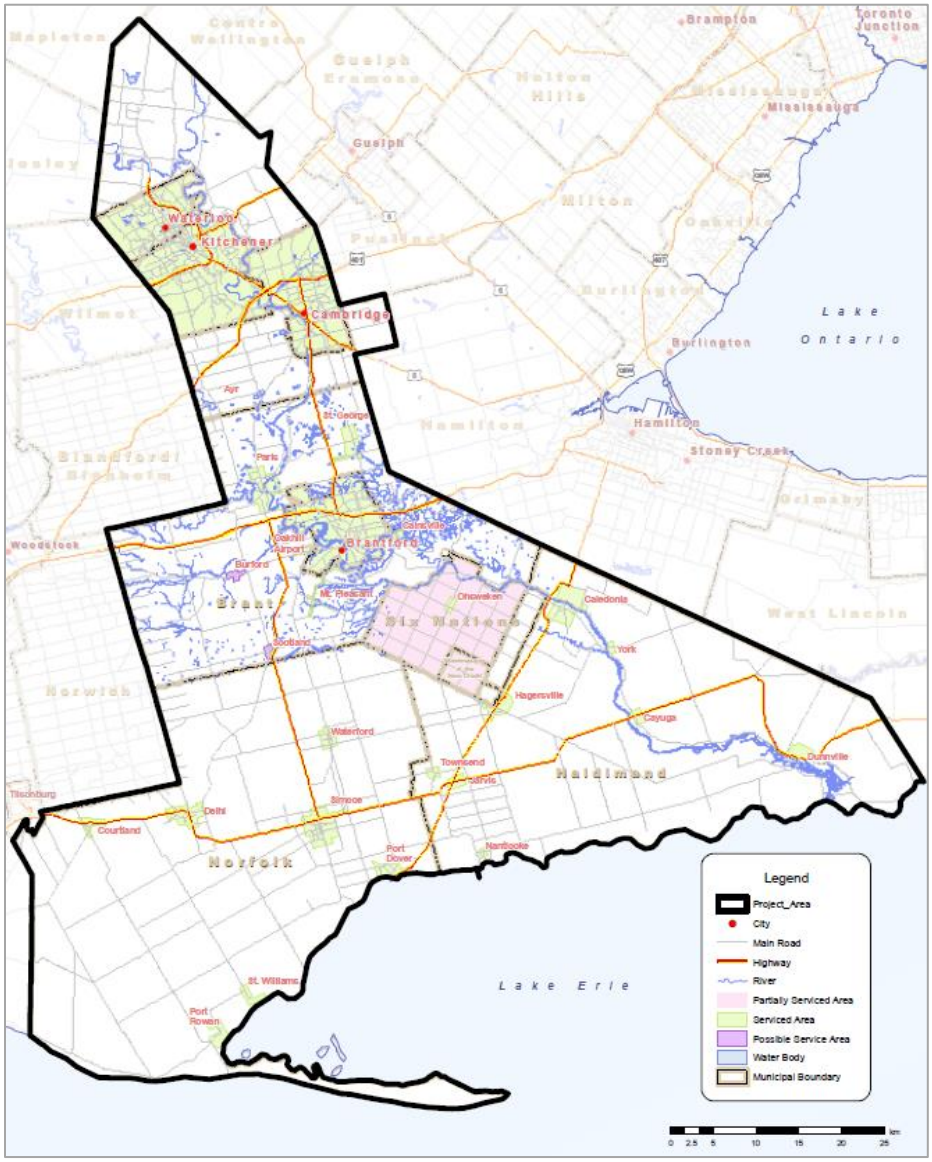


Figure 2-2 NGVAWS Boundaries and Existing Service Area

This study followed a previous concept to construct Nanticoke WTP to supply Lake Erie Industrial Park (LEIP) and the communities along Grand River, and around Nanticoke and the Regional Municipality of Waterloo. A detailed review of Partners' existing water systems and future water needs revealed that the Six Nations of the Grand Valley requires funding and a new WTP in the near future. Norfolk County would need to decommission the Delhi WTP and replace it with groundwater-based source.

The Region of Waterloo will require an additional water source by the year of 2034. The demand assessments were prepared for up to the year 2090, specifically for the NGVAWS project and based on existing planning information provided by each Partner. The required supply capacity was estimated to be 1,820 MLD, out of which approximately 1,000 MLD and 800 MLD would be Partner's maximum daily demand and raw industrial water demand, respectively.

The existing Nanticoke WTP is built on a 36 ha land on the shore of Lake Erie but during its design, it obtained the right to co-use one of the intakes of Ontario Power Generation (OPG) for a maximum capacity of 1,872 MLD. The current Nanticoke WTP is rated for 13.6 MLD and the Permit to Take Water (PTTW)

was renewed in 2014 for another 10 years. However, the Ministry of the Environment, Conservation and Parks (MECP) has indicated that they require progress to be shown towards the usage of the full capacity.

Out of seven (7) alternatives to supply water to all the Partners based on the forecasted 2090 water demand of 1,000 MLD, Full Treatment with an East/West Alignment for the Trunk Transmission Main was determined to be the most feasible option. The figure below shows the proposed system routing for the Norfolk County area.

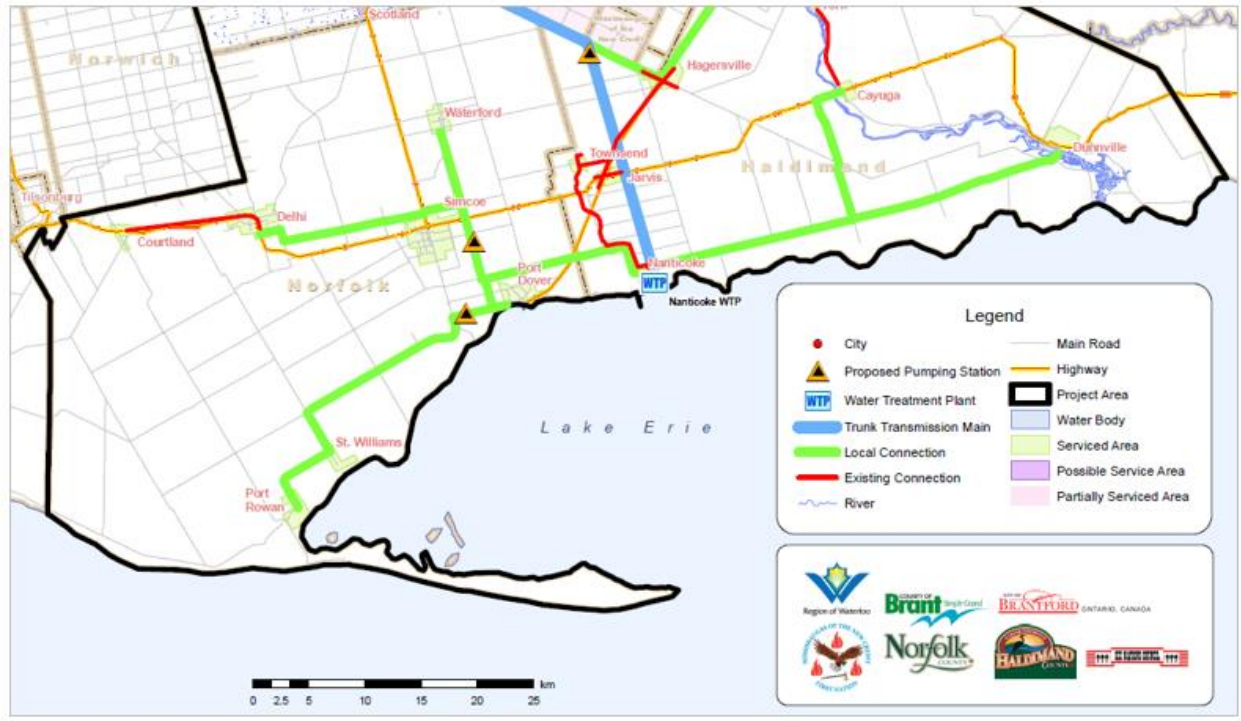


Figure 2-3 NGVAWS Supply to Norfolk County

2.4.4 LONG POINT REGION SOURCE PROTECTION AREA ASSESSMENT

The Long Point Region watershed encompasses Norfolk County, Haldimand County, Elgin County, and Oxford County. A map of the watershed is shown in Figure 2-4. The Lake Erie Region Source Protection Committee released the updated Long Point Region Source Protection Area Assessment report (LPRSPA) in March 2019. The LPRSPA is a summary of the studies undertaken in the Long Point Region Source Protection Area that form the basis of the Long Point Region Source Protection plan. The assessment identifies areas around drinking water sources that are vulnerable to contamination, determines threats to water quality and quantity, and ranks the potential threats based on significance.

1 **Simcoe:** Most groundwater wells in Simcoe are GUDI due to a connection with either Kent Creek or Patterson Creek. The GUDI wells have high intrinsic vulnerability as the water table level is high, and the soil material between the surface and water table is highly permeable. However, Chapel Street wellfield, which supplies approximately 30% of the community's demand, is not GUDI. The primary water quality threat in the Simcoe community is nitrate, resulting from agricultural activities, sanitary systems, and sewage systems.

2 **Port Dover**: The Port Dover WTP draws water from Lake Erie via an intake 457 m offshore and 2.9 m deep. The intake is relatively close and shallow when compared to other intakes in the Great Lakes. Few concerns were raised by the WTP operators regarding raw water quality. However, data between

1998 – 2007 from the Drinking Water Sampling Program (DWSP) consistently showed elevated levels of organic nitrogen in the raw water. These levels may be related to algae blooms, agricultural runoff, and/or wastewater discharge into Lake Erie. The aesthetic objectives of dissolved organic carbon, manganese, temperature and turbidity also exceeded the ODWQS guidelines in one or more samples taken in the DWSP.

3 **Delhi and Courtland:** Approximately 90% of Delhi's water is supplied by Wells No. 1 and No. 2, and the remaining 10% is supplied by the Delhi WTP (sourced from Lehman Dam). Wells No. 1 and 2, and the new Wells 3A and 3B, all draw from the same unconfined, intermediate aquifer. Wells No. 1 and 2 are considered GUDI as the intermediate aquifer has a potential connection to a shallow surficial aquifer. There is also a shallow water table within 4m of Well No. 1. The intrinsic vulnerability of the well field is considered high as the water table level is close to the surface and the soil material is highly permeable. Lehman Dam is also prone to contamination from agricultural activities, and an enhanced monitoring program for organic nitrogen was recommended as part of the Source Protection Program.

4 **Waterford:** The Waterford wells are GUDI as the supply aquifer is connected to the nearby Waterford Ponds. The intrinsic vulnerability of the well field is high as the water table is shallow and the soil material is highly permeable. Historically, there have been no water quality issues with the Waterford wells. The most significant drinking water threat is sanitary sewers and septic systems present within a 100 m radius of the WHPA.

5 **Port Rowan and St. Williams:** Port Rowan WTP draws water from Lake Erie via an intake located 365 m off shore at a depth of 0.9 m. The intake is relatively close and shallow. In the summer, shallow waters near the intake are prone to higher pH and temperature. The higher temperatures combined with nutrients in the water results in algae growth, which clogs the intake on a regular basis. Elevated organic nitrogen was also observed in all raw water samples taken for the DWSP between 1998 – 2007, which may be a result of algae blooms, agricultural runoff, and/or discharge from the Port Rowan sewage treatment lagoons. Hydrodynamic modelling was done as a part of the LPRSPA to determine if failure of the Port Rowan sewage lagoons could pose an E. coli threat to the WTP. The model illustrated that E. coli levels would be elevated near the intake. However, the levels were within the current treatment capacity of the WTP and County staff indicated that the levels were not a treatability concern.

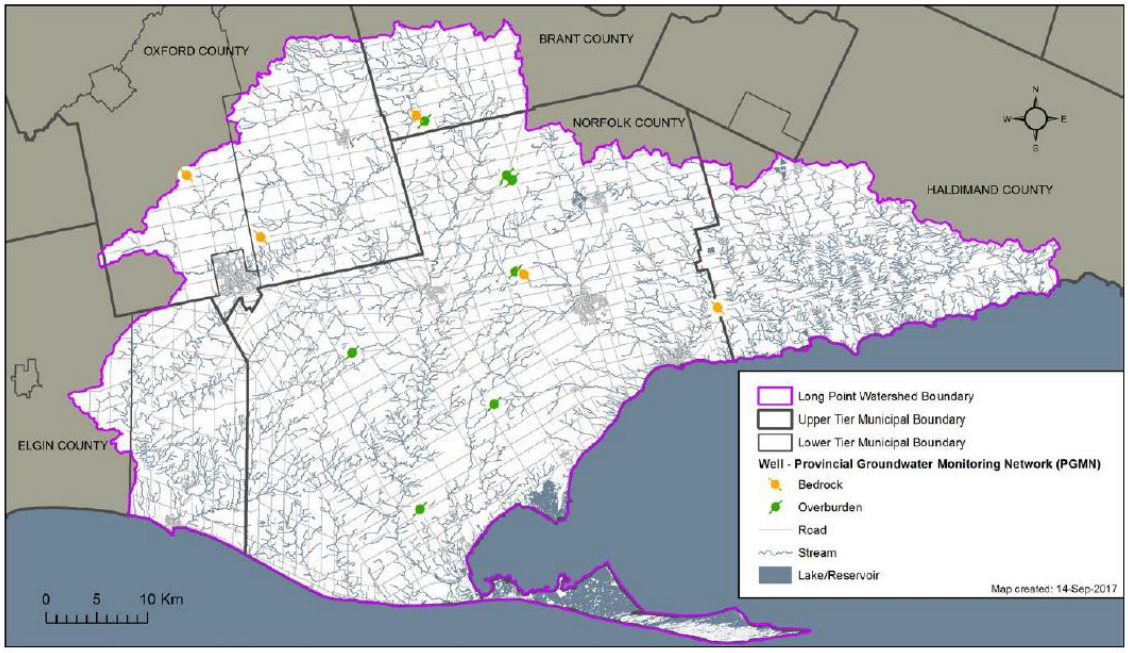


Figure 2-4 Long Point Region Watershed (Long Point Source Protection Assessment Report, 2019)

2.4.5 HALDIMAND/NORFOLK REGIONAL WATER SUPPLY STUDY DRAFT REPORT

In conjunction with this IUWS report, Haldimand County and Norfolk County retained WT Infrastructure to undertake a Haldimand/Norfolk Regional Water Supply Study. The draft report was completed in June 2020. The intent of the study was to assess various watermain routings to service Norfolk County from Nanticoke WTP, which is owned and operated by Haldimand County. The Nanticoke WTP is currently rated at 13,636 m^3/d, with a firm high lift pumping capacity of 39,742 m^3/d and a treated water storage capacity of 46,000 m^3/d. Currently, Haldimand County consumes a total 10,519 m^3/d under maximum day demand conditions (2019 MDD plus 2020 approved allocation), leaving 3,117 m^3/d net supply available for Norfolk County. WT Infrastructure indicated that Nanticoke WTP would need to increase its capacity by 30,000 m^3/d to accommodate the 2041 MDD of both Haldimand County and Norfolk County (excluding Port Rowan and St. Williams). WT Infrastructure estimated this expansion to cost $16.2M.

The focus of the WT Infrastructure report was on linear upgrades and routings to supply Norfolk County from Nanticoke WTP. In development of the different alternatives, WT Infrastructure considered the following:

- Servicing approach
- Pressurized Supply: the transmission main is pressurized to meet supply needs throughout some or all of the service area. Booster stations would be used to raise the pressure to the maximum hydraulic gradeline in the system and pressure reducing valves are used to correct the pressure to each specific pressure zone. Chlorine booster stations also need to be considered in this option. This option would permit connections to extents of the distribution system without needing to bring a transmission main in for re-pressurization.
- Treated Water Transmission: low pressure system that would supply water to the existing water treatment facilities, which would then conduct trim chlorination and boost the water pressure to the distribution system pressure. This option requires a central treatment plant for each community and a transmission main that extends from the central WTP into the community.
- Hybrid Supply: a combination system that would provide a pressurized system with chlorine boosting, however it would not be able to reach the maximum hydraulic gradeline.
- Connection points and pipeline configuration. WT studied various alignments for options that connected Nanticoke WTP only to Port Dover, and different alignment options connecting Nanticoke WTP to Simcoe/Waterford/Delhi. Port Dover was considered separately from the other communities due to the urgency of supply concerns.
- Pressure management options
- Other technical considerations including environmental, natural/cultural heritage factors.

WT Infrastructure presented six (6) different alignments, three (3) for a single connection to Port Dover (Figure 2-5) and three (3) of a regional supply to Norfolk County from Haldimand County. The regional supply involves a second connection through Simcoe. The recommended option is a pressurized supply option, presented as Alternative A in both figures. The total estimated cost of Alternative A as shown in Figure 2-6 is **$58.8M**. The Port Dover connection alone is estimated to be $8.7M (Figure 2-5), and the connection servicing Simcoe, Waterford and Delhi/Courtland is estimated to be $50.1M.

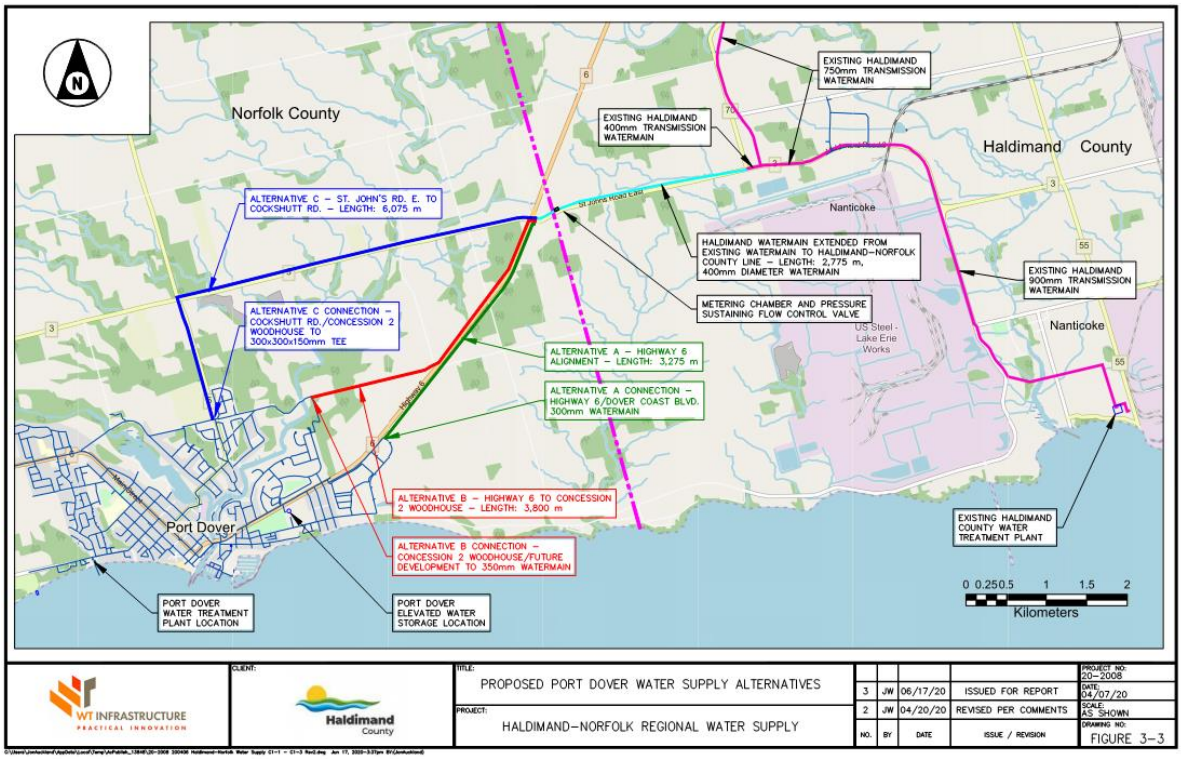


Figure 2-5 WT Infrastructure Port Dover Supply Alternatives

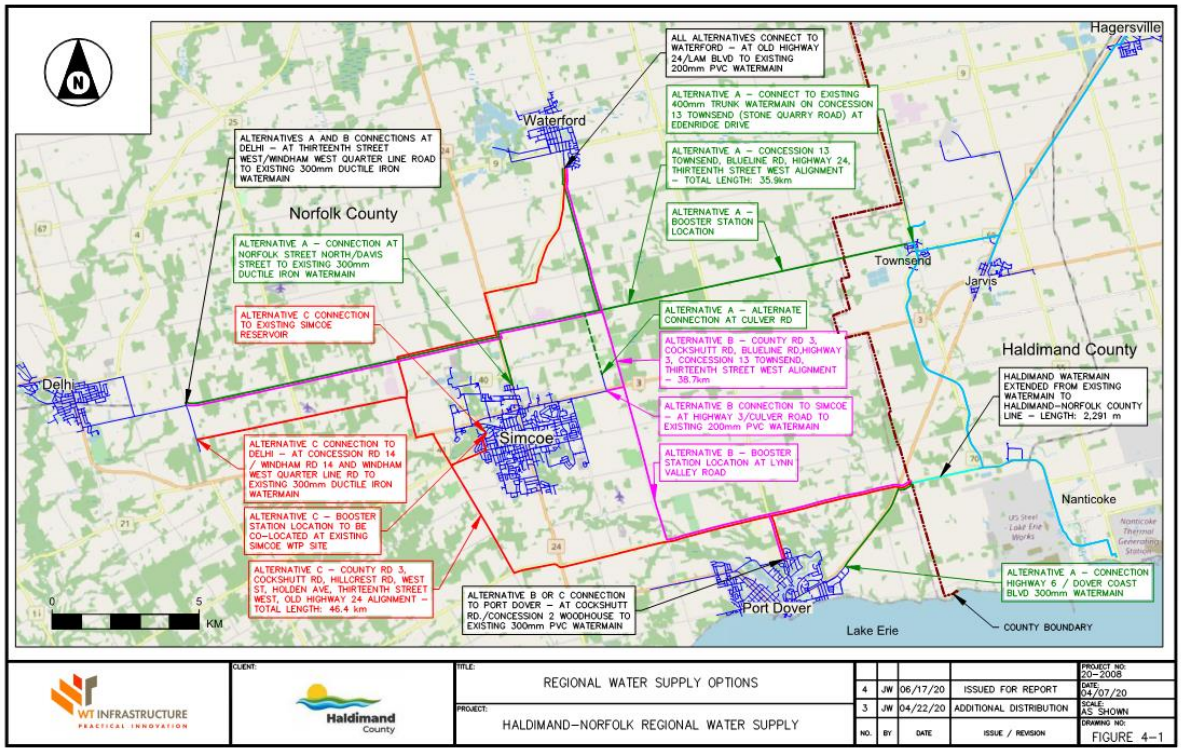


Figure 2-6 WT Infrastructure Regional Supply Alternatives

3 Existing System Overview

3.1 EXISTING INFRASTRUCTURE

The major communities in Norfolk County are Simcoe, Port Dover, Delhi & Courtland, Waterford, Port Rowan & St. Williams. A summary of the water supply sources for each of these communities is summarized in the table below.

Table 3-1 Overview of Existing System Infrastructure

COMMUNITY	SOURCE TYPE	SOURCES	STORAGE/PUMPING FACILITIES
Simcoe	Groundwater	8 Wells and 1 Infiltration Gallery	2 In-ground Reservoirs/ Booster Station and 1 Elevated Tank
Port Dover	Surface Water (Lake Erie)	1 Surface WTP	1 Elevated Tank
Delhi & Courtland	Groundwater and Surface Water	1 Surface WTP (to be decommissioned) and 4 Wells (includes the two news ones) in Delhi. Courtland supplied by transmission main from Delhi Wells to Courtland.	1 Standpipe (Delhi) 1 In-ground Reservoir/Booster Station (Courtland)
Waterford	Groundwater	2 Wells	1 Standpipe
Port Rowan & St. Williams	Surface Water (Lake Erie)	1 Surface WTP with a transmission main from Port Rowan to St. Williams.	1 Elevated Tank (Port Rowan) 1 Booster Station (St. Williams)

Most communities are self supplying except for Courtland (supplied by Delhi via a single transmission main) and St. Williams (supplied by Port Rowan via a single transmission main). The communities do not provide backup supply to each other.

Fluoride is added to the drinking water in Simcoe and Delhi i.e. Courtland drinking water also contains fluoride. Port Dover, Waterford, Port Rowan, and St. Williams do not practice fluoridation, and according to Norfolk County staff, these communities will not be adding fluoridation in the future.

3.1.1 SIMCOE

Simcoe is supplied by multiple groundwater wells: Chapel Street Well, Cedar Street Infiltration Gallery, Cedar Street Wells (5 GUDI wells with Well No. 1A no longer in use to do high iron), and Northwest Wells (3 GUDI wells with Well No.1 decommissioned due to high ammonia). The Chapel Street Well pumps directly into the Simcoe elevated tank. Cedar Street Wells discharge treated water into the Cedar Street Reservoir. The Northwest Wells discharge into the Northwest WTP for disinfection and distribution. In general, the infrastructure is aged, and the system is very complex to operate. Historically, Simcoe's groundwater experienced challenges from agricultural contamination (high nitrate, high ammonia, E.coli),

and high iron concentrations. Two (2) of the Cedar Street Wells and Northwest Well No. 3 are removed from service and rehabilitated once a year due to iron fouling. Northwest Well No. 2 is rehabilitated twice a year.

The County has had difficulty finding new groundwater supplies and only recently drilled two (2) new test production wells in the Northeast Well field, near Bloomsburg. At the time of writing, the County was conducting a 7-day pumping test. However, the sustained yield had yet to be confirmed and therefore their capacity will not be used when evaluating Simcoe's water supply capacity. The LPRSPA notes that the well head protection area around Bloomsburg has medium to high vulnerability.

The ISMP indicated that the Simcoe system has a firm capacity of 10,563 m^3/d. However, the ISMP also notes that in early 2016, the groundwater near the existing Cedar Street Well and the Infiltration Gallery showed contamination. This issue places the wells at high risk and therefore it is not recommended to rely on the capacity of these wells for Simcoe's system. According to ISMP, loss of the Cedar Street Wells and Infiltration Gallery would drop the firm capacity to 5,379 m^3/d. Following another survey of the existing groundwater wells in Norfolk County, the County's staff also confirmed that the operating capacities of all Simcoe groundwater sources are lower than the rated capacities due to operational constraints. The most recent (October 2019) operational production capacities shared by County's operational staff are believed to be even lower than the ones used in the ISMP. Please note the ISMP does not have the details of this with regards to each well and its capacity.

According to the new operational data received, the total operational capacity of the Simcoe water system is 9,850 m^3/d, which is equal to its installed capacity. Cedar Street Infiltration Gallery has the highest operational capacity of 2,678 m^3/d (average of 31 L/s). Therefore, the firm capacity of the Simcoe water system is 7,171 m^3/d, when the largest well is taken out of service. For the purposes of this study, the firm capacity of the Simcoe system is proposed to be 7,200 m^3/d in 2020.

Since the main objective of this study is to provide the County with a long-term and reliable water supply solution, additional assumptions were also made to ensure all groundwater supplies that are or may be at risk of contamination would not be part of the long-term solution. It is believed that the overall design should use a more conservative approach to ensure Simcoe's water demands are met. Based on the LPSRA and ISMP, Cedar Street Infiltration Gallery, Cedar Street Well No. 1A and 2A, and the Chapel Street Well have had poor water quality, low water levels, and were unreliable, and therefore are assumed to be taken out of service by 2023. Chapel Street was also reported to have mechanical challenges, in addition to aging casing. The assumption that these sources will be removed presents a worst case scenario, which has been applied to all subsequent analyses. Details on Simcoe's water quality concerns are presented in Table 3-9, and Sections 2.4.2 and 2.4.4. The County indicated that the intention is to keep Chapel Street Well operational for as long as possible. Retaining Chapel Street Well will not the impact the conclusions of this report, but will provide the County some buffer time to implement permanent solutions.

For the purposes of this study, the total installed and firm (operational) capacities for Simcoe water supply will be 7,171 m^3/d and 3,629 m^3/d in 2020 and 2023, respectively. The firm capacity is calculated as the sum of the operating capacities of the Northwest Wells and Cedar Street Wells 3 - 5 minus the capacity of Northwest Well No. 3. A summary of the Simcoe water system is found in Table 3-2.

A summary of Simcoe's water system infrastructure, capacities, PTTW/DWWPs and issues/concerns are found in Appendix A.

Table 3-2 Simcoe Water Production Infrastructure Overview

ITEM	DESCRIPTION
Source	Multiple Groundwater Sources
PTTW Capacity (Total, m^3/d)	19,362

ITEM	DESCRIPTION
Installed Capacity per DWWP (Total, m^3/d)	16,986
Actual Operating Capacity (Total, m^3/d)	9,850
Actual Firm Capacity (Total, m^3/d)	7,171 in 2020 (rounded up to 7,200 in calculations) 3,629 in 2023 (rounded up to 3,700)– refer to the explanation given above

3.1.2 PORT DOVER

A detailed review of the existing Port Dover WTP facility can be found in the following report: "Treatment Alternative Assessment Report – WSP 2016".

The Port Dover water system consists of the Port Dover WTP (conventional) and the Port Dover Elevated Tank. The WTP has a rated license capacity of 9,677 m^3/d. However, the installed capacity is only 5,000 m^3/d and the firm capacity 2,454 m^3/d. This is a result of aging equipment and unit process limitations, disinfection issues, and insufficient high lift pumping capacity. Neither the firm nor installed capacity is sufficient to meet current MDD (5,700 m^3/d). Currently, the MDD is met by drawing down the Port Dover Elevated Tank using the emergency supply.

The major concerns of the Port Dover WTP, in order of importance, are listed below. These concerns should be mitigated in the order presented below.

1. Clarification
2. Disinfection and High Lift Pumping
3. Filtration

Clarification

The Port Dover WTP currently only has one (1) operational clarifier which had undergone a complete structural rehabilitation in 2017 and was expected to reach end of life in 2022. Loss of the clarifier would have resulted in the Port Dover WTP having zero capacity. WSP began a project to replace the single clarifier with two (2) dissolved air flotation units (DAF) in 2020, and construction is anticipated to begin in 2021. The two (2) DAF units each have a capacity of 3,870 m^3/d, for a combined installed capacity of **7,720 m^3/d.**

Disinfection and High Lift Pumping

The Port Dover WTP's firm capacity is limited by the disinfection and high lift pump capacity (assuming the clarifier/DAFs are operational). In 2018, WSP initiated a project to install an Ultra Violet (UV) disinfection system and addition of one more high lift pump to provide redundancy (using the existing HLPs that are not being used at the plant due to shortage of disinfection contact time). This would increase the firm capacity of the WTP to **4,908 m^3/d**. The UV project was put on hold to focus on the clarification issue.

Filtration

The existing filters have experienced repeated structural challenges. Additionally, the Port Dover Elevated Tank provides backwash water for the filters, and thus cannot be taken offline for maintenance.

The Port Dover WTP has three (3) dual media gravity media filters. Filter 3 experienced structural failure twice in 2019, with the first during a backwash cycle in July 2019. The filter was then repaired. However, Filter 3 failed again in November 2019, which left the plant temporarily operating with only its two (2)

remaining filters in service. Because the filters are arranged sequentially, there was concern that Filters 1 and 2 would experience the same mode of failure if mitigation measures were not implemented.

WSP inspected Filter 3 in December 2019 and identified items requiring repair. In February 2020, all original repair welds were removed and new members were re-welded with acceptable weld. WSP identified that instantaneous pressure surges at the start of each backwash cycle likely contributed to the structural failure, and recommended the County slow the opening rate of the flow control valve. This successfully reduced the steady state and transient pressures during the backwash cycle on all filters. WSP also recommended the County to inspect Filters 1 and 2, and possibly conduct repairs in the same manner as Filter 3.

Due to the issues with the existing filters, WSP selected DAF units which can be converted to DAF-Filters when undertaking the clarification upgrade. DAF-Filters can perform both clarification and filtration in a single unit, and the two DAF-Filters will have a throughput of **7,300 m^3/d** combined. The current DAF Project has made provisions for the future conversion and the third DAF-Filter unit which will need to be installed at that time. This upgrade would allow the existing media filters to be converted to taste and odour (GAC) contactors.

When converting to DAF-Filters, the Port Dover WTP may need to add a backwash supply tank, a backwash waste holding tank, and upgrade the wastewater pumping station located onsite. A new backwash tank will allow the Port Dover elevated tank to come offline. A backwash waste holding tank may be necessary as there is a limitation on the flowrate that the WTP can discharge to the sanitary system. The wastewater pumping station may also need to be upgraded as there is only one (1) pump with no redundancy.

Table 3-3 Port Dover Water Production Infrastructure Overview

ITEM	DESCRIPTION
Source	Lake Erie
PTTW Capacity (Total, m^3/d)	9,677
Installed Capacity (Total, m^3/d)	9,677
Operating Capacity (Total, m^3/d)	4,908
2041 Maximum Daily Demand (m^3/d)	7,304
Firm Capacity (Total, m^3/d)	2,454

3.1.3 DELHI & COURTLAND

The Delhi water system is supplied by both four (4) groundwater wells, two (2) of which were commissioned in 2020, and surface water from the Lehman Dam. Wells No.1 and No. 2 are older, and groundwater produced by these two (2) wells are treated at the well pump house and pumped directly into the distribution system. In 2019, 90% of Delhi's demand was supplied by Wells No. 1 and No. 2, and the remainder supplied by Delhi WTP. The Delhi WTP (also known as the Lehman Dam Water Filtration Plant) draws water from the Lehman Dam. The WTP has a firm capacity of 4,500 m^3/d. The ISMP notes that the Delhi system currently has a firm capacity of 1,881 m^3/d.

The County commissioned two (2) new wells, Wells 3A and 3B, in early 2020 to increase the Delhi groundwater supply. Wells No. 1 and No. 2 cannot supply the total demand of the system, and the system would be at an even greater risk if one of two wells fail. Both older wells are GUDI and the presence of two wetlands (Nixon Ellaton Wetlands and Kent Creek Complex) nearby increases the risk of contamination (LPRSPA, 2019). The two (2) new wells are not GUDI. They would provide necessary redundancy and source security, particularly as there is an ongoing project to decommission the Delhi WTP. The Delhi WTP is aged, unreliable, and its the raw water is prone to high turbidity and agricultural contamination. For these reasons, the Delhi WTP has been excluded from subsequent sections.

The treated water is transported from the four (4) groundwater wells into Delhi via two (2) transmission mains. The newer transmission main was commissioned in 2020 and connects at the intersection of Windham Road 13 & Wilson Ave. and Fertilizer Road. Treated water is stored in the Delhi standpipe. A single transmission main transfers water from Delhi to the Courtland Reservoir and Booster Station. Courtland would be at risk if this transmission main breaks as this is the sole water supply for the community. However, it has sufficient storage capacity and according to ISMP, with an enhanced response time/program to watermain break, this risk with this matter can be mitigated.

A summary of the upgraded capacities of the groundwater system is provided in Table 3-4 and Table 3-5. The values are extracted from proposed upgrades in the ISMP, and previous reports for Delhi including the 7-day pumping test (WSP, 2016). For the purposes of this study, the firm capacity of Delhi water system is assumed to be 4,484 m^3/d in 2020, following the ongoing upgrades by other Consultants.

Table 3-4 Delhi Groundwater Well Supply Capacity

GROUNDWATER SOURCE	INSTALLED CAPACITY (M^3/D)	OPERATING CAPACITY (M^3/D)
Well 1	2,306	1,728
Well 2	2,306	1,814
Well 3A	942	942
Well 3B	2,264	2,264

Table 3-5 Delhi Water Production Infrastructure Overview

ITEM	DESCRIPTION
Source	Groundwater (4 operational wells in 2020)
PTTW (Total, m^3/d)	Not available
Installed Capacity per DWWP (Total, m^3/d)	7,819
Operating Capacity (Total, m^3/d)	6,747 (capacity of the existing Wells 1 and 2 are lower than DWWP – capacity provided by County Operation staff)
Firm Capacity (Total, m^3/d)	4,484

3.1.4 WATERFORD

Waterford is supplied by two (2) groundwater wells (Well 3 and Well 4). Raw water is pumped to a treatment plant, and then distributed to Waterford standpipe. The ISMP notes that the groundwater wells have a total installed capacity of 5,875 m^3/d. However, the County's staff indicated that the total operating capacity is actually 3,802 m^3/d, i.e. each well has an operating capacity of 1,901 m^3/d (22 L/s). The wells are closely spaced, and both draw from the same surficial aquifer, and there is a risk of contamination in both wells at the same time. A Provincially Significant Wetland surrounds these wells, which increases the risk of aquifer contamination.

The Waterford WTP has a firm capacity of 6,912 m^3/d and uses chemically enhanced filtration to remove iron and manganese. There are currently three (3) filters with the possibility of adding a fourth.

Waterford's water production capacity used in this study can be found in Table 3-6. A summary of Waterford's water system infrastructure, capacities, and issues/concerns can be found in Appendix A. Note that the PTTW for Well 3 and Well 4 are of 3,270 m^3/d and 2,946 m^3/d, respectively (total: 6,216 m^3/d). However, the rated capacity of the well pumps according to the DWWP is 2,938 m^3/d for each well (total rated capacity of 5,875 m^3/d).

Table 3-6 Waterford Water Production Infrastructure Overview

ITEM	DESCRIPTION
Source	Groundwater
PTTW Capacity (Total, m^3/d)	6,216
Installed Capacity (Total, m^3/d)	5,875
Operating Capacity (Total, m^3/d)	3,802
Firm Capacity (Total, m^3/d)	1,901

3.1.5 PORT ROWAN & ST. WILLIAMS

The Port Rowan system consists of a surface water WTP and one elevated tank in Port Rowan. Water is pumped from the elevated tank to a booster station in St. Williams, where it is re-chlorinated prior to its distribution to the network. There is only one transmission main that connects Port Rowan to St. Williams. The County has inspected this watermain and is in the process of replacing a portion of the main, with plans to replace and upsize the remaining sections.

The Port Rowan WTP is a conventional treatment plant with UV disinfection that sources water from Lake Erie. The plant is also equipped with pressurized GAC filters, upstream of the HLPs, to reduce trihalomethane (THM) concentration, and taste and odour. The production capacity of the plant is limited by its shallow intake and some treatment related issues. When the lake's water level changes, high turbidity levels in the raw water causes the filters to plug faster and the filters require multiple backwashes each day. The ISMP also noted that algae blooms have caused issues for the plant. In the summer of 2020, the County experienced challenges with microcystin, coloured water, and low chlorine residuals in Port Rowan's distribution system.

From the treatment side, it appears the production capacity of the Port Rowan WTP is limited by the filtration process. At the time of writing, the County was in the process of initiating a separate study to

review production capacities and bottlenecks of the Port Rowan WTP. A summary of the water production capacity of Port Rowan is shown in Table 3-7. The County is currently performing some works at the Port Rowan WTP. It is assumed that these works will not restore plant's firm capacity to its rated capacity. A summary of the Port Rowan & St. Williams' water system infrastructure, capacities, and issues/concerns can be found in Appendix A.

Table 3-7 Port Rowan Water Production Infrastructure Overview

ITEM	DESCRIPTION
Source	Lake Erie
PTTW/DWWP Capacity (Total, m^3/d)	3,040
Installed Capacity (Total, m^3/d)	N/A
Filter Operating Capacity (Total, m^3/d)	3,266 (two filters – each rated at 1,633 m^3/d)
WTP Firm Capacity (Total, m^3/d)	1,633 (per DWWP) 1,765 (per ISMP)[1]

1) For consistency, the ISMP firm capacity is used as a reference for all capacity deficit and surplus calculations.

3.2 SUMMARY OF WATER SYSTEM CAPACITIES – IUWS BASIS

Table 3-8 below provides a summary of the PTTW/DWWP, installed, and firm capacities per community used for all analysis in this Inter-Urban Water Study (IUWS) report. It should be noted that some firm capacities are different from ISMP values for the following reasons:

- For all communities, it was assumed that any works currently underway will be completed by 2020. Therefore, 2020 was used as the baseline year.
- Simcoe's groundwater wells are all at high risk as noted in the ISMP, LPRSPA, and discussions with the County. The 2020 firm capacity is proposed to be 7,171 m^3/d, lower than the ISMP value of 10,563 m^3/d. It is also assumed that by 2023, the firm capacity will reduce to 3,629 m^3/d as multiple sources is assumed to be taken out of service due to water quality concerns or operational constraints (see Section 3.1.1).
- In 2020, two (2) new groundwater wells were commissioned in Delhi (see Section 3.1.3). These have been included in the Delhi water supply production capacity.
- The ISMP appears to have calculated the firm capacity of all County's water systems using the rated capacities provided in the DWWP. To be more conservative, the IUWS calculates the firm capacity using the actual operating capacities provided by the County's staff, which for some communities are well below their rated capacity.

Table 3-8 Water System Capacity per Community, ISMP vs IUWS

COMMUNITY	PTTW / DWWP CAPACITY	INSTALLED CAPACITY	OPERATING CAPACITY	ISMP 2015 FIRM CAPACITY	IUWS 2020 FIRM CAPACITY BASELINE
Unit	m^3/d				
Simcoe	19,362	17,000	9,849	10,563	7,171[2]
Port Dover	9,677	5,000	4,908	2,454	2,454
Delhi & Courtland	9,143	7,819	6,800	1,881	4,484
Waterford	5,875	3,802	3,266	2,933	1,901
Port Rowan & St. Williams	3,040	3,300	1,633[1]	1,765	1,633

1 Filter capacity from DWWP

2 Simcoe's production capacity drops to 3,629 m^3/d in 2023.

3.3 WATER SUPPLY CONCERNS SUMMARY

A summary of the concerns relating to the water supply system of each community is presented in the section below. The concerns include potential issues in water distribution, source quantity, source security and treatment process

In general, concerns arise from the lack of redundancy and aging equipment. A number of communities also have localized areas with undersized water mains resulting in inadequate fire protection. These concerns are retrieved from the ISMP, ISMP site visit notes, LPRSPA, and recent discussions with the County.

Table 3-9 Simcoe Water Supply Concerns Summary

CONCERN TYPE	CONCERN DESCRIPTION
Source: Security	Simcoe's existing wells have poor quality due to occasional high ammonia, high nitrate, and/or high iron concentrations. Wells are at risk of agricultural contamination, iron fouling, and are also at risk of mechanical or well screen failure.
Source: Quantity	Simcoe is at risk of having inadequate water supply due to the inability to develop new wells with sufficient production volume and difficulty in obtaining regulatory approval. The LPRSPA assigned a Significant Risk Level to the vulnerable area containing Cedar St. wells and Chapel St. wells. The Cedar St. well field is at high risk of being incapable of meeting future demands, and Chapel St. well cannot be used to supplement the supply. The County operators also indicated that the current Cedar St. well water levels are lower than the preferred operational levels. There is also potential for unacceptable declines in groundwater contributions from Cedar St. to nearby surface water features and Provincially Significant Wetlands (PSW). The LPRSPA recommended pursuing additional water supplies outside the vulnerable area. Norfolk County is currently undertaking the Northeast Well Class EA to develop a new well outside of Simcoe.

CONCERN TYPE	CONCERN DESCRIPTION	
Distribution: Water mains	There are a number of undersized watermains in isolated locations resulting in sub-standard fire flows in portions of the Simcoe community.	
Potential Water Quality Threats	The following activities in the well head protection area present a potential threat to water quality: - Agricultural activities, including pesticide and fertilizer application - Waste disposal activities - Sewage and septic systems - Fuel handling and storage activities (oil pipelines) - Organic solvent and DNAPL handling activities	
Water Quality	Contaminants of Concern: 1. Nitrate (all) 2. Iron and Manganese 3. E. Coli and Total Coliforms (Cedar St.) 4. TCE (Cedar St.Well 3) 5. Chloroform (Cedar St.Well 2) 6. Sodium (Cedar St.)	Rationale: 1. Nitrate was detected to be very close or above the 50% MAC limit at all wellfields. Nitrate is released from agricultural activities. Septic and sewage systems also contribute to Cedar St. and Chapel St. nitrate issue. 2. Iron and manganese at all well fields consistently exceeded the ODWQS aesthetic objectives, however these are being treated at the plant. 3. Total Coli was detected 329 times between 2005 – 2016 and E. Coli was detected 48 times at Cedar St. wellfield. However, the County operator stated there is sufficient disinfection in the treatment system to mitigate any issues/concerns. 4. TCE has been detected at Cedar St. Well 3 since 2017, ranging between 0.6 and 0.8 ug/L. This is less than 50% MAC (5 ug/L). TCE concentration is not increasing, however it is currently being sampled monthly. 5. Chloroform has ranged between 0.5 and 1.4 ug/L at Cedar St. Well 2 since 2016. This is less than 2.4 ug/L as prescribed in the Soil, Ground Water and Sediment Standards. Chloroform concentration is not increasing and is currently being sampled monthly. 6. Per the LPRSPA, sodium at Cedar St. well field was consistently above the Health Advisory level of 20 mg/L. However, the exact level was not specified.

Table 3-10 Port Dover Water Supply Concerns Summary

CONCERN TYPE	CONCERN DESCRIPTION	
Source: Security	There has been an increasing number of algae blooms in Lake Erie, resulting in filter clogging and release of unacceptable levels of microcystin toxins.	
Treatment: Redundancy	There is insufficient HLP capacity in Port Dover WTP, which is a result of disinfection issues.	
Treatment: General	Port Dover WTP intake can become blocked by frazil ice formation.	
Treatment: General	The Port Dover ET cannot be taken offline otherwise the WTP cannot backwash the filters.	
Distribution: General	The northwest corner of Port Dover has marginal pressure and limited fire protection as a result of higher ground elevations. A number of small areas also have inadequate fire protection due to undersized water mains.	
Source Water Quality	Contaminants 1. Organic Nitrogen 2. Microcystin Toxins	Rationale 1. Presence of organic nitrogen in raw water: This may be due to algae blooms, agricultural runoff, and/or wastewater discharges into Lake Erie. 2. Microcystin toxins are released by algae blooms.

Table 3-11 Delhi & Courtland Water Supply Concerns Summary

CONCERN TYPE	CONCERN DESCRIPTION
Distribution: Redundancy	The distribution system from wells to Delhi and from Delhi to Courtland each consist of one singular main.
Distribution: General	The northwest corner of Delhi has marginal pressure and limited fire protection due to higher ground elevations. A number of small areas in Delhi also have inadequate fire protection due to undersized water mains.
Distribution: Redundancy (Courtland)	Per the ISMP, the Courtland Reservoir and Booster Station only has one large pump. Thus, there is insufficient firm capacity to meet maximum day plus fire flow demand. Pump start up is slow and does not meet fire department requirements.

CONCERN TYPE	CONCERN DESCRIPTION	
Prescribed Drinking Water Quality Threats (PDWQ)	The following activities in the well head protection area or near Lehman Dam present a potential threat to water quality: - Agricultural activities, including pesticide and fertilizer application - Fuel handling and storage activities	
Source Water Quality	Contaminants 1. Iron, manganese 2. THM	Rationale 1. Iron and manganese presence in Wells 1 and 2. 2. From 2010 – 2013, the quarterly average THM concentrations exceeded 50% of MAC (100 ug/L) at Well No. 1 and No.2. However, the quarterly THM has been decreasing since 2013 to 32.3 ug/L in 2016 and is not considered to be a concern.

Table 3-12 Waterford Water Supply Concerns Summary

CONCERN TYPE	CONCERN DESCRIPTION	
Source: Redundancy Security	Both wells that supply Waterford are GUDI, draw from the same aquifer, and are spaced very close together. There is a high risk of both wells being contaminated at once.	
Distribution: Redundancy	There is only one watermain connecting the wells to the distribution system (lack of redundancy).	
Prescribed Drinking Water Quality Threats (PDWQ)	The following activities in the well head protection area present a potential threat to water quality: - Agricultural activities - Sewage and septic systems - DNAPL handling activities	
Source Water Quality	Parameter 1. Manganese 2. Temperature	Rationale 1. Manganese concentrations varied between 0.08 to 0.36 mg/L in both Well 3 and Well 4. 2. The temperature of Well 4 consistently exceeded the ODWQS objective of 15 °C. Occasional exceedances were noted for Well 3.

Table 3-13 Port Rowan & St. Williams Water Supply Concerns Summary

CONCERN TYPE	CONCERN DESCRIPTION	
Source: Security	The intake at the Port Rowan WTP is very shallow. During low lake levels and storm event, no raw water can be supplied to the plant. The increasing number of algae blooms in Lake Erie in recent years have also caused difficulties for the plant. High turbidity clogs the filters and they require multiple backwashes per day.	
Distribution: General	The fire flow in the north end adjacent to Lakeshore Rd and Concession Rd. 1 is inadequate as there is only a single supply pipe feeding the large area. Approximately 200 m of water mains are undersized in Port Rowan.	
Distribution: Redundancy (St. Williams)	There is only one watermain supplying St. Williams from Port Rowan (lack of redundancy). No standby power is available at the St. Williams Booster Pumping Station, which may result in inadequate pressure in the boosted zone.	
Water Quality	Parameter 1. Microcystic toxins 2. Temperature	Rationale 1. Microcystic toxins are released by algae blooms, which have become increasingly frequent in Lake Erie over the last few years. 2. The temperature of the raw water is often high in the summer months due to the shallow depth of the intake. Higher temperatures contribute to algae blooms, increased microbial count, and decreased water palatability.

3.4 WATER DEMANDS (2015)

Table 3-14 summarises the water demands as described in the ISMP. The per capita demands and maximum daily/hourly factors were calculated based the historical data from 2000 to 2014. The per capita demand is measured in litres per capita (LPCD). This baseline was then used to calculate the current (2015) demand/population.

Table 3-14 Summary of Water Demands (2015)

COMMUNITY	BASELINE				DEMAND (2015)			
Parameter	**Q ave**	**Q max.d**	**Max Day Factor**	**Peak Hour Factor**	**Population**	**Q ave**	**Q max.d**	**Q peak.h**
Units	(Lpcd)	(Lpcd)	(MDF)	(PHF)	ppl	(m^3/d)	(m^3/d)	(m^3/d)
Simcoe	344	523	1.52	2.85	15,727	5,259	7,947	14,988
Port Dover	360	750	2.08	3.00	7,054	2,594	5,401	7,782
Delhi & Courtland	248	477	1.92	3.00	3,738	1,538	2,929	4,614
Waterford	232	434	1.87	3.00	6,154	894	1,673	2,682
Port Rowan & St. Williams	376	849	2.26	3.75	1,966	772	1,742	2,895

The charts below illustrate that Simcoe and Port Dover are the largest water users in Norfolk County. Simcoe accounts for 48% and 40% of the average day (ADD) and maximum day (MDD) demands in the County, followed by Port Dover with an average day demand and maximum day demand of 23% and 27%, respectively.

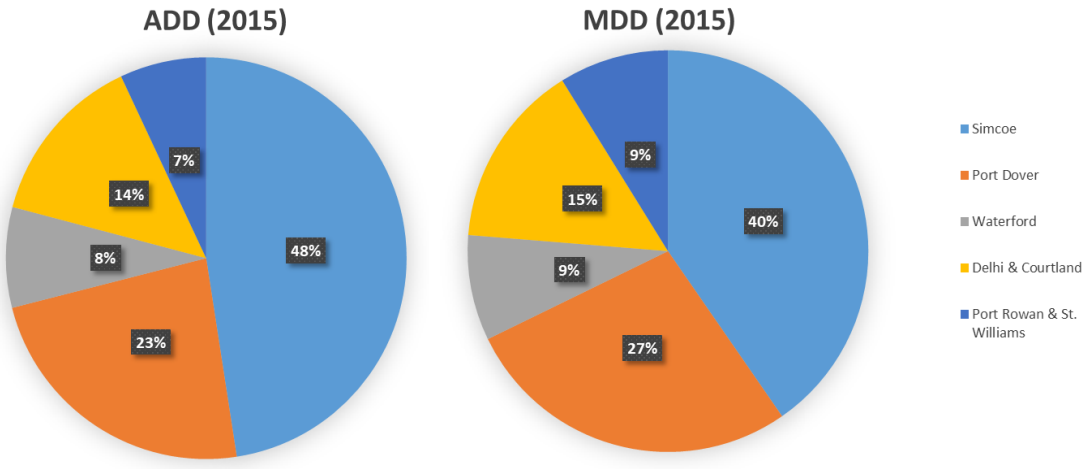


Figure 3-1 Average Day Demand and Maximum Day Demand (2015)

3.5 STORAGE REQUIREMENTS (2015)

The ISMP calculated the storage requirements for each community based on the 2015 demands. All communities in Norfolk County are provided with piped fire flow except Delhi, Courtland and St. Williams. The transmission main in Delhi and Courtland is not designed to carry peak flows necessary for fire flow and therefore, fire demand is provided by local storage and/or pumping. St. Williams and other areas outside of urban boundaries are not supplied by a water pipe dedicated for fire fighting.

Table 3-15 Storage Requirements (ISMP 2015)

SYSTEM NAME	TYPE	STORAGE REQUIRED (M^3)	TOTAL STORAGE AVAILABLE (M^3)	TOTAL USEABLE STORAGE (M^3)
Simcoe	Elevated Tank + Cedar Reservoir + Northwest Reservoir	6,983	12,409	3,409
Port Dover	Elevated Tank	4,239	5,000	4,500[1]
Waterford	Stand Pipe	1,648	2,700	657
Delhi & Courtland	Stand Pipe + Courtland Reservoir	2,906 (Delhi) 902 (Courtland)	3,955 (Delhi) 1,077 (Courtland)[2]	947 (Delhi) 880 (Courtland)
Port Rowan & St. Williams	Port Rowan Elevated Tank	1,295	1,816	1600

1 Based on the shop drawings of the ET, the total useable storage volume is 5,000 m^3.

2 The ISMP notes that the total useable storage is determined based on the maximum volume that the pumps can draw down at the Courtland reservoir. Some pump upgrades are required for firm capacity.

4 Future water supply requirement

4.1 POPULATION AND EMPLOYMENT FORCASTS

In 2014, Hemson Consulting conducted a population projection study for Norfolk County. The table below shows the 2015 and 2041 population values from the Hemson report which were used to develop all future demands for these communities in the ISMP. Port Dover is expected to see the highest growth by 2041 and the overall County population is projected to grow 20%.

Table 4-1 Population Growth in Norfolk County - Hemson Consulting Ltd. (2014)

COMMUNITY	EXISTING POPULATION	FUTURE POPULATION	PROJECTED POPULATION GROWTH (%)
Simcoe	15,272	17,380	13.8%
Port Dover	7,054	9,640	36.7%
Waterford[1]	3,738	4,970	33.0%
Delhi & Courtland	6,154	6,430	4.5%
Port Rowan & St. Williams	1,966	2,620	33.3%
Total	**34,184**	**41,040**	**20.1%**

1 The County noted that Waterford urban boundaries may potentially be expanded in the future. At the time this report was written, no official applications have been received by the County relating to this matter and thus additional demands have not been included.

4.2 FUTURE WATER DEMAND PROJECTIONS

Table 4-2 summarises the water demands as described in the ISMP for 2041. Where population is greater than 2000, a peak hour factor of 3.38 was used for the Baseline values. It should be noted that this data was reviewed for accuracy and some minor discrepancies were observed.

Table 4-2 Summary of Water Demands (2041) - ISMP

WATER SYSTEM	BASELINE				FUTURE DEMAND			
Parameter	**Q ave**	**Q max.d**	**Max Day Factor**	**Peak Hour Factor**	**Population**	**Q ave**	**Q max.d**	**Q peak.h**
Unit	(Lpcd)	(Lpcd)	(MDF)	(PHF)	ppl	(m^3/d)	(m^3/d)	(m^3/d)
Simcoe	344	523	1.52	2.85	*17,380*	5,981	9,038	17,046
Port Dover	360	750	2.08	3.00	9,640	3,506	7,300	10,518
Delhi & Courtland	248	477	1.92	3.00	4,970	1,606	3,059	4,818
Waterford	232	434	1.87	3.00	6,430	1,174	2,198	3,522
Port Rowan & St. Williams	376	849	2.26	3.75	2,620	1,014	2,287	3,427
Total Needs					**41,040**	**13,281**	**23,882**	

WSP verified the 2041 average/maximum day demands using the average/maximum day per capita demands and bulk water demands in the ISMP. The calculated values are slightly higher than the 2041

demands calculated in the ISMP demands. To be conservative, the higher demand values were used in this study (Table 4-3).

Table 4-3 Calculated Demands (2041)

COMMUNITY	POPULATION	AVERAGE DAY DEMAND (M^3/D)	MAXIMUM DAY DEMAND (M^3/D)
Simcoe	17,380	5,979	9,090
Port Dover	9,640	3,470	7,230
Waterford	4,970	1,153	2,157
Delhi & Courtland	6,430	1,595	3,067
Port Rowan & St. Williams	2,620	985	2,224
Total Needs	**41,040**	**13,182**	**23,768**

The charts below illustrate that Simcoe and Port Dover will remain the largest water users in Norfolk County in 2041. Simcoe will account for 38% and 45% of the maximum day and average day demands in the County, followed by Port Dover with a maximum day and average day demand of 39% and 26%, respectively.

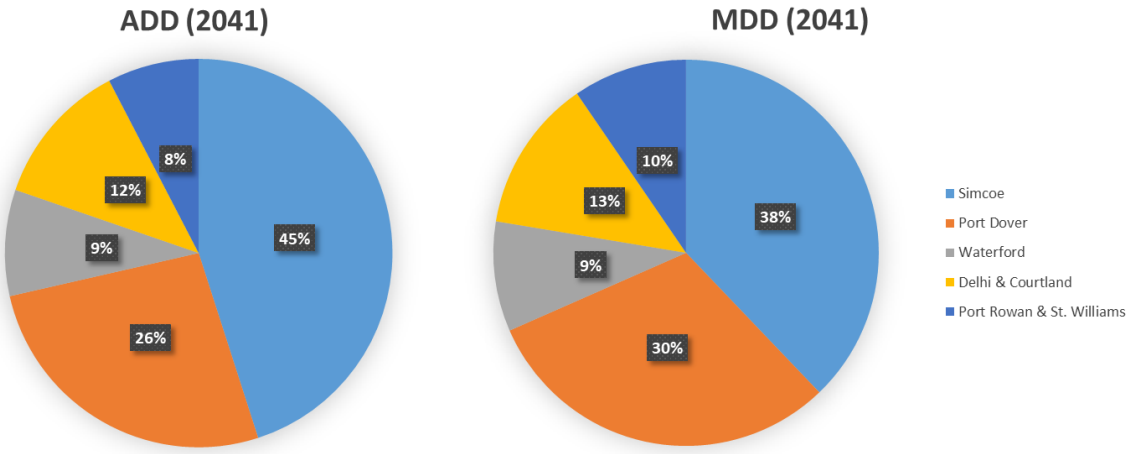


Figure 4-1 Average Day Demand and Maximum Day Demand (2041)

The County's staff indicated that there has been great interest in developments in Simcoe and Waterford, which may potentially present a significant increase in demands. At the time of writing this report, confirmed demand increases were not available and have not been included.

4.3 STORAGE DEMAND PROJECTIONS

Table 4-4 shows a summary of the 2041 projected storage requirements presented in the ISMP, which is calculated using the MDD and required fire flows.

Table 4-4 Storage Requirements (2041)

SYSTEM NAME	STORAGE REQUIRED (m^3)
Simcoe	7,325
Port Dover	4,833
Waterford	1,984
Delhi & Courtland	2,941 (Delhi) 908 (Courtland)
Port Rowan & St. Williams	1,659

5 GAP ANALYSIS

5.1 SYSTEM DEFICIENCIES

5.1.1 CURRENT AND PROJECTED SUPPLY DEFICIENCIES

The current production capacities of the water supply systems and the projected deficiencies of each community are summarized in Table 5-1. A summary of the approach, key concerns, and assumptions used to determine each value is presented in the following sections. Detailed descriptions on the existing infrastructure and current issues are presented in Section 3.1 and Section 3.3 respectively.

NOTE: All demands and capacities were rounded up for ease of calculation.

SURPLUS AND DEFICIENCY

The surplus or deficiency of a system is calculated as the difference between maximum day demand (MDD) and its firm capacity. The firm capacities shown in Table 5-1 are calculated using the current operating capacities provided by the County's operations staff to be more conservative and better reflect the existing situation.

RISK

Risk is the product of the probability of a situation occurring and the severity of the consequence. A high-level risk analysis was conducted to identify the communities that are at the highest risk of experiencing water supply deficits.

SIMCOE

Simcoe currently has sufficient firm supply capacity to meet its average day demand (ADD). However, during the maximum day demand (MDD), the County is required to draw into the emergency supply in the storage reservoir to meet its demands. Simcoe is at a high-risk of having insufficient water supply as its existing groundwater wells have limited capacity and have previously experienced challenges with contamination. Some wells have already been taken out of service due to water quality concerns and/or operational constraints. Efforts to find new groundwater supplies have generally been unsuccessful, although the County was conducting well pump testing in Northeast Simcoe at the time of writing. In 2020, Simcoe has a firm capacity of 7,200 m^3/d with a supply deficiency of 1,000 m^3/d. It is assumed that all wells which have previously experienced contamination will be removed from service by the end of 2022. This will reduce Simcoe's firm capacity to 3,700 m^3/d in 2023. Using the 2023 firm capacity as the base value, Simcoe is projected to have a production deficiency of 5,400 m^3/d by 2041. Simcoe system deficiencies are shown in Figure 5-1.

The County's staff indicated that there has been great interest in developments in Simcoe, which may potentially present a significant increase in demands. At the time of writing this report, confirmed demand increases were not available and have not been included.

PORT DOVER

Port Dover (PD) was assigned the highest risk rating of all the communities as it is already experiencing water supply deficiency under MDD conditions. Due to the lack of reliability of the existing PDWTP, Norfolk Council has implemented a "development freeze" in Port Dover as of September 2019.

The Port Dover WTP has sufficient firm capacity to meet ADD, but does not have sufficient firm capacity (2,500 m^3/d) nor installed capacity (5,000 m^3/d) to meet current MDD demands (5,700 m^3/d). This is primarily due to disinfection issues and insufficient high lift pumping capacity. Currently, MDD is met by

drawing down the Port Dover elevated tank using the emergency supply. The elevated tank also cannot be taken offline as it supplies backwash water for the Port Dover filters.

Previously, it was identified that the highest risk was associated with the single old clarifier that is expected to reach end of service life by 2022. WSP began a project to replace the clarifier with DAFs in 2020 with construction anticipated to complete in 2021. This will bring the clarification capacity to 7,300 m^3/d, however, the WTP will still be limited by the high lift pumping capacity. Port Dover system deficiencies are shown in Figure 5-2.

After high lift pumping capacity challenges are resolved, the filtration process at the Port Dover WTP should also be upgraded.

DELHI & COURTLAND

The Delhi/Courtland system is considered to be at low-risk. With the addition of the two (2) new wells (Well 3A and 3B), the Delhi system will have a supply surplus in both 2020 (1,500 m^3/d) and 2041 (1,400 m^3/d). However, there is only one transmission main supplying Courtland from Delhi. Failure of this transmission main would put Courtland's supply at risk, however, the ISMP did not recommend upgrades to this transmission main as Courtland has sufficient storage. Since Delhi does not have any deficiency, no graph was generated.

WATERFORD

Waterford is considered to be medium-high risk as both of its groundwater wells draw from the same GUDI aquifer. There is a risk that surface runoff may result in contamination of both wells. This would reduce Waterford's supply capacity to zero. Currently, Waterford has a firm capacity of 2,000 m^3/d and supply surplus of 200 m^3/d. The system is projected to have a deficiency of 200 m^3/d in 2041. Waterford system deficiencies are shown in Figure 5-3.

The County indicated that there is a potential for significant growth in Waterford, however, demand increase information was not available at the time of writing.

PORT ROWAN & ST. WILLIAMS

The Port Rowan WTP has a firm capacity of 1,765 m^3/d. Per the ISMP, the plant's production capacity is limited by its shallow intake (resulting in increased challenges from algae and high turbidity) and several treatment related factors. If these issues are resolved and the plant can operate at its DWWP rated capacity of 3,040 m^3/d, the Port Rowan & St Williams system will not have any deficiencies in 2041. For the purposes of this study, Port Rowan is assumed to have a deficiency of 600 m^3/d in 2041 and is rated medium risk in Table 5-1.

The St. Williams community is supplied by a single transmission main from Port Rowan. Failure of this transmission main would result in loss of supply to the St. Williams community. However, St. Williams has sufficient storage capacity and according to the ISMP, with an enhanced response time/program to a watermain break, the risk with this matter can be mitigated.

Table 5-1 Water Supply Deficiencies

HORIZON	BASE YEAR 2020			2020		2041			
Communities	Capacity			**Demands**	**Surplus or (Deficiency)[1]**	**Demands**	**Surplus or (Deficiency)[5]**	**Concerns / Issues**	**Risk**
Unit: m3/d	**Installed**	**Operational**	**Firm**	**MDD**		**MDD**			
Simcoe	17,000	9,900	7,200 (3,700 in Year 2023)[2]	8,200	(1,000)	9,100	(5,400)[2]	Groundwater/aquifers are at risk of contamination and/or operational difficulties. Some wells have already been taken out of service to ensure water quality and safety. Existing wells have limited capacity. Historically, the County has been unsuccessful in finding additional groundwater supplies. There is also potential for significant demand increase in Simcoe.	**High**
Port Dover	5,000	5,000	2,500[3]	5,700	(3,200)	7,300	(4,800)[3]	Port Dover WTP operates below rated capacity (2.5 MLD vs 7.5 MLD) due to limitations in unit process capacity and disinfection issues. Backwash water is provided by the elevated tank. If the elevated tank is shut down, Port Dover system capacity would also drop to zero. There have also been structural challenges with the existing filters. Development Freeze - in effect as of 2019.	**High High**
Waterford	5,875	3,900	2,000	1,800	200	2,200	(200)	Both wells draw from one aquifer which is at risk of contamination from surface runoff. If aquifer becomes contaminated, Waterford supply capacity would be zero. There is also potential for significant demand increase.	**Medium High**
Delhi & Courtland	7,900	6,800[4]	4,500[4]	3,000	1,500	3,100	1,400	Existing Delhi Surface WTP to be decommissioned.	**Low**
Port Rowan & St. Williams	3,300	3,300	1,700	1,800	(100)	2,300	(600)	Shallow intake impacts WTP performance and limits its capacity. Algae is also a growing concern.	**Medium**
Total	**39,075**	**28,900**	**17,900**	**20,500**	**(2,600)**	**24,000**	**(12,100)**	**County-wide system does not meet current or future demands.**	

1 Although deficiency in supply has been identified in Simcoe, Port Dover & Port Rowan based on MDD, it is important to note that for those days the County is required to draw from the available storage facilities. However, in case of a fire incident, or watermain break on the same day, the community would be at risk of not having sufficient water supply (as described above).
2 See Simcoe section above.
3 See Port Dover section above.
4 See Port Rowan & St. Williams section above.
5 Surplus (Deficiency) = Firm Capacity in 2020 – MDD in 2041. Numbers shown in parentheses represent deficiency in supply. With respect to Port Dover & Simcoe, their firm capacity in 2023 was used.

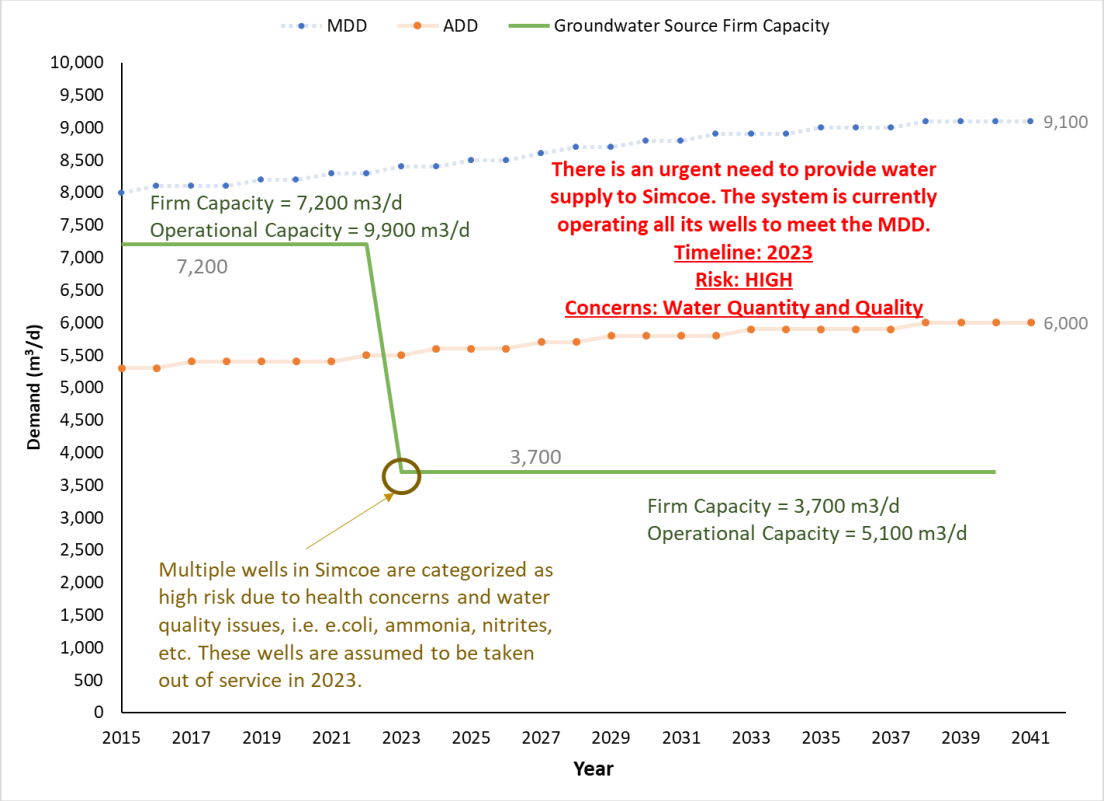


Figure 5-1 Simcoe Water System Analysis - Demand and Capacities vs Time

Figure 5-2 Port Dover Water System Analysis - Demand and Capacities vs Time

Figure 5-3 Waterford Water System Analysis – Demand and Capacities vs Time

5.1.2 CURRENT AND PROJECTED STORAGE DEFICIENCIES

The current and projected storage deficiencies are shown in Table 5-2. It is assumed that there have been no changes in storage capacity since the ISMP was published. A summary of the key concepts, assumptions, and recommendations is presented in the following section.

USEABLE STORAGE

Per the ISMP, "Useable" storage is defined as the capacity that can be discharged from an in-ground reservoir beyond the well or treatment plant input, plus the top 10 m of any gravity (elevated) storage. Storage facilities that do not have the pumping capacity to discharge more than their input are considered to have a useable storage of zero.

SIMCOE

Simcoe has an existing storage deficiency of 3,574 m^3. WSP calculated the projected 2041 deficiency by taking the difference between the existing total useable capacity and the 2041 storage requirement shown in the ISMP. This resulted in a projected deficiency of 3,916 m^3, which is a slightly higher than the deficiency presented in the ISMP (3,751 m^3). The difference in negligible; however, this value should be confirmed by the County.

The ISMP suggests that the storage deficiency can be rectified by providing additional high lift pumping (HLP) capacity at the Cedar Street and Northwest Reservoirs. This assumes that no structural upgrades are required to meet the storage requirements of Simcoe. Currently, the useable volume of both reservoirs is zero. The ISMP proposes to increase the Cedar St. HLPs capacity from 157 L/s to 185 L/s and the Northwest HLPs capacity from 52 L/s to 164 L/s.

PORT DOVER

The ISMP notes that Port Dover elevated tank (ET) has a useable volume of 4,500 m^3. However, ET's shop drawing indicates that elevated tank has useable volume of 5,000 m^3; the County should confirm the useable storage. In either case, Port Dover has sufficient capacity for current demands and may have a small surplus for 2041. The ISMP did not recommend additional storage be installed. However, the current elevated tank cannot be taken offline as it is used to backwash the filters at the Port Dover WTP.

DELHI & COURTLAND

Delhi and Courtland have separate storage facilities. The two communities are anticipated to have storage deficiencies of 1,994 m^3 and 28 m^3, respectively, in 2041. The ISMP notes that the Delhi deficiency can be resolved by two pumps (1+1) at the base of the standpipe, in the existing pumping station structure. During the review meeting in December 2019, the County noted that no storage upgrades have been performed in Delhi. The ISMP did not provide a recommendation for the Courtland system. However, it is noted that current firm capacity of the Courtland facility does not meet maximum day plus fire flow demand.

WATERFORD

In 2041, Waterford will have storage deficiency of 1,327 m^3 as its standpipe has a relatively small capacity. The ISMP recommended adding a new booster station at the base of its existing standpipe. During the review meeting in December 2019, the County noted that no storage upgrades have been performed in Waterford.

PORT ROWAN & ST. WILLIAMS

Port Rowan has a storage surplus and no additional storage is recommended at this time.

Overall, once the short-term recommendations from the ISMP has been implemented, storage deficiency does not appear to be an issue. All communities have a local floating storage, which helps maintain the pressure throughout the system and be used in emergency situations.

Table 5-2 Water Storage Deficiencies

COMMUNITY	STORAGE TYPE	BASE YEAR: 2020		2020		2041	
Unit: m^3		Total storage available	Total useable storage	Requirement	Surplus or (Deficiency)	Requirement	Surplus or (Deficiency)
Simcoe	Elevated Tank + Cedar Reservoir + Northwest Reservoir	12,409	3,409	6,983	(3,574)	7,325	(3,916)[1]
Port Dover	Elevated Tank	5,000	4,500[2]	4,239	261	4,833	(333)
Waterford	Stand Pipe	2,700	657	1,648	(991)	1,984	(1,327)
Delhi & Courtland	Stand Pipe + Courtland Reservoir	3,955 (Delhi) 1,077 (Courtland)	947 (Delhi) 880 (Courtland)	2,906 (Delhi) 902 (Courtland)	(1,959) Delhi (22) Courtland	2,941 (Delhi) 908 (Courtland)	(1,994) Delhi (28) Courtland
Port Rowan & St. Williams	Elevated Tank	1,816	1600	1,295	305	1,659	(59)

1 ISMP storage deficiency for Simcoe in 2041 is 3,751 m^3. See description above.

2 Shop drawings indicate the total useable volume of the Port Dover ET is 5,000 m^3.

5.2 IMPACT OF BLENDING AND CHANGING WATER SOURCES

5.2.1 BLENDING

Due to population growth and resultant water demand increase, many municipalities are finding it difficult to provide required flows using a single source. For groundwater systems such as those used in Norfolk County, excessive depletion of the aquifer may also result in negative impacts to associated surface water bodies. As a result, source water blending has become an increasingly common practice in recent years.

Municipalities may blend raw water or treated water from multiple sources of different types, or from multiple sources of the same type. Using blended water increases the total available supply, and potentially also increases the system's operational flexibility and resiliency to climate change. However, the chemical equilibrium may shift when introducing water with different chemistries, and the new equilibrium may be incompatible with the characteristics of the boundary layer along the pipe walls. This is a common challenge in systems that blend multiple types of sources (ex. groundwater with surface water). As a result, blended waters are typically of lower quality than single sourced water (Lovins III etc., 2005).

Municipalities may also choose to blend treated waters of the same source type (ex. surface water from two different treatment plants). In this case, the treatment process and the chemicals added should be reviewed to determine whether introducing finished water from a different WTP will negatively impact the distribution system.

POTENTIAL WATER QUALITY CHARACTERISTICS IMPACTED

Blending can impact a number of water quality characteristics. These are summarized in Table 5-3. In general, blending raw waters together prior to treatment is preferable for process control. If treated waters are to be blended, mixing waters with similar water qualities (i.e. same source type and similar treatment process) will likely have less impact on water quality than blending waters with significantly different water chemistries.

Table 5-3 Potential Impact of Blending on Water Quality Characteristics

WATER QUALITY CHARACTERISTIC	DESCRIPTION
Disinfectant residual and bacterial count	Blending multiple source types may result in a loss of disinfectant residual and subsequent bacterial growth. In a case study of the Pinellas County Utilities system (III, Duranceau, Powell, & Voorhees, 2005), it was found that blending sources resulted in an increase of total coliforms and heterotrophic plate counts (HPC). This problem may be aggravated if the sources use different types of disinfectants (such as blending chloraminated and chlorinated water).
Suspended solids	Solids may become resuspended during flow reversal and turbidity may increase. Flow reversal may occur in blending zones where different sources meet.
Taste and odour	There may be an increase in taste and odour (T&O) complaints due to chemical and/or biological reactions. T&O issues are more pronounced in cast iron piping.

WATER QUALITY CHARACTERISTIC	DESCRIPTION
Water temperature	Blending can be useful in lowering water temperature to prevent bacterial growth. However, the difference in temperature should be controlled to prevent pipe bursting (Pearson & Singer, 1973).
pH and corrosivity	pH and corrosivity are primary concerns as they impact pipe wall corrosion and/or pipe material leaching. Groundwater typically has a higher alkalinity, hardness, and pH than surface waters. When the two are blended, the overall distribution system alkalinity and pH changes. This has been found to impact the release of copper, lead, and iron from pipe walls. Different pipe materials have different requirements to prevent leaching. For example, high alkalinity has been found to increase corrosion of copper and lead pipes but decrease corrosion of iron pipes (Imran, et al., 2006). Cast iron pipes are generally of a greater concern for pipe material leaching compared to PVC and cement (including both cement pipes and cement lined ductile iron pipes). Cast iron pipes are also prone to tuberculation, and the corrosion deposits on pipe walls have been found to increase biofilm growth and contribute to disinfection residual decay. Use of pH control and corrosion inhibitors should be reviewed if treated waters are to be blended. Corrosion inhibitors such as ortho- and poly-phosphates are typically more effective at higher pH values thus pH adjustment is often performed together for corrosion control. If two treated waters are blended and the overall pH is lowered, corrosion inhibitors may become less effective.

5.2.2 CHANGING SOURCE WATERS

Impacts on water quality described in Table 5-3 may also occur if changing to a new water source. However, water quality will generally stabilize after the transition is complete and a new chemical equilibrium is established between the pipe walls and finished water.

5.2.3 MONITORING AND CONTROL

Prior to utilizing blended sources or changing source waters, it is recommended that the County perform a thorough analysis to identify potential water quality concerns. This involves water quality studies, corrosion control studies, and bench testing. These studies will help determine the impact of the new or blended water on the end customer's water quality, optimal blending ratios, pipe corrosion concerns and whether corrosion inhibitors should be added to the treatment process. **Water quality analysis is particularly important if the distribution system contains lead pipes as blending or changing source waters may change corrosivity and result in pipe material leaching.**

When blending, a key parameter to control is the relative proportion of the blended sources. The ratio of the blended sources should be maintained at a constant value to minimize fluctuations in water chemistry. If the blending ratios fluctuate constantly, it will be difficult for the blended water to reach chemical equilibrium. When blending treated water, it is preferable for blending to occur inside a controlled environment, such as within a reservoir, rather than within the distribution system as this allows the operator to make process adjustments as needed. Adjustments can include changing the blending ratio, pH or alkalinity control, or boosting disinfectant residual. Flow monitoring and various control systems will be needed, and flow and blending schedules should also be considered. In addition, water temperature, hydraulics and water age should also be monitored.

Swabbing and flushing should be undertaken before commissioning the blended or new supply. This will help remove legacy biofilm and minimize the negative microbial impact on water quality. Additional monitoring and flushing may be required when using a blended source, or during the initial transition phase when a new source water is introduced.

6 Project objectives

6.1 DEFINITION OF PROBLEM OR OPPORTUNITY

Upon review of the supporting documentation, the problem statement is defined as:

"To provide safe, reliable and secure water supply with appropriate redundancies in all communities, supporting growth to 2041"

The Inter-Urban Water Supply project was initiated to address some of the recommendations proposed in the ISMP in 2016. This IUWS study will identify the preferred approach to address the existing system issues such as unreliability of groundwater sources, insufficient overall storage, inadequate fire protection, insufficient pressure in some areas, lost capacity at the surface WTPs and groundwater sources, and the inability to service future development. The focus of the project is to secure water supply to all Norfolk County customers through establishing a network of water transmission facilities to interconnect all five urban areas:

- Port Dover – Simcoe
- Port Dover – Port Rowan & St. Williams (in some cases)
- Delhi & Courtland – Simcoe
- Waterford – Simcoe

6.2 STUDY OBJECTIVES

The objectives of this project are to identify the infrastructure requirement to:

- Ensure acceptable Levels of Service are maintained throughout the system (i.e. pressures, fire flows)
- Improve the reliability and robustness of the system by providing redundancy of supply (if possible), floating storage and standby power
- Assess and include the need for any intermediate pump stations, storage and re-chlorination. It is understood that the need for fluoridation will be analyzed further for Simcoe and Delhi. Per the RFP document, Delhi and Simcoe are the only communities that currently fluoridate their treated water. Since Delhi supplies water to Courtland as well, a total of three communities have fluoridated water.
- Identify alternatives to interconnect water supply system in Norfolk County and to eliminate dependence on groundwater.
- Investigate possibility of having one central lake-based supply from Port Dover or adjacent municipality e.g. Haldimand County or Elgin Area, to reduce dependency on groundwater supplies. Following additional discussions, the County would also like to investigate the possibility of having two lake based Water Treatment Plants, one in Port Dover and one in Port Rowan. This option has been added to the scope of the project and will be evaluated as one of the potential alternatives.
- Redistribution of water treatment capacity in different communities to allow offsetting the risk associated with communities at high risk of water infrastructure failure or with projected deficiency in 2041 per ISMP.

7 Alternative solutions

7.1 APPROACH AND CRITERIA FOR SHORTLISTING

The following approach was used to establish and compare different alternatives:

1. Pre-determine a list of criteria for shortlisting alternatives.
2. Establish a long list of alternatives.
3. Compare the long list of alternatives against the pre-determined criteria to determine the alternatives that warrant further analysis.

The following criteria were considered during a preliminary evaluation before proceeding to shortlisting:

- Can the alternative resolve the issues in communities with high-high, high, and medium-high risks?
- Does the alternative provide a county-wide solution?
- Is the cost of the alternative in the same rough order of magnitude (ROM) as other alternatives or is the alternative significantly more expensive?

The Long List of Alternatives (Section 7.2) presents a high-level overview of the proposed upgrades and the rationale behind each alternative. After the preliminary evaluation, six alternatives were shortlisted (Section 7.3) for a more in-depth assessment of:

- Timeline
- Cost
- Ability to resolve current issues and adaptability to mitigate future issues/risks
- Source water blending

7.2 LONG LIST OF ALTERNATIVES

To establish the potential solutions, three (3) main alternatives were first developed, each presenting a different water supply source. Water can be supplied from within Norfolk County (Alternative 1 – County owned system) or purchased from Haldimand County (Alternative 2) or Elgin County (Alternative 3). Then, multiple sub-alternatives were developed within each alternative to define or justify how water is being supplied and distributed. The long list of these alternatives is presented in Table 7-1.

For all alternatives, Municipal Class Environmental Assessment studies (Municipal Class EA – Schedule B and potentially Schedule C) and amendments to the Norfolk County Master Plan will be required. If County is to implement a County-Wide solution, amendment to the ISMP is potentially required to revise the long-term solution proposed by the ISMP, i.e. Local System Upgrades. It should also be noted that in all alternatives, the recommended upgrades to local storage and distribution systems are assumed to be required and would have to be implemented as per the ISMP.

Table 7-1 Long List of Alternatives

ALTERNATIVE	DESCRIPTION
Alternative 1 - Supply from Norfolk County (Complete)	
Alt 1.0	Existing infrastructure upgrades without interconnection
Alt 1.1	Port Dover WTP Upgrades + Local Supplies/Upgrades per ISMP
Alt 1.2	Centralized WTP in Port Dover to Service all County Communities (24 MLD)
Alt 1.3	Two lake-based WTPs with interconnection
Alternative 2 - Supply from Haldimand County (Partial or Complete)	
Alt 2.0	Supply Raw Water Only with Local Treatment in Norfolk County
Alt 2.1	Nanticoke WTP Upgrade to Meet Port Dover Demands Only
Alt 2.2	Nanticoke WTP Upgrade to Meet Port Dover + Simcoe + Waterford Demands. One Connection: Nanticoke to Port Dover
Alt 2.3	Nanticoke WTP Upgrade to Meet Port Dover + Simcoe + Waterford Demands. Two Connections: Nanticoke to Port Dover and Townsend to Simcoe
Alt 2.4	Port Dover WTP Upgrade to Meet Current Demand Nanticoke WTP Upgrade to Meet Simcoe + Waterford Demands - Future expansion to include Port Dover Two Connections: Townsend to Simcoe and Nanticoke to Port Dover
Alt 2.5	Nanticoke WTP Upgrade to Meet All Norfolk County Future Demands Two Connections: Townsend to Simcoe and Nanticoke to Port Dover
Alternative 3 - Supply from Elgin Area WSS (Partial or Complete)	
Alt 3.0	Supply Raw Water Only with Local Treatment in Norfolk County
Alt 3.1	Elgin Area WSS Upgrade to Meet All Norfolk County Future Demands
Alt 3.2	Connecting Elgin Area WSS to Meet Port Rowan Demands Only and Upgrade Port Dover or Nanticoke WTPs to Meet other Demands

ASSUMPTIONS

The following assumptions apply to all alternatives:

Norfolk Water Treatment Plants and Groundwater Wells

- The Port Rowan and Delhi water supply systems are assumed to be self sustaining and having the capability to supply their demands (see Section 5.1.1), except for centralized supply options i.e. Alternatives 1.2, 2.5 and 3.1. Port Rowan WTP has multiple issues, however upgrading the plant to restore its firm capacity to its licence rated capacity would be sufficient to meet the local community's demands.
- The new Delhi wells (3A and 3B) commissioned in 2020 are included in capacity calculations (see Section 3.1.3).

- The new test wells in North East side of Simcoe were not included in the calculation for firm capacity of Simcoe. It was also assumed that Simcoe wells which are prone to contamination will be taken out of service by the end of 2022. Simcoe's firm supply capacity in 2023 is assumed to be 3,700 m^3/d (see Section 3.1.2 and Section 5.1.1).

Nanticoke WTP

- The Nanticoke WTP in Haldimand County has a rated capacity 13,636 m^3/d.
- Upgrades at Nanticoke WTP are expected to provide a maximum possible firm capacity of 43,000m^3/d. For details on upgrades required, see Section 7.2.5.
- Haldimand County indicated that its projected 2041 MDD is 22,000 m^3/d, which includes 20,000 m^3/d for Haldimand proper (Jarvis, Hagersville, Caledonia, Cayuga and the Lake Erie Industrial Park) and a new 2,000 m^3/d connection to Six Nations. The timeline for the new connection and annual projected demand increases were not provided.
- The Nanticoke WTP can supply 2,800 m^3/d to Norfolk County from 2021 until upgrades are completed at the Nanticoke WTP.
    - This value was retrieved from rate study conducted by Watson & Associates Economists Ltd. ("Watson") for a Haldimand – Norfolk regional supply in 2020, and confirmed with Norfolk County staff.
- WSP estimates that the Nanticoke WTP can achieve 43,000 m^3/d firm capacity by 2028, whereas the Watson's report appears to have estimated that this capacity can be achieved by 2024. WSP selected a more conservative value due to the extensive upgrades required and to provide the County one year of buffer to finalize any water servicing related decisions. For all subsequent analyses, it is assumed that Nanticoke WTP can supply 2,800 m^3/d to Norfolk County from 2021 until 2028.
- Nanticoke WTP Expansion Class EA Schedule C has expired. A new or amended one is required.

Class EA Procedures and Timelines

- Any work relating to water servicing strategy upgrades (Class EAs etc.) will begin is 2022. This provides the County a buffer period to finalize any financial or jurisdiction related decisions.
- Per Municipal Engineers Association Municipal Class Environmental Assessment (MCEA) procedures, municipalities should review and update their master plans every five years and/or when major changes occur to changes of the Master Plan. Hence, Norfolk County should review and update the ISMP for all alternatives. The estimated timeline for master plan updates is 2022 – 2023.
- The timeline to design & construct any water transmission mains is assumed to be 3 years.
- All proposed water transmission mains are assumed to be routed along existing right of ways, i.e. no land acquisition is required and therefore, fall under Class EA Schedule A/A+
- It is assumed that any water treatment plant expansion beyond its rated capacity requires Class EA Schedule C.
- It is assumed that construction of any booster stations and storage infrastructure requires Class EA Schedule B.
- Any and all Class EA requirements can be completed within the same timeframe as Master Plan amendments (2022-2023).

7.2.1 ALTERNATIVE 1.0 – EXISTING INFRASTRUCTURE UPGRADES WITHOUT INTERCONNECTION

This alternative recommends upgrading the water systems of all communities per the ISMP's "Multiple Upgrade" option. Each community will continue to operate independently. The key water supply infrastructure upgrades recommended in the ISMP include:

- Construct a new well to the Northeast of Simcoe. At the time of writing, the County was in the process of conducting a seven day well test and production yields had not yet been confirmed. To be conservative, the capacity of the proposed northeast wells have not been included in capacity calculations. In general, the County has had significant difficulty both in locating new groundwater wells with sufficient capacity, and in obtaining regulatory approval for drilling new wells.
- Urgent upgrades to the Port Dover WTP, including upgrades to the disinfection process, clarification process, and the plant intake to increase the WTP's firm capacity. The County rehabilitated the clarifier in 2017, but the other proposed upgrades have been on hold to focus on clarification issues. As discussed in Section 3.1.2, WSP initiated a project to increase the Port Dover WTP capacity; however, this project has been postponed. The ISMP also recommends connecting Port Dover WTP to Simcoe; however, this is not feasible without the Port Dover WTP upgrades as neither system has significant supply surplus.
- Develop a new well with adequate firm capacity to meet Delhi's MDD. Two (2) new wells were commissioned in 2020. (see Section 3.1.3).
- Deepen the Port Rowan intake and upgrade the Port Rowan WTP to better handle algae blooms. The County has yet to perform this upgrade.
- Upgrades in local distribution systems to provide sufficient fire flow and pressure.

The projected firm capacity and surplus/deficiency following the recommended upgrades by ISMP is shown in Table 7-2. The assumed 2023 firm capacities are used for Simcoe and Port Dover calculations (see Sections 3.1 and 5.1.1). This deficiency/surplus was calculated assuming no upgrades to either Port Dover or Port Rowan WTPs and no additional wells in Simcoe.

Table 7-2 Alternative 1.0 Projected Flows with Proposed Local Upgrades

COMMUNITY	FIRM CAPACITY POST UPGRADES IN 2020 (M^3/D)	PROJECTED SURPLUS/DEFICIENCY IN 2041 (M^3/D)
Simcoe	3,700	-5,400
Port Dover	0	-7,300
Waterford	2,000	-200
Delhi & Courtland	4,500	1,400
Port Rowan & St. Williams	1,700	-600

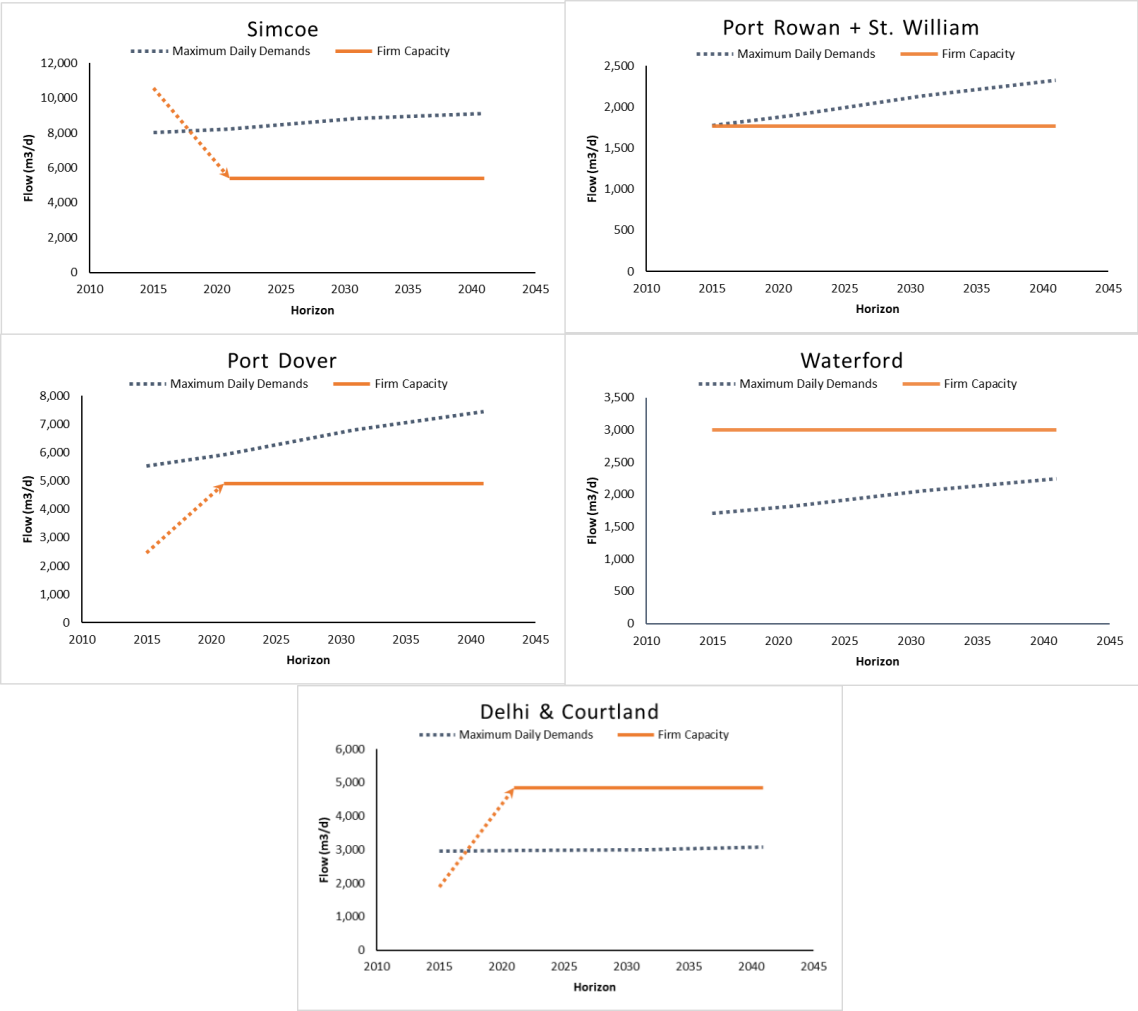


Figure 7-1 Alternative 1.1 - Maximum Daily Demands and Firm Capacity Analysis

As seen in Figure 7-1, this option will not resolve the supply deficiency in Simcoe, Port Dover, or Waterford. Even with the upgrades, the local plants/sources cannot still meet their own demands. Groundwater dependence is not eliminated in any community. As such, this option was not considered further.

7.2.2 ALTERNATIVE 1.1 – PORT DOVER WTP UPGRADES TO SUPPLY DEFICIENCES IN OTHER COMMUNITIES + INTERCONNECTION + LOCAL UPGRADES

Alternative 1.1 suggests upgrading the Port Dover WTP to supply the local MDD, and to provide supplemental flow to Simcoe and Waterford. Both groundwater systems, in addition to the Delhi wells, would remain online. The Port Dover WTP would require a firm capacity increase to 11,720 m^3/d. This was calculated by summing the 2041 supply surplus/deficiencies of Simcoe, Waterford, Delhi, and Port Dover seen in Table 5-1. The proposed interconnection is shown in Figure 7-2. Port Rowan is excluded from the interconnection as it is very far from both Delhi and Port Dover (approximately 32km to 35km to either community) and the connection is cost prohibitive. It is recommended to upgrade the Port Rowan WTP to its DWWP rated capacity (3,040 m^3/d) so that the Port Rowan & St. Williams system can be self sufficient. They have sufficient local floating storage and therefore can operate independently.

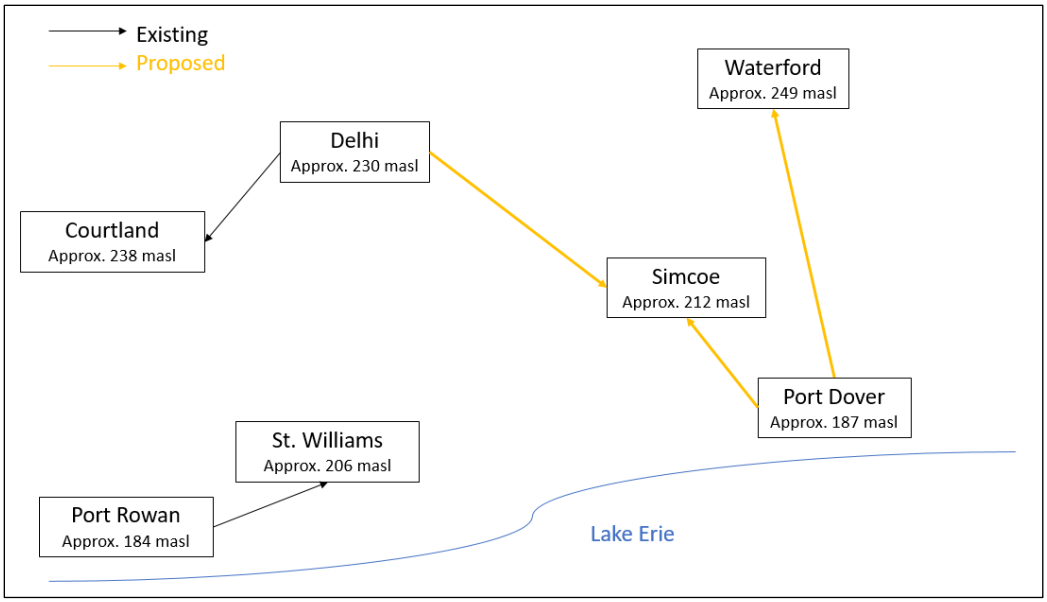


Figure 7-2 Alternative 1.1 High-Level Presentation of the Proposed Interconnection

The projected increase in firm capacity and surplus/deficiency following the recommended upgrades is shown in Table 7-3. The assumed 2023 firm capacities were used for Simcoe and Port Dover calculations (see Sections 3.1 and 5.1.1).

Table 7-3 Alternative 1.1 Projected Flows with Proposed Upgrades

COMMUNITY	FIRM CAPACITY POST UPGRADES IN 2020 (M^3/D)	PROJECTED SURPLUS/DEFICIENCY IN 2041 (M^3/D)
Simcoe	3,700	-5,400
Port Dover	0	-7,300
Waterford	2,000	-200
Delhi & Courtland	4,500	1,400
Port Rowan & St. Williams	1,700	0[1]
Total	**11,900**	**-11,720**
Port Dover WTP Proposed Firm Capacity	**11,720**	**System deficiency → 0**

1 See above.

Figure 7-3 compares the cumulative maximum day demand in each horizon for Norfolk County communities (interconnected). As shown, Port Dover WTP would need to be upgraded to 11,720 m^3/d to meet all demands.

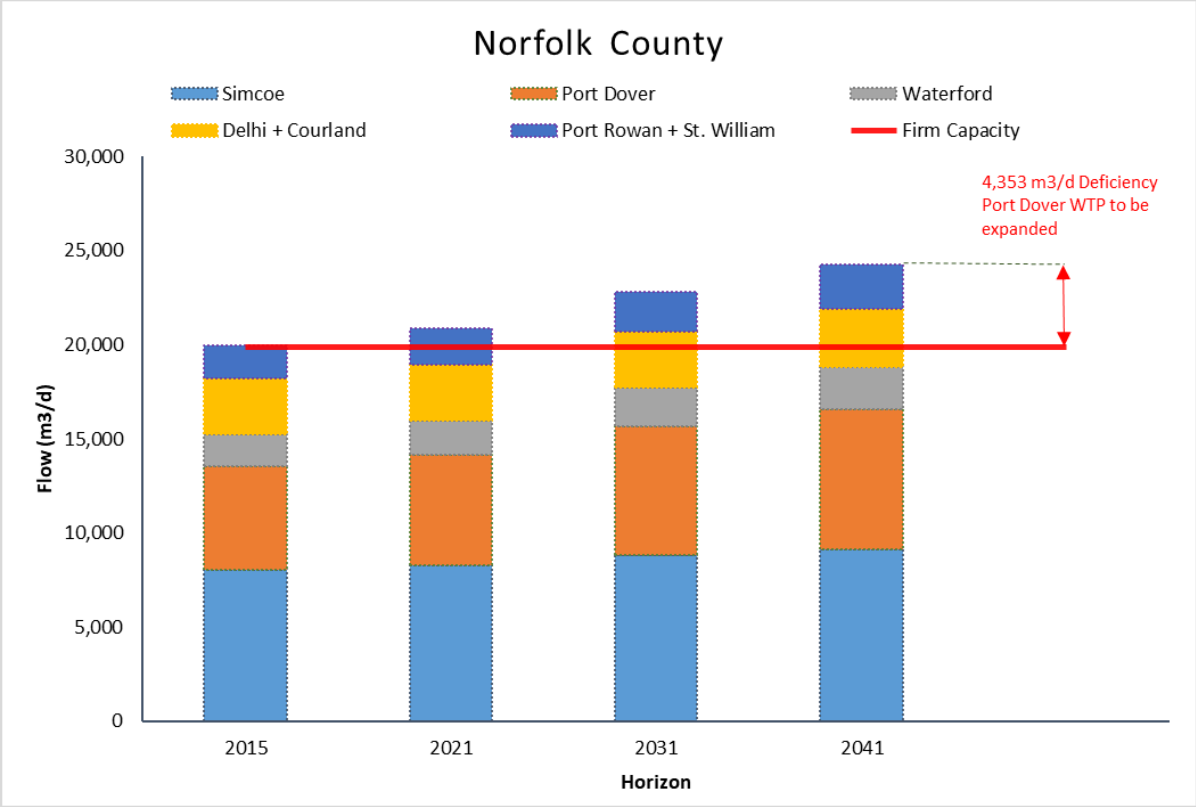


Figure 7-3 Alternative 1.1 Projected MDD and Supply Capacity

This alternative provides Simcoe and Waterford with supply redundancy. However, both communities would still be dependent on groundwater sources that are highly unreliable and are prone to contamination. Both communities would also be using a blended supply i.e. blending surface water with groundwater. As discussed in Section 5.2, blending often results in significant water quality challenges due to the highly different characteristics between surface water and groundwater. Changing the source water may also incur a negative impact on the aging piping, however there are measures that can be taken to reduce the impact.

7.2.3 ALTERNATIVE 1.2 – CENTRALIZED WTP IN PORT DOVER TO SERVICE ALL COUNTY COMMUNITIES (24 MLD) + INTERCONNECTIONS

This alternative aligns with the ISMP's "County-Wide System Alternative". One of the proposed options in the ISMP was to construct a new WTP in Port Dover with sufficient supply capacity to meet the 2041 demands of all communities in the County. The proposed location of the WTP was on Blueline Road between Radical Road and Highway 6. The new intake and low lift pump station were located at the south end of Blueline Road. However, this option was not considered at the time due to its high upfront capital cost.

Once all communities are interconnected, a review of the 2041 maximum day demands (MDD) for the County results in a total required supply capacity of approximately 24,000 m^3/d (24 MLD), with an average day demand (ADD) of 13,200 m^3/d.

Table 7-4 Alternative 1.2 - 2041 Demand Requirement for Norfolk County

YEAR	2041		
Community	**Population**	**Average Day Demand** (m^3/d)	**Maximum Day Demand** (m^3/d)
Simcoe	17,380	6,000	9,100
Port Dover	9,640	3,500	7,300
Waterford	4,970	1,200	2,200
Delhi & Courtland	6,430	1,600	3,100
Port Rowan & St. Williams	2,620	1,000	2,300
Total	**41,040**	**13,200**	**24,000**

In this alternative, the centralized plant is expected to be located in Port Dover. Following consultation with the County's project team, the following three sites were proposed for the new Centralized Lake-Based WTP:

- Within the same property as the water tower and WWTP. The County noted that this property is in Port Dover West and additional land may need to be purchased for the WTP, low lift station, and intake.

- ISMP preferred location: Blueline Rd. between Hwy 6 and Radical Rd. There will be many developments happening in this area, however, there is no sewer network there. The wastewater collection system will need to be extended to the site to receive backwash and other plant flows (on-site equalization and residue management to reduce loadings to the WWTP would be considered in any further development of this site).

- Parkette located in front of the existing Port Dover WTP – 603 Nelson St.

- It should be noted that all utility corridors are owned by the County. Currently, the County does not own any railways between Simcoe and Waterford.

Figure 7-4 is a high-level presentation of the proposed interconnection between the communities.

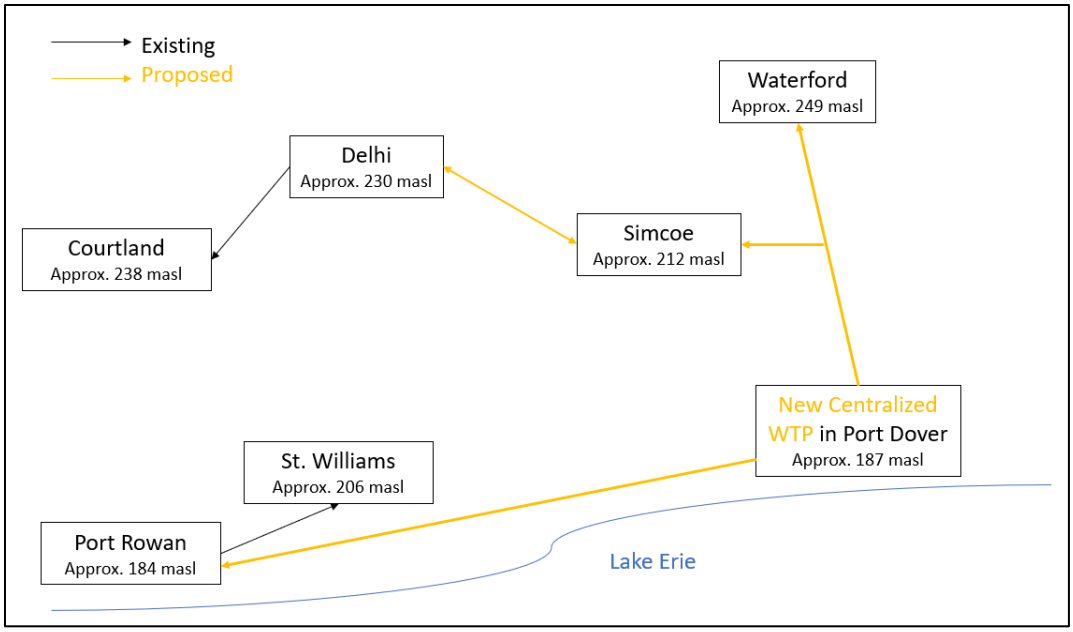


Figure 7-4 Alternative 1.2 - High-Level Presentation of the Proposed Interconnection

In this alternative, the new Centralized WTP will supply the demands in all communities. The existing Port Dover and Port Rowan WTPs, and the groundwater systems in Simcoe and Waterford will be all be decommissioned. The Delhi groundwater system can remain online as it provides good water quality and quantity. However, it should only be used as an emergency supply as blending the two sources will likely result in water quality issues. This option allows the County to eventually decommission the Delhi groundwater system, if desired. The proposed interconnection can potentially allow Waterford to back feed Port Dover using its emergency storage supply if needed.

HYDRAULIC ANALYSIS

This alternative will reduce the need of community specific upgrades for existing facilities, and remove the operation of most groundwater wells and treatment systems. This alternative provides interconnection to service the ADD, MDD and MDD+FF for each community to reduce storage and boosting requirements. However, these should be considered to maintain level of service (LOS). Technical servicing considerations for each community is as follows:

- Port Dover – A new WTP with 24 MLD firm capacity is required to resolve current deficiencies. The new high lift pumps should be suitable to provide ADD, MDD, and MDD+FF LOS to multiple communities. New min. 400 mm diameter watermains are to be constructed between Port Dover-Simcoe and Port Dover-Port Rowan, in addition to dedicated interconnections from Port Dover-Waterford and Port Dover-Delhi via boosting at Simcoe. The interconnected piping is to be connected to existing facilities or to new dedicated booster stations with reservoirs. This is due to the fact that treated water cannot flow from Simcoe to Port Dover due to the presence of fluoride in Simcoe water. Similarly, Waterford cannot be supplied by Simcoe water. Therefore, practically Simcoe cannot supply to any community except Delhi.
- Port Rowan – The existing Port Rowan WTP is to be decommissioned. A new min. 400 mm diameter interconnection between Port Dover-Port Rowan is required to provide supply and domestic service for ADD, MDD and MDD+FF. A local reservoir/booster station may be installed at the existing WTP site, or at a new site, to provide the local MDD+FF storage and to maintain local distribution LOS.
- Delhi & Courtland – A new min.400 mm diameter interconnection supply from Port Dover/Simcoe is required to provide the local community with ADD, MDD and MDD+FF LOS. Local storage facilities should be optimized for MDD+FF LOS. Twinning of the Delhi-Courtland

interconnection would provide redundancy of service for Courtland as well as the new Simcoe-Delhi interconnection. However, twinning is not recommended at this time per ISMP. The groundwater system may be decommissioned in the future. Upgrades to existing Courtland reservoir/booster station are recommended.

- Simcoe – The groundwater wells are to be decommissioned. The interconnection between Port Dover/Simcoe and Simcoe/Waterford will provide supply redundancy to Simcoe. Treatment upgrades are required to re-chlorinate and fluoridate water (for Simcoe) received from Port Dover and Waterford. The treatment upgrades can be implemented at the existing Northwest WTP, or at a new facility. Source water from Port Dover may be shared between Delhi, Courtland and Simcoe through a new min.400 mm diameter interconnection to service MDD+FF LOS. Alternatively, the Port Dover feed may be used to service only MDD conditions, and the MDD+FF LOS can be provided by the local community storage facilities.
- Waterford – The groundwater system is to be decommissioned. The ADD, MDD, and MDD+FF LOS in Waterford will be provided by the Port Dover WTP. Upgrades to the Waterford boosting and/or storage facilities should be considered to maintain MDD + FF LOS in the local community.

Refer to Appendix B for an overview map of the infrastructure alternatives.

Additional Considerations – Interconnection provides redundancy between communities; however, systems become dependent on dedicated interconnected supply. Transmission main twinning will provide additional redundancy. An operational strategy focused on water cycling will address water age concerns within storage facilities.

7.2.4 ALTERNATIVE 1.3 – TWO LAKE-BASED WTPS WITH INTERCONNECTION

Following consultation with County's staff, a review of Port Rowan as one of the potential sources of supply was deemed beneficial and therefore was added to the long-list of alternatives for evaluation. In this alternative, the two lake-based WTPs refer to Port Dover and Port Rowan WTPs.

Figure 7-5 is a high-level presentation of the proposed interconnection between the communities.

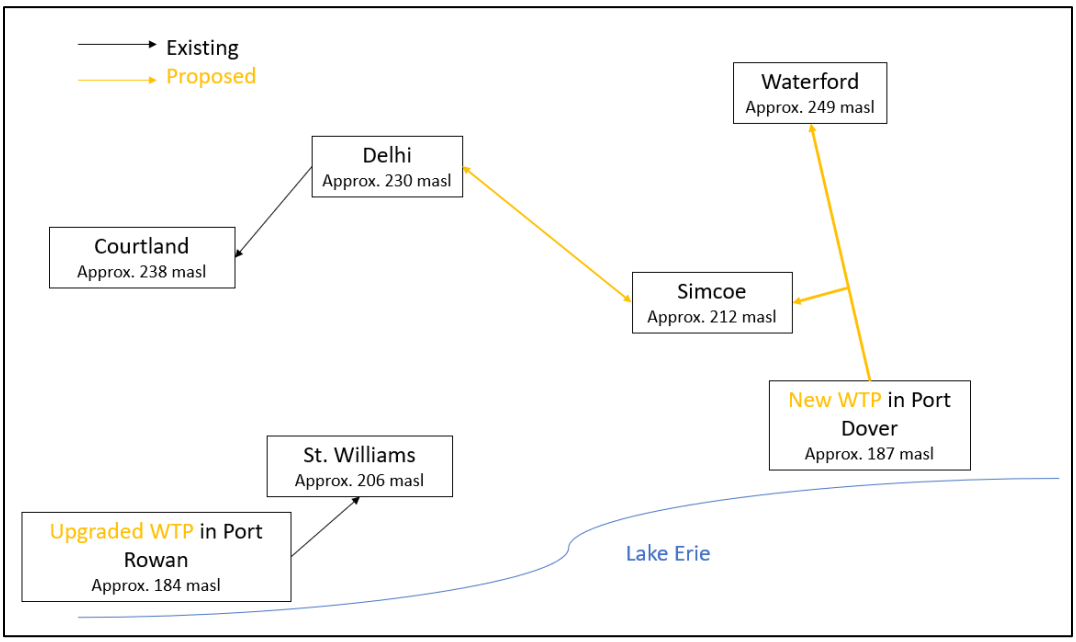


Figure 7-5 Alternative 1.3 - High-Level Presentation of the Proposed Interconnection

This alternative suggests using Port Dover WTP to supply to all communities except Port Rowan. As previously discussed in Section 7.2.2, Port Rowan is far from the other communities and interconnection is cost prohibitive. Port Rowan has an existing WTP and a storage facility, thus it has no need for an additional source. The Port Rowan WTP will be upgraded to meet the Port Rowan & St. Williams 2041 MDD (3 MLD) only. All other communities will be supplied by the Port Dover WTP (21 MLD). This option eliminates the need for groundwater systems.

County staff noted that a Class EA was completed by Byron Wiebe in 2005 to review water treatment/supply in Port Rowan. That EA concluded that a new intake would be needed to address quality concerns, with an estimated capital cost of $9M (2005$). The intake was located into Lake Erie, outside the area of influence of Long Point. However, during the stakeholder reviews, a resident expressed concern about the possibility of intake damage from ice. Due to the existing issues and capacity constraints at the Port Rowan WTP, the County took the initiative to conduct another EA to explore groundwater conditions in this community and potentially changing the source from Lake Erie to groundwater. The study found elevated nitrate concentrations in the four production wells they had built. Additional exploratory work was not completed, pending completion of the ISMP in 2016. The ISMP identified that a "New Intake" in Lake Erie would be the best technical solution. However, "Deepening the Existing Intake" was recommended at the time due to cost ($0.5M in $2015 per ISMP), potential challenges with residents of Long Point (proposed location), and the County Operations staff reporting that the Port Rowan WTP has never been offline for more than several hours at a time.

At this time, it is recommended to install a new intake for Port Rowan WTP. With climate change, increased algae blooms and other environmental changes in Lake Erie, deepening the intake may no longer be the preferred solution. A new intake with a low lift station at Long Point and watermain to the Port Rowan WTP would completely eliminate the current issues. Construction of the new intake can be undertaken without disruption to the existing intake. If the existing intake is offline, Port Rowan does not have any other water supply sources and would potentially require trucked water. Any modifications to the existing intake or installation of a new intake will require extensive discussions with the Ministry of Environment, Conservation, and Parks (MECP), Ministry of Natural Resources and Forestry (MNRF), and Department of Fisheries and Oceans (DFO).

In addition to the new intake, it is also recommended that the Port Rowan WTP undergo treatment upgrades. The ISMP indicated that a treatability study was conducted by XCG Consultants in 2014 which evaluated treatment alternatives that would allow the Port Rowan WTP to operate at its rated capacity. Per the XCG study, a building expansion would also be necessary.

HYDRAULIC ANALYSIS

This alternative uses two surface water supplies located in Port Dover and Port Rowan to meet the demands of the entire County. The new interconnections will reduce community specific upgrades of existing facilities and eliminate the need for groundwater system. The interconnection will also provide the ADD, MDD and MDD+FF LOS to all communities. New local boosting and storage facilities are recommended to optimize the performance of this option. Technical servicing considerations for each community is as follows:

- Port Dover – Construction of a new WTP is required to resolve current deficiencies and to provide supply to the connected communities (21 MLD). Additional high lift pumping capacity and potential storage upgrades are also required to ensure ADD, MDD, and MDD+FF LOS is met in all communities. New min. 400 mm diameter watermains are to be constructed between Port Dover-Simcoe, in addition to dedicated interconnection from Port Dover-Waterford and Port Dover-Delhi via boosting at Simcoe. Interconnected piping should be connected to existing facilities or to new dedicated booster stations with reservoirs.
- Port Rowan – Upgrades to existing WTP and a new intake are required to produce adequate supply and to provide sufficient high lift pumping capacity (3 MLD) to boost water to connected

communities. A new min. 400 mm diameter interconnection between Port Rowan – Port Dover will provide supply redundancy to both communities, but not included in this alternative.

- Delhi & Courtland – The groundwater system is to be decommissioned. The ADD, MDD, and MDD+FF LOS will be provided by a new min. 400 mm diameter interconnection from Port Rowan to Delhi. Delhi will also have redundant supply from the interconnection with Simcoe. Treatment upgrades will be required to re-chlorinate and fluoridate water received from Port Dover. A local reservoir/booster station may be added at the current Delhi WTP site or at a new site to provide local MDD+FF storage and to maintain distribution LOS.
- Simcoe – The groundwater wells are to be decommissioned. The interconnection between Port Dover/Simcoe and Simcoe/Waterford will provide supply redundancy to Simcoe. Treatment upgrades are required to re-chlorinate and fluoridate water received from Port Dover and Waterford. The treatment upgrades can be implemented at the existing Northwest WTP, or at a new facility. Source water from Port Dover may be shared between Delhi, Courtland and Simcoe through a new min.400 mm diameter interconnection to service MDD+FF LOS. Alternatively, the Port Dover feed may be used to service only MDD conditions, and the MDD+FF LOS can be provided by the local community storage facilities.
- Waterford – The groundwater system is to be decommissioned. The ADD, MDD, and MDD+FF LOS in Waterford will be provided by the Port Dover WTP. Upgrades to the Waterford boosting and/or storage facilities should be considered to maintain MDD + FF LOS in the local community.

Refer to Appendix B for an overview map of the infrastructure alternatives.

Additional Considerations – Interconnection provides redundancy between communities; however, systems become dependent on dedicated interconnected supply. Transmission main twinning provides additional redundancy. An operational strategy focused on water cycling will address water age concerns within storage facilities.

7.2.5 NANTICOKE WATER TREATMENT PLANT

The following sections describe alternatives that involve supplying Norfolk County from Haldimand County ("Haldimand"). Haldimand is located immediately east of Norfolk County as shown in Figure 7-6.

Figure 7-6 Map of Norfolk and Haldimand Counties

Haldimand is supplied by the Nanticoke WTP, which sources water from Lake Erie. Nanticoke has two (2) intakes, each approximately 6.3m deep. The Nanticoke WTP has a PTTW of 1,818,000 m^3/d, however, the MECP has placed an interim limit of 437,000 m^3/d on Nanticoke's PTTW until certain regulatory requirements have been satisfied. Based on the Nanticoke Drinking Water System 2019 Annual Water Quality Report, 351,688m^3/d of the Nanticoke PTTW raw water allotment was available for use. There is sufficient raw water to supply both Norfolk's demands and Haldimand's demands.

HALDIMAND COUNTY DEMANDS

The Nanticoke WTP has a rated capacity of 13,636 m^3/d. In discussions with Haldimand held on October 2nd, 2019, it was identified that Haldimand's 2019 ADD was approximately 5,000 m^3/d. Based on WT Infrastructure's report (see Section 2.4.5), Nanticoke WTP has a net available supply of 3,117 m^3/d that can be used by Norfolk County in 2020.

On September 9th, 2020, Haldimand County indicated that its projected 2041 MDD is 22,000 m^3/d. This includes 20,000 m^3/d for Haldimand County proper (Jarvis, Hagersville, Caledonia, Cayuga and the Lake Erie Industrial Park), and 2,000 m^3/d for a new connection to Six Nations that Haldimand is anticipating on completing. The Nanticoke WTP can provide 2,800 m^3/d to Norfolk County from 2021 until Nanticoke WTP upgrades are completed.

NANTICOKE WTP CAPACITY

Nanticoke WTP consists of low lift pumps, chemical coagulation, two (2) high rate clarifiers (Actiflo), three (3) filters, sodium hypochlorite primary and secondary disinfection, high lift pumps, and two reservoirs. No fluoride is added. There is sufficient land on-site to construct a new treatment building, or expand the treatment building.

The treatment of the Nanticoke WTP can be expanded in phases by adding different combinations of filters and Actiflo per WSP's 2016 Highway 6 Corridor Servicing Study. Based on the Watson & Associates Economists Ltd. "Haldimand and Norfolk Water Supply Feasibility" study and discussions held with Haldimand County, the maximum achievable firm capacity of Nanticoke WTP is **43,000 m^3/d.** This 30,000 m^3/d firm capacity requires the upgrades shown in Table 7-5 (retrieved from Watson's report).

Table 7-5 Nanticoke WTP 43 MLD Upgrades

PROCESS UNIT	EXPANSION REQUIREMENTS
Raw Water Pumps	• Increased pump capacity required.
Raw Water Conveyance	• New raw water main to the greenfield WTP will be required.
Sedimentation	• Add 3 high rate sedimentation trains. Installed capacity (5 x 9 MLD)
Coagulant Feed System	• New chemical storage and feed system required.
Filtration	• Add five multimedia filters. Installed capacity (8 x 6 MLD).
Backwash	• New backwash storage required. • New backwash pump and air scour blower required.
Disinfection	• New NaOCl storage and feed system required.

Treated Waster Conveyance	• New treated water line to existing clear well • Increase filtered water line size from clear well to reservoir. • Raise clear well level to overcome head losses.
Reservoir	• Install additional baffling.
Residuals Treatment	• Assess backwash equalization tank and lagoon performance to confirm that no upgrades are required.
Electrical Servicing	• New additional electrical loads for proposed greenfield plant. Additional standby power required.
Building Services	• New natural gas supply, service water and drainage flows required.
Building Footprint	• New greenfield building required.
High Lift Pumping	• Existing pumping capacity 39.7 MLD. Need for pump replacements to be assessed based on condition, potential for energy savings, and timing of service extensions.

7.2.6 ALTERNATIVE 2.0 – PURCHASE RAW WATER FROM HALDIMAND COUNTY

Alternative 2.0 suggests purchasing raw water from Haldimand County, treating the water in Norfolk County at a centralized location, and distributing the water to other communities via transmission mains.

This alternative considered building a connection from the Nanticoke WTP intake to Port Dover. Port Dover is located closest to the Norfolk-Haldimand border and was chosen to minimize length of the transmission main (i.e. minimize cost). However, the existing Port Dover WTP does not have sufficient treatment capacity to meet the County's 2041 MDD (24 MLD). Thus, in addition to the new Haldimand-Norfolk transmission main and interurban connections within Norfolk County, a new WTP is also required at Port Dover. This would result in a significantly higher cost than purchasing treated water from Haldimand. The purchasing agreements would likely be complicated, and operations would be more difficult. This option was also evaluated in the NGVAWS (see Section 2.4.3), which indicated that purchasing treated water is preferable over raw water. During a review workshop, the County staff confirmed that purchasing raw water is not preferred by them, and therefore, this alternative was not pursued further.

7.2.7 ALTERNATIVE 2.1 – NANTICOKE WTP UPGRADE TO MEET PORT DOVER DEMANDS ONLY

Alternative 2.1 involves purchasing treated water from the Nanticoke WTP to meet Port Dover demands only. The other Norfolk communities would also be interconnected as shown in Figure 7-7. The Port Rowan WTP would require a new intake and process upgrades to meet its DWWP rated capacity of (3,040 m^3/d) to supply Port Rowan & St. Williams. As previously discussed, connecting Port Rowan to the other communities is cost prohibitive due to transmission main length.

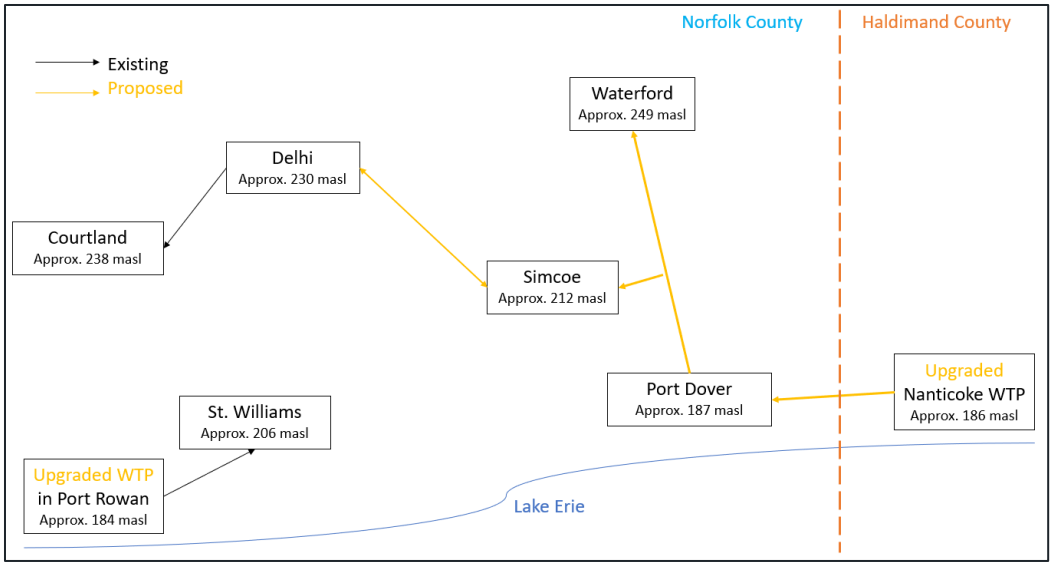


Figure 7-7 Alternative 2.1 and Alternative 2.2 – High Level Presentation of Proposed Interconnection

The purpose of this option is to resolve the immediate supply shortage in Port Dover as discussed in Sections 3.1.4 and 5.1.1. However, this alternative does not address the challenges faced by Simcoe (high risk) nor Waterford. Both these communities would continue to be dependent on existing groundwater systems, which are prone to contamination and/or incapable of providing adequate firm capacity.

7.2.8 ALTERNATIVE 2.2 - NANTICOKE WTP UPGRADE TO MEET PORT DOVER + SIMCOE + WATERFORD DEMANDS WITH ONE CONNECTION

Alternative 2.2 involves purchasing treated water from Nanticoke WTP to provide supply for Port Dover, Simcoe and Waterford. The Port Rowan WTP will be upgraded to meet rated DWWP capacity (see Section 7.2.4). This alternative requires the Nanticoke WTP to increase its firm capacity to 43,000 m^3/d to meet the combined 2041 MDD of both counties, excluding Port Rowan and St. Williams.

This alternative suggests the same interconnections as Alternative 2.1 (Figure 7-7). The connection point is chosen to be Port Dover as it is in immediate need of supply firm capacity, and it is located closest to the Nanticoke WTP. The objective of this alternative is to mitigate the risks in the three communities of concern: Port Dover, Simcoe, and Waterford. The Port Dover WTP, and the groundwater wells in Simcoe and Waterford would be decommissioned. The Delhi groundwater wells would be kept online and can be used to supplement Simcoe until Nanticoke WTP upgrades are complete.

7.2.9 ALTERNATIVE 2.3 – NANTICOKE WTP UPGRADE TO MEET PORT DOVER + SIMCOE + WATERFORD DEMANDS WITH TWO CONNECTIONS

Alternative 2.3 recommends purchasing treated water from Nanticoke WTP to supply Port Dover, Simcoe, and Waterford. The same Nanticoke WTP upgrades are recommended as those described in Alternative 2.2, however two connections are proposed from Nanticoke WTP: one from Nanticoke WTP through Townsend to Simcoe, and another from Nanticoke WTP to Port Dover. This is contrasted with Alternative 2.2 which only includes one connection from Nanticoke WTP to Port Dover. A high-level presentation of the proposed interconnection is shown in Figure 7-8.

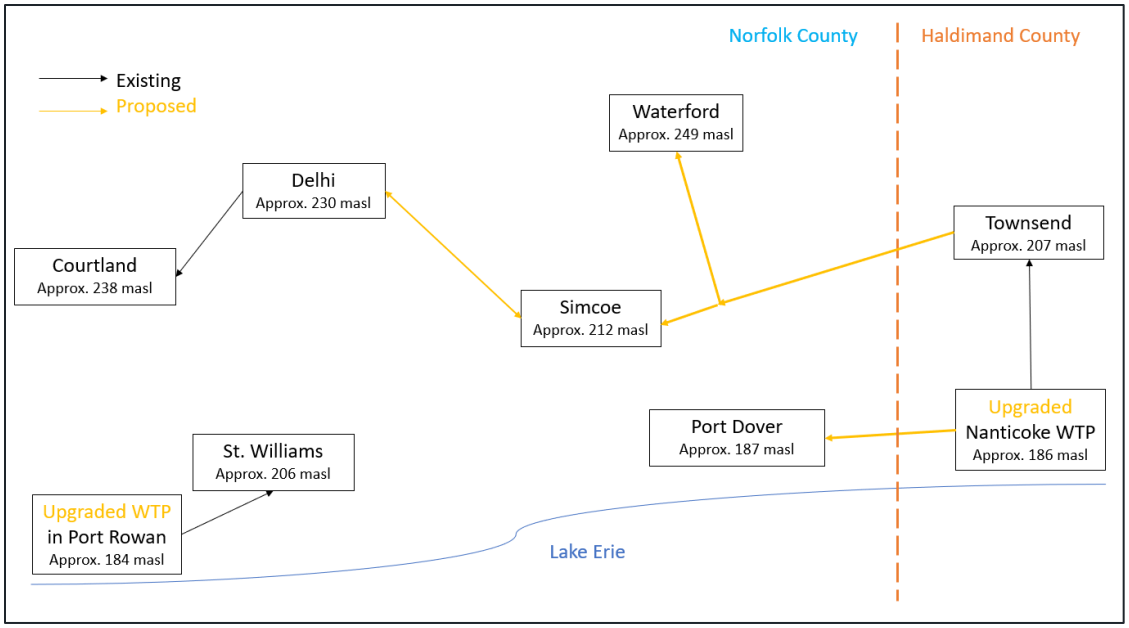


Figure 7-8 Alternative 2.3 - High Level Presentation of Proposed Interconnection

Similar to Alternative 2.2, this alternative is anticipated to mitigate the risks in Port Dover, Simcoe, and Waterford. However, a major concern in Alternative 2.2 is the lack of supply redundancy. That is, if any issue were to occur in the Nanticoke – Port Dover transmission main, all communities would be without any supply. To mitigate this risk, a large reservoir or a second connection is required. A second connection was considered preferable as large reservoirs are prone to water age challenges and can be difficult to operate. Therefore, this alternative proposes a connection from Townsend to Simcoe. Townsend was chosen as there are existing stubs connecting Nanticoke to Townsend, and allows Simcoe to be supplied directly from Nanticoke WTP. Simcoe can be supplemented by Delhi while Nanticoke WTP upgrades are being undertaken. The connection from Townsend to Simcoe can also be rapidly utilized by Waterford, which has a potential for significant demand increase.

A variation of this alternative is to construct a twinned main from Nanticoke WTP to Port Dover. However, this variation does not provide as good of redundancy to Simcoe or Waterford. An additional connection between Port Dover and Simcoe can also be considered at a later date to provide increased redundancy for the two communities. This connection is considered a low priority at this time and has not been included in cost estimates.

The Port Rowan WTP is recommended to be upgraded to meet its DWWP rated capacity (see Section 7.2.4).

7.2.10 ALTERNATIVE 2.4 - PORT DOVER WTP + NANTICOKE WTP UPGRADE TO MEET SIMCOE + WATERFORD DEMANDS - FUTURE EXPANSION TO INCLUDE PORT DOVER

Alternative 2.4 suggests upgrading the Port Dover WTP to meet the demands in the local Port Dover community, and feeding Simcoe and Waterford from Nanticoke WTP. The communities are proposed to be interconnected as shown Figure 7-9. It is assumed that full expansion of the Nanticoke WTP is needed for this option, as Port Dover will eventually also be supplied by Nanticoke WTP. Depending on Haldimand's demands and when the new Haldimand – Six Nations connection will be constructed, it may be possible to phase the expansion over an extended period (see Section 7.2.5) and only a partial expansion may be needed to supply Simcoe and Waterford in the interim. For the purposes of this project, it is assumed that the Nanticoke WTP will need to be expanded to 43 MLD in one single phase due to the lack of

information regarding Haldimand's demands. The Delhi to Simcoe connection can be constructed immediately as Delhi has a surplus capacity that can be used to supplement Simcoe.

The Port Rowan WTP is recommended to be upgraded to meet its DWWP rated capacity (see Section 7.2.4).

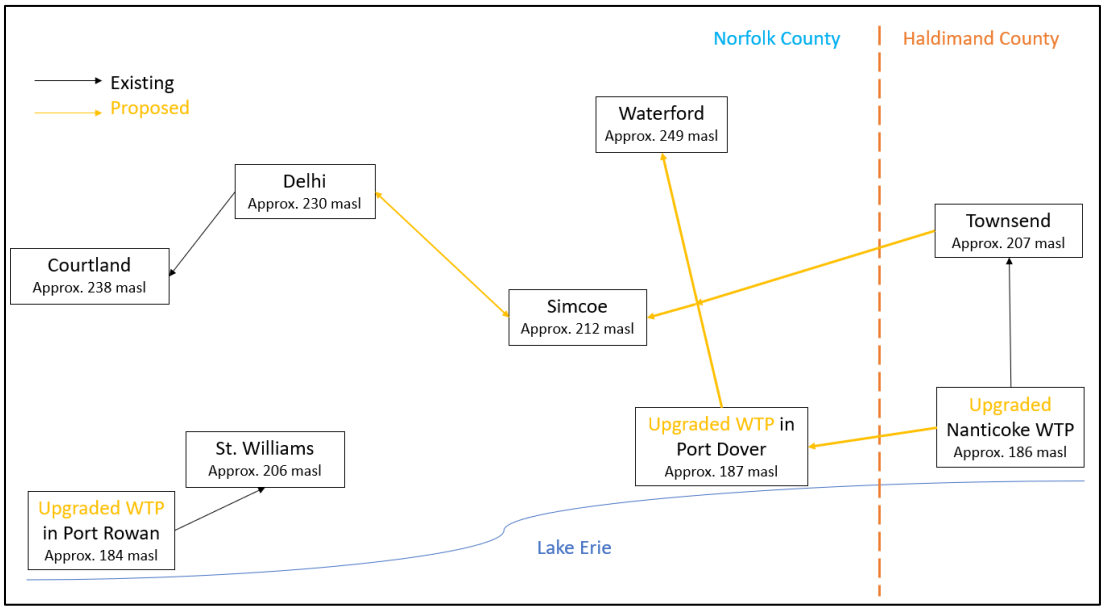


Figure 7-9 Alternative 2.4 - High-level presentation of Proposed Interconnection

Alternative 2.4 differs from Alternatives 2.1 – 2.3 as it prioritizes the groundwater systems at risk. The Port Dover WTP upgrade project (to firm capacity of 7.3 MLD) can be re-instated immediately so that Port Dover will become self-sufficient. This allows all surplus capacity at the Nanticoke WTP be directed towards Simcoe. Nanticoke WTP does not have enough surplus to meet Simcoe's 2020 ADD nor MDD, and Simcoe's groundwater wells will need to be kept online until upgrades at Nanticoke WTP are completed. Supplementing Simcoe from Nanticoke WTP would potentially also introduce water quality issues arising from blending groundwater with surface water. To minimize these issues, it is recommended that Simcoe blend water in a fixed ratio (proportion) to reduce fluctuations in water characteristics.

In addition to the Townsend – Simcoe connection, an additional connection from Nanticoke WTP to Port Dover is included. This provides supply redundancy and security to the wider interurban system as discussed in Section 7.2.8. However, this connection is not required if the County chooses to keep the Port Dover WTP online as the local Port Dover community already has floating storage. The proposed routing would be similar to Alternative 2.3, shown in Figure 7-15. For the purposes of this project, the Port Dover – Nanticoke connection has been included in subsequent cost estimates.

7.2.11 ALTERNATIVE 2.5 - NANTICOKE WTP UPGRADE TO MEET ALL NORFOLK COUNTY FUTURE DEMANDS + TWO CONNECTIONS

Alternative 2.5 stipulates decommissioning all water production and treatment systems in Norfolk County and relying solely on Nanticoke WTP for water supply. Nanticoke WTP will need to provide 24,000 m^3/d to Norfolk County in addition to an estimated 22,000 m^3/d for Haldimand County in 2041 (total demand 46,000 m^3/d). The total demand exceeds the maximum possible firm capacity of the Nanticoke WTP (43,000 m^3/d). Thus, this alternative is not feasible.

7.2.12 ALTERNATIVE 3 – SUPPLY FROM ELGIN COUNTY

Alternatives 3 considers purchasing raw or treated water from Elgin County (see Table 7-1), the municipality adjacent to Norfolk County on the west side. Three sub-alternatives were developed as follow:

- Alternative 3.0 - Purchasing raw water for the entire County
- Alternative 3.1 - Supply of treated water from Elgin Area Water System (EAWSS) to all Norfolk County communities
- Alterative 3.2 - Partial supply from the EAWSS to support Port Rowan demands only

These options were considered as Port Rowan is relatively close to the Elgin – Norfolk border. However, a visual review of the communities in Elgin County near the shared border (based on population and size) shows that there are potentially no primary watermains nearby. Therefore, it appears that connecting Elgin County to Norfolk requires a 77 km watermain from EAWSS to Port Rowan. In addition, it was found that connecting Port Rowan to other Norfolk communities is cost prohibitive due to distance (approximately 35 km apart). Due to the length of the watermains, it is clear that none of the sub-alternatives presented above are cost effective. Therefore, this option was not studied any further and was not shortlisted.

7.2.13 EVALUATION OF ALTERNATIVES FOR SHORTLISTING

The evaluation used to short-list alternatives is presented in Table 7-6, and rejected alternatives are shown below. This is due to the fact that these alternatives are either not technically/financially feasible, or do not meeting the minimum requirement of this study, which is inter-urban connection:

- Alternative 1.0
- Alternative 2.0
- Alternative 2.5
- Alternative 3.0
- Alternative 3.1
- Alternative 3.2

Table 7-6 Selection of Alternatives for Shortlisting

ALTERNATIVES		PRELIMINARY CRITERIA							
		CAN THE DEVELOPMENT FREEZE IN PORT DOVER BE LIFTED?	DOES IT PROVIDE A LONG-TERM RELIABLE WATER SUPPLY FOR PORT DOVER?	CAN CAPACITY CONSTRAINTS IN SIMCOE BE RESOLVED?	CAN CAPACITY CONSTRAINTS IN WATERFORD BE RESOLVED?	CAN CAPACITY CONSTRAINTS IN PORT ROWAN AND DELHI BE RESOLVED?	CAN CAPACITY CONSTRAINTS IN THE ENTIRE COUNTY BE RESOLVED?	CAN DEPENDENCY ON GROUNDWATER SYSTEMS BE ELIMINATED?	SHORT LISTED? CRITERIA: SHOULD BE ABLE TO RESOLVE COUNTY-WIDE ISSUES AND CONCERNS (COUNTY WIDE SOLUTION) TARGET: AT THE MINIMUM, SHOULD RESOLVE COMMUNITIES THAT FALL WITHIN THE FOLLOWING RISK CATEGORIES: HIGH HIGH MEDIUM HIGH
Alternative 1 - Supply from Norfolk County (Complete)									
Alt 1.1	Port Dover WTP Upgrades + Local Supplies/Upgrades per ISMP	Yes	Yes (15-20 yrs.)	No	No	Port Rowan and Delhi are assumed to have sufficient local water supply capacity	**No - however all communities will be interconnected, but supply is limited.**	No - Simcoe, Waterford will still be dependent on groundwater (Delhi groundwater is assumed to be adequate)	No, this alternative was not shortlisted as it will not provide a long-term solution for all communities in the County that are/will face supply/quality issues.
Alt 1.2	Centralized WTP in Port Dover to Service all County Communities (24 MLD)	Yes	Yes	Yes	Yes	Yes	Yes - all communities will be interconnected	Yes	Yes
Alt 1.3	Two Lake-Based WTPs with Interconnection	Yes	Yes	Yes	Yes	Yes	Yes - all communities except Port Rowan & St. Williams will be interconnected	Yes	Yes
Alternative 2 - Supply from Haldimand County (Partial or Complete)									
Alt 2.1	Nanticoke WTP Upgrade to Meet Port Dover Demands Only	Yes	Yes	No	No	Port Rowan and Delhi are assumed to have sufficient local water supply capacity	No - however all communities will be interconnected, but supply is limited.	No - Simcoe, Waterford will still be dependent on groundwater (Delhi groundwater is assumed to be adequate)	No, this alternative was not shortlisted as it will not provide a long-term solution for all communities in the County that are/will face supply/quality issues.

ALTERNATIVES		PRELIMINARY CRITERIA							
		CAN THE DEVELOPMENT FREEZE IN PORT DOVER BE LIFTED?	**DOES IT PROVIDE A LONG-TERM RELIABLE WATER SUPPLY FOR PORT DOVER?**	**CAN CAPACITY CONSTRAINTS IN SIMCOE BE RESOLVED?**	**CAN CAPACITY CONSTRAINTS IN WATERFORD BE RESOLVED?**	**CAN CAPACITY CONSTRAINTS IN PORT ROWAN AND DELHI BE RESOLVED?**	**CAN CAPACITY CONSTRAINTS IN THE ENTIRE COUNTY BE RESOLVED?**	**CAN DEPENDENCY ON GROUNDWATER SYSTEMS BE ELIMINATED?**	**SHORT LISTED? CRITERIA: SHOULD BE ABLE TO RESOLVE COUNTY-WIDE ISSUES AND CONCERNS (COUNTY WIDE SOLUTION)** **TARGET: AT THE MINIMUM, SHOULD RESOLVE COMMUNITIES THAT FALL WITHIN THE FOLLOWING RISK CATEGORIES:** **HIGH** **HIGH** **MEDIUM HIGH**
Alt 2.2	Nanticoke WTP Upgrade to Meet Port Dover + Simcoe + Waterford Demands. One connection: Nanticoke to Port Dover	Yes	Yes	Yes	Yes	Port Rowan and Delhi are assumed to have sufficient local water supply capacity	Yes - all communities except Port Rowan & St. Williams will be interconnected	Yes – excluding Delhi which is assumed to have adequate groundwater. Delhi can continue using groundwater until the County chooses to decommission the wells.	Yes
Alt 2.3	Nanticoke WTP Upgrade to Meet Port Dover + Simcoe + Waterford Demands. Two connections: Nanticoke to Port Dover and Townsend to Simcoe	Yes	Yes	Yes	Yes	Port Rowan and Delhi are assumed to have sufficient local water supply capacity	Yes - all communities except Port Rowan & St. Williams will be interconnected	Yes - Excluding Delhi where groundwater is assumed to be adequate. Delhi can continue using groundwater until the County chooses to decommission the wells. Delhi can also be connected to Simcoe to allow for emergency supply.	Yes
Alt 2.4	Port Dover WTP Upgrade to Meet Current Demand Nanticoke WTP Upgrade to Meet Simcoe + Waterford Demands - Future expansion to include Port Dover Two connections: Townsend to Simcoe and Nanticoke to Port Dover	Yes	Yes	Yes	Yes	Port Rowan and Delhi are assumed to have sufficient local water supply capacity	Yes - all communities except Port Rowan & St. Williams will be interconnected	Yes - Excluding Delhi where groundwater is assumed to be adequate. Delhi can continue using groundwater until the County chooses to decommission the wells. Delhi can also be connected to Simcoe to allow for emergency supply.	Yes

ALTERNATIVES		PRELIMINARY CRITERIA							
		CAN THE DEVELOPMENT FREEZE IN PORT DOVER BE LIFTED?	**DOES IT PROVIDE A LONG-TERM RELIABLE WATER SUPPLY FOR PORT DOVER?**	**CAN CAPACITY CONSTRAINTS IN SIMCOE BE RESOLVED?**	**CAN CAPACITY CONSTRAINTS IN WATERFORD BE RESOLVED?**	**CAN CAPACITY CONSTRAINTS IN PORT ROWAN AND DELHI BE RESOLVED?**	**CAN CAPACITY CONSTRAINTS IN THE ENTIRE COUNTY BE RESOLVED?**	**CAN DEPENDENCY ON GROUNDWATER SYSTEMS BE ELIMINATED?**	**SHORT LISTED? CRITERIA: SHOULD BE ABLE TO RESOLVE COUNTY-WIDE ISSUES AND CONCERNS (COUNTY WIDE SOLUTION)** **TARGET: AT THE MINIMUM, SHOULD RESOLVE COMMUNITIES THAT FALL WITHIN THE FOLLOWING RISK CATEGORIES:** **HIGH** **HIGH** **MEDIUM HIGH**
Alt 2.5	Nanticoke WTP Upgrade to Meet All Norfolk County Future Demands Two connections: Townsend to Simcoe and Nanticoke to Port Dover	Yes	Yes	Yes	Yes	No	No - however all communities will be interconnected, but supply is limited.	Yes	No, this alternative was not shortlisted as the maximum achievable firm capacity of Nanticoke WTP is less than the combined 2041 MDD of Haldimand plus Norfolk.

7.3 SHORTLISTED ALTERNATIVES

This section describes the implementation, timeline, and budget of the five (5) shortlisted alternatives. The major timeline items for all alternatives can be divided into the following general categories:

1. Municipal Class Environmental Assessment (Class EA) process and Master Plan amendments
2. Construction of inter-urban connections (transmission mains between the communities)
3. Water treatment plant upgrades or construction of new water treatment plant(s)
4. If supplied by Haldimand County, construction of the watermain between Nanticoke WTP to Port Dover and/or Townsend to Simcoe.

The assumptions made during development of the timelines is shown in Section 7.2.

7.3.1 ALTERNATIVE 1.2 – CENTRALIZED WTP IN PORT DOVER TO SERVICE ALL COUNTY COMMUNITIES (24 MLD) + INTERCONNECTIONS

Alternative 1.2 suggests servicing all communities with a County-owned centralized WTP in Port Dover. Figure 7-10 shows the firm capacities and MDD of the Port Dover, Simcoe, Waterford, and Port Rowan systems. Port Dover is currently undergoing a project to replace its clarifier with two (2) DAF units, however, its capacity will still be limited to 2,500 m^3/d due to high lift pumping constraints. Simcoe's capacity would also reduce in 2023, as it is assumed that the groundwater wells which are subject to operational risks will be taken offline (see Section 5.1.2). Port Rowan is also expected to have a small deficiency in the future. In this alternative, the Delhi community would also be supplied by the centralized plant and would not rely on groundwater. All groundwater systems would be eventually decommissioned.

It is estimated that the County could complete the required Class EAs and Master Plan amendments between 2022 and the end of 2023. Per the Municipal Class EA Manual Appendix A, the inter-urban connections potentially fall under Schedule A/A+ (if no land acquisition is required), Schedule B for pumping stations (PS) and new storage facilities, and Schedule C for the new Centralized WTP. The Delhi – Simcoe connection could be constructed from 2022 to 2024. This would provide a short term solution for Simcoe as Delhi has surplus capacity that can be used by Simcoe. Delhi would stop supplementing Simcoe once the Centralized WTP is connected to avoid blending and potential water quality challenges. Once the Centralized WTP is complete, Delhi's groundwater wells could potentially be decommissioned as well and Delhi could transition to surface water. However, the County may choose to delay this transition for other operational reasons if required, since the Delhi groundwater wells are currently in good condition.

In 2024, construction of the Port Dover to Simcoe transmission main, and construction of the new Centralized WTP (24 MLD) could begin. The development freeze in Port Dover could potentially be lifted in 2028. By 2030, Port Dover, Simcoe, and Waterford would all be fully supplied by surface water. All communities would be interconnected by 2033. Construction of the interconnections could be phased to better align with the County's budgetary needs; however, priority should be given to the high-risk communities, i.e. Simcoe and Port Dover and then Waterford.

An overview of the implementation of Alternative 1.2 is shown in Figure 7-10.

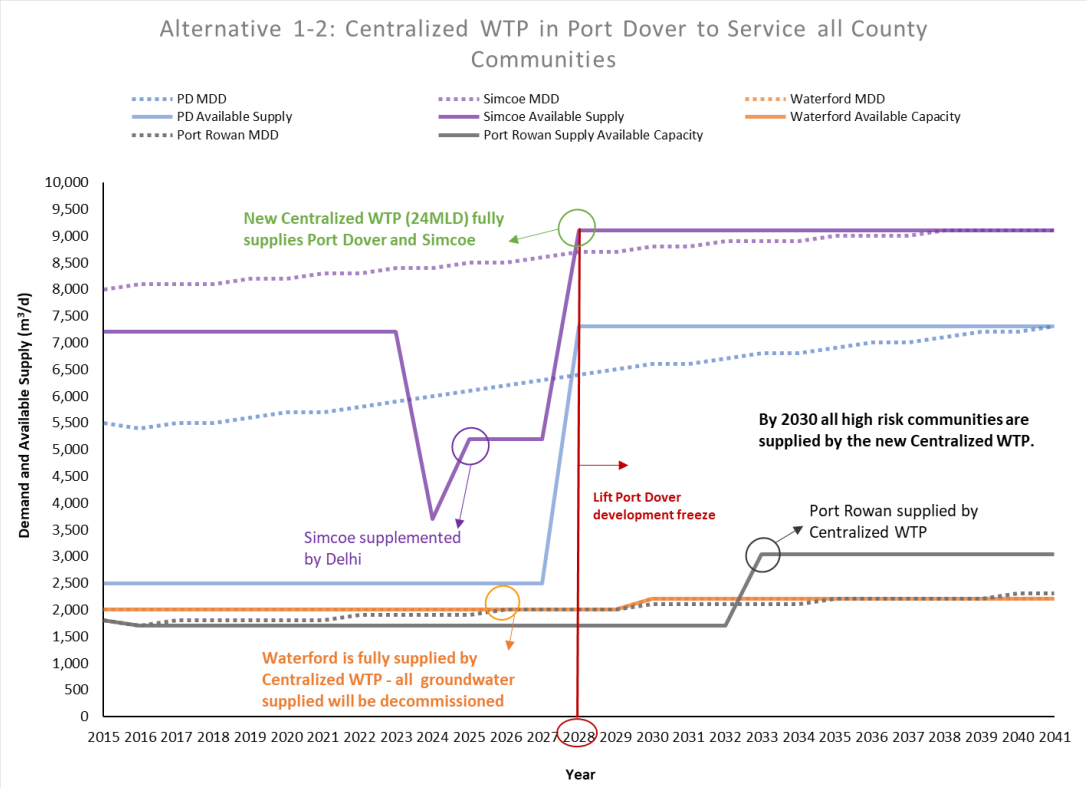


Figure 7-10 Alternative 1.2 Implementation

WATER QUALITY ANALYSIS

This alternative involves supplementing Simcoe from Delhi in the short term and eventually changing the source water of all historically groundwater supplied communities to Lake Erie. As described in Section 5.2, changing and/or blending water sources can have a negative impact on a number of water quality characteristics. This section presents a preliminary water quality analysis of the proposed alternative.

WSP typically does not recommend blending treated waters from different sources together, particularly if the blending occurs within distribution system pipes as the operator will have limited control over water quality. However, because Simcoe has a water supply deficit (based on firm capacity) under existing conditions and there is potential for significant demand increase, supplementing Simcoe from Delhi can be done as a short term solution until the Centralized WTP is completed and Simcoe can fully transition to surface water. It is assumed that the two (2) new Delhi wells also use free chlorine residual, same as the older Delhi wells and all Simcoe wells. Because the source type is the same (both groundwater), disinfectant type is the same, and the treatment processes are generally similar, limited water quality challenges are anticipated when Simcoe is supplemented by Delhi. However, the County is still recommended to undertake a water quality study before introducing a new source into the Simcoe system.

WSP also reviewed the 2019 – 2020 pH, alkalinity, and hardness of treated water in the communities of Simcoe and Port Dover. The aforementioned parameters are of particular interest as they impact pipe corrosion. As shown in Figure 7-11, the pH of the treated water is relatively similar in both communities. Figure 7-12 shows that the Simcoe historically had higher alkalinity and hardness compared to Port Dover, which is expected as Simcoe is supplied by groundwater. Higher alkalinity, hardness, and pH values generally result in less corrosion in pipes. Changing the source type may destabilize the chemical equilibrium in Simcoe distribution mains, and appropriate treatment processes/operations should be applied to minimize pipe corrosion. Note that this option provides the County full control over the treatment processes, which is beneficial when trying to maintain water quality.

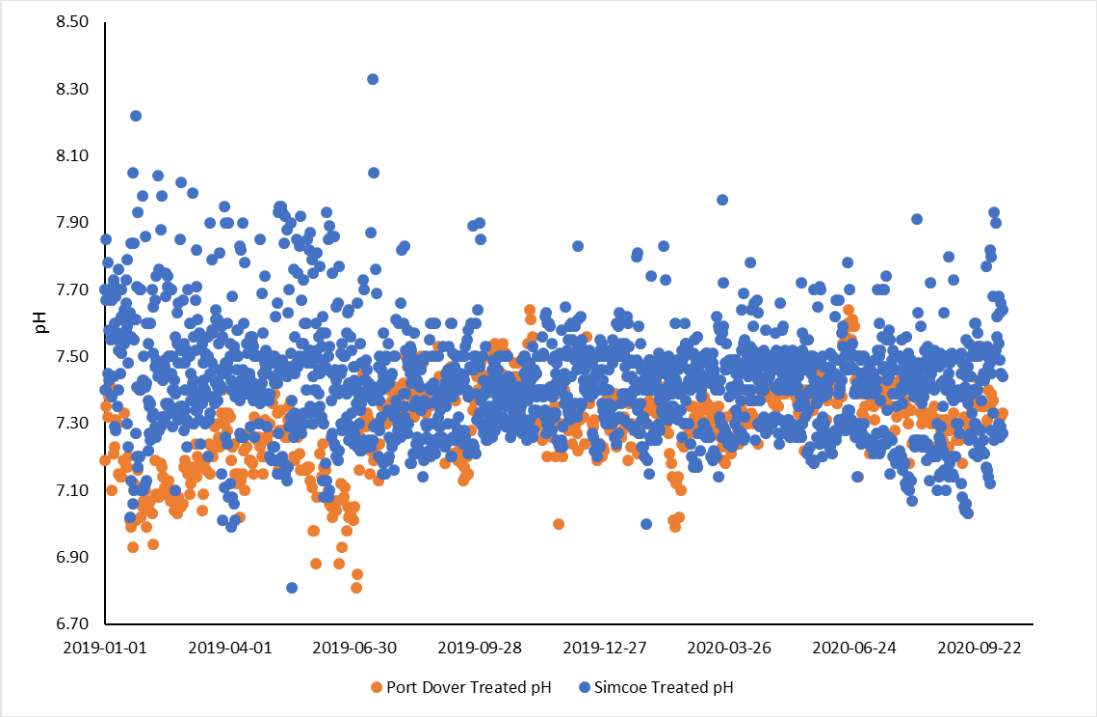


Figure 7-11 Comparison of Port Dover and Simcoe Treated Water pH

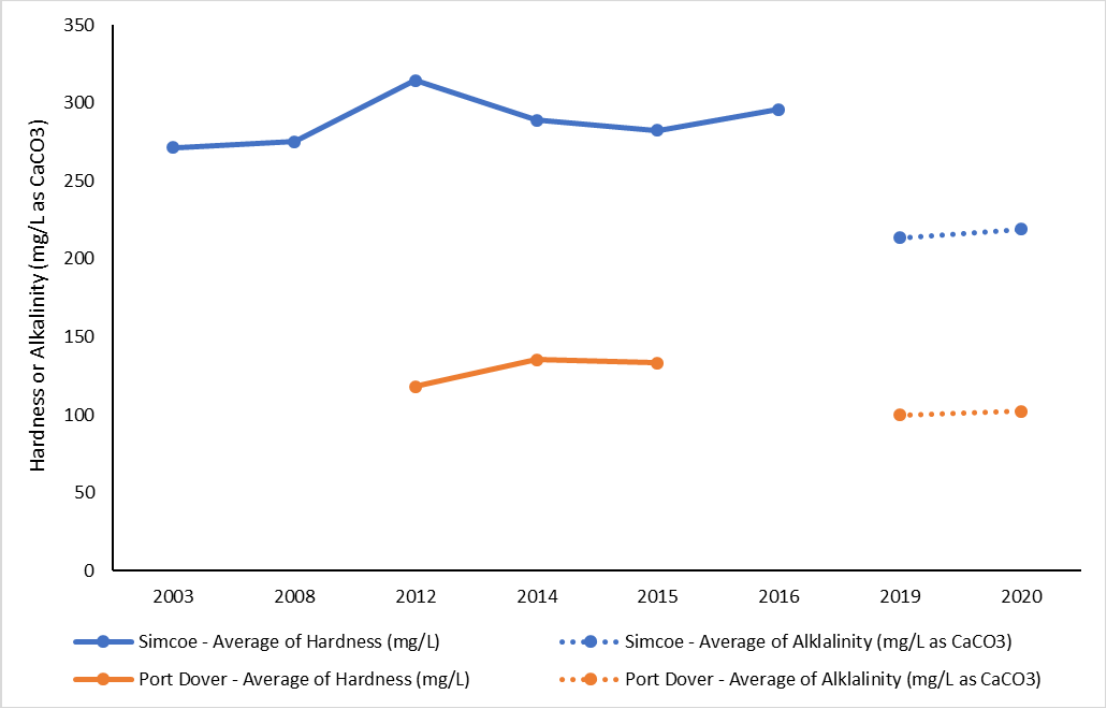


Figure 7-12 Comparison of Port Dover and Simcoe Treated Water Hardness and Alkalinity

7.3.2 ALTERNATIVE 1.3 – TWO LAKE-BASED WTPS WITH INTERCONNECTION

Alternative 1.3 suggests using two (2) lake-based WTPs to meet the demands of the County. One WTP will supply Port Rowan & St. Williams, and the other will supply all other communities. The implementation schedule is shown in Figure 7-13.

This alternative recommends building a new intake and upgrading the Port Rowan WTP (see Section 7.2.4). It is assumed that a Schedule B Class EA is required as the County will need to acquire land for the new intake and the existing treatment building will need to be expanded. (Reference: Municipal Class EA Manual Appendix A – Schedule B, Water Projects, No. 3 "Expand the existing water treatment plant including intake up to existing rated capacity where land acquisition is required"). The Port Rowan WTP is anticipated to produce 3 MLD by 2027. If no land acquisition is required, the Port Rowan upgrades would fall under a Schedule A+ and the project could be accelerated. The County should confirm land rights if this alternative is selected.

The Delhi – Simcoe connection could be constructed between 2022 – 2024, allowing Simcoe to have supplementary capacity by 2025. Delhi would stop supplementing Simcoe once the new Port Dover WTP (21 MLD) is complete to avoid blending and introducing potential water quality challenges.

The new Port Dover WTP (21 MLD) would service all communities to the east side of the Norfolk County. It is estimated that construction of this WTP could be completed by the end of 2027. In 2028, Port Dover and Simcoe, and potentially Delhi, would both be supplied by the new WTP. Waterford would be supplied by the new WTP in 2030. By this stage all groundwater wells could potentially come offline, however the County may choose to keep Delhi on groundwater for a longer period if needed.

The advantage of this option over constructing one centralized plant is that it eliminates the need to have an interconnection between Port Dover and Port Rowan (~35 km of watermain), and reduces the watermain costs by approximately $30M. Although the cost of the new intake for the Port Rowan WTP is significant (~$13.5M), this option is still more financially feasible than one centralized plant. However, managing one centralized plant is more preferable over a managing two.

WATER QUALITY ANALYSIS

The same water quality related concerns as described in Alternative 1.2 (Section 7.3.1) also apply to this alternative.

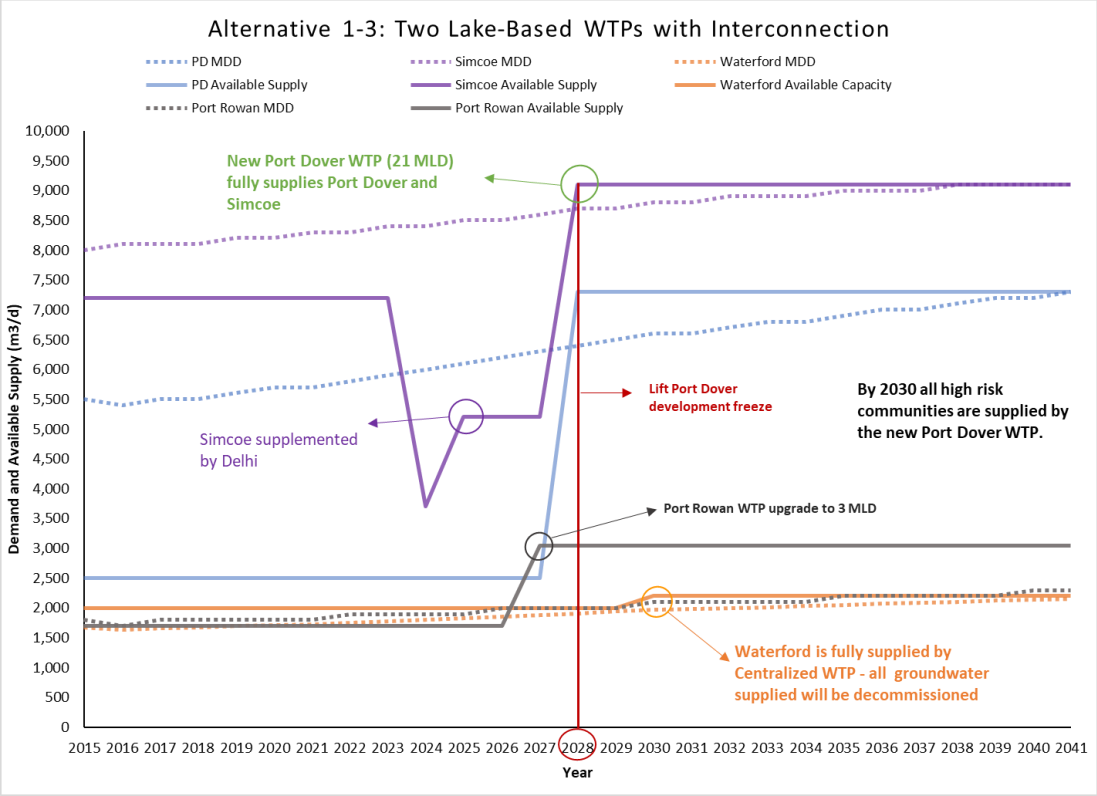


Figure 7-13 Alternative 1.3 Implementation

7.3.3 ALTERNATIVE 2.2 – NANTICOKE WTP UPGRADE TO MEET PORT DOVER + SIMCOE + WATERFORD DEMANDS WITH ONE CONNECTION

Alternative 2.2 suggests connecting Port Dover to the Nanticoke WTP immediately to obtain supplemental supply. As discussed in Section 7.2.5, it is assumed that Nanticoke WTP can provide 2,800 m^3/d to Port Dover between 2021 and completion of the Nanticoke WTP upgrades. This volume is insufficient for Port Dover to meet its MDD even in 2020, and thus the existing Port Dover WTP must remain operational until Nanticoke WTP is fully upgraded.

The transmission mains between Nanticoke and Port Dover, and between Delhi and Simcoe could be constructed between 2022 – 2024. These are recommended to be done in conjunction with the Class EAs and the Norfolk County Master Plan amendments (2022 – 2023), as the transmission mains could potentially be Schedule A+ projects. As shown in Figure 7-14, this could provide supplementary supply to Port Dover and Simcoe by 2025. Nanticoke WTP is expected to provide 2,800 m^3/d to Port Dover until upgrades are complete. The Port Dover WTP would still likely need to draw backwash water from the distribution system during the time it is still operational (i.e. the Port Dover Elevated Tank cannot come offline).

It is assumed that the Nanticoke WTP expansion to 43,000 m^3/d (see Section 7.2.5) would be undertaken between 2024 – 2027. The interconnection between Port Dover and Simcoe could potentially be constructed at the same time. By 2028, Port Dover, Simcoe, and Waterford would be fully supplied by Nanticoke WTP (i.e. Simcoe would no longer be supplemented by Delhi). All communities, except Port Rowan and St. Williams, are anticipated to be interconnected by 2035. Port Rowan & St. Williams would be supplied by the Port Rowan WTP, which is recommended to undergo upgrades to meet the DWWP rated capacity (see Section 7.2.4). It is estimated that these upgrades could be completed by 2027.

An overview of the implementation of Alternative 2.2 is shown in Figure 7-14.

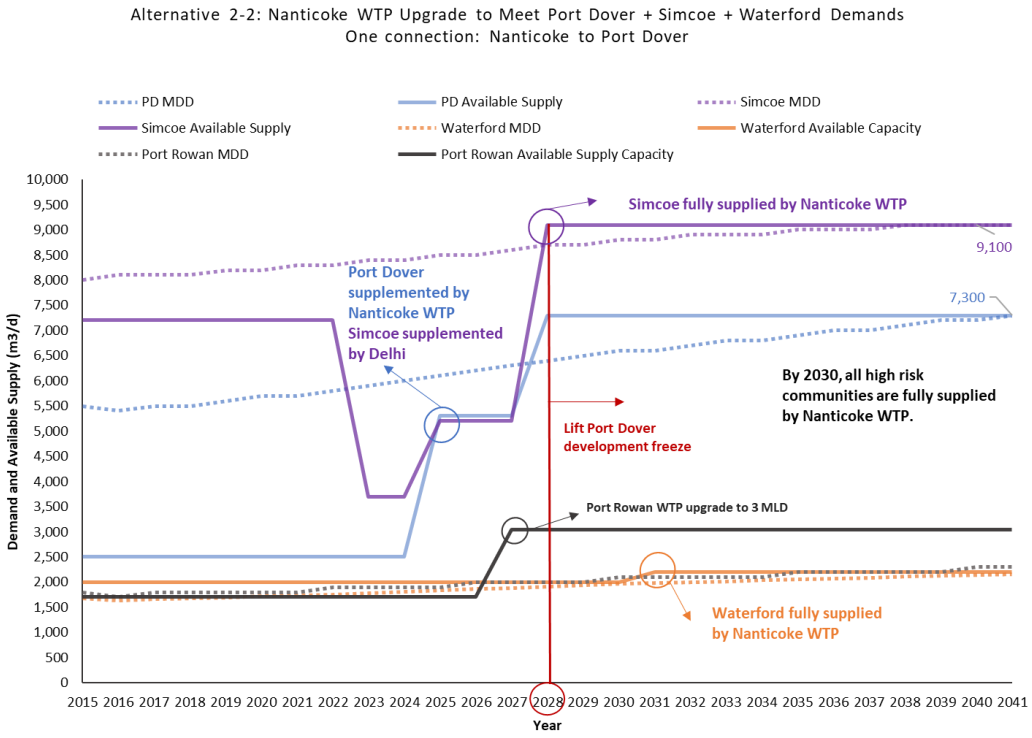


Figure 7-14 Alternative 2.2 Implementation

It should be noted that as industry best practice, an upgrade to a WTP is triggered when its demand reaches 80% of its rated capacity. Typically, WTPs are designed to meet the MDD of the community they are servicing. This is a very conservative approach as the probability of all communities experiencing MDD at the same time is relatively low. Further, the installed capacity of the plant is higher than the firm capacity, as the firm capacity is defined as the "capacity with the largest unit out of service". It is recommended that both Norfolk County and Haldimand County monitor and review the demands at the Nanticoke WTP every 5 years, per master planning requirements, to determine whether expansion is required at the any time in the future.

WATER QUALITY ANALYSIS

The same water quality concerns regarding supplementing Simcoe with Delhi groundwater as described in Alternative 1.2 (Section 7.3.1).

WSP also reviewed the pH, alkalinity, hardness, and free chlorine residuals of Nanticoke distribution system water, and Port Dover and Simcoe treated water. Very little information was received for the Nanticoke system and WSP relied primarily on the published annual water quality reports. Note that this is a very preliminary review and WSP strongly recommends the County conduct a separate water quality study and a corrosion control study prior to changing source waters or blending source waters. A summary of the comparison is shown in Table 7-7.

Table 7-7 Comparison of Nanticoke, Port Dover, Simcoe Water Quality

WATER QUALITY PARAMETER	NANTICOKE DWS[1]	PORT DOVER	SIMCOE
Total Hardness (CaCO3, mg/L)	76 - 174	118 - 142[2]	248 - 329[2]
Alkalinity (CaCO3, mg/L)	92 - 99	98 - 104[2]	207 - 224[2]
pH	7.72 - 8.22	7.00 -7.50[3]	7.02 – 7.98[3]
Free chlorine residual (mg/L)	0.38 - 1.38	0.68 - 1.7[3]	0.19 - 1.60[3]

1) Nanticoke DWS refers to Lake Erie Industrial Park, Townsend, Jarvis, Hagersville distribution systems. Information was retrieved from 2018 and 2019 Nanticoke annual water quality reports, with one outlier value for Hagersville total hardness from 2018-09-18 removed. No information was available for Nanticoke WTP finished water.
2) Retrieved from Port Dover and Simcoe 2012 - 2020 distribution system results.
3) Retrieved from Port Dover WTP and Simcoe treatment facility 2019 – 2020 treated water results.

In general, blending waters from the same source type and treated with similar processes is less likely to result in negative water quality impacts (see Section 5.2 for more information on impact of blending and switching water sources). Both Port Dover WTP and Nanticoke WTP source water from Lake Erie. Both use free chlorine as the disinfectant residual, and neither perform corrosion control nor backend pH control. Based on Table 7-7, the total hardness and alkalinity in the Port Dover and Nanticoke systems are similar, and the Nanticoke treated water has higher pH. The pH range of the Nanticoke water is generally in line with the targets for new water treatment plants. The free chlorine residuals in the Nanticoke system are generally lower compared to Port Dover, however, low chlorine residuals can be mitigated by the addition of a chlorine booster station at the Norfolk – Haldimand border. The chlorine booster station has been included in the cost estimate of this alternative. Overall, minimal water quality and pipe corrosion impacts are anticipated if the community of Port Dover uses a blended supply (Port Dover WTP with Nanticoke WTP) or switches the supply entirely to Nanticoke WTP.

The impact of switching the Simcoe supply from groundwater to Nanticoke WTP treated surface water is much more unpredictable. As shown in Table 7-7, the total hardness and alkalinity measured in the Simcoe distribution system are much higher than in the Nanticoke distribution system, whereas the pH is lower. As such, changing Simcoe's supply to Nanticoke WTP may introduce pipe corrosion issues. To mitigate this challenge, the County can consider adding corrosion inhibitors, such as ortho- or polyphosphates, just before the Nanticoke treated water enters the Simcoe distribution system. The need for corrosion inhibitors should be confirmed in a separate corrosion control study. If phosphates are used, the County should monitor for biofilm growth and ensure that the pH is maintained at a level where the phosphate is effective. Simcoe may also experience taste and odour, and coloured water during the first phase of the transition. These problems will be more noticeable in cast iron pipes.

Switching Simcoe to a surface water supply will also impact the rate of chlorine residual decay in the distribution system. This is due to intrinsically different characteristics of surface water and groundwater, and a water quality study should be conducted to determine how the treated surface water will interact with the existing biofilm. This will help determine the need for a chlorine booster station and what the optimal chlorine dosage should be.

Overall, water quality challenges will likely occur if a surface water supply is introduced to the Simcoe system, whether through blending or switching the source entirely. Generally, water quality challenges are most pronounced during the transition phase, and gradually become less frequent after pipe wall chemistry re-stabilizes and the system reaches steady state. During the transition phase, the County will likely need to increase water quality monitoring and flushing/swabbing. The same water quality concerns also apply to Waterford and Delhi if these communities are switched to a surface water supply.

WT Infrastructure ("WT") was retained by the County to conduct hydraulic analysis on the preferred routings for the Nanticoke to Port Dover routing. WT presented three (3) alternatives, all involving supplying Port Dover with a direct pressure connection as it is economically unfeasible to provide a low pressure connection to the existing Port Dover WTP for re-pressurization. Based on WT's analysis, there is sufficient capacity in the Port Dover distribution system for community supply, thus the connections only connect to the distribution system and not to the Port Dover elevated tank.

As shown in Figure 7-15, there are three (3) stub connections from the 750 mm transmission main between the Nanticoke WTP and Townsend Storage Tanks. WT's analysis indicated that the only feasible connection point is the stub on St. John's Road (Haldimand Road 3). In all proposed alternatives, the Haldimand transmission main would need to extend from this stub to the Haldimand-Norfolk border along St. John's Road (2,291 mm of 400 mm transmission main). A boundary metering chamber and chlorine booster station would also be needed near the county border. From St. John's Road, three (3) different alignments to Port Dover were presented. The preferred alternative is along Highway 6 to Dover Coast Blvd (Alternative A in Figure 7-15), which includes a new 400 mm watermain of length 3,275m connecting to an existing 400 mm distribution watermain in Port Dover. This alternative is similar to the others in terms of environmental conditions and impact, however, it has a lower capital cost and can be readily integrated into a regional supply system. The estimated cost of this routing is $8.7 million.

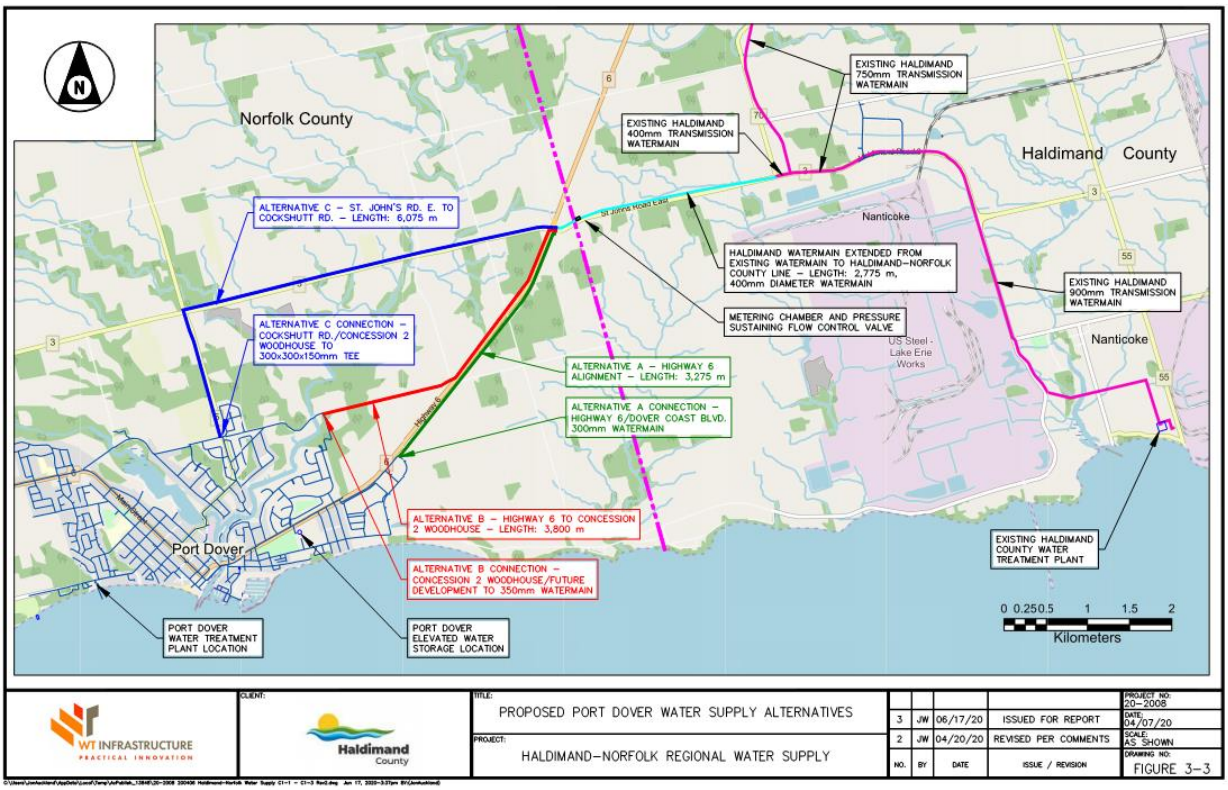


Figure 7-15 Alternative 2.2 Watermain Routing

7.3.4 ALTERNATIVE 2.3 – NANTICOKE WTP UPGRADE TO MEET PORT DOVER + SIMCOE + WATERFORD DEMANDS WITH TWO CONNECTIONS

The concept behind Alternative 2.3 is very similar to Alternative 2.2. However, in this alternative two connections are proposed from Nanticoke WTP to Norfolk County:

1. Nanticoke WTP to Port Dover,

2. Nanticoke WTP to Simcoe via Townsend.

In this alternative, the only source of supply to Port Dover, Simcoe, and Waterford would Nanticoke WTP. Thus, having an additional connection between the two Counties provides redundancy and helps ensure continuous supply of water even in case of a watermain break. As shown in Figure 7-16, the timeline and implementation of Alternative 2.3 is similar to Alternative 2.2. Simcoe can be supplemented by Delhi in 2025, and Port Dover can be supplemented by Nanticoke WTP in 2025. As discussed in Section 7.2.8, Nanticoke WTP currently does not have sufficient surplus capacity to help Port Dover meet its MDD. It is anticipated that Nanticoke's expansion to 43,000 m^3/d firm capacity could be completed by the end of 2027, and Port Dover, Waterford, and Simcoe could be fully supplied by Nanticoke WTP in 2028. At this point, the Port Dover development freeze may potentially be lifted, and Delhi would stop supplementing Simcoe. Port Rowan WTP upgrades (see Section 7.2.4) could occur independently of Nanticoke WTP upgrades and it is estimated that Port Rowan can become self sufficient by 2027.

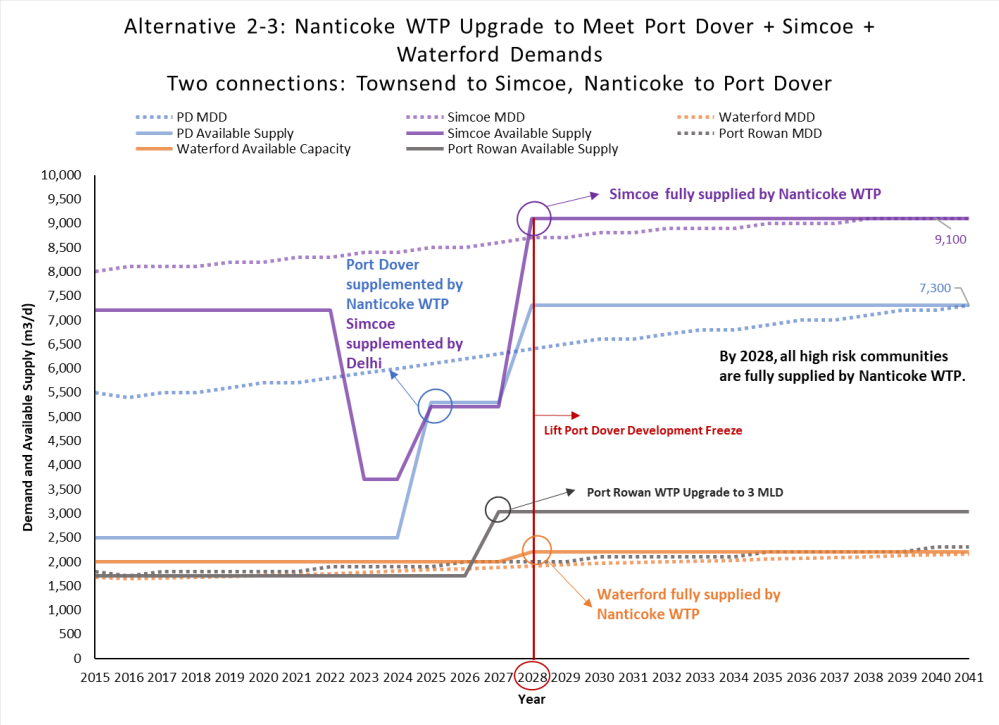


Figure 7-16 Alternative 2.3 Implementation

WATER QUALITY ANALYSIS

The same water quality analysis described in Alternative 2.2 (Section 7.3.3) also apply to this alternative.

HYDRAULIC ANALYSIS

WT Infrastructure's recommended routing for this alternative is shown in Figure 7-17. This alternative involves two (2) connections between Norfolk and Haldimand: one along Highway 6 and St. Johns Road to Port Dover, and one trunk watermain extending from the connection at Stone Quarry Road along Concession 13 Townsend to Simcoe, Delhi, and Waterford. The Port Dover connection is the same as discussed in Section 7.3.3. The other connection is a 500 mm trunk watermain on Concession 13 Townsend connecting to an existing 400 mm stub on Stone Quarry Road by Edenridge Drive. The 500 mm watermain would connect to a pressure boosting station, after which it would become a 600 mm until Highway 24. A boundary metering chamber, boundary chlorine boosting system, and pressure zone control valves would also be required. This option involves a pressurized supply, as a low pressure option is not feasible due to the location and availability of existing treatment plants in Waterford, Simcoe, and Delhi. The total estimated cost for this alternative is $58.8 million dollars.

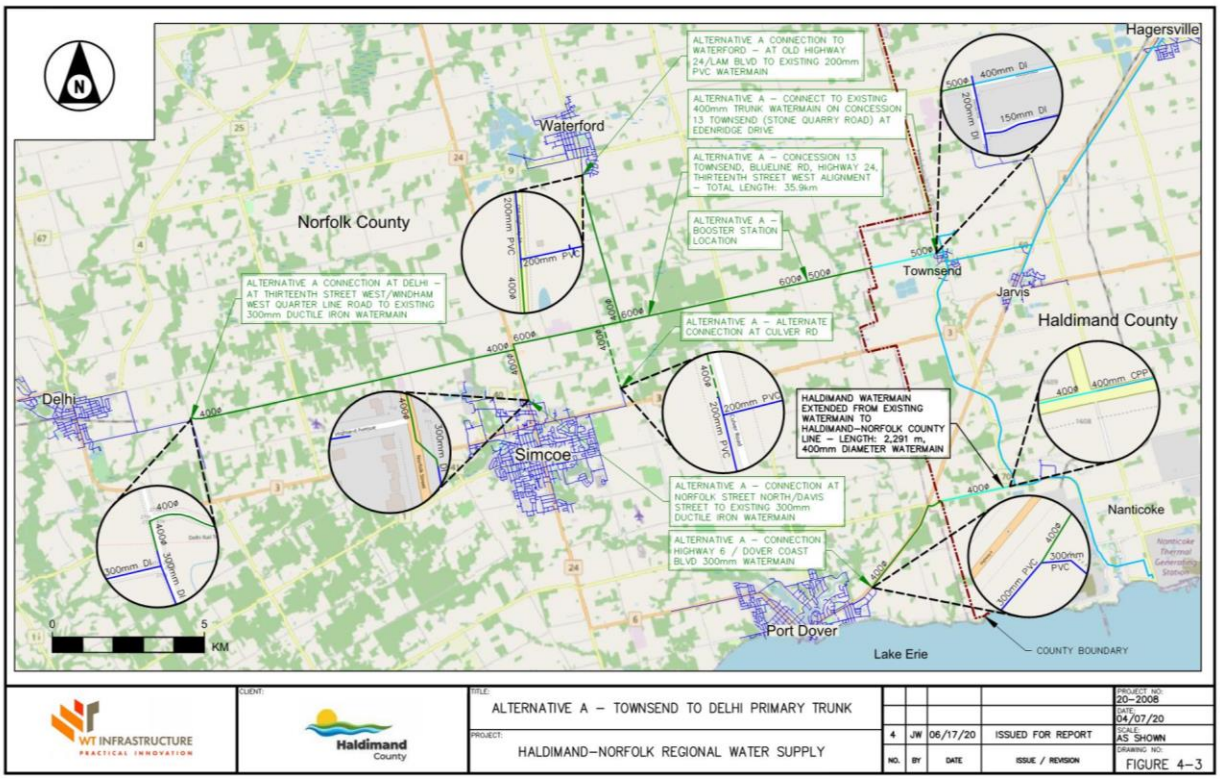


Figure 7-17 Alternative 2.3 Watermain Routing

7.3.5 ALTERNATIVE 2.4 - PORT DOVER WTP UPGRADE + NANTICOKE WTP UPGRADE TO MEET SIMCOE + WATERFORD DEMANDS - FUTURE EXPANSION TO INCLUDE PORT DOVER

Alternative 2.4 allows Port Dover to become self sufficient and any supplementary supply from Nanticoke WTP to be directed to Simcoe. In this alternative, Port Dover WTP would be upgraded to meet the local community's 2041 projected demands. The proposed Port Dover upgrades include installation of new UV disinfection units, upgrades to the high lift pumps, purchasing an additional DAF unit and conversion to DAF-Filters, and retrofitting the existing filters to taste and odour filters only. Two connections between Haldimand and Norfolk are proposed, with the same routing as presented in Figure 7-17.

An overview of the implementation of Alternative 2.4 is shown in Figure 7-18.

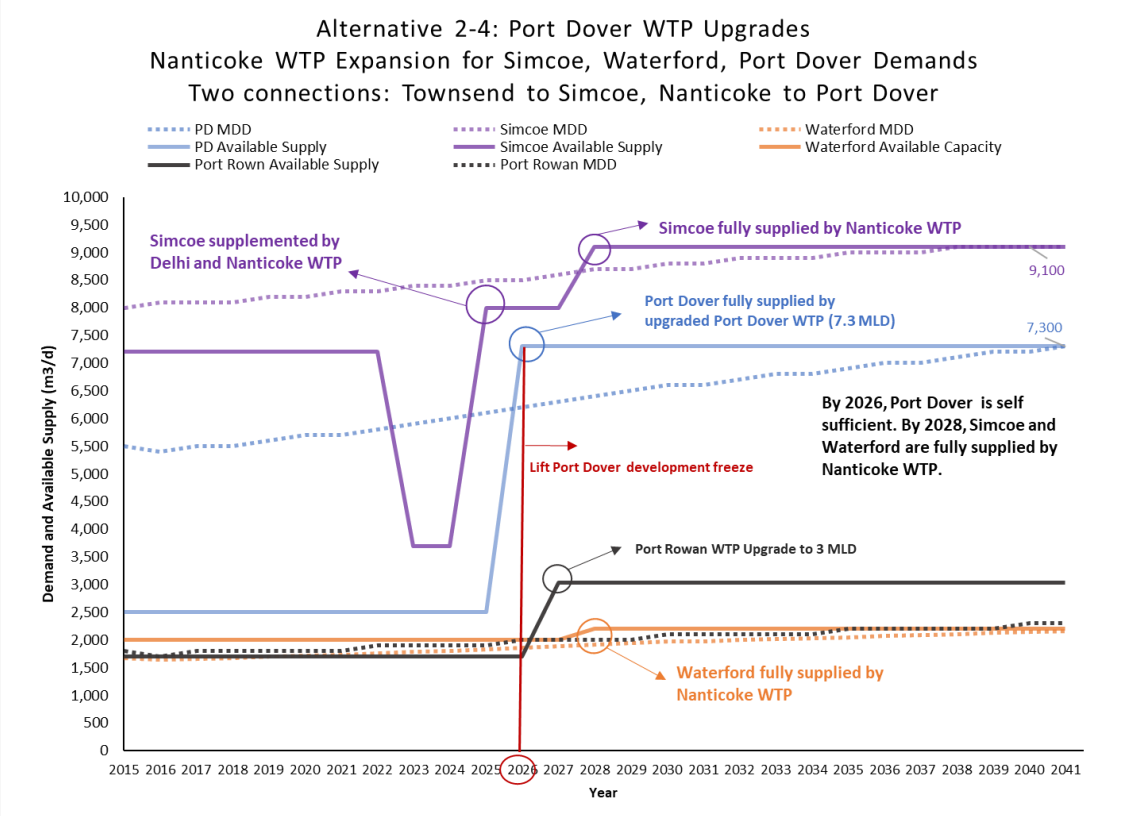


Figure 7-18 Alternative 2.4 Implementation

As shown in Figure 7-18, it is anticipated that Port Dover WTP would be self sufficient by 2026. Construction of the Nanticoke to Simcoe via Townsend connection, and the Delhi to Simcoe connection, could potentially be undertaken at the same time as Port Dover WTP upgrades. It is estimated that Nanticoke WTP would be able to provide supplemental flow to Simcoe by 2025. Nanticoke WTP is estimated to be able to provide a maximum flow of 2,800 m^3/d as discussed earlier. The Simcoe groundwater wells would need to remain online until 2028, however Simcoe could be supplemented by both Nanticoke WTP and Delhi wells between 2025 – 2028.

Construction of the Simcoe – Waterford transmission main is assumed to commence in 2024 and be completed by the end of 2026. This allows Waterford to be fully supplied by Nanticoke WTP immediately once upgrades are complete. Since this alternative has measures for an upgraded Port Dover WTP to meet its local 2041 demands, the Port Dover – Nanticoke connection is not urgently needed unless the County decides to decommission the Port Dover WTP. For the purposes of providing a frame of reference for cost and timeline, the Port Dover connection was included in year 2029 for this study. However, this connection could be pushed to a later date because the Port Dover WTP could potentially remain in service for another 15 – 20 years.

The Port Rowan & St. Williams system would continue to operate independently, and it is assumed that the Port Rowan WTP upgrades (see Section 7.2.4) can be completed by 2027.

WATER QUALITY ANALYSIS

The same water quality analysis regarding switching Port Dover and Simcoe to Nanticoke WTP supply as described in Alternative 2.2 (see Section 7.3.3) also apply to this alternative. However, additional water quality concerns may arise in Simcoe as there will be an extended period where Simcoe will be supplied by a blend of local groundwater, Delhi groundwater, and Nanticoke WTP surface water. Blending multiple sources as proposed in this alternative is typically not recommended, however, this alternative allows

Simcoe to minimize its supply deficit. This is an important consideration as there is potential for significant demand increase in Simcoe.

Introducing a new source, particularly of a different type, may de-stabilize the pipe wall chemistry. For this reason, it is important to keep the blending ratio constant, and an “optimum” ratio should be selected to minimize water quality concerns. The ratio should be determined through a water quality study, including pilot or bench testing. Consideration should also be given to allow the sources to first blend in a reservoir, or in a similar environment, prior to introducing the blended water to the distribution system. This would allow the County to control the ratio of the blend, and to add disinfectants or other chemical treatment as needed. The County can use a flow paced approach and coordinate with Haldimand County to control the volume of water coming in from the Townsend transmission main. If this option is selected, further hydraulic modeling should be conducted to determine if there is a suitable location for the blending, and how Norfolk County would coordinate with Haldimand County. The County should also thoroughly flush and clean watermains prior to introducing blended water.

HYDRAULIC ANALYSIS

The same piping routing and hydraulics considerations as described in Alternative 2.3 (Section 7.3.4).

7.3.6 SUMMARY OF SHORT-LISTED ALTERNATIVES

The table and figures below present a summary of the shortlisted alternatives. In this section, PS refers to pumping stations.

Table 7-8 Summary of Short Listed Alternatives

ALT.	DESCRIPTION	NEW OR UPGRADED PDWTP	NANTICOKE WTP EXPANSION	INTER-URBAN CONNECTION (IUC)	LOCAL UPGRADES PER ISMP	CONNECTION FROM NANTICOKE WTP TO PORT DOVER	CONNECTION FROM TOWNSEND TO SIMCOE	CLASS EA REQUIREMENT& MASTER PLAN UPDATES	TIMELINE
Alt no.1.2	Centralized WTP in Port Dover to Service all County Communities	**NEW 24 MLD**	**No**	**Yes**	**Yes**	**No**	**No**	**Schedule A for IUC Schedule B for PS Schedule C for WTP Upgrades**	**2022 - 2023 Norfolk MP incl. Class EA Schedule C** **2024 – 2027 Design & Construction for Centralized PDWTP** **2022 - 2032 IUC Phasing**
Alt no.1.3	Two Lake-Based WTPs with Interconnection	**NEW 21 MLD**	**No**	**Yes – excluding Port Rowan**	**Yes**	**No**	**No**	**Schedule A for IUC Schedule B for PS PRWTP Upgrades Schedule C for WTP Upgrades**	**2022 - 2023 Norfolk MP incl. Class EA Schedule C** **2024 – 2027 Design & Construction for PDWTP Upgrades, Port Rowan WTP Upgrades** **2022 - 2030 IUC Phasing**
Alt no.2.2	Nanticoke WTP Upgrade to Meet Port Dover + Simcoe + Waterford Demands. One connection: Nanticoke to Port Dover	No	**Yes – Nanticoke WTP expansion to 43 MLD**	**Yes – excluding Port Rowan**	**Yes**	**Yes** **Length: 10.9 km Diameter: 400 mm PS not required**	**No**	**Schedule A for IUC Schedule B for PS Schedule C for WTP Upgrades**	**2022 – 2023 Norfolk MP, Nanticoke Class EA Schedule C** **2022 – 2024 Design & Construction Nanticoke to Port Dover Transmission Main** **2024 – 2027 Nanticoke WTP Expansion** **2022 – 2031 Phasing of Remaining IUC**

ALT.	DESCRIPTION	NEW OR UPGRADED PDWTP	NANTICOKE WTP EXPANSION	INTER-URBAN CONNECTION (IUC)	LOCAL UPGRADES PER ISMP	CONNECTION FROM NANTICOKE WTP TO PORT DOVER	CONNECTION FROM TOWNSEND TO SIMCOE	CLASS EA REQUIREMENT& MASTER PLAN UPDATES	TIMELINE
Alt no.2.3	Nanticoke WTP Upgrade to Meet Port Dover + Simcoe + Waterford Demands. Two connections: Nanticoke to Port Dover and Townsend to Simcoe		**Yes – Nanticoke WTP expansion to 43 MLD**	**Yes – excluding Port Rowan**	**Yes**	**Yes** **Length: 10.9 km** **Diameter: 400 mm** **PS not required**	**No** **Length: 4.7 km** **Diameter: 500 mm** **PS Required**	**Schedule A for IUC** **Schedule B for PS and ET** **Schedule C for WTP Upgrades**	**2022 – 2023 Norfolk MP, Nanticoke Class EA Schedule C** **2022 – 2024 Design & Construction Nanticoke to Port Dover Transmission Main** **2024 – 2027 Nanticoke WTP Expansion** **2025 – 2027 Design & Construction Townsend to Simcoe Transmission Main** **2022 – 2028 Phasing of Remaining IUC**
Alt no.2.4	Port Dover WTP Upgrade to Meet Current Demand Nanticoke WTP Upgrade to Meet Simcoe + Waterford Demands - Future expansion to include Port Dover. Two connections: Townsend to Simcoe and Nanticoke to Port Dover	**UPGRADE: 7.3 MLD**	**Yes – Nanticoke WTP expansion to 43 MLD**	**Yes – excluding Port Rowan**	**Yes**	**Yes** **Length: 10.9 km** **Diameter: 400 mm** **PS not required**	**No** **Length: 4.7 km** **Diameter: 500 mm**	**Schedule A/B for IUC** **Schedule B for PS and ET (Nanticoke-Haldimand Connection)** **Schedule C for WTP Upgrades**	**2022 – 2023 Norfolk MP, Nanticoke Class EA Schedule C** **2022 – 2024 Design and Construction of Port Dover WTP Upgrades** **2022 – 2024 Design & Construction Townsend to Simcoe Transmission Main, Delhi to Simcoe Transmission Main** **2024 – 2027 Design & Construction Nanticoke WTP Upgrades** **2024 – 2027 Design & Construction Simcoe to Waterford Transmission Main** **2028 – 2030 Phasing of Remaining IUC**

7.3.7 SUMMARY OF TIMELINES OF SHORT-LISTED ALTERNATIVES

Below is a summary of all the shortlisted alternatives timeline, indicating the year each capital project will be implemented. Alternatives 2.3 and 2.4 do not include a Port Dover – Simcoe connection, however, both these communities will be connected to Nanticoke WTP.

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
MP and EA	Norfolk MP, Class EA											
Construction Phasing - Transmission Mains	**Delhi to Simcoe Connection**											
			Port Dover to Simcoe Connection			**Simcoe to Waterford Connection**			Other IUC interconnection			
Construction Phasing - WTP			Centralized WTP Construction (24 MLD)									
Status				Simcoe Partially Supplied by Delhi					**Port Dover, Simcoe, Waterford Fully Supplied by new Centralized WTP**			**All communities are Interconnected**

Figure 7-19 Alternative 1.2 Timeline

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
MP and EA	Norfolk MP, Class Eas											
Construction Phasing - Transmission Mains			**Port Dover to Simcoe Connection**			**Simcoe to Waterford Connection**						
	Delhi to Simcoe Connection											
Construction Phasing - WTP			New Port Dover WTP (21 MLD), Port Rowan WTP Upgrades (3 MLD)									
Status									**Port Dover, Simcoe, Waterford Fully Supplied by new Centralized WTP**	**All communities are Interconnected (except Port Rowan)**		

Figure 7-20 Alternative 1.3 Timeline

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
MP and EA	Norfolk MP, Nanticoke WTP Class EA and Transmission Main Class EAs											
Construction Phasing - Transmission Mains from Haldimand	**Nanticoke to Port Dover Connection**											
Construction Phasing - Transmission Mains in Norfolk	**Delhi to Simcoe Connection**											
				Port Dover to Simcoe Connection			**Simcoe to Waterford Connection**					
Construction Phasing - WTP			Nanticoke WTP Expansion to 43 MLD, Port Rowan Upgrade to 3 MLD									
Status				**Port Dover Partially Supplied by Nanticoke, Simcoe Partially Supplied by Delhi**						**Simcoe, Port Dover, Waterford Fully Supplied by Nanticoke**	**All communities are Interconnected (except Port Rowan)**	

Figure 7-21 Alternative 2.2 Timeline

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
MP and EA	Norfolk MP, Nanticoke Class EA											
Construction Phasing - Transmission Mains from Haldimand	**Nanticoke to Port Dover Connection**			**Nanticoke to Simcoe via Townsend Connection**								
Construction Phasing - Transmission Mains in Norfolk	**Delhi to Simcoe Connection**											
			Simcoe to Waterford Connection									
Construction Phasing - WTP			Nanticoke WTP Expansion to 43 MLD									
Status				**Port Dover Partially Supplied by Nanticoke**			**Simcoe and Waterford Fully Supplied by Nanticoke**	**All Communities interconnected (except Port Rowan)**				

Figure 7-22 Alternative 2.3 Timeline

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
MP and EA	Norfolk MP, Nanticoke Class EA											
Construction Phasing - Transmission Mains from Haldimand	**Nanticoke to Simcoe via Townsend Connection**						**Nanticoke to Port Dover Connection**					
Construction Phasing - Transmission Mains in Norfolk	**Delhi to Simcoe Connection**											
			Simcoe to Waterford Connection									
Construction Phasing - Port Dover WTP	**Port Dover WTP Upgrades to 7.3 MLD**											
			Nanticoke WTP Expansion to 43 MLD									
Status				**Simcoe Partially Supplied by Nanticoke and Delhi**	**Port Dover Fully Supplied by Port Dover WTP**		**Simcoe and Waterford Fully Supplied by Nanticoke**			**All Communities interconnected (except Port Rowan)**		

Figure 7-23 Alternative 2.4 Timeline

7.3.8 EVALUATION OF SHORTLISTED ALTERNATIVES VIS A VIS PORT DOVER

Table 7-9 provides a summary of the impact of each alternative specifically to the Port Dover community. This is due current water supply deficiency in Port Dover and the fact that there is a development freeze in effect as of September 2019. Therefore, the County is investigating different alternatives to provide a secure and reliable water solution to this community.

Table 7-9 Evaluation of Shortlisted Alternatives with Respect to Port Dover

	Alt. 1.2	**Alt. 1.3**	**Alt. 2.2**	**Alt. 2.3**	**Alt. 2.4**
Facts/Description	Centralized WTP in Port Dover to Service all County Communities	Two Lake-Based WTPs with Interconnection Port Rowan WTP to supply Port Rowan & St. Williams New Port Dover WTP to supply All Other Communities	Nanticoke WTP Upgrade to Meet Port Dover + Simcoe + Waterford Demands. One connection: Nanticoke to Port Dover	Nanticoke WTP Upgrade to Meet Port Dover + Simcoe + Waterford Demands. Two connections: Nanticoke to Port Dover and Townsend to Simcoe	Port Dover WTP Upgrade to Meet Current Demand Nanticoke WTP Upgrade to Meet Simcoe + Waterford Demands - Future expansion to include Port Dover Two connections: Townsend to Simcoe and Nanticoke to Port Dover
Year by which a reliable water supply to Port Dover can be implemented	2028	2028	2028	2028	2026
Timeline to implement permanent, reliable water solution (GAP)	8	8	8	8	6
Proposed Fast Tracking Options	1. Using fused HDPE pipe for the water transmission mains in place of PVC - depends on the type of installation, diameter of pipe required, availability of specialized contractors in Ontario 2. Use "Incentive" contract types to allow reaching the targeted timelines. Please note that this will add a premium to the overall cost. The cost estimates presented below does not include any premiums for fast tracking the project. 3. Pre-select and pre-purchase process equipment for WTP expansions 4. Pre-consultation with MECP to investigate if the Master Planning and Class EA processes could be shortened for this project due to its urgency.				

Based on the above, Alternative 2.4 would be the preferred option for Port Dover as it allows Port Dover to meet its MDD in the shortest timeline. However, a key assumption made in this evaluation is that Nanticoke WTP upgrades to 43 MLD will be completed in 2027. If confirmation is received from Haldimand County that this upgrade can be completed by 2026 or before, then the timelines of Alternative 2.2 and Alternative 2.3 would be equally preferable as Alternative 2.4 with regards to Port Dover. Additionally, Alternative 2.4 may result in increased water quality challenges in Simcoe compared to Alternative 2.3 and Alternative 2.4 as a result of source water blending.

8 COST ANALYSIS

This section presents the cost analysis for each of the shortlisted alternatives. The following assumptions were made when developing the cost estimates:

COST ANALYSIS ASSUMPTIONS

General

- All values are in $2020.
- The level of cost estimate: Rough Order of Magnitude (ROM).
- Costs of water quality and corrosion control studies were not included as they should be performed for all alternatives. These studies are estimated to be in the range of $20,000 each.
- The ISMP recommends $9M in Storage Upgrades and $6 in Local Distribution System upgrades (2016 dollars). It is assumed these upgrades must be performed regardless of whether the County chooses to proceed with an interurban system. Therefore, these costs (about $17M total in 2020 dollars) have not been included in the cost estimate for this study.
- Distribution system related operating costs (flushing, sampling etc.) are not included as they will be required regardless of alternative selected.
- Net Present Value Calculations were based on:
    - Interest Rate: 3%.
    - Inflation Rate: 2%
    - The interest rate and inflation rate were selected to match the Haldimand-Norfolk rate study conducted by Watson in 2020.

Norfolk WTP and Groundwater Wells

- For the purposes of this study, the unit cost for construction of new WTPs and upgrading an existing WTP was estimated to be $1,450/$m^3$ and $1,330/$m^3$ treated water, respectively. These values are based on historical cost data and do not include the cost of the intake. All costs were rounded to the nearest dollar.
- A new Centralized WTP in Port Dover cost to fully supply all Norfolk County communities is estimated to cost $51.3M including a new intake. This was calculated by bringing the ISMP estimate of $44M from 2016 dollars to 2020 dollars.
- It was assumed that Port Rowan WTP would have a new intake, as the study to deepen the intake is dated and another study should be conducted to evaluate the new conditions of the site. Also, considering the scope of this study, a robust long-term solution should be implemented to ensure a reliable system. The study conducted by Byron Wiebe in 2005 estimated that the cost of a new intake, low lift pump station and a new watermain from the Long Point location to the Port Rowan WTP would be approximately $9M in 2005 dollars. Therefore, this estimated was adjusted for 2020 and the estimated cost was assumed to be 50% more than the original cost resulting in an updated cost of $13.5M.
- The cost to upgrade the treatment processes and treatment building of Port Rowan WTP is estimated to be $4.7M. This was calculated by bringing the ISMP estimate of $4M from 2016 to 2020 dollars.
- Operational (treatment) costs:
    - Port Dover WTP: $0.60/m3. This was calculated by dividing Port Dover's annual Operations Cost (2017- 2019) by Port Dover WTP's firm capacity of 2,500 m3/d. This was also verified by performing the same calculation using 2017 – 2019 production

data, which resulted in costs of approximately $0.55 to $0.60 per cubic metre treated water.

- Port Rowan WTP: Assumed same as Port Dover
- Groundwater Wells: 0.45/m3 (based on similar projects)

Nanticoke WTP

- Nanticoke WTP will have a maximum firm capacity of 43 MLD when fully expanded.
- Based on the rate study conducted by Watson, Norfolk County will pay for 72% of capital costs associated with Nanticoke WTP expansion, and 100% of costs associated with transmission mains and booster stations associated with bringing water from Nanticoke to Norfolk County (including infrastructure located within Haldimand County borders).
- Based on the Watson report, the total estimated cost for Nanticoke WTP upgrades to maximum capacity (43 MLD) is $20.25M, including contingency and engineering (20% each). Norfolk County will pay $14.58M capital costs and Haldimand County will pay the remainder.
- Based on the Watson rate study, Norfolk County is estimated to pay:
  - $1.74 per cubic meter of treated water prior to Nanticoke WTP upgrades (i.e. when Haldimand County provides 2,800 m3/d to Norfolk County). This includes $1.52 per cubic meter paid to Haldimand (purchase rate) plus $0.22 per cubic metre debt payment.
  - $1.99 per cubic meter of treated water after Nanticoke WTP undergoes upgrades (i.e. when Haldimand County provides 21,600 m3/d to Norfolk County. This includes $1.64 per cubic meter paid to Haldimand (purchase rate) plus $0.35 per cubic metre debt payment.
  - The debt payment includes the capital costs for Nanticoke WTP upgrades and transmission mains located within Haldimand County borders, thus the capital costs of these items have not been accounted for separately. Debt payments are calculated over a 20-year term at 3% interest.

Transmission Mains and Booster Stations

- All alternatives include Inter-Urban Connection cost (IUC), however some alternatives do not include the connection between Port Dover and Port Rowan. Only Alternative 1.2 has a complete IUC.
- Transmission main costs (including booster stations, metering chambers etc.) were retrieved from WT Infrastructure's report. Costs of transmission mains located within Haldimand County borders were excluded as these are accounted for within the purchase rate plus debt rate described above.
  - Alternative 2.2 in this report is based on Alternative B in WT Infrastructure's report (estimate $59.5M)
  - Alternatives 2.3 and Alternative 2.4 are based on Alternative A in WT Infrastructure's report (estimate $50M).
  - Alternatives 1.2 and Alternative 1.3 IUC are based on Alternative A. It should be noted that WT Infrastructure provided a cost estimate for a connection from Port Dover to St. Williams (19 km), but not from Port Dover to Port Rowan (34.5 km). This report uses the WT Infrastructure's cost as a basis and estimated the Port Dover to Port Rowan connection as $32M. In comparison, the cost of the Port Dover to St. Williams connection is $22.9M.
- For Alternatives 1.2 and Alternative 1.3, booster stations for IUC connections were estimated to be $6M ($2020).

- All transmission mains are within the right of the way – any land easements or Schedule B Class EA due to land easements is not included in the cost estimate or the proposed timeline.
- Watermain Unit Costs: *(These values were retrieved from WT Infrastructure's report. Note that these costs can vary depending on geographical location, conditions of the site, geotechnical investigation, restorations, etc.)*
    - 500 mm: $700 per meter of pipe
    - 400 mm: $600 per meter of pipe
    - 300 mm: $600 per meter of pipe
    - The Unit costs do not include restoration, dewatering, servicing, temporary connection. Site specific conditions have not been considered in the cost. Soil condition unknown.

Table 8-1 provides a summary of all the costs associated with each alternative, along with a 21-year life cycle cost analysis. Overall, alternatives that involve Norfolk supplying its own water have higher capital costs, but lower NPV values over the course of a 21 year span. This is because the purchased water rate from Haldimand is significantly higher than the cost of Norfolk County operating its own facilities.

Table 8-1 Cost Analysis of Short Listed Alternatives

COST	ALT. 1.2	ALT. 1.3	ALT. 2.2	ALT. 2.3	ALT. 2.4
Norfolk WTP *Port Dover and Port Rowan WTPs.*	$57,166,000	$69,470,000	$18,170,000	$18,170,000	$29,630,000
Transmission Mains[1] *Inter-Urban Connection, includes pumping stations, metering chambers etc.*	$71,690,000	$39,710,000	$59,580,000	$50,870,189	$50,870,189
Other	$500,000	$500,000	$650,000	$650,000	$650,000
Total Capital Cost ($2020) **Cost Estimate Level: Rough Order of Magnitude (ROM)**	$129,356,000	$109,680,000	$78,400,000	$69,690,189	$81,150,189
Life Cycle Cost Analysis (2020-2041)					
Capital Cost (NPV)	$120,750,000	$104,150,000	$73,460,000	$66,250,000	$76,950,000
Operational Cost (NPV)	$75,890,000	$75,890,000	$163,030,000	$166,020,000	$169,490,000
TOTAL (NPV)	**$196,640,000**	**$180,030,000**	**$236,480,000**	**$232,270,000**	**$246,440,000**

1 Capital costs for transmission mains located within Haldimand County used to supply Norfolk County, and the capital cost associated with upgrading Nanticoke WTP are not included. The capital costs for these items are included into the Purchase Water Rate plus debt payment and are part of the Operational Cost NPV.

8.1 SENSITIVITY ANALYSIS

In this section, each alternative was evaluated financially using various factors. Multiple "what-if" scenarios were developed to assess their sensitivity using Net Present Values (NPV). These scenarios were classified under six major categories as follow:

- Impact of variable capital cost of water treatment plants on NPV (Port Dover and Port Rowan only, Nanticoke WTP upgrade costs are accounted for within Purchased Water rate plus debt payment).
- Impact of variable capital cost of water transmission mains on NPV (booster pumping stations, boundary metering chambers, fire hydrants etc. are included under this category). This does not include the transmission mains located within Haldimand County borders as these watermains are accounted for in the Purchased Water Rate plus debt payment.
- Impact of purchased water rate on NPV
- Impact of operational cost fluctuation on NPV

The results are shown in Table 8-2 and the following figures.

Table 8-2 Sensitivity Analysis of Short Listed Alternatives

Sensitivity Margin	WTP	Transmission Mains	Purchased Water Rate	Operational Cost
Alt.1.2				
-30%	$180,430,000	$176,770,000	-	$173,870,000
0%	$196,640,000	$196,640,000	-	$196,640,000
30%	$212,850,000	$216,510,000	-	$219,400,000
Alt.1.3				
-30%	$160,150,000	$168,830,000	-	$157,270,000
0%	$180,030,000	$180,030,000	-	$180,030,000
30%	$199,920,000	$191,240,000	-	$202,800,000
Alt.2.2				
-30%	$231,320,000	$219,790,000	$187,570,000	-
0%	$236,480,000	$236,480,000	$236,480,000	-
30%	$241,640,000	$253,170,000	$285,390,000	-
Alt.2.3				
-30%	$227,110,000	$217,740,000	$182,460,000	-
0%	$232,270,000	$232,270,000	$232,270,000	-
30%	$237,420,000	$246,790,000	$282,070,000	-
Alt.2.4				
-30%	$237,990,000	$232,000,000	$195,590,000	-
0%	$246,440,000	$246,440,000	$246,440,000	-
30%	$254,890,000	$260,880,000	$297,290,000	-

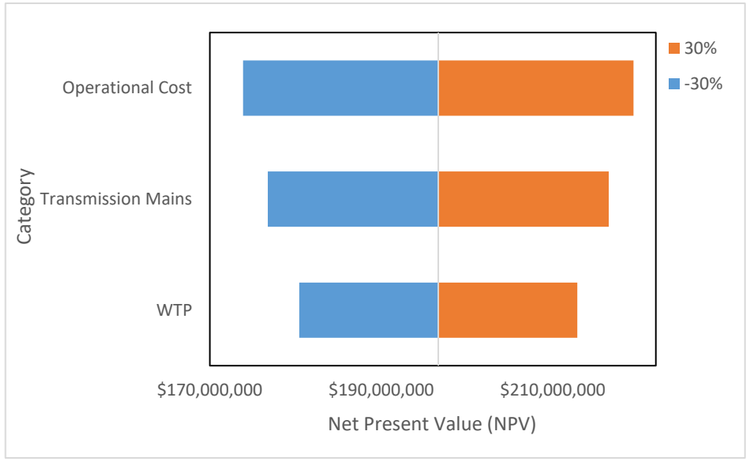


Figure 8-1 Alternative 1.2 - Sensitivity Analysis

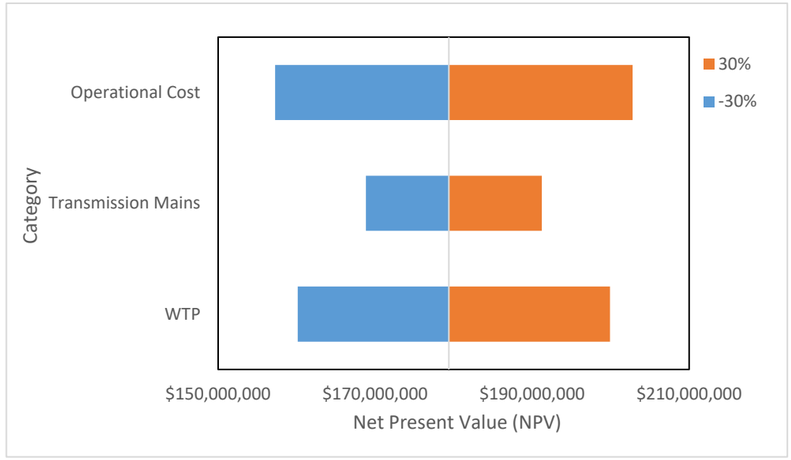


Figure 8-2 Alternative 1.3 - Sensitivity Analysis

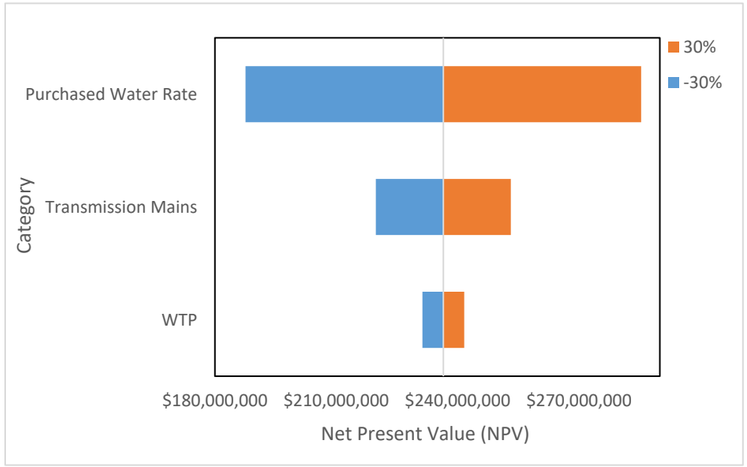


Figure 8-3 Alternative 2.2 - Sensitivity Analysis

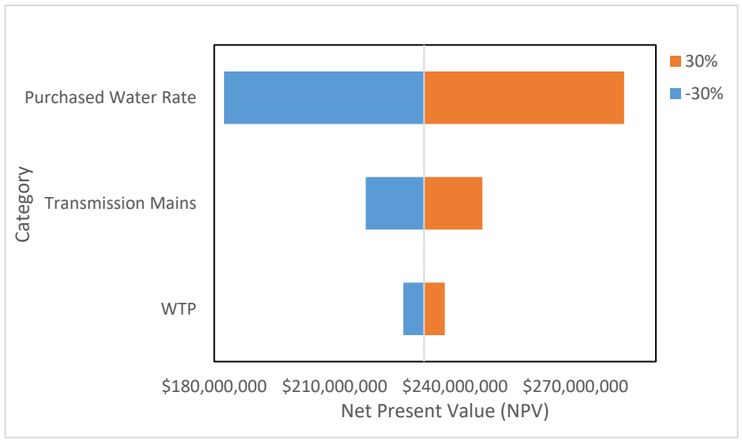


Figure 8-4 Alternative 2.3 - Sensitivity Analysis

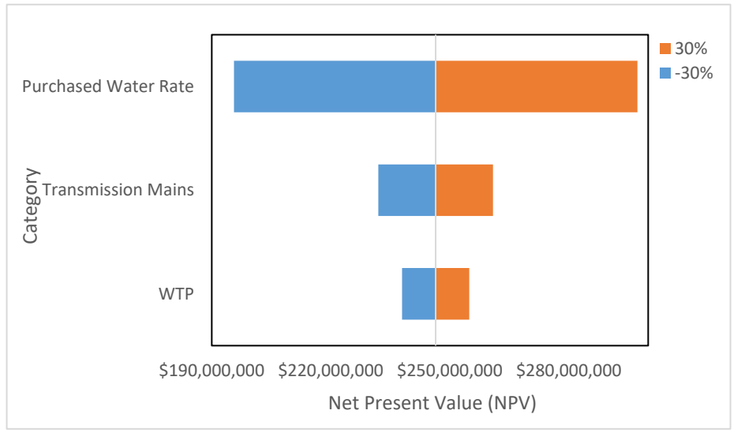


Figure 8-5 Alternative 2.4 - Sensitivity Analysis

The sensitivity analyses indicate that the operational costs or the purchased water rate has the most significant impact on NPV in all alternatives. Figure 8-3, Figure 8-4, Figure 8-5 indicate that the indicate that the purchased water rate has a significantly higher impact than WTP or transmission main related costs for alternatives that involve purchasing water from Haldimand. This is also in line with Table 8-2, which indicates that the operational costs have a higher impact than capital costs on NPV for Alternative 2.2 – 2.4.

Figure 8-1and Figure 8-2indicate that while operational costs are still the most sensitive factor, transmission main and/or WTP upgrade related costs will also heavily impact the NPV. Alternative 1.3 is more sensitive to WTP capital costs compared to Alternative 1.2, but less sensitive to transmission main costs.

9 RISK ANALYSIS

Due to the magnitude of this study, it is very important to identify and evaluate all risks associated with the IUWS alternatives given the existing technical, financial, environmental and regulatory and social constraints. The following risk categories (Table 9-1) are the initial proposed risk management factors proposed by WSP.

Table 9-1 Risk Categories

RISK CATEGORY	DEFINITION
Technical	Risks associated with the design, configuration, construction, operation, resources, infrastructure, ownership for the Project. This also includes risks associated with potable water quality and quantity, watermain breaks, storage requirement, and schedule of the project.
Financial	Issues related to Project financing (i.e. rates, budget management, division of costs)
Environmental	Risks related to harmful effects to the environment or impacts on sensitive landscapes, weather, heritage sites due to harmful discharges to air, land, and impact on water bodies in the case of new intakes.
Public Health	Risks relating to interruption in supply or degradation of quality, which can result in loss of fire suppression capability or human health problems.
Regulatory	Risks relating to permitting or compliance related issues.
Social and Cultural	Risks that could impact stakeholder acceptance of IUWS outcome, including impacts on aesthetics, traffic (post construction), and heritage sites. Duration of construction was not considered as the timelines for all proposed alternatives are relatively similar.

To avoid, as much as possible, the uncertainty throughout the project, it is important to follow a structured risk management process. The first step is to clearly define the objectives based on which the risks are identified, and the types of risks considered i.e. impact of risks on the ultimate goal of the IUWS Study. The potential front-end risks can be identified using the “What if Analysis” methodology and exercising different scenarios that can occur during the project. These scenarios are identified based on experience and knowledge of the stakeholders involved in the project. After the potential risks were identified, each item was assigned a likelihood and severity. Mitigation or control measures were then developed to reduce

overall risk and decrease the number of critical and high risk items. Table 9-2, Table 9-3, and Table 9-4 present, respectively, the likelihood rating scale, severity rating scale, and risk rating scale.

Table 9-2 Risk Likelihood Rating

	LIKELIHOOD
5	ALMOST CERTAIN to happen
4	LIKELY to happen at some point
3	MODERATE possible, it might happen
2	UNLIKELY not likely to happen
1	RARE practically impossible

Table 9-3 Risk Severity Rating

RATING	SEVERITY	DESCRIPTION
5	Catastrophic	Public Health: Death or serious injury among staff. Environment: Severe and irreversible contamination of environmentally sensitive areas. Affected Customers: Large number of customers affected for extended period of time. Financial: Significant unplanned investment would be required to repair/replace (greater than $1,000,000). Reputation: Significant loss of reputation.
4	Major	Public Health: Severe injury or health hazards among workers or customers. Environment: Significant but reversible environmental impact on limited areas. Affected Customers: Small number of customers affected for extended period of time or large number of customers affected for minimal amount of time. Financial: Unplanned investment would be required to repair / replace (less than $1,000,000). Reputation: Some potential loss of reputation.
3	Moderate	Public Health: Minor injuries or illness among service workers only; no impact on customers. Environment: Easily reversible environmental impact on limited area. Affected Customers: Small number of customers affected for short period of time. Financial: Unplanned investment would be required to repair / replace however could be covered by contingency funds in existing operations and maintenance budget. Reputation: Minor loss of reputation - easily regained.

RATING	SEVERITY	DESCRIPTION
2	Minor	Public Health: No injuries or illness among service workers; no impact on customers. Environment: Very minor environmental impact on known and controllable area. Affected Customers: minimum number of customers affected for short period of time. Financial: planned investment would be required to repair / replace however could be covered by contingency funds in existing operations and maintenance budget. Reputation: No loss of reputation.
1	Negligible	Public Health: No injuries or illness amongst customers or staff. Environment: Very minor environmental impact. Affected Customers: Customers are unaffected. Financial: Minor investment required. Reputation: No loss of reputation.

Table 9-4 Risk Decision Matrix

CONSEQUENCES	PROBABILITY 5	4	3	2	1
A	CR	CR	HR	HR	MR
B	CR	HR	HR	MR	LR
C	HR	HR	MR	LR	LR
D	HR	MR	LR	LR	LR
E	MR	LR	LR	LR	LR

A summary of the critical and high risks shown in Table 9-5 and a summary of the relative percentage of risk ratings for each alternative are shown in Figure 9-1 through Figure 9-5. “Uncontrolled risk” refers to the raw risk before mitigation or control measures are applied. “Residual risk” refers to risk remaining after mitigation measures are applied. In general, Alternatives 1.2 and 1.3 have more critical risks and high risks than Alternatives 2.2 – 2.4, both before and after mitigation measures are applied. The critical risks primarily stem from construction of a new intake and high capital costs. The most significant risks for Alternatives 2.2 – 2.4 relate to jurisdiction, water rates, and delays in expanding Nanticoke WTP.

The complete risk matrices are shown in Appendix C.

Table 9-5 Summary of Critical and High Risks

		Alt 1.2	Alt 1.3	Alt 2.2	Alt 2.3	Alt 2.4
1 **Inability to secure funding**	Uncontrolled Risk	CR	CR	HR	CR	CR
	Residual Risk	HR	HR	HR	HR	HR
REASON: Council does not approve funds. This risk is higher for alternatives with higher capital costs.						
IMPACT: Project cannot go forward and water supply issues would not be resolved.						
MITIGATION MEASURES: Hold multiple meetings with the Council and all stakeholders to ensure they are aware of the upcoming project. Ensure that there is buy-in for the recommended solution, and complete comprehensive stakeholder engagement throughout the EA and planning process. Look at forming a separate working group for Council to ensure that they are fully informed and engaged. For Alt 2.2 – 2.4, hold further discussions with Haldimand County to determine if there are opportunities to share costs.						
2 **Delays in permitting timelines including environmental assessment processes**	Uncontrolled Risk	CR	CR	HR	HR	HR
	Residual Risk	HR	HR	HR	HR	HR
IMPACT: Duration and scope of project may be extended. Additional studies, design, and thus funding may be required to proceed with project.						
REASON: All alternatives involve Schedule A/A+ and Schedule B Class EAs for watermains and booster stations. Schedule C Class EAs would be required for construction of a new WTP in Port Dover, new intake at Port Rowan WTP, or expansion of Nanticoke WTP. Schedule C Class EAs require extensive planning and consultation, and request by stakeholders for additional studies, not agreeing with proposed design etc. could delay the process. The approval process for new intakes can be particularly challenging. Delays in permitting is a higher risk for Alt 1.2 and Alt 1.3 as these options require new intakes in Port Dover to supply either the entirety or the majority of Norfolk County. If the intake approval process for the new WTP is delayed, this may impact the water supply of multiple communities. In comparison, the risk associated with the Port Rowan WTP intake is lower. A new Port Rowan WTP intake is recommended for Alt 1.3, Alt 2.2 – 2.4, however, this intake would only impact two (2) communities: Port Rowan and St. Williams. There is also a potential option to deepen the existing intake if constructing a new one is not feasible. Hence, the biggest permitting related risk pertains to a new Port Dover intake.						
MITIGATION MEASURES: Hold multiple meetings with the MECP and other permitting agencies to ensure they are aware of the upcoming project. Ensure permitting requirements are considered when deciding transmission main routings.						

3 **Unable to locate a proper location for the new intake (Port Dover and Port Rowan)**		**Alt 1.2**	**Alt 1.3**	**Alt 2.2**	**Alt 2.3**	**Alt 2.4**
	Uncontrolled Risk	CR	CR	MR	MR	MR
	Residual Risk	HR	HR	LR	LR	LR

REASON:
It may be difficult to site a new intake with an appropriate depth and distance away from shore given that Lake Erie is relatively shallow. Presence of stormwater ponds, shallow areas, nearby wastewater treatment outfall etc. will limit the availability of locations.

IMPACT:
Project implementation timeline would be extended. Communities, particularly Simcoe and Port Dover, would be at risk of water deficiency. Port Dover would remain in a development freeze.

MITIGATION MEASURES:
Hold multiple meetings with the MECP and other permitting agencies to ensure they are aware of the upcoming project. In the case of Port Rowan WTP, re-evaluate whether modifying the existing intake through deepening or other means can resolve water quality issues if a new intake cannot be sited.

4 **Longer than anticipated timeline to construct the new Port Dover WTP or expand Nanticoke WTP**		**Alt 1.2**	**Alt 1.3**	**Alt 2.2**	**Alt 2.3**	**Alt 2.4**
	Uncontrolled Risk	CR	CR	HR	HR	HR
	Residual Risk	HR	HR	MR	MR	MR

REASON:
Construction taking longer due to unforeseen issues. This risk is higher for Alt 1.2 and Alt 1.3 as all communities would need to rely on existing supplies until the construction new WTPs are complete, which may be difficult for Simcoe and Port Dover. For Alt 2.2 - Alt 2.4, delays in the Nanticoke WTP expansion is a high risk as without the upgrades, Nanticoke WTP will not have sufficient capacity to allow Port Dover or Simcoe to meet MDD.

IMPACT:
Communities, particularly Simcoe and Port Dover, would be at risk of water deficiency. Port Dover would remain in a development freeze.

MITIGATION MEASURES:
Ensure Project Management controls on both the design and construction phase of the project. Pre-qualification of the contractors to ensure they are capable of completing a plant of this size and complexity.

5 **Changing or blending existing supplies with new surface water supplies (either from new Port Dover based WTP or Nanticoke WTP)**		**Alt 1.2**	**Alt 1.3**	**Alt 2.2**	**Alt 2.3**	**Alt 2.4**
	Uncontrolled Risk	HR	HR	HR	HR	HR
	Residual Risk	MR	MR	MR	MR	HR

REASON:
Simcoe and Waterford will be changed to a surface water supply, either from a new WTP in Port Dover or from Nanticoke WTP. In Alt 2.2 and Alt 2.3, Port Dover will be partially supplemented by Nanticoke WTP, but this is anticipated to have minimal water quality impact.
In all alternatives, Simcoe will be supplemented by Delhi groundwater before upgrades at surface water treatment plants are completed. This will result in groundwater blending in Simcoe. In Alt. 2.4, Simcoe will have a blended supply of Nanticoke surface water, Simcoe groundwater, and Delhi groundwater until Nanticoke WTP upgrades are complete.

IMPACT:
Potential water quality challenges including pipe corrosion, accelerated loss of disinfectant residual, taste and odour etc. These issues are anticipated to be the most pronounced in Alt 2.4 due to groundwater and surface water blending. Alt 1.2 and Alt 1.3 have a slightly lower risk as Norfolk County will have more control on finished water quality as it will be supplying its own water.

MITIGATION MEASURES:
Conduct water quality and corrosion control studies, and bench testing. Determine whether lead pipes exist in distribution system and whether additional chlorine or corrosion inhibitors are needed. Increase flushing and water quality monitoring during transition phase. Avoid blending where possible.

6 **Inability to locate site for new Port Dover WTP and land easement issues**		**Alt 1.2**	**Alt 1.3**	**Alt 2.2**	**Alt 2.3**	**Alt 2.4**
	Uncontrolled Risk	HR	HR	-	-	-
	Residual Risk	HR	HR	-	-	-

REASON:
There are limited lands available in Port Dover and it may be challenging to attain a property to site the plant. There is available land owned by Norfolk County near the existing wastewater treatment plant and elevated tank, however, additional land may be needed for low lift pumping and intake.

IMPACT:
Communities, particularly Simcoe and Port Dover, would be at risk of water deficiency. Port Dover would remain in a development freeze.

MITIGATION MEASURES:
At the feasibility stage and during the Municipal Class EA Schedule C additional lands would have to be identified early in the process. Start negotiations with land owners if land acquisition is required.

7 **Jurisdiction issues**		**Alt 1.2**	**Alt 1.3**	**Alt 2.2**	**Alt 2.3**	**Alt 2.4**
	Uncontrolled Risk	-	-	HR	HR	HR
	Residual Risk	-	-	HR	HR	HR

REASON:
Failure to come to an agreement regarding ownership and cost division.

IMPACT:
Jurisdiction will impact ownership of facilities and division of cost of upgrades (present and future), in addition to guaranteed supply capacities. This is particularly important for Nanticoke WTP related upgrades as limited information regarding Haldimand County's own demand projections were available at the time of writing. Failure to come to an agreement regarding jurisdiction will delay project implementation.

MITIGATION MEASURES:
Increased communication with Haldimand County during planning process.

8 **Purchased water rate increase over time**		**Alt 1.2**	**Alt 1.3**	**Alt 2.2**	**Alt 2.3**	**Alt 2.4**
	Uncontrolled Risk	-	-	HR	HR	HR
	Residual Risk	-	-	MR	MR	MR

REASON:
Nanticoke WTP requires higher operational costs, additional maintenance, capital upgrades in the future.

IMPACT:
Annual operating cost of Norfolk County water system will increase and residents' water rate will increase. This may result in resident complaints and/or potential political issues. Norfolk County will have less control of water rates in options that involve purchasing water from Haldimand than if it supplies its own water.

MITIGATION MEASURES:
Conduct a water rate study and ensure that agreement is reached. Increase communication with Haldimand County and cap purchase water rates in agreements for a fixed number of years.

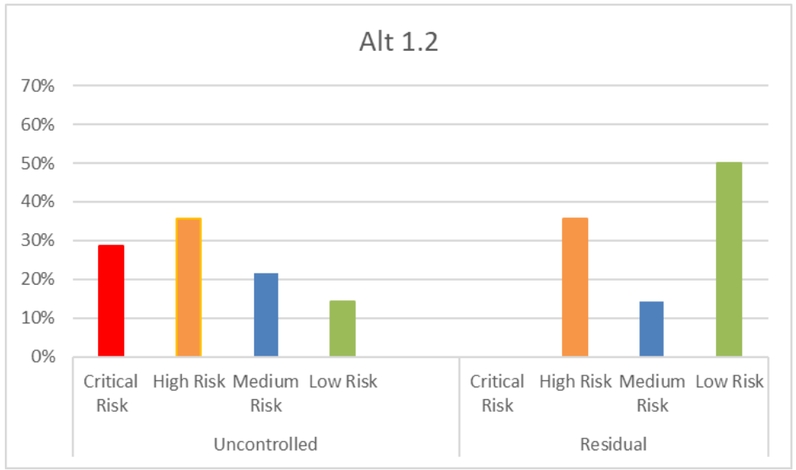


Figure 9-1 Alternative 1.2 Risk Analysis

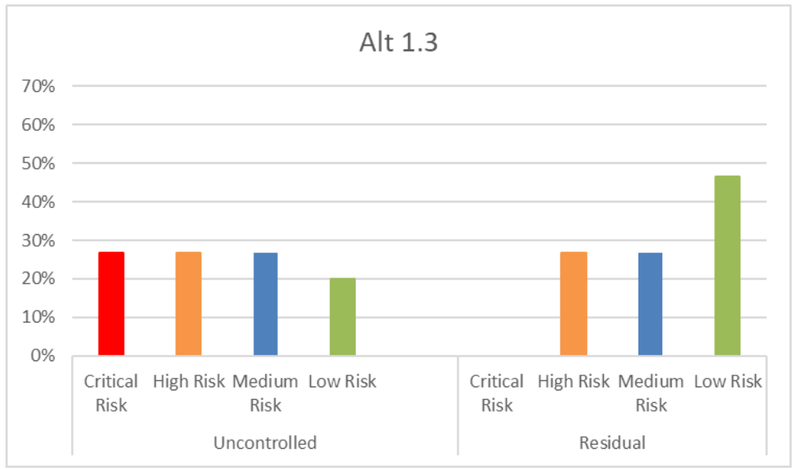


Figure 9-2 Alternative 1.3 Risk Analysis

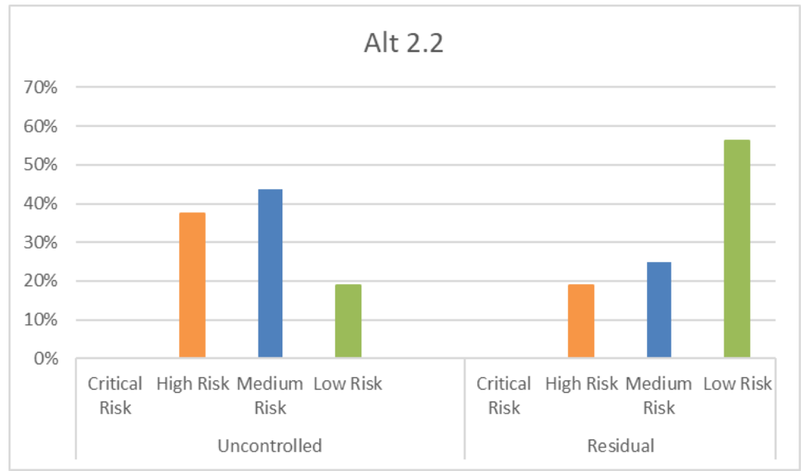


Figure 9-3 Alternative 2.2 Risk Analysis

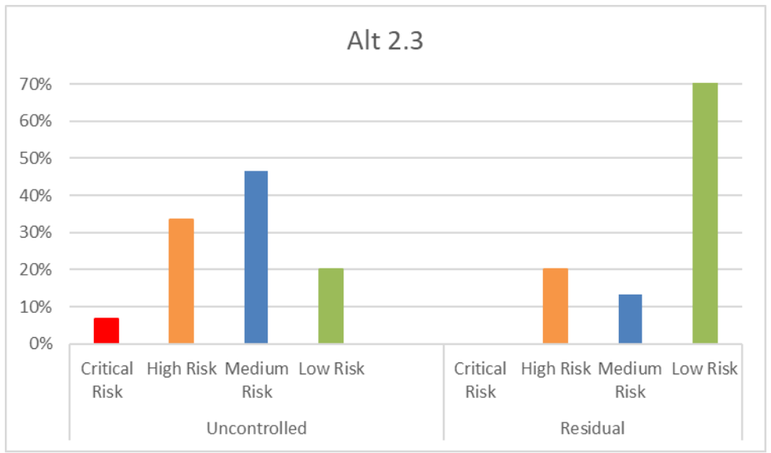


Figure 9-4 Alternative 2.3 Risk Analysis

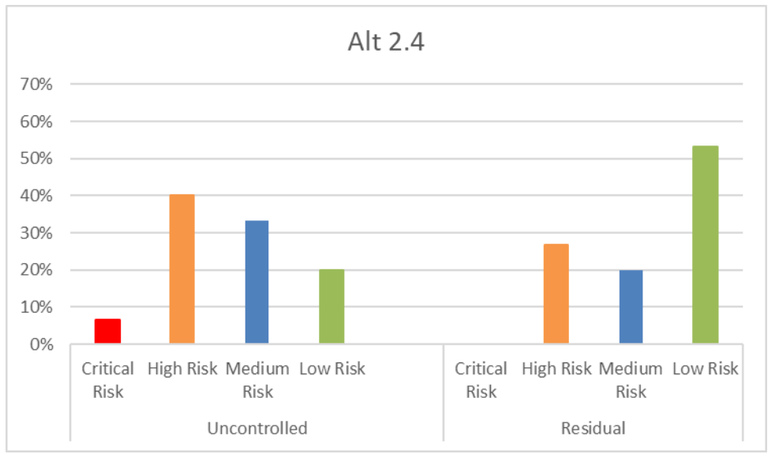


Figure 9-5 Alternative 2.4 Risk Analysis

10 EVALUATION OF ALTERNATIVES

The short-listed alternatives discussed in the previous section will be evaluated using the following categories:

- Natural Environment
- Technical Environment
- Social and Cultural Environment
- Financial Environment

The complete evaluation matrix is shown in Appendix D. Criteria were established for each category and assigned a weight. The higher the weight, the more important the criterion. Alternatives were evaluated against each criterion and assigned a score, with higher scores indicating the more preferable option. The following sections provide a summary of the evaluation.

10.1 NATURAL ENVIRONMENT

Natural environment considered the impact to lake aquatic life and surface water quality, impact to wetlands and terrestrial ecosystems, and impact to groundwater quality. Alternative 1.2 and Alternative 1.3 scored the lowest in this category as they are anticipated to have higher environmental impact from construction of new intakes, and greenfield construction of WTPs. The impact of transmission mains was anticipated to be largely similar between all alternatives, however, fewer interconnections were considered more preferable.

Alternative 2.2 scored the highest with 11 out of 12 points.

10.2 TECHNICAL ENVIRONMENT

Technical Environment held the most weight of all categories, with 52 out of 100 possible points. The most important criteria in this category include security and quantity of supply, impact on water quality, and constructability. Maintenance/operating effort (excluding cost) and timeline to meet Simcoe/Port Dover supply were also considered, in addition to potential for phasing infrastructure and ability to mitigate climate change. Alternatives with the following characteristics are preferable:

- Multiple sources of supply or multiple connections with Nanticoke WTP
- Allows Norfolk County to have good control over supply volume, including potential to expand supply capacity
- Allows Norfolk County to mitigate water quality issues, if any
- Lower construction difficulty and fewer permitting requirements
- Easier to maintain and operate (effort only, excludes cost)
- Shorter timeline to achieve MDD supply in either Port Dover or Simcoe

In general, Alternative 1.2 and Alternative 1.3 provide Norfolk County better control over supply quantity and water quality because the WTPs will be owned and operated by Norfolk County. However, this also means they require increased operating effort. Construction of a new intake is anticipated to be difficult, and there could be a number of potential delays arising from permitting issues. Phasing is not possible as the WTP will be greenfield construction and the timeline thus to achieve MDD supply in either Port Dover or Simcoe could be prolonged.

Alternatives 2.2 and 2.3 generally have higher constructability scores because they do not involve construction of a new intake at Port Dover. Expansion of the Nanticoke WTP could potentially be phased depending on Haldimand County's demands. These options also require less operating effort in comparison to Alternative 1.2 and 1.3 as Norfolk would be purchasing treated water from Haldimand. However, Norfolk County would have less control over water quality. Alternative 2.3 has better security of supply compared to Alternative 2.2 as Norfolk County will have two (2) connections to Haldimand instead of one (1). These two (2) alternatives are estimated to have similar timelines to achieve MDD supply in either Port Dover or Simcoe as Alternatives 1.2 and 1.3.

The evaluation of Alternative 2.4 is similar to that of Alternatives 2.2 and 2.3, but it would have the best security of supply as Norfolk County will be supplied by three surface WTPs (Port Dover, Port Rowan, Nanticoke). Additionally, this alternative is estimated to have the shortest timeline to achieve MDD supply in Port Dover, since it involves upgrading the existing Port Dover WTP to meet its own local demands. This could potentially be faster than upgrading the Nanticoke WTP as Norfolk County has full control over what occurs in Port Dover. However, Alternative 2.4 will likely have the most significant water quality challenges as Simcoe will be supplied by a blend of groundwater and surface water for a few years until Nanticoke WTP upgrades are complete. This option also requires the highest operating effort because increased coordination with Haldimand County is required (especially during the interim blending period), and Norfolk would still need to operate its existing facilities.

Alternative 2.3 scored the highest in the Technical Environment category with 41 points out of 52.

10.3 SOCIAL AND CULTURAL ENVIRONMENT

Social and Cultural Environment considered the impact of alternatives on visual aesthetics, archaeological features and First Nations Land, and traffic and transportation network (post construction). The difference in scores between alternatives was primarily driven by construction resulting from WTP upgrades or construction, as the impact of the transmission main network is anticipated to be relatively similar.

Alternatives 2.2, 2.3, and 2.4 scored the highest with a tied score of 3 out of 11.

10.4 FINANCIAL ENVIRONMENT

Alternatives were evaluated based on the capital cost net present value (CAPEX NPV) and operating cost NPV (see Table 8-1 for values). CAPEX NPV was assigned 13 points, and OPEX NPV assigned 12 points. The alternative with the lowest NPV was assigned the highest score, and others were scored as a percentage of the NPV. The equation used is shown below.

$$NPV\ Score = Max\ Score \times \left[1 - \left(\frac{(CN_2 - CN_1)}{CN_1}\right)\right]$$

$$CN_1 = lowest\ CAPEX\ or\ OPEX\ NPV$$

$$CN_2 = alternative\ CAPEX\ or\ OPEX\ NPV$$

The differences between the OPEX NPVs of Alternatives 2.2 and 2.3 and the lowest OPEX NPV were so large that both these alternatives scored zero (0) for OPEX NPV. Alternative 1.3 scored the highest in the Financial category with 23 points out of 25.

10.5 SUMMARY OF EVALUATION

Each alternative has advantages and disadvantages, and selection of the final solution will depend on the County's priorities. In general:

- Alternatives 1.2 and 1.3 offer Norfolk County the most control in terms of water quantity (i.e. potential for future expansion) and water quality. These alternatives also have lower operating costs as Norfolk County would be responsible for owning and operating all facilities. However, there is a significant risk involved in siting and constructing a new intake (especially the new Port Dover intake), and timelines may potentially become longer than estimated in this report if relevant permits cannot be obtained. In both alternatives, delays in permitting would put multiple Norfolk communities at risk of a water supply deficiency.
- Alternatives 2.2, 2.3 and 2.4 offer Norfolk County less control, however, they reduce the risks associated with a new intake. A new intake is recommended for Port Rowan WTP in these three (3) alternatives, however, there is an option to deepen the existing intake and/or undertake treatment upgrades if a new intake is not feasible.
- Alternatives 2.2 and 2.3 will likely require the least operating effort as water treatment will be performed by Haldimand County. However, this will also increase the 20-year NPV because the estimated purchase water rate is significantly higher than Norfolk's historic operating rate.
- Alternative 2.4 has the shortest timeline for Port Dover to meet MDD and for Simcoe to receive supplementary supply from Nanticoke WTP. Note that while all alternatives involve supplementing Simcoe from Delhi in the short term, the supplementary capacity that Nanticoke WTP (2,800 m3/d) can provide is nearly twice that of Delhi (1,500 m3/d). However, this is also the most expensive and operationally challenging option, and is the most likely to encounter water quality challenges.

11 RECOMMENDATIONS AND NEXT STEPS

11.1 RECOMMENDED ALTERNATIVE

The purpose of this study is to identify a long term solution for water servicing of the entire Norfolk County. However, each individual community has its own water supply concerns, and the prioritization of these concerns will have a significant impact on the decision making process. A summary of the County's major water supply concerns is presented below.

- Port Dover
    - The Port Dover WTP does not have sufficient firm capacity to meet demand and a development freeze has been in place since September 2019. The development freeze may potentially lead to other political or financial challenges if unresolved. This is the community of highest concern.
- Simcoe
    - Simcoe is at risk of not having sufficient source water.
    - The County indicated there is potential for significant demand increase in Simcoe.
- Port Rowan and St. Williams
    - The Port Rowan WTP supplying Port Rowan and St. Williams often experiences problems with algae due to its shallow intake, which results in the WTP not being able to operate at its DWWP rated capacity.
- Waterford
    - Both groundwater wells in Waterford are GUDI and are supplied by the same aquifer. If one well is contaminated, the other may also become contaminated.
    - The County indicated that there is potential for significant demand increase in Waterford.

Following the Cost Analysis (Section 8), Risk Analysis (Section 9), and completion of the Evaluation Matrix (Section 10), two (2) different preferred alternatives are recommended based depending on the County's priorities.

If timeline is the greatest concern, Alternative 2.4 would be the preferred option. This alternative involves upgrading Port Dover WTP to meet its local 2041 MDD. Simcoe would be supplemented by both Delhi and Nanticoke WTP in the short term, and would eventually be fully supplied by Nanticoke WTP. Waterford would also be supplied by Nanticoke WTP.

An connection from Nanticoke to Port Dover has also been included for 2029 to provide additional supply redundancy, however, it is not urgent and could be delayed to a later date.

Advantages:

- Shortest timeline to lift Port Dover development freeze
- Simcoe will receive supplementary supply from Nanticoke WTP and Delhi in the short term
- The connection from Nanticoke to Simcoe can also be rapidly utilized by Waterford
- Port Rowan WTP upgrades can occur independently of Nanticoke WTP upgrades
- Good supply security

Disadvantages:

- Most expensive option (highest total NPV)
- Most difficult operation
- Potential water quality issues in Simcoe
- Norfolk has less control over water rate, water supply capacity, and water quality
- Least preferred from a County wide perspective based on evaluation matrix

From a more balanced perspective wherein timeline is not the greatest priority, Alternative 2.3 would be the preferred option. This option involves supplying Port Dover, Simcoe, and Waterford from an upgraded Nanticoke WTP. Two (2) connections, one from Nanticoke to Port Dover, and one from Townsend to Simcoe, are recommended. Port Dover would be receive supplementary capacity from Nanticoke WTP in the short term. A Simcoe-Delhi connection would allow Simcoe to be supplemented by Delhi, and Simcoe would eventually be fully supplied by Nanticoke WTP. Port Rowan WTP would be upgraded independently.

Advantages:

- Avoids risks and uncertainties associated with a new intake in Port Dover
- Potential to phase infrastructure upgrades
- Good supply security
- Provides immediate/short term supplementary capacity to both Port Dover and Simcoe
- Ease of operation

Disadvantages:

- Longer timeline to lift Port Dover development freeze
- Second most expensive option
- Norfolk has less control over water rate, water supply capacity, and water quality

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APPENDIX

A EXISTING INFRASTRUCTURE REVIEW

Project Norfolk IUWS
No. 181-09161-00
Location Norfolk County
Subject Norfolk VI
Details **Reference: Stephanie Davis (2019-10-09) and ISMP (2016) and LPRSPA (March 2019)**

Name	Description	No. of Pumps	Installed Capacity		Operating Capacity		Firm Capacity (2020)	Note
Simcoe			l/s	m3/d	l/s	m3/d	m3/d	
Cedar Street Infiltration Gallery	Stream Ten (10) brick-lined dug wells interconnected to a common header discharging by gravity to a collection chamber	1.0	40.4	3,490.6	31.0 average	2,678.4	0 - To be taken out of service due to health concerns over WQ	Frequent hits of ecoli Upstream nutrients entering the groundwater Failure of Wells Due to operational constraints, operates at approximately 2,000 m3/d
Cedar Street Wells	Total of five (5) Wells (drilled):							2 wells/year need rehab due to iron fouling TCE, Chloroform detected in the past (LPRSPA) Least preferred source
	Well No.1A	1.0	20.9	1,805.8	High iron, no longer in use	0.0	0	Very high iron levels - operations run it as little as possible High nitrate levels, wellhead runs through some industrial areas Operates at much lower rates (12L/s)
	Well No.2A	1.0	11.4	985.0	5.0 average	432.0	0 - To be taken out of service due operational constraints	Very high iron levels Operates at much lower rates (4 - 6L/s otherwise water drops below screen level)
	Well No.3	1.0	15.1	1,304.6	12.0 average	1,036.8	1037	Generally runs well Roof needs to removed for well service - resulted in damage to walls
	Well No.4	1.0	15.1	1,304.6	5.0 average	432.0	432	Roof needs to be removed for well service
	Well No.5	1.0	15.1	1,304.6	11.0 average	950.4	950	Generally runs well Roof needs to be removed for well service
Chapel Street Well	Well 1	1.0	25.6	2,211.8	20.0 average	1,728.0	0 - To be taken out of service due to health concerns over WQ	Very old Lead Well for Simcoe System Pumps 365 days, 24 hours/day, site visit notes say 2100 m3/d capacity No other wells could be found around this well High nitrate levels (agricultural impact, aquifer contamination) Mechanical failure, well screen failure Aging casing
Northwest Wells	Well No.1 - Decommissioned	0.0	Decomissioned	0.0	0.0	0.0	0	Decomissioned due to very high ammonia
	Well No.2	1.0	26.5	2,289.6	14.0 average	1,209.6	1210	Rehabbed 2x a year due to iron fouling
	Well No.3	1.0	26.5	2,289.6	16.0 average	1,382.4	1382	Rehabbed every year due to iron fouling
	NEW WELL	1.0	0.0	0.0	0.0	0.0	0	Test production well confirmed - to be constructed. Sustained yeild to be confirmed. Target: 4,560 m3/d (each approx. 2,280 m3/d)
	NEW WELL	1.0	0.0	0.0	0.0	0.0	0	Test production well now in construction to be tested in North East of Simcoe. Sustained yeild to be confirmed.
TOTAL			**196.6**	**16,986.2**	**0.0**	**9,849.6**	**3,629**	Firm capacity was calculated by taking the largest well out of service. Current Firm capacity was assumed to 9,850 m3/d minus the largest well out of service (i.e. infiltration gallery) = 7,171 m3/d
Delhi & Courtland								
Well Pumphouse 1	Well No. 1	1.0	26.7	2,306.9	20.0 average	1,728.0	1728	
Well Pumphouse 2	Well No. 2	1.0	26.7	2,306.9	21.0 average	1,814.4	1814	
Well 3A	Well No.3a	1.0	10.9	941.8	10.9	941.8	942	To come in service in 2020 - currently in construction

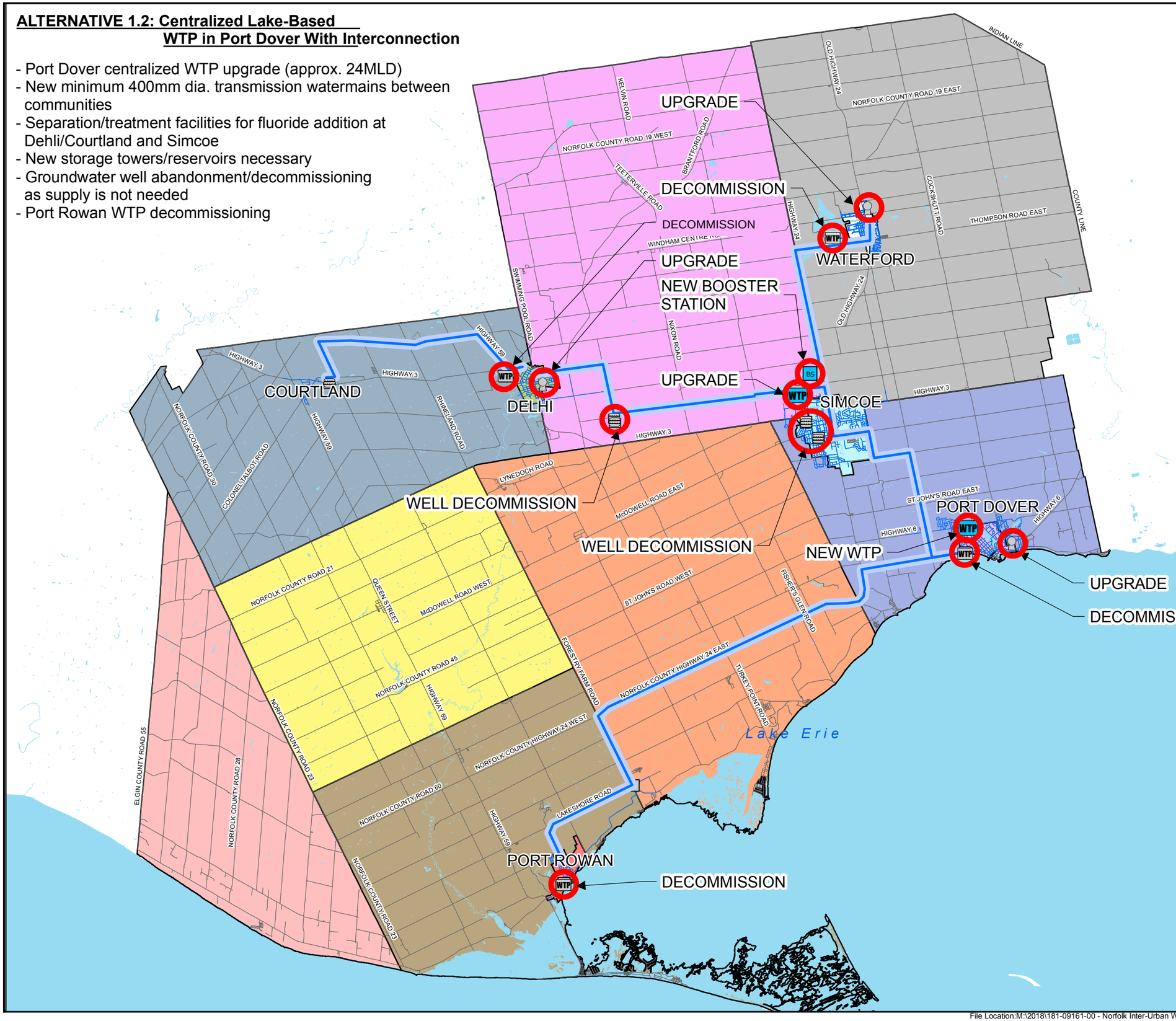
Well 3B	Well 3B	1.0	26.2	2,263.7	26.2	2,263.7	2264	To come in service in 2020 - currently in construction
Courtland Wells	Well 1	1.0	Decomissioned	0.0	0.0	0.0	0	
	Well 2	1.0	Decomissioned	0.0	0.0	0.0	0	
	Well 3	1.0	Decomissioned	0.0	0.0	0.0	0	
TOTAL			**90.5**	**7,819.2**	**78.1**	**6,747.8**	**4,484**	
Waterford								
Thompson Road Wells	Total of two (2) Wells:							Elevated temperatures noted at both wells, wells located next to former aggregate extraction pits (LPRSPA) Possibility of contamination from proximity to sanitary sewers/septic tanks, agriculture activites, DNAPL (LPRSPA)
	Well No.3	1.0	34.0	2,937.6	22.0 average	1,900.8	1901	Concern: lack of redundancy. Waterford is supplied by singular well field. If well field is contamined, entire system would shut down.
	Well No.4	1.0	34.0	2,937.6	22.0 average	1,900.8	1901	
TOTAL			**68.0**	**5,875.2**	**0.0**	**3,801.6**	**1,901**	
Port Dover								
Lake Erie Supplied (Surface WTP)	Conventional Treatment Trains with only two HLPs - Filters also have a firm capacity of 4,462 m3/d							Single Clarifier in poor condition. High Risk HLPs low firm capacity CT Issues Small Clearwell Insuffient Filtration Capacity
	HLP4	1.0	28.4	2,454.0	28.4	2,454.0	2454	
	HLP5	1.0	28.4	2,454.0	28.4	2,454.0	2454	
TOTAL			**56.8**	**4,908.0**	**56.8**	**4,908.0**	**2,454**	Firm capacity was calculated by taking the largest HLP out of service. Assuming clarifier remains in operation. Firm capacity in 2023 will be zero (end of clarifier service life)
Port Rowan & St. Williams								
Lake Erie Supplied (Surface WTP)	Conventional Treatment Trains with three HLPs and two clarifier. Limiting process is the filtration step							HLPs firm capacity is 3,058 m3/d
	Filter 1	1.0	18.9	1,633.0	18.9	1,633.0	1633	Filters keep clogging and require frequent backwash due to bad water quality (shallow intake)
	Filter 2	1.0	18.9	1,633.0	18.9	1,633.0	1633	
TOTAL			**37.8**	**3,266.0**	**37.8**	**3,266.0**	**1,633**	Firm capacity was calculated by taking the one filter out of service.

APPENDIX

B MAPS OF SHORTLISTED ALTERNATIVES

ALTERNATIVE 1.2: Centralized Lake-Based WTP in Port Dover With Interconnection

- Port Dover centralized WTP upgrade (approx. 24MLD)
- New minimum 400mm dia. transmission watermains between communities
- Separation/treatment facilities for fluoride addition at Dehli/Courtland and Simcoe
- New storage towers/reservoirs necessary
- Groundwater well abandonment/decommissioning as supply is not needed
- Port Rowan WTP decommissioning



WSP
1224 GARDINERS RD, SUITE 201
KINGSTON, ONTARIO,
CANADA, K7P 0G2
WWW.WSP.COM

NORFOLK COUNTY
185 ROBINSON STREET, SUITE 100
SIMCOE, ONTARIO
N3Y 5L6

LEGEND

- WTP — WATER TREATMENT PLANT
- BS — BOOSTER STATION
- ELEVATED STORAGE TANK
- RESERVOIR
- WATER MAIN
- WATER BODY
- ROAD
- TOWNSHIP BOUNDARIES

TOWNSHIP

- Charlotteville
- Delhi
- Houghton
- Middleton
- Woodhouse
- Port Dover
- North Walsingham
- Port Rowan
- Simcoe
- South Walsingham
- Townsend
- Waterford
- Windham

Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Engineering Department, City of Barrie 2017.

Scale: 0 2,000 4,000 Meters
1:190,000

N W E S

Project:
Inter-Urban Water Supply
Norfolk County, Ontario

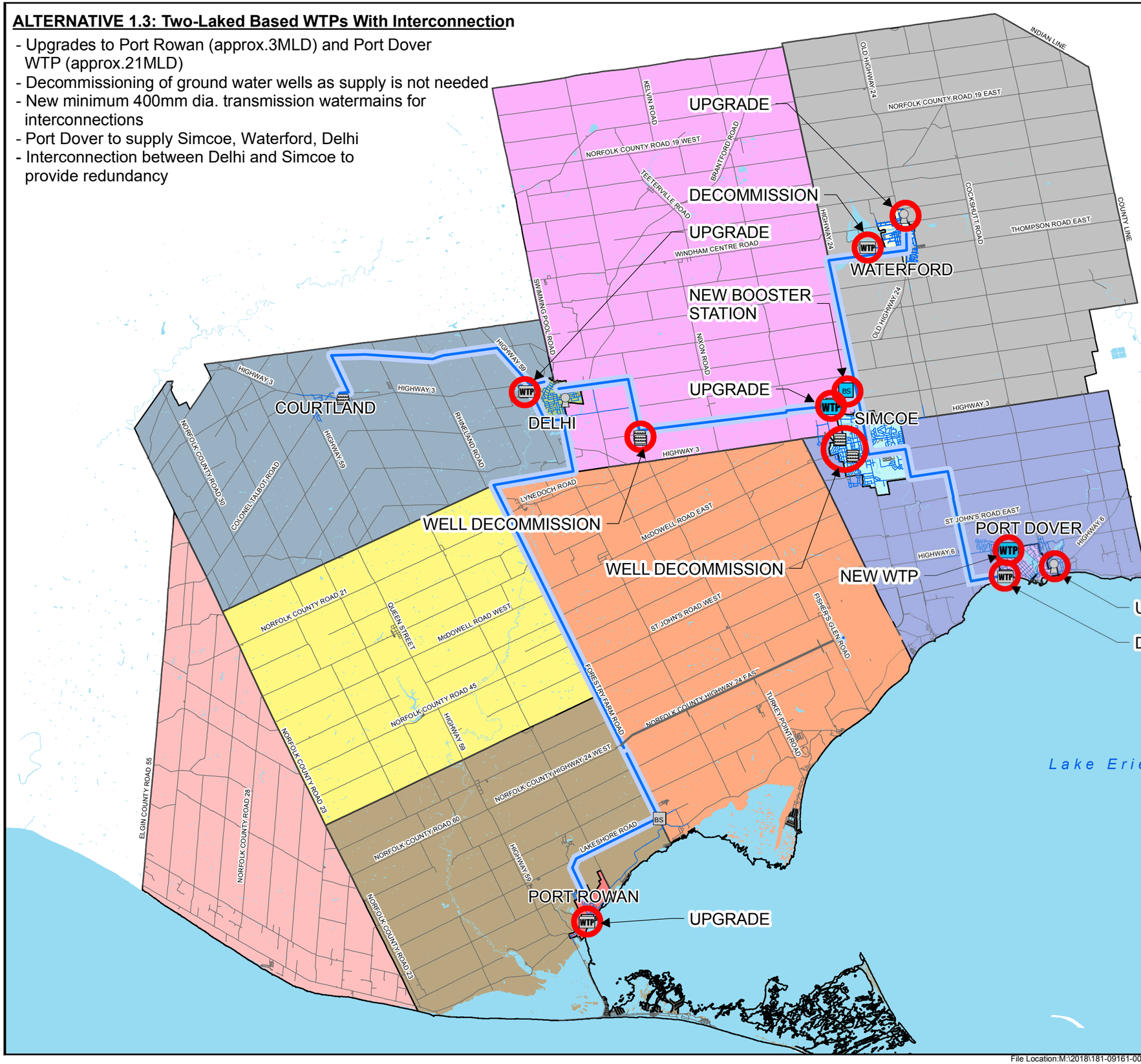
Title:
ALTERNATIVE 1.2

Project No.:	Date:		
181-09161-00	November 2019		
Drawn By: RJ	Checked By: MF	Code: MP	Figure No.:

File Location:M:\2018\181-09161-00 - Norfolk Inter-Urban WS\3.0 Technical\3.11 GIS\Working Maps\181-09161-00_Overview_Transmission_System-Alternative5-10-3.mxd

ALTERNATIVE 1.3: Two-Laked Based WTPs With Interconnection

- Upgrades to Port Rowan (approx.3MLD) and Port Dover WTP (approx.21MLD)
- Decommissioning of ground water wells as supply is not needed
- New minimum 400mm dia. transmission watermains for interconnections
- Port Dover to supply Simcoe, Waterford, Delhi
- Interconnection between Delhi and Simcoe to provide redundancy



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LEGEND

- WTP — WATER TREATMENT PLANT
- BS — BOOSTER STATION
- ELEVATED STORAGE TANK
- RESERVOIR
- WATER MAIN
- WATER BODY
- ROAD
- TOWNSHIP BOUNDARIES

TOWNSHIP

- Charlotteville
- Delhi
- Houghton
- Middleton
- Woodhouse
- Port Dover
- North Walsingham
- Port Rowan
- Simcoe
- South Walsingham
- Townsend
- Waterford
- Windham

Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Engineering Department, City of Barrie 2017.

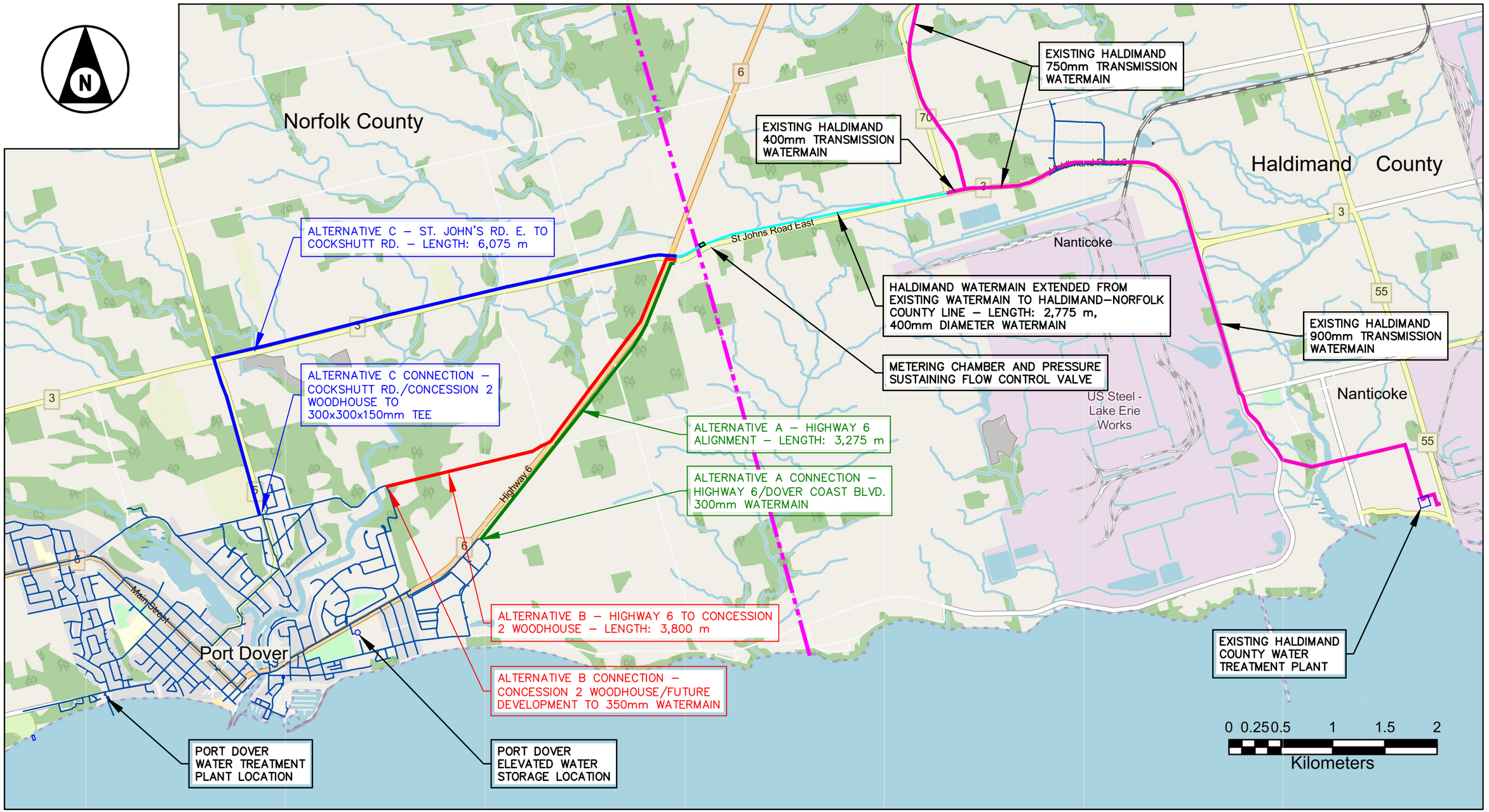
Scale: 0 2,050 4,100 Meters
1:190,000

Project:
Inter-Urban Water Supply
Norfolk County, Ontario

Title:
ALTERNATIVE 1.3

Project No.:	Date:		
181-09161-00	November 2019		
Drawn By:	Checked By:	Code:	Figure No.:
RJ	MF	MP	C-4

File Location:M:\2018\181-09161-00 - Norfolk Inter-Urban WS\3.0 Technical\3.11 GIS\Working Maps\181-09161-00_Overview_Transmission_System-Alternative6-10-3.mxd



WT INFRASTRUCTURE
PRACTICAL INNOVATION

CLIENT: Haldimand County

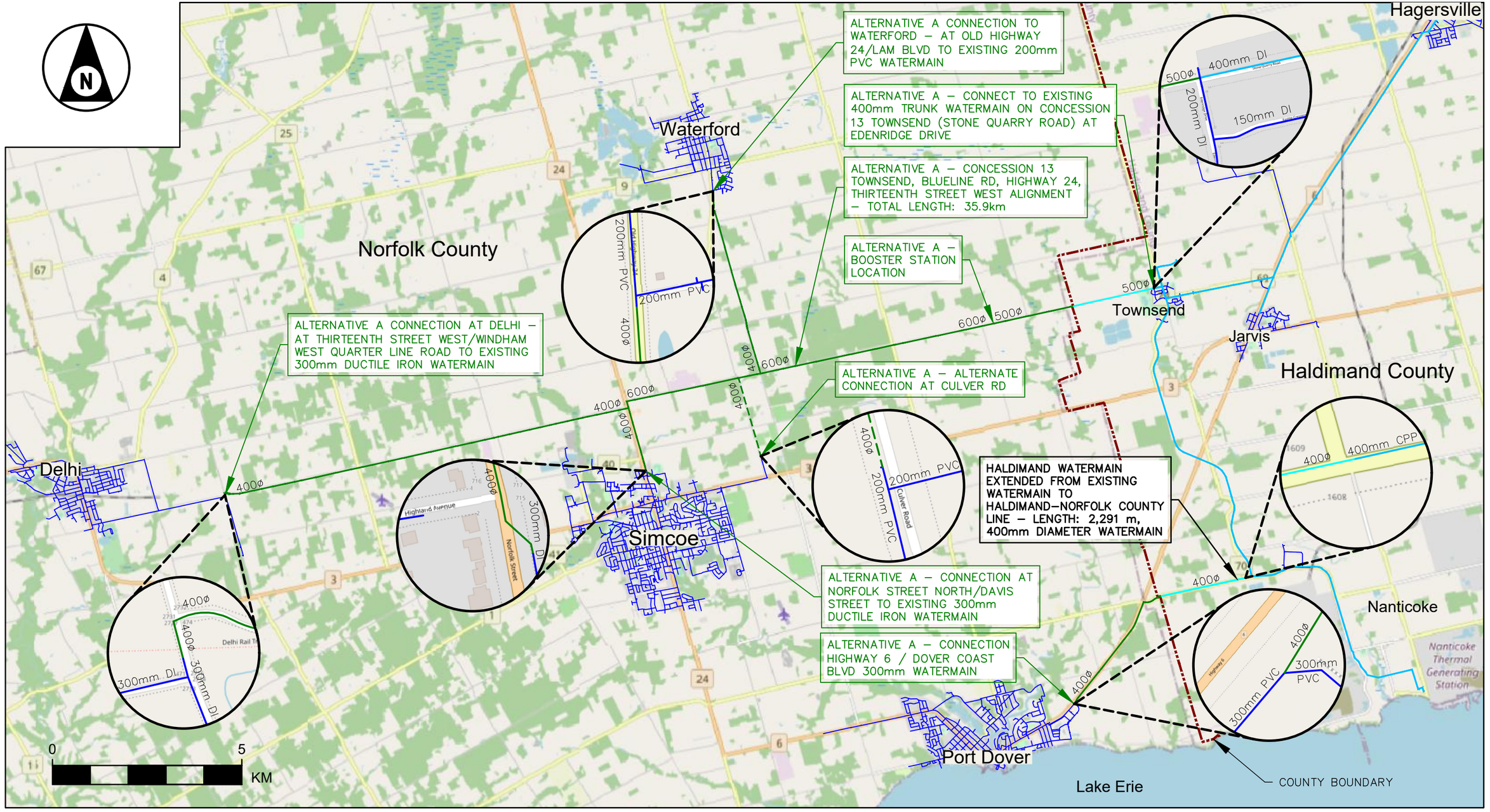
TITLE: PROPOSED PORT DOVER WATER SUPPLY ALTERNATIVES

PROJECT: HALDIMAND–NORFOLK REGIONAL WATER SUPPLY

NO.	BY	DATE	ISSUE / REVISION
3	JW	06/17/20	ISSUED FOR REPORT
2	JW	04/20/20	REVISED PER COMMENTS

PROJECT NO: 20–2008
DATE: 04/07/20
SCALE: AS SHOWN
DRAWING NO: FIGURE 3–3

C:\Users\JonAuckland\AppData\Local\Temp\AcPublish_13848\20–2008 200406 Haldimand–Norfolk Water Supply C1–1 – C1–3 Rev2.dwg Jun 17, 2020–3:37pm BY:(JonAuckland)



WT INFRASTRUCTURE PRACTICAL INNOVATION	CLIENT: Haldimand County	TITLE: ALTERNATIVE A – TOWNSEND TO DELHI PRIMARY TRUNK PROJECT: HALDIMAND–NORFOLK REGIONAL WATER SUPPLY		PROJECT NO: 20–2008 DATE: 04/07/20 SCALE: AS SHOWN DRAWING NO: FIGURE 4–3

NO.	BY	DATE	ISSUE / REVISION
4	JW	06/17/20	ISSUED FOR REPORT

APPENDIX

C RISK MATRICES

APPENDIX

C-1 *ALTERNATIVE 1.2*

Alternative **1.2 - Centralized WTP in Port Dover**

Design Intent: *One centralized lake-based WTP provides water to all Norfolk County communities*
Features *Capacity of the new WTP* 24 MLD
Norfolk County owns and operates the WTP
All groundwater sources to be decommissioned i.e. Simcoe, Waterford and Delhi

Inter-Urban Connection *PD to Simcoe*
PD to Port Rowan
Simcoe to Waterford
Simcoe to Delhi

Item no.	Identified Risk	Risk Category	Possible Causes	Impact Category	Consequences/Impact Description	Uncontrolled risks			Mitigation Measures	Residual risks			Actions required	Comments/issues
						Likelihood	Severity of Consequences	Risk level		Likelihood	Severity of consequences	Risk level		
1	Inability to locate a site for the new WTP and land easement issues	Technical	Limited available lands in Port Dover May be challenging to attain property to site the plant. Available land owned by the Norfolk near the existing WWTP and elevated tower, however they might need additional land for low lift pumping and intake.	Project Success	Any delays in locating a site for the new WTP can directly impact the project implementation time and therefore puts all residents at risk. Specifically Simcoe and Port Dover which are already in urgent need of water	C	5	HR	At the feasibility stage and during the Municipal Class EA Schedule C additional lands would have to be identified early in the process.	D	5	HR	Start a schedule C Municipal Class EA Schedule C. Start negotiations with land owners if land acquisition of easement is required. The land acquisition process can take over one year. Therefore it will be critical to the overall project implementation schedule.	
2	Inability to secure funding for the project	Financial	Council does not approve the required funds.	Project Success	Water issues remain and the timeline for solutions would be seriously impacted.	B	5	CR	Hold multiple meetings with the Council and all stakeholders to ensure they are aware of the upcoming project. Ensure that there is buy-in for the recommended solution. Complete comprehensive stakeholder engagement throughout the EA and planning process. Look at forming a separate working group for Council to ensure that they are fully informed and engaged.	C	5	HR	County to initiate conversations with the stakeholders.	
3	Delays in permitting timelines including environmental assessment processes	Regulatory	Request by stakeholders for additional studies, not agreeing with the proposed design, etc. Also, since expanding the Port Dover WTP is a Schedule C Class EA, it requires extensive planning and consultation which could delay the process. Furthermore, the approval process for the new intake could be challenging and the timeline is out of the control of the County.	Timeline	This can impact duration of the project and require additional work in terms of extra studies and design i.e. impacting the required funding to continue with the project	B	5	CR	Hold multiple meetings with the MECP and other permitting agencies to ensure they are aware of the upcoming project.	C	5	HR	County to initiate pre-consultation with all permitting agencies, specifically MECP.	
4	Longer than anticipated timeline to construct the new WTP	Technical	Construction taking longer due to unforeseen issues	Timeline	Cannot lift the development freeze, and would put the communities in danger i.e. Simcoe and Port Dover at risk of water deficiency	B	5	CR	Ensure Project Management controls on both the design and construction phase of the project. Pre-qualification of the contractors to ensure they are capable of completing a plant of this size and complexity.	C	5	HR	Keep monitoring all groundwater wells in both Simcoe and Waterford. PDWTP is currently replacing the single old clarifier with DAF units, thus it is no longer considered at risk for having zero production capacity.	
5	Failure of multiple existing filters at the existing PDWTP	Technical	Existing filters' structure have recently failed and limited the plant's production capacity	Water Quantity	PDWTP cannot produce sufficient potable water to its residents during the period the new centralized WTP is being constructed. Filter 3 has failed twice in 2019. The most likely cause is the high pressure from the filter backwash causing stress on the filter structural elements (e.g. filter false floor). This could also cause a premature failure on the other two filters. However, it is unlikely that all 3 filters will fail at the same	B	4	HR	Inspection and refurbishing all the filters prior to its failure, during low demand periods. The new DAF units at PDWTP which are anticipated to be commissioned in 2021 can also be converted to DAF-Filters, so the existing filters can be converted to T&O filters only.	D	4	MR	Redundancy in unit operations. The filters were rehabilitated in 2019 and new piping put in place to change flow patterns and reduce stress from backwashing.	
6	Watermain break between communities i.e. Inter-Urban connections	Technical	Pipe failure, high pressures, accidents	Water Quantity	Communities could be without water for a short period of time while the watermain break is being fixed	E	5	MR	Have a detailed and robust Emergency Response Plan with regards to watermain breaks to allow timely and efficient action. There is emergency water storage in each community. The storage availability should be reviewed.	E	3	LR	Make sure all ISMP short and medium term solutions with regards to local storages are implemented to ensure sufficient emergency storage is available in each community	
7	Lake Erie water quality issues with climate change	Public Health	Algal bloom, emerging contaminants, taste and odour issues, etc.,	Water Quality	Additional processes would have to be reviewed and implemented to ensure the WTP is able to handle sudden changes in the raw water quality. Intake needs to be deep and further off shore. This will increase the cost of the intake	A	3	HR	Design a multi-barrier treatment system	D	3	LR	Redundancy in unit operations	

8	Unable to locate a proper location for the new intake	Technical	Proximity to stormwater ponds, shallow areas, nearby the WWTP effluent pipe, etc.	Timeline	Project implementation timeline would be extended	B	5	CR	Hold multiple meetings with the MECP and other permitting agencies to ensure they are aware of the upcoming project.	C	5	HR	Intake redundancy where possible.		
9	Having only one source of supply for all Norfolk County communities and risk of failure	Public Health	Natural disasters e.g. flooding	Water Quantity	No potable water production capacity	D	5	HR	Have a robust Emergency response plans in place and ensure sufficient storage in available throughout the network.	E	3	LR	Consider addition of a reservoir at the WTP or in the network to top up the emergency supplies in the distribution system as required - potential issue: water stagnation (cost of new reservoir not included).		
10	Unfamiliarity of the operations with the new treatment processes	Public Health	New processes, complex system	Water Quality	Could potentially impact the quality of the water produced and public complaints	D	4	MR	Continuous training of operators, ensure availability of technical staff in case of an issue, detailed O&M manuals and a robust document management system in place	E	4	LR	Shut down the plant for a short period and ensure all health and safety procedures are in place.		
11	Inability to acquire land for the interconnecting watermains	Technical	Agreements, cost of land, etc.	Timeline	Delay interconnection implementation timeline and therefore inability to supply water to Simcoe and Waterford or Delhi as planned. Simcoe is at the highest risk and therefore a focus on that interconnection would have to be a priority.	C	3	MR	Detailed and planned watermain routing to minimize any land easement requirements and stay within the right of the way. If land acquisition is required, it might trigger an EA schedule B.	D	3	LR	Change routing to minimize, as much as possible, the need to acquire any lands.		
12	Considerable changes to the projected demands	Technical	New developments, water conservation, etc.	Water Quantity	The designed WTPs are not sized correctly and might either require expansion or derating	C	2	LR	Keep monitoring population growth and demand projections and take action accordingly. Build the plant modularly to enable processes to come off-line.	D	2	LR	Review the demands and projected growth every 5 years through master plans		
13	Water rate increase over time	Financial	Higher operational costs, additional maintenance, proposed capital works	Project Success	Norfolk County residents complaints and politicians involvements	C	2	LR	Increased communication with public.	C	2	LR			
14	Changing groundwater systems to surface water systems or blending groundwater with groundwater.	Public Health	Simcoe and Waterford will be supplied by surface water and groundwater wells will be decommissioned. Simcoe will be supplemented by Delhi for short period.	Water Quality	Corrosion Issues, water quality issues, public complaints, disturbing the network	A	3	HR	Conduct water quality and corrosion control studies, and bench testing. Determine whether lead pipes exist in distribution system and whether additional chlorine or corrosion inhibitors are needed. Increase flushing and water quality monitoring during transition phase.	A	1	MR			

APPENDIX

C-2 *ALTERNATIVE 1.3*

Alternative **1.3 - Two Lake-Based WTP in Port Dover and Port Rowan**

Design Intent: *One lake-based WTP in Port Dover to supply to Port Dover, Simcoe, Waterford, Delhi and Courtland (Future) and the other in Port Rowan to supply to Port Rowan and St.Williams*

Features
Capacity of the new Port Dover WTP 21 MLD
Capacity of the upgraded Port Rowan WTP (new intake) 3 MLD
Norfolk County owns and operates the WTP
All groundwater sources to be decommissioned i.e. Simcoe, Waterford and Delhi. Note: As Delhi has sufficient capacity and no water quality/quantity issues, decommissioning of the existing system can occur in the future, as required.

Inter-Urban Connection
PD to Simcoe
Simcoe to Waterford
Simcoe to Delhi

Item no.	Identified Risk	Risk Category	Possible Causes	Impact Category	Consequences/Impact Description	Uncontrolled risks			Mitigation Measures	Residual risks			Actions required	Comments/issues
						Likelihood	Severity of Consequences	Risk level		Likelihood	Severity of consequences	Risk level		
1	Inability to locate a site for the new WTP and land easement issues	Technical	Limited available lands in Port Dover May be challenging to attain property to site the plant. Available land owned by the Norfolk near the existing WWTP and elevated tower, however they might need additional land for low lift pumping and intake. Difficulty in locating new intake as the intake may need to be very far offshore, depending on the depth.	Project Success	Any delays in locating a site for the new WTP can directly impact the project implementation time and therefore puts all residents at risk. Specifically Simcoe and Port Dover which are already in urgent need of water	D	5	HR	At the feasibility stage and during the Municipal Class EA Schedule C additional lands would have to be identified early in the process.	E	5	MR	Start a schedule C Municipal Class EA Schedule C. Start negotiations with land owners if land acquisition of easement is required. The land acquisition process can take over one year. Therefore it will be critical to the overall project implementation schedule.	
2	Inability to secure funding for the project	Financial	Council does not approve the required funds.	Project Success	Water issues remain and the timeline for solutions would be seriously impacted.	B	5	CR	Hold multiple meetings with the Council and all stakeholders to ensure they are aware of the upcoming project. Ensure that there is buy-in for the recommended solution. Complete comprehensive stakeholder engagement throughout the EA and planning process. Look at forming a separate working group for Council to ensure that they are fully informed and engaged.	C	5	HR	County to initiate conversations with the stakeholders.	
3	Delays in permitting timelines including environmental assessment processes	Regulatory	Request by stakeholders for additional studies, not agreeing with the proposed design, etc. Also, since expanding the Port Dover WTP is a Schedule C Class EA, it requires extensive planning and consultation which could delay the process. Furthermore, the approval process for the new intake could be challenging and the timeline is out of the control of the County.	Timeline	This can impact duration of the project and require additional work in terms of extra studies and design i.e. impacting the required funding to continue with the project	B	5	CR	Hold multiple meetings with the MECP and other permitting agencies to ensure they are aware of the upcoming project.	C	5	HR	County to initiate pre-consultation with all permitting agencies, specifically MECP.	
4	Longer than anticipated timeline to construct the new Port Dover WTP	Technical	Construction taking longer due to unforeseen issues	Timeline	Cannot lift the development freeze, and would put the communities in danger (i.e. Simcoe and Port Dover) of water deficiency	B	5	CR	Ensure Project Management controls on both the design and construction phase of the project. Pre-qualification of the contractors to ensure they are capable of completing a plant of this size and complexity.	C	5	HR	Keep monitoring all groundwater wells in both Simcoe and Waterford. PDWTP is currently replacing the single old clarifier with DAF units, thus it is no longer considered at risk for having zero production capacity.	
5	Failure of multiple existing filters at the existing PDWTP	Technical	Existing filters' structure have recently failed and limited the plant's production capacity	Water Quantity	PDWTP cannot produce sufficient potable water to its residents during the period the new centralized WTP is being constructed. Filter 3 has failed twice in 2019. The most likely cause is the high pressure from the filter backwash causing stress on the filter structural elements (e.g. filter false floor). This could also cause a premature failure on the other two filters. However, it is unlikely that all 3 filters will fail at the same time.	C	4	HR	Inspection and refurbishing all the filters prior to its failure, during low demand periods. The new DAF units at PDWTP which are anticipated to be commissioned in 2021 can also be converted to DAF-Filters, so the existing filters can be converted to T&O filters only.	D	4	MR	Redundancy in unit operations. The filters were rehabilitated in 2019 and new piping put in place to change flow patterns and reduce stress from backwashing.	
6	Watermain break between communities i.e. Inter-Urban connections	Technical	Pipe failure, high pressures, accidents	Water Quality	Communities could be without water for a short period of time while the watermain break is being fixed'	E	4	LR	Have a detailed and robust Emergency Response Plan with regards to watermain breaks to allow timely and efficient action. There is emergency water storage in each community. The storage availability should be reviewed.	E	3	LR	Make sure all ISMP short and medium term solutions with regards to local storages are implemented to ensure sufficient emergency storage is available in each community	
7	Lake Erie water quality issues with climate change	Public Health	algal bloom, emerging contaminants, taste and odour issues, etc.,	Water Quality	Inability of WTP to handle sudden changes in the raw water quality	A	3	HR	Design a multi-barrier treatment system	C	3	MR	Redundancy in unit operations	
8	Unable to locate a proper location for both new intakes	Technical	Proximity to stormwater ponds, shallow areas, nearby the WWTP effluent pipe, etc.	Timeline	Project implementation timeline would be extended	A	5	CR	Hold multiple meetings with the MECP and other permitting agencies to ensure they are aware of the upcoming project. Consider all options including constructing a deeper and further intake into Lake Erie for Port Rowan, rather than a new intake.	B	4	HR	Intake redundancy where possible.	
9	Failure of both WTP at the same time	Public Health	Natural disasters e.g. flooding	Water Quantity	No potable water production capacity in County.	E	5	MR	Have a robust Emergency response plans in place and ensure sufficient storage in available throughout the network.	E	3	LR	Consider addition of a reservoir at the WTP or in the network to top up the emergency supplies in the distribution system as required - potential issue: water stagnation (cost of new reservoir not included).	
10	Unfamiliarity of the operations with the new treatment processes	Public Health	New processes, complex system	Water Quality	Could potentially impact the quality of the water produced and public complaints	D	4	MR	Continuous training of operators, ensure availability of technical staff in case of an issue, detailed O&M manuals and a robust document management system in place	E	4	LR	Shut down the plant for a short period and ensure all health and safety procedures are in place.	

11	Considerable changes to the projected demands	Technical	New developments, water conservation, etc.	Water Quantity	The designed WTPs are not sized correctly and might either require expansion or derating	B	2	MR	Keep monitoring population growth and demand projections and take action accordingly	D	2	LR	Review the demands and projected growth every 5 years through master plans	
12	Inability to acquire land for the interconnecting watermains	Technical	Agreements, cost of land, etc.	Timeline	Delay interconnection implementation timeline and therefore inability to supply water to Simcoe and Waterford or Delhi as planned. Simcoe is at the highest risk and therefore a focus on that interconnection would have to be a priority.	D	3	LR	Detailed and planned watermain routing to minimize any land easement requirements and stay within the right of the way. If land acquisition is required, it might trigger an EA schedule B.	D	3	LR	Change routing to minimize, as much as possible, the need to acquire any lands.	
13	Water rate increase over time	Financial	Higher operational costs, additional maintenance, proposed capital works	Project Success	Norfolk County residents complaints and politicians involvements	C	2	LR	Increased communication with public.	C	2	LR	Consider conducting a water rate study prior to adopting to this solution	
14	Inability to locate site for new Port Rowan WTP intake	Technical	Previous study indicated proposed intake location away from Long Point may subject intake to ice damage	Project Success	Port Rowan WTP cannot operate at DWWP rated capacity and there would be a supply deficiency. Potential treated water quality challenges.	C	3	MR	At the feasibility stage and during the Municipal Class EA Schedule C additional lands would have to be identified early in the process. Undertake process treatment upgrades to allow WTP to better handle poor water quality.	D	2	LR	If relocating intake is not an option, consider deepening the existing intake.	
15	Changing groundwater systems to surface water systems or blending groundwater with groundwater.	Public Health	Simcoe and Waterford will be supplied by surface water and groundwater wells will be decommissioned. Simcoe will be supplemented by Delhi for short period.	Water Quality	Corrosion Issues, water quality issues, public complaints, disturbing the network	A	3	HR	Conduct water quality and corrosion control studies, and bench testing. Determine whether lead pipes exist in distribution system and whether additional chlorine or corrosion inhibitors are needed. Increase flushing and water quality monitoring during transition phase.	A	1	MR		

APPENDIX

C-3 *ALTERNATIVE 2.2*

Alternative **2.2 - Nanticoke WTP Upgrade to Supply to Port Dover, Simcoe and Waterford with One Connection**

Design Intent: *Upgrading Nanticoke WTP to supply to Port Dover, Simcoe and Waterford (and eventually Delhi through Inter-connection) through one connection between Nanticoke to Port Dover*

Features
Upgraded Capacity of Nanticoke WTP 43 MLD
Port Rowan upgraded to rated capacity
Haldimand County owns and operates the WTP
All groundwater sources to be decommissioned i.e. Simcoe, Waterford, except Delhi Note: As Delhi has sufficient capacity and no water quality/quantity issues, decommissioning of the existing system can occur in the future, as required.
Nanticoke connection to Port Dover

Inter-Urban Connection *PD to Simcoe*
Simcoe to Waterford
Simcoe to Delhi

Item no.	Identified Risk	Risk Category	Possible Causes	Impact Category	Consequences/Impact Description	Uncontrolled risks			Mitigation Measures	Residual risks			Actions required	Comments/issues
						Likelihood	Severity of Consequences	Risk level		Likelihood	Severity of consequences	Risk level		
1	Inability to secure funding for the project	Financial	Council does not approve the required funds.	Project Success	Communities water issues remain and other solutions should be investigates which will impact timeline.	C	5	HR	Hold multiple meetings with the Council and all stakeholders to ensure they are aware of the upcoming project. Divide the cost of Nanticoke WTP upgrade with Haldimand County.	D	5	HR	County to initiate conversations with the stakeholders.	Haldimand indicated that the Nanticoke WTP upgrade costs would be split 72/28 Norfolk/Haldimand. It is assumed that alternatives with lower costs will have lower likelihood of being unable to secure funding.
2	Delays in permitting timelines including environmental assessment processes	Regulatory	Request additional studies, not agreeing with the proposed design, etc.	Timeline	This can impact the implementation time of the project and require additional work in terms of design i.e. impacting the required funding to continue with the project	C	5	HR	Hold multiple meetings with the MECP and other permitting agencies to ensure they are aware of the upcoming project.	D	5	HR	County to initiate pre-consultation with all permitting agencies, specifically MECP.	The proposed upgrades are well within Nanticoke WTP's current PTTW.
3	Longer than anticipated timeline in upgrading Nanticoke WTP	Technical	Construction taking longer due to unforeseen issues	Timeline	Would put the communities in danger i.e. Simcoe and Port Dover at risk of water deficiency. However, there is currently surplus capacity at Nanticoke WTP which can be used to supplement Port Dover in the short term.	C	3	MR	Ensure Project Management controls on both the design and construction phase of the project. Pre-qualification of the contractors to ensure they are capable of completing a plant of this size and complexity.	D	3	LR	Keep monitoring all groundwater wells in both Simcoe and Waterford.	Delays anticipated to be less likely and less consequential compared to Alt 1.2 and Alt 1.3 as Nanticoke is an existing plant and was designed to be easily expanded.
4	Delay in construction of interconnection from Nanticoke to Port Dover	Technical	Construction taking longer due to unforeseen issues	Timeline	Cannot lift the development freeze, and would put the communities in danger i.e. Simcoe and Port Dover at risk of water deficiency. However, the existing Nanticoke WTP needs to be upgraded in order to provide Port Dover with sufficient water to meet MDD, and it is likely upgrading the WTP will take longer than constructing the transmission.	D	4	MR	Ensure Project Management controls on both the design and construction phase of the project. Pre-qualification of the contractors to ensure they are capable of completing a plant of this size and complexity.	E	5	MR		
5	Failure of existing filters at PDWTP prior to Nanticoke WTP completing upgrades	Technical	Existing filters' structure have recently failed and limited the plant's production capacity.	Water Quantity	PDWTP will be unable to produce potable waters without filters. The existing filters failed twice in 2019, however, it is unlikely that all the filters will fail at the same time. Nanticoke WTP can still supplement flow to Port Dover without upgrades.	C	2	LR	Inspection and refurbishing all the filters prior to its failure, during low demand periods.	D	1	LR	Redundancy in unit operations. The filters were rehabilitated in 2019 and new piping put in place to change flow patterns and reduce stress from backwashing.	
6	Watermain break between communities i.e. Inter-Urban connections	Technical	Pipe failure, high pressures, accidents	Water Quality	Communities could be without water for a short period of time while the watermain break is being fixed	E	4	LR	Prepare detailed and robust Emergency Response Plan with regards to watermain breaks to allow timely and efficient action. There is emergency water storage in each community. The storage availability should be reviewed.	E	3	LR	Make sure all ISMP short and medium term solutions with regards to local storages are implemented to ensure sufficient emergency storage is available in each community	
7	Lake Erie water quality issues with climate change	Public Health	Algal bloom, emerging contaminants, taste and odour issues, etc.,	Water Quality	Inability of WTP to handle sudden changes in the raw water quality	C	3	MR	Design a multi-barrier treatment system. Operate Actiflo units at lower rate.	C	1	LR	Redundancy in unit operations	
8	Watermain break between Nanticoke and Port Dover (the only source of supply to Norfolk County from Nanticoke)	Technical	Pipe failure, high pressures, accidents	Water Quantity	No water supply to Norfolk County from Nanticoke (i.e. Port Dover, Simcoe, Waterford)	E	5	MR	Have a detailed and robust Emergency Response Plan with regards to watermain breaks to allow timely and efficient action. There is emergency water storage in each community. The storage availability should be reviewed.	E	3	LR	Consider having two direct supply from Haldimand County to Norfolk County e.g. have a twinned main between Nanticoke to Port Dover or connect Nanticoke to Port Dover and Townsend to Simcoe. Or construct a new reservoir in the network	

9	Having only one source of supply for Port Dover, Simcoe, Waterford and Delhi and risk of failure. Same risk for Port Rowan	Public Health	Natural disasters e.g. flooding	Water Quantity	No potable water production capacity	E	5	MR	Have a robust Emergency response plans in place and ensure sufficient storage in available throughout the network.	E	3	LR	Consider addition of a reservoir at the WTP or in the network to top up the emergency supplies in the distribution system as required - potential issue: water stagnation (cost not included).	
10	Water rate increase over time	Financial	Higher operational costs, additional maintenance, proposed capital works to rehabilitate to the Nanticoke WTP	Project Success	Norfolk County residents complaints and politicians involvements	B	4	HR	Communications, capping the operational cost in agreements with Haldimand county for fixed number of years.	B	2	MR	Consider conducting a water rate study prior to adopting to this solution	
11	Jurisdiction issues	Financial	Division of costs of upgrades	Project Success	Failure to come to an agreement can adversely impact project's implementation timeline and final objective of the project	C	5	HR	Increased communication with Haldimand County during planning process.	D	5	HR		
12	Considerable changes to the projected demands	Technical	New developments, water conservation, etc.	Water Quantity	The Nanticoke WTP cannot fully supply Haldimand in addition to Port Dover, Simcoe, Waterford.	E	5	MR	Ensure contract is worded appropriately. Keep monitoring population growth and demand projections and take action accordingly	E	1	LR	Review the demands and projected growth every 5 years through master plans	
13	Inability to acquire land for the interconnecting watermains	Technical	Agreements, cost of land, etc.	Timeline	Delay interconnection implementation timeline and therefore inability to supply water to Simcoe and Waterford or Delhi as planned. Simcoe is at the highest risk and therefore a focus on that interconnection would have to be a priority.	D	3	LR	Detailed and planned watermain routing to minimize any land easement requirements and stay within the right of the way. If land acquisition is required, it might trigger an EA schedule B.	D	2	LR	Change routing to minimize, as much as possible, the need to acquire any lands.	
14	Inability to locate site for new Port Rowan WTP intake	Technical	Previous study indicated proposed intake location away from Long Point may subject intake to ice damage	Project Success	Port Rowan WTP cannot operate at DWWP rated capacity and there would be a supply deficiency. Potential treated water quality challenges.	C	3	MR	At the feasibility stage and during the Municipal Class EA Schedule C additional lands would have to be identified early in the process. Undertake process treatment upgrades to allow WTP to better handle poor water quality.	D	3	LR	If relocating intake is not an option, consider deepening the existing intake.	
15	Delay in expansion of Nanticoke	Technical	Construction taking longer due to unforeseen issues	Timeline	Cannot lift the development freeze, and would put the communities in danger i.e. Simcoe and Port Dover at risk of water deficiency.	D	5	HR	Ensure Project Management controls on both the design and construction phase of the project. Pre-qualification of the contractors to ensure they are capable of completing a plant of this size and complexity.	E	5	MR		
16	Changing groundwater systems to surface water systems or blending groundwater with groundwater.	Public Health	Simcoe and Waterford will be supplied by surface water and groundwater wells will be decommissioned. Simcoe will be supplemented by Delhi for short period.	Water Quality	Corrosion Issues, water quality issues, public complaints, disturbing the network	A	3	HR	Conduct water quality and corrosion control studies, and bench testing. Determine whether lead pipes exist in distribution system and whether additional chlorine or corrosion inhibitors are needed. Increase flushing and water quality monitoring during transition phase.	A	1	MR		

APPENDIX

C-4 ALTERNATIVE 2.3

Alternative **2.3 - Nanticoke WTP Upgrade to Supply to Port Dover, Simcoe and Waterford with Two Connections**

Design Intent: *Upgrading Nanticoke WTP to supply to Port Dover, Simcoe and Waterford (and eventually Delhi through Inter-connection) through two connection*

Features *Upgraded Capacity of Nanti* 43 MLD
Port Rowan upgraded to rated capacity

Haldimand County owns and operates the WTP

All groundwater sources to be decommissioned i.e. Simcoe, Waterford, except Delhi Note: As Delhi has sufficient capacity and no water quality/quantity issues, decommissioning of the existing system can occur in the future, as required.

Inter-Urban Connection Nanticoke connection to Port Dover & Townsend to Simcoe
PD to Simcoe
Simcoe to Waterford
Simcoe to Delhi

Item no.	Identified Risk	Risk Category	Possible Causes	Impact Category	Consequences/Impact Description	Uncontrolled risks			Mitigation Measures	Residual risks			Actions required	Comments/issues
						Likelihood	Severity of Consequences	Risk level		Likelihood	Severity of consequences	Risk level		
1	Inability to secure funding for the project	Financial	Council does not approve the required funds.	Project Success	Communities water issues remain and other solutions should be investigates which will impact timeline.	B	5	CR	Hold multiple meetings with the Council and all stakeholders to ensure they are aware of the upcoming project.	C	5	HR	County to initiate conversations with the stakeholders.	Haldimand indicated that the Nanticoke WTP upgrade costs would be split 72/28 Norfolk/Haldimand. It is assumed that alternatives with lower costs will have lower likelihood of being unable to secure funding.
2	Delays in permitting timelines including environmental assessment processes	Regulatory	Request additional studies, not agreeing with the proposed design, etc.	Timeline	This can impact the implementation time of the project and require additional work in terms of design i.e. impacting the required funding to continue with the project	C	5	HR	Hold multiple meetings with the MECP and other permitting agencies to ensure they are aware of the upcoming project.	D	5	HR	County to initiate pre-consultation with all permitting agencies, specifically MECP.	The proposed upgrades are well within Nanticoke WTP's current PTTW.
3	Longer than anticipated timeline in upgrading Nanticoke WTP	Technical	Construction taking longer due to unforeseen issues	Timeline	Would put the communities in danger i.e. Simcoe and Port Dover at risk of water deficiency	C	4	HR	Ensure Project Management controls on both the design and construction phase of the project. Pre-qualification of the contractors to ensure they are capable of completing a plant of this size and complexity.	D	3	LR	Keep monitoring all groundwater wells in both Simcoe and Waterford.	Delays anticipated to be less likely and less consequential compared to Alt 1.2 and Alt 1.3 as Nanticoke is an existing plant and was designed to be easily expanded.
4	Delay in construction of interconnection from Nanticoke to Port Dover	Technical	Construction taking longer due to unforeseen issues	Timeline	Cannot lift the development freeze, and would put the communities in danger i.e. Simcoe and Port Dover at risk of water deficiency	D	4	MR	Ensure Project Management controls on both the design and construction phase of the project. Pre-qualification of the contractors to ensure they are capable of completing a plant of this size and complexity.	E	4	LR		
5	Delay in interconnection from Nanticoke to Simcoe	Technical	Construction taking longer due to unforeseen issues	Timeline	Simcoe and/or Waterford would be at risk of water deficiency.	D	4	MR	Ensure Project Management controls on both the design and construction phase of the project. Pre-qualification of the contractors to ensure they are capable of completing a plant of this size and complexity.	E	4	LR		
6	Failure of existing filters at the existing PDWTP	Technical	Existing filters' structure have recently failed and limited the plant's production capacity	Water Quantity	PDWTP will be unable to produce potable waters without filters. The existing filters failed twice in 2019, however, it is unlikely that all the filters will fail at the same time. Nanticoke WTP can still supplement flow to Port Dover without upgrades.	B	2	MR	Inspection and refurbishing all the filters prior to its failure, during low demand periods.	B	1	LR	Redundancy in unit operations. The filters were rehabilitated in 2019 and new piping put in place to change flow patterns and reduce stress from backwashing.	

7	Watermain break between communities i.e. Inter-Urban connections	Technical	Pipe failure, high pressures, accidents	Water Quality	Communities could be without water for a short period of time while the watermain break is being fixed'	E	3	LR	Have a detailed and robust Emergency Response Plan with regards to watermain breaks to allow timely and efficient action. There is emergency water storage in each community. The storage availability should be reviewed.	E	1	LR	Make sure all ISMP short and medium term solutions with regards to local storages are implemented to ensure sufficient emergency storage is available in each community	
8	Lake Erie water quality issues with climate change	Public Health	algal bloom, emerging contaminants, taste and odour issues, etc.,	Water Quality	Inability of WTP to handle sudden changes in the raw water quality	C	3	MR	Design a multi-barrier treatment system	C	1	LR	Redundancy in unit operations	
9	Watermain break between Nanticoke and Port Dover or Nanticoke to Simcoe	Technical	Pipe failure, high pressures, accidents	Water Quantity	No water supply directly from Nanticoke to either Port Dover or Simcoe. However, the other transmission main from Nanticoke into Norfolk would still provide water supply.	E	3	LR	Have a detailed and robust Emergency Response Plan with regards to watermain breaks to allow timely and efficient action. Each community has storage.	E	3	LR	Consider having two direct supply from Haldimand County to Norfolk County e.g. have a twinned main between Nanticoke to Port Dover or connect Nanticoke to Port Dover and Townsend to Simcoe. Or construct a new reservoir in the network	
10	Having only one source of supply for Port Dover, Simcoe, Waterford and Delhi and risk of failure. Same risk for Port Rowan	Public Health	Natural disasters e.g. flooding	Water Quantity	No potable water production capacity	E	5	MR	Have a robust Emergency response plans in place and ensure sufficient storage in available throughout the network.	E	3	LR	Consider addition of a reservoir at the WTP or in the network to top up the emergency supplies in the distribution system as required - potential issue: water stagnation (cost not included).	
11	Water rate increase over time	Financial	Higher operational costs, additional maintenance, proposed capital works to rehabilitate to the Nanticoke WTP	Project Success	Norfolk County residents complaints and politicians involvements	B	4	HR	Communications, capping the operational cost in agreements with Haldimand county for fixed number of years.	B	2	MR	Consider conducting a water rate study prior to adopting to this solution	
12	Jurisdiction issues	Financial	Division of costs of upgrades	Project Success	Failure to come to an agreement can adversely impact project's implementation timeline and final objective of the project	C	5	HR	Increased communication with Haldimand County during planning process.	D	5	HR		
13	Considerable changes to the projected demands	Technical	New developments, water conservation, etc.	Water Quantity	The Nanticoke WTP cannot fully supply Haldimand in addition to Port Dover, Simcoe, Waterford.	E	5	MR	Ensure contract is worded appropriately. Keep monitoring population growth and demand projections and take action accordingly	E	1	LR	Review the demands and projected growth every 5 years through master plans	
14	Inability to acquire land for the interconnecting watermains	Technical	Agreements, cost of land, etc.	Timeline	Delay interconnection implementation timeline and therefore inability to supply water to Simcoe and Waterford or Delhi as planned. Simcoe is at the highest risk and therefore a focus on that interconnection would have to be a priority.	D	3	LR	Detailed and planned watermain routing to minimize any land easement requirements and stay within the right of the way. If land acquisition is required, it might trigger an EA schedule B.	D	3	LR	Change routing to minimize, as much as possible, the need to acquire any lands.	
14	Inability to locate site for new Port Rowan WTP intake	Technical	Previous study indicated proposed intake location away from Long Point may subject intake to ice damage	Project Success	Port Rowan WTP cannot operate at DWWP rated capacity and there would be a supply deficiency. Potential treated water quality challenges.	C	3	MR	At the feasibility stage and during the Municipal Class EA Schedule C additional lands would have to be identified early in the process. Undertake process treatment upgrades to allow WTP to better handle poor water quality.	D	2	LR	If relocating intake is not an option, consider deepening the existing intake.	
15	Changing groundwater systems to surface water systems or blending groundwater with groundwater.	Public Health	Simcoe and Waterford will be supplied by surface water and groundwater wells will be decommissioned. Simcoe will be supplemented by Delhi for short period.	Water Quality	Corrosion Issues, water quality issues, public complaints, disturbing the network	A	3	HR	Conduct water quality and corrosion control studies, and bench testing. Determine whether lead pipes exist in distribution system and whether additional chlorine or corrosion inhibitors are needed. Increase flushing and water quality monitoring during transition phase.	A	1	MR		

APPENDIX

C-5 *ALTERNATIVE 2.4*

Alternative **2.4 - Port Dover WTP Upgrade and Nanticoke Upgrade (S+W+PD (future)) + Two Connection**

Design Intent: *Upgrading Nanticoke WTP to supply to Port Dover, Simcoe and Waterford (and eventually Delhi through Inter-connection) through two connection*

Features *Upgraded Capacity of Nanticoke WTP* 43 MLD

Permanent treatment system at the Port Dover WTP to be self sustained Capacity = 7.3 MLD

Port Rowan upgraded to rated capacity

All groundwater sources to be decommissioned i.e. Simcoe, Waterford, except Delhi Note: As Delhi has sufficient capacity and no water quality/quantity issues, decommissioning of the existing system can occur in the future, as required.

Inter-Urban Connection First connect Townsend to Simcoe and Nanticoke connection to Port Dover (in the fututre)

PD to Simcoe

Simcoe to Waterford

Simcoe to Delhi

Item no.	Identified Risk	Risk Category	Possible Causes	Impact Category	Consequences/Impact Description	Uncontrolled risks			Mitigation Measures	Residual risks			Actions required	Comments/issues
						Likelihood	Severity of Consequences	Risk level		Likelihood	Severity of consequences	Risk level		
1	Inability to secure funding for the project	Financial	Council does not approve the required funds.	Project Success	Communities water issues remain and other solutions should be investigates which will impact timeline.	B	5	CR	Hold multiple meetings with the Council and all stakeholders to ensure they are aware of the upcoming project.	C	5	HR	County to initiate conversations with the stakeholders.	Haldimand indicated that the Nanticoke WTP upgrade costs would be split 72/28 Norfolk/Haldimand. It is assumed that alternatives with lower costs will have lower likelihood of being unable to secure funding.
2	Delays in permitting timelines including environmental assessment processes	Regulatory	Request additional studies, not agreeing with the proposed design, etc. Also, since expanding the PDWTP is a Schedule C Class EA, it requires two PICs which could delay the approval process.	Timeline	This can impact the implementation time of the project and require additional work in terms of design i.e. impacting the required funding to continue with the project	C	5	HR	Hold multiple meetings with the MECP and other permitting agencies to ensure they are aware of the upcoming project.	D	5	HR	County to initiate pre-consultation with all permitting agencies, specifically MECP.	
3	Longer than anticipated timeline to upgrade Port Dover WTP	Technical	Construction taking longer due to unforeseen issues	Timeline	Cannot lift the development freeze, and would put the Port Dover at risk of water deficiency.	C	5	HR	Ensure Project Management controls on both the design and construction phase of the project. Pre-qualification of the contractors to ensure they are capable of completing a plant of this size and complexity.	E	5	MR		
4	Longer than anticipated timeline to upgrade Nanticoke WTP	Technical	Construction taking longer due to unforeseen issues	Timeline	Cannot lift the development freeze, and would put Simcoe at risk of water deficiency	C	3	MR	Ensure Project Management controls on both the design and construction phase of the project. Pre-qualification of the contractors to ensure they are capable of completing a plant of this size and complexity.	D	3	LR	Keep monitoring all groundwater wells in both Simcoe and Waterford.	
5	Failure of multiple existing filters prior to commissioning upgraded Nanticoke WTP.	Technical	Existing filters' structure have recently failed and limited the plant's production capacity	Water Quantity	PDWTP will be unable to produce potable waters without filters. The existing filters failed twice in 2019, however, it is unlikely that all the filters will fail at the same time.	E	5	MR	Inspection and refurbishing all the filters prior to its failure, during low demand periods.	B	1	LR	Redundancy in unit operations. The filters were rehabilitated in 2019 and new piping put in place to change flow patterns and reduce stress from backwashing.	
6	Watermain break between communities i.e. Inter-Urban connections.	Technical	Pipe failure, high pressures, accidents	Water Quality	Communities could be without water for a short period of time while the watermain break is being fixed'	E	3	LR	Have a detailed and robust Emergency Response Plan with regards to watermain breaks to allow timely and efficient action. There is emergency water storage in each community. The storage availability should be reviewed.	E	1	LR	Make sure all ISMP short and medium term solutions with regards to local storages are implemented to ensure sufficient emergency storage is available in each community	
7	Lake Erie water quality issues with climate change	Public Health	algal bloom, emerging contaminants, taste and odour issues, etc.,	Water Quality	Inability of WTP to handle sudden changes in the raw water quality	C	3	MR	Design a multi-barrier treatment system	C	1	LR	Redundancy in unit operations	
8	Watermain break between Nanticoke and Simcoe	Technical	Pipe failure, high pressures, accidents	Water Quantity	No water supply from Nanticoke	E	4	LR	Have a detailed and robust Emergency Response Plan with regards to watermain breaks to allow timely and efficient action.	E	1	LR	Consider having two direct supply from Haldimand County to Norfolk County e.g. have a twinned main between Nanticoke to Port Dover or connect Nanticoke to Port Dover and Townsend to Simcoe. Or construct a new reservoir in the network (cost not included).	

9	Water rate increase over time	Financial	Higher operational costs, additional maintenance, proposed capital works to rehabilitate to the WTP	Project Success	Norfolk County residents complaints and politicians involvements	B	4	HR	Communications, capping the operational cost in agreements with Haldimand county for fixed number of years.	B	2	MR	Consider conducting a water rate study prior to adopting to this solution	
10	Jurisdiction issues	Financial	Division of costs of upgrades	Project Success	Failure to come to an agreement can adversely impact project's implementation timeline and final objective of the project	C	5	HR	Communications,	D	5	HR		
11	Inability to acquire land for the interconnecting watermains	Technical	Agreements, cost of land, etc.	Timeline	Delay interconnection implementation timeline and therefore inability to supply water to Simcoe and Waterford or Delhi as planned - also delayed connection between Nanticoke and Port Dover	D	3	LR	Detailed and planned watermain routing to minimize any land easement requirements and stay within the right of the way.	D	3	LR	Change routing to minimize, as much as possible, the need to acquire any lands. Also, ensure having a temporary solution present at the Port Dover WTP.	
12	Blending groundwater with surface water	Public Health	Topping up the deficiency in Simcoe and Waterford using supply from Nanticoke WTP. Simcoe will also be supplemented by Delhi.	Water Quality	Corrosion Issues, water quality issues, public complaints, disturbing the network	A	3	HR	Mix a fix percentage/quantity of surface water. Require water quality adjustment prior to distribution, require an additional reservoir for mixing purposes	A	2	HR	Blending is not recommended.	
13	Considerable changes to the projected demands	Technical	New developments, water conservation, etc.	Water Quantity	The designed WTPs are not sized correctly and might either require expansion or derating	E	5	MR	Ensure contract is worded appropriately. Keep monitoring population growth and demand projections and take action accordingly	E	1	LR	Review the demands and projected growth every 5 years through master plans	
14	Inability to locate site for new Port Rowan WTP intake	Technical	Previous study indicated proposed intake location away from Long Point may subject intake to ice damage	Project Success	Port Rowan WTP cannot operate at DWWP rated capacity and there would be a supply deficiency. Potential treated water quality challenges.	C	3	MR	At the feasibility stage and during the Municipal Class EA Schedule C additional lands would have to be identified early in the process. Undertake process treatment upgrades to allow WTP to better handle poor water quality.	D	3	LR	If relocating intake is not an option, consider deepening the existing intake.	
15	Delay in expansion of Nanticoke	Technical	Construction taking longer due to unforeseen issues	Timeline	Cannot lift the development freeze, and would put the communities in danger i.e. Simcoe and Port Dover at risk of water deficiency.	D	5	HR	Ensure Project Management controls on both the design and construction phase of the project. Pre-qualification of the contractors to ensure they are capable of completing a plant of this size and complexity.	E	5	MR		

APPENDIX

D EVALUATION MATRIX

Evaluation Criteria	Weight	Supply from Norfolk County		Supply from Haldimand County		
		Alt 1.2 - Centralized WTP in Port Dover	Alt 1.3- Two Lake Based WTP in Port Dover and Port Rowan	Alt 2.2- Nanticoke WTP Upgrade to Supply to Port Dover, Simcoe and Waterford with One Connection	Alt 2.3 - Nanticoke WTP Upgrade to Supply to Port Dover, Simcoe and Waterford with Two Connection	Alt 2.4- Port Dover WTP Upgrade and Nanticoke Upgrade (S+W+PD (future)) + Two Connection
Description of Alternative		- One new centralized 24 MLD WTP in Port Dover to supply all Norfolk communities - Norfolk County owns and operates the WTP - All groundwater sources to be decommissioned (Delhi groundwater decommissioning can be done at later date) - All communities interconnected: Port Dover to Simcoe, Port Dover to Port Rowan, SImcoe to Waterford, Simcoe to Delhi	- One lake-based WTP in Port Dover to supply to Port Dover, Simcoe, Waterford, Delhi and Courtland (Future) and the other in Port Rowan to supply to Port Rowan and St.Williams - Port Dover WTP: 21 MLD, Port Rowan WTP: 3 MLD - All groundwater sources to be decommissioned (Delhi groundwater decommissioning can be done at later date) - Interconnections: Port Dover to Simcoe, Simcoe to Waterford, Simcoe to Delhi	- Upgrade Nanticoke WTP to 43 MLD to supply Port Dover, Simcoe, Waterford, Delhi - Nanticoke WTP operated by Haldimand County, with 75% of upgrade costs paid by Norfolk County - Upgrade Port Rowan WTP to full rated capacity: 3 MLD - Interconnections: Nanticoke to Port Dover, Port Dover to Simcoe, Simcoe to Waterford, Simcoe to Delhi - All groundwater sources decomissioned (Delhi can be decommissioned at a later date)	- Upgrade Nanticoke WTP to 43 MLD to supply Port Dover, Simcoe, Waterford, Delhi - Nanticoke WTP operated by Haldimand County, with 75% of upgrade costs paid by Norfolk County - Upgrade Port Rowan to rated capacity: 3 MLD - Interconnections: Nanticoke to Port Dover, Nanticoke to Simcoe through Townsend, Simcoe to Waterford, Simcoe to Delhi - All groundwater sources decomissioned (Delhi can be decommissioned at a later date)	- Upgrade Nanticoke WTP to 43 MLD to supply Simcoe, Waterford, Port Dover (future), Delhi (future) - Nanticoke WTP operated by Haldimand County, with 75% of upgrade costs paid by Norfolk County - Upgrade Port Rowan to rated capacity: 3 MLD - Interconnections: Nanticoke to Port Dover, Nanticoke to Simcoe through Townsend, Simcoe to Waterford, Simcoe to Delhi - All groundwater sources decomissioned (Delhi can be decommissioned at a later date)
Natural Environment	**12**	**5**	**8**	**11**	**10**	**10**
Impact to lake aquatic life and lake surface water quality		High impact on aquatic life (Lake Erie) anticipated as a new intake required. A new waste stream discharging from Centralized WTP to surface water may potentially be required.	High impact on aquatic life (Lake Erie) near Port Dover and medium impact on Port Rowan anticipated. A new waste stream discharging from new PDWTP to surface water may be required.	No change anticipated for Nanticoke WTP intake thus low impact anticipated for aquatic life. Medium impact anticipated near Port Rowan due to new intake.	No change anticipated for Nanticoke WTP intake thus low impact anticipated for aquatic life. Medium impact anticipated near Port Rowan due to new intake.	No change anticipated for Nanticoke WTP intake thus low impact anticipated for aquatic life. Medium impact anticipated near Port Rowan due to new intake.
	5	1	1	5	5	5
Impact to wetlands and terrestrial ecosystem, water crossing, stream morphology		Potentially higher impact to these environmental factors due to high total length of interconnecting watermains. However, these impacts can be minimized by conducting appropriate studies during the feasibility and Class EA stage. Decommissioning of groundwater wells in Simcoe will reduce impact on nearby wetlands.	This option requires the least interconnection piping thus the lowest impact is anticipated. Impact can be minimized by performing appropriate studies during the feasbility and Class EA stage. Decommissioning of groundwater wells in Simcoe will reduce impact on nearby wetlands.	This option requires new piping in both Haldimand and Norfolk. Increased piping length will potentially increase environmental impact. Impact can be minimized by performing appropriate studies during the feasbility and Class EA stage. Decommissioning of groundwater wells in Simcoe will reduce impact on nearby wetlands.	This option requires new piping in both Haldimand and Norfolk. Increased piping length will potentially increase environmental impact. Impact can be minimized by performing appropriate studies during the feasbility and Class EA stage. Decommissioning of groundwater wells in Simcoe will reduce impact on nearby wetlands.	This option requires new piping in both Haldimand and Norfolk. Increased piping length will pot Decommissioning of groundwater wells in Simcoe will reduce impact on nearby wetlands.entially increase environmental impact. Impact can be minimized by performing appropriate studies during the feasbility and Class EA stage.
	5	2	5	4	3	3
Impact to groundwater quality		All groundwater sources will eventually be decommissioned and no negative impact is anticipated.	All groundwater sources will eventually be decommissioned and no negative impact is anticipated.	All groundwater sources will eventually be decommissioned and no negative impact is anticipated.	All groundwater sources will eventually be decommissioned and no negative impact is anticipated.	All groundwater sources will eventually be decommissioned and no negative impact is anticipated.
	2	2	2	2	2	2
Technical Environment	**52**	**25**	**28**	**32**	**41**	**37**
Constructability		Lower constructability due to requirement of new intake for new Port Dover WTP.	Lower constructability due to requirement of new intake for new Port Dover WTP and new Port Rowan WTP.	High constructability as this mainly involves expansion of Nanticoke WTP, which was designed to be expanded. A new intake is also recommended at Port Rowan WTP, but the Port Rowan WTP impacts fewer communities than the Nanticoke WTP expansion.	High constructability as this mainly involves expansion of Nanticoke WTP, which was designed to be expanded. Two interconnections are recommended. A new intake will also be required at Port Rowan WTP, but the Port Rowan WTP impacts fewer communities than the Nanticoke WTP expansion.	Medium constructability as both Port Dover and Nanticoke WTP will need to undergo upgrades, and two interconnections are recommended. Port Rowan WTP is also recommended to have a new intake.
	10	1	1	10	9	7
Potential to phase infrastructure		All communities estimated to be serviced by new Centralized WTP by 2028 (i.e. Port Dover development freeze cannot be lifted and Simcoe will not have sufficient firm capacity until then). Construction of watermain upgrade can be phased but WTP construction cannot be phased as it is a greenfield build.	All communities estimated to be serviced by new 21 MLD Port Dover WTP by 2028 (i.e. Port Dover development freeze cannot be lifted and Simcoe will not have sufficient firm capacity until then). Construction of watermain upgrade can be phased but PDWTP construction cannot be phased as it is a greenfield build. However, Port Rowan WTP upgrades can occur independently of PDWTP construction.	Port Dover can be supplemented by Nanticoke WTP by 2025. Nanticoke WTP upgrades can potentially be phased, depending on Haldimand County demands. Port Rowan WTP upgrades can occur independently of Nanticoke WTP upgrades. Watermain upgrades can be phased.	Port Dover can be supplemented by Nanticoke WTP by 2025. Nanticoke WTP upgrades can potentially be phased, depending on Haldimand County demands. Port Rowan WTP upgrades can occur independently of Nanticoke WTP upgrades. Watermain upgrades can be phased. Increased flexibility as either Port Dover or Simcoe can become the first connection to Nanticoke.	Simcoe can be supplemented by Nanticoke by 2025 and Port Dover can be self sufficient by 2026. Nanticoke WTP upgrades can potentially be phased, depending on Haldimand County demands. Port Rowan WTP upgrades can occur independently of Nanticoke WTP upgrades. Watermain upgrades can be phased.
	2	1	1	2	2	2
Timeline for achieve MDD supply in Port Dover/Simcoe		Port Dover and Simcoe anticipated to meet MDD by 2028.	Port Dover and Simcoe anticipated to meet MDD by 2028.	Port Dover and Simcoe anticipated to meet MDD by 2028.	Port Dover and Simcoe anticipated to meet MDD by 2028.	Shortest timeline for Port Dover to meet MDD (2026). Simcoe can meet MDD by 2028.
	5	1	1	1	1	5

Evaluation Criteria	Weight	Supply from Norfolk County		Supply from Haldimand County		
		Alt 1.2 - Centralized WTP in Port Dover	Alt 1.3- Two Lake Based WTP in Port Dover and Port Rowan	Alt 2.2- Nanticoke WTP Upgrade to Supply to Port Dover, Simcoe and Waterford with One Connection	Alt 2.3 - Nanticoke WTP Upgrade to Supply to Port Dover, Simcoe and Waterford with Two Connection	Alt 2.4- Port Dover WTP Upgrade and Nanticoke Upgrade (S+W+PD (future)) + Two Connection
Maintenance and operating effort required, impact on existing facilities (not considering costs)		All existing Norfolk treatment facilities will be decommissioned, which will reduce operating effort compared to current operations. However, Norfolk County will be wholly responsible for operating the new WTP. Chemical system upgrades or changes to storage turnover operating strategy may be required at existing storage facilities to prevent chlorine loss issues due to water age/stagnation, or pipe corrosion issues.	All existing Norfolk groundwater facilities and the existing PDWTP will be decommissioned, which will reduce operating effort compared to current operations. However, Norfolk County will be wholly responsible for operating the WTPs. Chemical system upgrades or changes to storage turnover operating strategy may be required at existing storage facilities to prevent chlorine loss issues due to water age/stagnation, or pipe corrosion issues.	High risk communities will be supplied by treated water supplied by Nanticoke WTP (little effort required) and treatment facilities in those communities will be decommissioned. Norfolk will need to continue operating all existing storage facilities, and Port Rowan WTP. Changes in turnover/operating strategy of the storage facilities may be required to prevent water stagnation and chlorine loss. New corrosion control system may be required.	High risk communities will be supplied by treated water supplied by Nanticoke WTP (little effort required) and treatment facilities in those communities will be decommissioned. Norfolk will need to continue operating all existing storage facilities, Port Rowan WTP. Changes in turnover/operating strategy of the storage facilities may be required to prevent water stagnation and chlorine loss. New corrosion control system may be required.	Norfolk County will need to continue operating 2 surface water WTP, and all existing storage facilities. However, the high risk groundwater sources in Simcoe and Waterford will be decommissioned and supplied with treated water from Nanticoke. Changes in turnover/oeprating strategy of the storage facilities to prevent water stagnation and chlorine loss. New corrosion control system may be required. This option requires the most coordination between Haldimand/Norfolk.
	5	3	3	5	5	1
Impact on water quality		Improvement in water quality anticipated as groundwater sources of highest water quality concern will be decommissioned. Depending on location and depth of intake, the raw water quality may also be better compared to existing conditions. There will likely be some water quality complaints during transition from groundwater to surface water which can be mitigated by increased flushing. Some water quality concerns may occur when Simcoe is supplemented by Delhi.	Improvement in water quality anticipated as groundwater sources of highest water quality concern will be decommissioned. Two separate WTPs will also decrease the water age/chlorine decay. However, there will likely be some water quality complaints during transition from groundwater to surface water which can be mitigated by increased flushing. Raw water quality may also improve if the new intakes are located deeper int the lake and further offshore compared to existing WTP. Some water quality concerns may occur when Simcoe is supplemented by Delhi.	Nanticoke WTP produces treated water of similar or better water quality as current Port Dover WTP, however, the water age will increase. With appropriately sized chlorine booster stations, chlorine issues can be mitigated. There will likely be come water quality complaints during transition from groundwater to surface water which can be mitigated by increased flushing. Corrosion control systems for Simcoe and Waterford may be required. Some water quality concerns may occur when Simcoe is supplemented by Delhi.	Nanticoke WTP produces treated water of similar or better water quality as current Port Dover WTP, however, the water age will increase. With appropriately sized chlorine booster stations, chlorine issues can be mitigated. There will likely be come water quality complaints during transition from groundwater to surface water which can be mitigated by increased flushing. Corrosion control systems for Simcoe and Waterford may be required. Some water quality concerns may occur when Simcoe is supplemented by Delhi.	Port Dover water quality anticipated to improve. Simcoe will likely have water quality issues during blending, and additional chemical systems (ex. chlorine booster, corrosion control) may be needed. Water quality concerns may also arise when Simcoe and Waterford fully transition to surface water.
	10	10	10	8	9	3
Security and quantity of supply		Sufficient supply anticipated to service all of Norfolk County. Norfolk also has complete control over operation and water usage allocation, however, all needs will be met by one source.	Sufficient supply anticipated to service all of Norfolk County. Norfolk also has complete control over operation, water usage allocation. Two WTPs also provides increased redundancy.	Sufficient supply anticipated for Port Dover, Simcoe, Waterford. Less security as there is only one interconnection, and Norfolk does not have full control over Nanticoke WTP operations.	Nanticoke WTP anticipated to have sufficient capacity for all 3 communities, and Port Rowan WTP will also be operating. Two interconnections allows for increased operational flexibility.	Nanticoke WTP anticipated to have sufficient capacity for all 3 communities. Norfolk will be supplied by 3 surface WTP. Two interconnections allows for increased operational flexibility.
	10	3	5	2	9	10
Potential for future expansion on water supply		Centralized WTP would only supply Norfolk County thus there is increased flexibility to increase water supply capacity. However, this needs to be considered when designing the intake and PTTW.	New WTPs would only supply Norfolk County thus there is increased flexibility to increase water supply capacity. However, this needs to be considered when designing the intake and PTTW.	Nanticoke WTP capacity would be shared and Norfolk would have less control over available capacity. There is less flexibility to re-allocate/re-distribute Nanticoke supply as there is only one interconnection.	Nanticoke WTP capacity would be shared and Norfolk would have less control over available capacity. There is more flexibility to re-allocate/re-distribute Nanticoke supply as there are two connections.	Nanticoke WTP capacity would be shared and Norfolk would have less control over available capacity. There is more flexibility to re-allocate/re-distribute Nanticoke supply as there are 2 connections and Port Dover is self sufficient.
	5	5	5	1	2	4
Ability to mitigate impacts of climate change		Only one source of supply for entire County (no redundancy). If Centralized WTP cannot operate normally, there will be no potable water supply in entire County.	Two sources of supply for County.	Depth and location of Nanticoke WTP intake will reduce climate change related water quality issues (ex. algae). Less resiliency as there is only one connection between Haldimand to Norfolk. Port Rowan WTP will operate independently.	Depth and location of Nanticoke WTP intake will reduce climate change related water quality issues (ex. algae). Two connections increases resiliency.	Depth and location of Nanticoke WTP intake will reduce climate change related water quality issues (ex. algae). Retaining Port Dover WTP will also increase resiliency of the system (i.e. Port Dover WTP may be able to continue operating if climate change related event prevents Nanticoke WTP from operating normally). Two connections increases resiliency.
	5	1	2	3	4	5

Evaluation Criteria	Weight	Supply from Norfolk County		Supply from Haldimand County		
		Alt 1.2 - Centralized WTP in Port Dover	Alt 1.3- Two Lake Based WTP in Port Dover and Port Rowan	Alt 2.2- Nanticoke WTP Upgrade to Supply to Port Dover, Simcoe and Waterford with One Connection	Alt 2.3 - Nanticoke WTP Upgrade to Supply to Port Dover, Simcoe and Waterford with Two Connection	Alt 2.4- Port Dover WTP Upgrade and Nanticoke Upgrade (S+W+PD (future)) + Two Connection
Social and Cultural Environment	**11**	**1**	**1**	**3**	**3**	**3**
Impact on visual aesthetics		High impact anticipated as this will be a large greenfield building. New lake use restrictions may also need to be implemented due to new intake. Potentially increased acoustic impact due to increased pumping, however, this can be mitigated with proper design.	High impact anticipated for new Port Dover WTP and medium impact anticipated for Port Rowan WTP. New lake use restrictions may also need to be implemented due to new intakes. Potentially increased acoustic impact due to increased pumping, however, this can be mitigated with proper design.	Low impact anticipated for Nanticoke WTP expansion as it will be on same property as existing WTP.	Low impact anticipated for Nanticoke WTP expansion as it will be on same property as existing WTP.	Low impact anticipated for Nanticoke WTP expansion and Port Dover WTP as it will be on same existing property.
	3	1	1	3	3	3
Impact on archaeological and heritage features, First Nations land		No impact anticipated for construction of new WTP (assumed to be on County owned land). Potential impact for new watermains - watermains will only be in Norfolk County.	No impact anticipated for construction of new WTP (assumed to be on County owned land). Potential impact for new watermains - watermains will only be in Norfolk County.	No impact anticipated for WTP expansion. Potential impact for new watermains - new watermains in both Haldimand and Norfolk.	No impact anticipated for WTP expansion. Potential impact for new watermains - new watermains in both Haldimand and Norfolk.	No impact anticipated for WTP expansion. Potential impact for new watermains - new watermains in both Haldimand and Norfolk.
	6	6	6	5	4	4
Impact on traffic and existing transportation network (post construction)		No impact anticipated for construction of new WTP (assumed to be on County owned land). Potential impact for new watermains - watermains will only be in Norfolk County.	No impact anticipated for construction of new WTP (assumed to be on County owned land). Potential impact for new watermains - watermains will only be in Norfolk County.	No impact anticipated for WTP expansion. Potential impact for new watermains - new watermains in both Haldimand and Norfolk.	No impact anticipated for WTP expansion. Potential impact for new watermains - new watermains in both Haldimand and Norfolk.	No impact anticipated for WTP expansion. Potential impact for new watermains - new watermains in both Haldimand and Norfolk.
	2	2	2	2	2	2
Financial Environment	**25**	**14**	**18**	**12**	**13**	**11**
CAPEX NPV						
	13	2	6	12	13	11
OPEX NPV						
	12	12	12	0	0	0
Total	**100**	**45**	**55**	**58**	**67**	**61**