



**NIAGARA FEASIBILITY PHASE 2
IMPLEMENTATION TECH MEMO**

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1.0 Introduction

1.1 BACKGROUND AND CRITERIA

A Phase 2 Study to propose servicing solutions for irrigation in the northern areas of Niagara is complete. As part of this assignment, alternative servicing solutions were generated for areas below the Escarpment using piped or open channel infrastructure. Opinions of probable cost were also generated for the proposed infrastructure for each of the servicing alternatives. A subsequent Natural and Social Environment Report evaluated the various servicing alternatives and recommended preferred alternatives. Based on the outcome of these studies, one preferred servicing alternative has been recommended for each of the following service areas:

- West District Zone A (Lincoln and St. Catharines)
- East District (Niagara-On-the-Lake)

Public Information Centres were held in October in Niagara-on-the-Lake (NOTL) and Lincoln to inform the public about the background studies and the recommended preferred alternatives and to receive comments.

It is recognized that these types of projects are capital intensive and consume substantial amounts of time, capital and manpower resources to implement. Consequently, it was proposed in the Request for Proposal that a technical memorandum (tech memo) outlining the implementation methodology be prepared as an Addendum to the final project report, wherein each preferred alternative be examined to establish a logical sequence of progression.

We feel that the following parameters will be vital in the development of the implementation plan:

Demand and Willingness

The demand and willingness of the growers could be a good indication of the areas that could be serviced earlier than others. The phasing methodology put forward in this tech memo proposes to install the primary infrastructure first to maximize the opportunity for growers to have access to an irrigation water source. Secondary infrastructure comprising of smaller diameter pipes and appurtenances could be phased based on the demonstrated demand and willingness of individual or groups to participate. In this tech memo, we have proposed phasing for the secondary infrastructure as well. However, this has been done to establish a probable cost opinion and a time frame to prepare an outline of the different phases recognizing that there is further potential to re-work the phasing schemes.

Implementation Time

A phase should comprise a complete series of infrastructure that could be designed and implemented in a reasonable time frame, such that the end user could avail the facilities and the payback could be initiated on the borrowed money. In deciding the magnitude of infrastructure to be implemented in a single phase, consideration has been given to a scope of work that could reasonably be completed and operational within five years. It is expected that each phase would last five years and the proposed infrastructure will be implemented within this time frame. Implementation would include all the studies, design, approvals, construction and commissioning necessary for that phase of work.

Funding Requirements

The opinion of probable cost for the proposed infrastructure is approximately \$95 million. Obtaining lump sum funding for such a large amount is not feasible. A logical process would be to obtain funding for a portion of the project, implement, and start paying back in order to demonstrate to the funding agencies the economic viability of the project. This would also potentially pave the way for funding for the subsequent phases.

Policy and Regulatory Requirements

Regulatory agencies responsible for ensuring the protection and preservation of the natural and social environment, and also for managing the water resources, could have concerns with the full scale implementation of a project of this magnitude. It is possible that they would impose certain additional conditions or ask the project proponents to take certain measures to minimize the impacts to the environment and limit the water takings from natural sources. In such a case, it would be prudent to start with a pilot project to demonstrate the ability to implement a scheme that is in compliance with the policy and regulatory requirements without the need for excessively restrictive conditions. This could potentially streamline the regulatory and approvals process down the road for subsequent phases.

1.2 WEST DISTRICT ZONE A

An implementation plan has been developed for the West District Zone A, which is presented in Section 4.0. Servicing for this zone has been divided into four phases. Figure 1, which is appended at the end of the tech memo, presents the staged implementation plan for the West District Zone A.

1.3 EAST DISTRICT

Servicing for the East District has been proposed in a single phase, considering the magnitude of work involved, and the opinion of probable cost. As such, a separate section for an implementation plan for the East District has not been prepared in this tech memo. We have

assumed that the implementation for the East District will be offset from Phase 1 of the West District Zone A.

2.0 Preferred Alternatives

As noted in Section 1, one preferred alternative was recommended for each of the service areas, namely the West District Zone A, and the East District. These alternatives are described in detail along with the other alternatives in the *Engineering Report*. The preferred alternatives are described briefly below in order to better explain the implementation methodology in the following sections.

2.1 WEST DISTRICT ZONE A

Four alternatives (W1 to W4) were prepared for the West District Zone A. Alternative W1 was recommended as the preferred servicing alternative.

2.1.1 Intakes

Servicing Alternative W1 comprises of a single intake with an ultimate capacity of 147 ML/d. Three potential intake locations were identified in the *Engineering Report*.

- Lake Ontario near Sann Road; or
- Jordan Harbour at 1st Avenue; or
- Lake Ontario near 5th St. Louth.

The Social and Natural Environmental Report concluded that Jordan Harbour was not a suitable intake location and therefore will not be considered for implementation. Lake Ontario was identified as a reliable source of water for the West District Zone A.

Task 4 – In the *Regulatory Requirements and Related Considerations* technical memorandum by Kinkead Consulting, it was noted that, at this stage, it cannot be ascertained whether one lake-based intake location has a regulatory advantage over the other. Moreover, there is potential for the actual intake location to vary from the two identified above based on further detailed studies. Relocating the intake would not significantly impact the overall cost of the alternative. However, based on the selected location, some pipe sizes may need to be re-defined, and this would be established at the detailed design phase.

At this time, we have identified the implementation plan based on the intake located in the vicinity of Sann Road.

2.1.2 Servicing Infrastructure

The preferred alternative is to service the area using a pipe distribution network to convey water from the intake to the fields. The proposed pipe sizes vary from 150 mm to 900 mm. In addition, 24 minor and 2 major road, rail or stream crossings are proposed.

Two booster pumping stations are proposed to ensure that the pressures are within the acceptable range. The booster pumping stations are proposed at the following locations:

- Booster Pumping Station No.1 Capacity = 8,073 m³/d (1480 USGPM) in the vicinity of Third St. Louth near Regional Rd. 81
- Booster Pumping Station No.2 Capacity = 96,285 m³/d (17,663 USGPM) in the vicinity of John St. and Victoria Rd., in Vineland

2.1.3 Opinion of Probable Cost

The opinion of probable cost for Alternative W1 is \$75 million. Detailed opinions for probable cost were prepared for each alternative in the *Engineering Report*. The table for Alternative W1 is reproduced below from the *Engineering Report*.

Table 1: Opinion of Probable Capital Cost for Irrigation Infrastructure – Alternative W1

Item	Diameter (mm)	Unit Amount	Unit	Unit Cost	Cost
Pipe	150	18,149	m	\$123	\$2,227,060
	200	0	m	\$136	\$ -
	250	815	m	\$150	\$22,400
	300	27,969	m	\$169	\$4,716,410
	350	32,111	m	\$222	\$7,142,450
	400	7,599	m	\$247	\$1,879,920
	450	5,285	m	\$287	\$1,515,050
	500	6,788	m	\$320	\$2,169,110
	600	11,702	m	\$448	\$5,241,210
	750	16,154	m	\$505	\$8,159,390
900	13,625	m	\$669	\$9,116,900	
Pipe Subtotal					\$42,289,900
Minor Crossing (Small creek, railway)	*150	1	lump sum	\$75,000	\$75,000
	*300	6	lump sum	\$75,000	\$450,000
	*350	7	lump sum	\$75,000	\$525,000
	*400	1	lump sum	\$75,000	\$75,000
	*450	1	lump sum	\$75,000	\$75,000
	*600	1	lump sum	\$75,000	\$75,000
	*900	4	lump sum	\$75,000	\$300,000
	^400	1	lump sum	\$75,000	\$75,000
	^750	2	lump sum	\$75,000	\$150,000
Minor Crossing Subtotal					\$1,800,000
Major Crossing (QEW, Jordan Harbour)	450	1	lump sum	\$175,000	\$175,000
	900	1	lump sum	\$175,000	\$175,000
Major Crossing Subtotal					\$350,000

Item	Diameter (mm)	Unit Amount	Unit	Unit Cost	Cost
Pumping Station	Intake	1705	L/s	\$3,500	\$5,969,220
	Booster 1	93	L/s	-	\$1,000,000
	Booster 2	1114	L/s	\$3,500	\$3,900,400
Pumping Station Subtotal					\$10,869,620
Subtotal					\$55,309,520
Allowance for contingencies, permits, approvals and engineering, etc. (35%)					\$19,358,330
Total Cost (excluding GST)					\$74,667,900

^ denotes a creek crossing

* denotes a railway crossing

bold denotes a QEW crossing

Note: Pumping station costs do not take into account the land costs.

2.2 EAST DISTRICT

Three alternatives (E1 to E3) were prepared for the East District. Alternative E3 was recommended as the preferred servicing alternative. Alternative E3 plans to build on the existing infrastructure in NOTL with major and minor upgrades to the existing channels, drains, and ditches in addition to building some new channels.

2.2.1 Intakes

Servicing Alternative E3 proposes one new intake, capacity upgrades for two existing intakes, and relocation of one intake without capacity upgrades. Details are reproduced below from the *Engineering Report*:

- Intake 1: Lock 3 Gravity Feed (New, Proposed Capacity 53,965 m³/d (9,900 USGPM))
- Intake 2: Eastchester Pumping Station (No Upgrades, Existing Capacity 21,800 m³/d (4,000 USGPM))
- Intake 3: Queenston Pumping Station (Upgraded Capacity 81,765 m³/d (15,000 USGPM))
- Intake 4: Ontario Hydro Canal Pumping Station (Upgraded Capacity 33,000 m³/d (6,050 USGPM))

It is recommended that Intake 2 be relocated upstream on the Welland Canal. Total capacity of the upgraded intakes would be 190 ML/d.

2.2.2 Servicing Infrastructure

Alternative E3 proposes to convey water from the intakes to the fields using primarily an open channel system. This alternative plans to build on the existing open channel that is currently used for irrigation. Existing channels will be modified in addition to providing new channels with a purpose to:

- Service a larger area
- Intensify the service levels

2.2.3 Opinion of Probable Cost

The opinion of probable cost for Alternative E3 is \$19 million. Detailed opinions for probable cost were prepared for each alternative in the *Engineering Report*. The table for Alternative E3 is reproduced below from the *Engineering Report*.

Table 2: Opinion of Probable Capital Cost for Irrigation Infrastructure – Alternative E3

Item	Diameter (mm)	Unit Amount	Unit	Unit Cost (\$)	Cost (\$)
Proposed Irrigation Channel	n/a	18198	m	\$20	\$363,950
Proposed Supply and Transfer Pipeline	750	5903	m	\$510	\$3,010,580
Major Crossing (QEW, Hwy 405)	750	1	lump sum	\$175,000	\$175,000
Pumping Station	Hydro	382	L/s	\$6,500	\$2,482,610
	Queenston	946	L/s	\$3,500	\$3,312,230
	ABL	252	L/s	\$8,000	\$2,018,480
Pumping Station Subtotal					\$7,813,320
Transfer Pumping Station	TMC	147	lump sum	-	\$1,000,000
	Church St	147	lump sum	-	\$1,000,000
Transfer Pumping Station Subtotal					\$2,000,000
Gravity Intake			lump sum		\$1,000,000
Subtotal					\$14,362,850
Allowance for contingencies, permits, approvals and engineering etc. (35%)					\$5,027,000
Total Cost (excluding GST)					\$19,389,900

3.0 Phasing Methodology

3.1 METHODOLOGY

As discussed in Section 1.0, in order to establish a methodology for phasing the implementation of the preferred servicing alternatives, the following criteria were considered:

- Demand and Willingness
- Implementation Time
- Funding Requirements
- Policy and Regulatory Requirements

Each of these criteria is discussed in the following sections for their impacts on the phasing methodology relating to the proposed servicing scheme. A detailed implementation plan is proposed in Section 4.0 for the West District Zone A. The East District servicing scheme is proposed to be implemented in a single phase owing to its cost and the magnitude of work involved. Therefore, a separate section has not been prepared for the East District.

3.2 DEMAND AND WILLINGNESS

Demand and willingness of the growers to participate are vital factors in deciding the sequence of progression of a servicing scheme. Section 4.0 identifies the trunk infrastructure and the secondary infrastructure for each phase for the West District Zone A. Area coverage identified is based on demand numbers established by land survey and crop demand calculations as a part of this project. It is recognized that land uses can change over time, as well as the grower willingness or ability to participate. Actual demand is more likely to be established based on land cover at time of construction, as well as the grower's need for irrigation based on the prevailing market forces. However, for the purposes of this exercise, the demand locations and amounts derived for this study are deemed sufficient.

It is important to note that although the trunk infrastructure may well be provided as identified; secondary infrastructure could be re-visited based on the willingness and the demand at that time. The purpose of identifying secondary infrastructure in this memo is primarily to establish an opinion of probable cost and a time frame attributed to each phase. We recognize that the grower demand will ultimately determine the sequence of progression of the secondary infrastructure.

3.3 IMPLEMENTATION TIME

The Niagara Irrigation Project proposes to cover an area of approximately 11,000 ha. The project plans to install/upgrade pipelines and open channels for an approximate length of

165 kilometers, in addition to intakes, and booster pumping stations. Recognizing that it would not be practical to install the entire infrastructure through a single project, it is important to phase the installation keeping in mind the time required to implement a phase. Various components envisaged for each phase are:

- Supplementary Technical Studies and Environmental Study Reports
- Preliminary Design
- Detailed Design, Approvals and Tender
- Construction and Commissioning

Probable time for completion for a single phase is considered to be five years, with two and a half years for completing the supplementary technical studies, preliminary and detailed design, and a similar time frame for construction and commissioning.

If it is necessary to achieve an accelerated schedule, we would propose that supplementary technical studies for the next phase be initiated at the time of construction of the previous phase.

3.4 FUNDING REQUIREMENTS

Infrastructure projects as large as the proposed irrigation project are capital intensive. As such, a large part of the money required to undertake such projects is borrowed or granted from provincial or federal governments or from other funding agencies. If the funds were borrowed all at once, it may adversely affect the debt financing capability of the governing organization. Consequently, large projects could be phased such that the governing organization could start paying back principal and interest on the amounts borrowed for a particular phase, and borrow money for the next phase thereby spreading out the total borrowed amount over a longer term.

Since this project has an overall opinion of probable cost of approximately \$95 million, with approximately \$75 million attributed to the West District Zone A, it is proposed to break down the overall project into smaller phases.

Since the proposed upgrades in the East District (NOTL) have a probable cost of approximately \$19 million, the East District is deemed to be a suitable candidate for a single phase. However, it is recommended that this work for the East District be offset in time from the West District phase to avoid a bottleneck in available resources such as program management, design, financing, and construction.

3.5 POLICY AND REGULATORY REQUIREMENTS

Water takings from water bodies typically require permits and approvals from various regulatory agencies that are responsible for preserving different features and uses of the natural resources such as the environment, navigation, power generation, etc. As such any undertaking relating to the withdrawing of water from water bodies, distribution and application to the fields for irrigation would require approvals from these regulatory agencies.

As the project area proposed to be serviced by irrigation is relatively large, it would require substantial quantities of water being withdrawn from the various water bodies (147 ML/d for the West District Zone A and 190 ML/d for the East District).

In such a case, it would be prudent to demonstrate to the regulatory agencies through a pilot irrigation project that a well designed and implemented scheme can provide an economic benefit to the Region and at the same time ensure that it is environmentally sound and makes efficient use of water. We propose to utilize this approach in the planning of Phase 1 for the West District Zone A.

4.0 West District Zone A

The West District Zone A is proposed to be serviced in four phases. Servicing infrastructure for each phase has been identified and is presented in Figure 1. Sections providing a detailed description of each phase also summarize the infrastructure that will be provided along with opinions of probable cost and an estimated time frame for completion. We have baselined Phase 1 for commencement in 2009, and have established the timing for the subsequent phases based on this baseline.

For the intake and pumping stations, it is assumed that 80 percent of the capital cost will be incurred in the phase that they are first constructed. The remaining 20 percent of the capital cost will be incurred in the subsequent phases when mechanical and electrical equipment upgrades will be required to service a larger area.

4.1 PHASE 1

The preferred alternative for the West District Zone A is associated with a single intake. Two potential locations have been identified, and both of these locations are in Lake Ontario. Logical progression of service areas for phasing would be to service areas close to the intake during the first phase and service areas away from the intake in the subsequent phases. For the purpose of this phasing report, intake location 1: Lake Ontario in the vicinity of Sann Road has been considered.

4.1.1 Service Area and Demand

Phase 1 proposes to service an area of 440 hectares. The average day demand for Phase 1 is 19,820 m³/d.

4.1.2 Infrastructure Components and Opinion of Probable Cost

Table 3 summarizes the infrastructure components proposed in this phase along with their opinions of probable cost.

Table 3: Opinion of Probable Capital Cost for Irrigation Infrastructure for Phase 1

Item	Diameter (mm)	Unit Amount	Unit	Unit Cost	Cost
Pipe	150	605	m	\$123	\$74,240
	350	3116	m	\$222	\$693,090
	750	3437	m	\$505	\$1,736,030
	900	11853	m	\$669	\$7,931,200
Pipe Subtotal					\$10,434,560

Item	Diameter (mm)	Unit Amount	Unit	Unit Cost	Cost
Minor Crossing (Small creek, railway)	*350	2	lump sum	\$75,000	\$150,000
	*900	2	lump sum	\$75,000	\$150,000
Minor Crossing Subtotal					\$300,000
Major Crossing (QEW, Jordon Harbour)	900	1	lump sum	\$175,000	\$175,000
Major Crossing Subtotal					\$175,000
Pumping Station	Intake	--	--	--	\$4,774,000
Pumping Station Subtotal					\$4,774,000
Subtotal					\$15,683,560
Allowance for contingencies, permits, approvals and engineering, etc. (35%)					\$5,489,250
Total Cost (excluding GST)					\$21,172,800

^ denotes a creek crossing

* denotes a railway crossing

bold denotes a QEW crossing

Note: Pumping station costs do not take into account the land costs.

4.1.3 Estimated Time Frame for Implementation

It is estimated that the supplementary technical studies for Phase 1 will commence in 2009 and the pre-design and detailed design will carry on until 2011, when construction will begin. It is estimated that construction could be completed by 2013, and Phase 1 could be commissioned by 2014.

4.2 PHASE 2

4.2.1 Service Area and Demand

Phase 1 proposes to service an area of 1,200 hectares. The average day demand for Phase 1 is 58,760 m³/d.

4.2.2 Infrastructure Components and Opinion of Probable Cost

Table 4 summarizes the infrastructure components proposed in this phase along with their opinions of probable cost.

Table 4: Opinion of Probable Capital Cost for Irrigation Infrastructure for Phase 2

Item	Diameter (mm)	Unit Amount	Unit	Unit Cost	Cost
Pipe	150	3,782	m	\$123	\$464,090
	300	13,659	m	\$169	\$2,303,320
	450	433	m	\$287	\$124,130
	750	11,612	m	\$505	\$5,865,220
	900	6,862	m	\$669	\$4,591,570
Pipe Subtotal					\$13,348,330
Minor Crossing (Small creek, railway)	*300	5	lump sum	\$75,000	\$375,000
	*900	2	lump sum	\$75,000	\$150,000
	^750	2	lump sum	\$75,000	\$150,000
Minor Crossing Subtotal					\$675,000
Major Crossing (QEW, Jordon Harbour)	900	1	lump sum	\$175,000	\$175,000
Major Crossing Subtotal					\$175,000
Pumping Station	Intake 1	--	--	--	\$397,840
	Booster 2	--	--	--	\$3,120,320
Pumping Station Subtotal					\$3,518,160
Subtotal					\$17,716,490
Allowance for contingencies, permits, approvals and engineering, etc. (35%)					\$6,200,770
Total Cost (excluding GST)					\$23,917,300

^ denotes a creek crossing

* denotes a railway crossing

bold denotes a QEW crossing

Note: Pumping station costs do not take into account the land costs.

4.2.3 Estimated Time Frame for Implementation

As discussed in Section 3.3, supplementary technical studies for this phase can begin in 2012, upon the completion of the design and tendering stage for Phase 1. It is estimated that the Class Environmental Assessment (EA) and design for Phase 2 will carry on until 2014. It is estimated that construction could be completed by 2016, and Phase 2 could be commissioned by 2017.

4.3 PHASE 3

4.3.1 Service Area and Demand

Phase 3 proposes to service an area of 1,280 hectares. The average day demand for Phase 3 is 24,660 m³/d.

4.3.2 Infrastructure Components and Opinion of Probable Cost

Table 5 summarizes the infrastructure components proposed in this phase along with their opinions of probable cost.

Table 5: Opinion of Probable Capital Cost for Irrigation Infrastructure for Phase 3

Item	Diameter (mm)	Unit Amount	Unit	Unit Cost	Cost
Pipe	150	20,721	m	\$123	\$2,542,670
	200	4725	m	\$136	\$642,740
	250	4669	m	\$150	\$701,240
	400	3067	m	\$247	\$758,750
	450	3,994	m	\$287	\$1,144,960
	600	3,294	m	\$448	\$1,475,350
	750	2,765	m	\$505	\$1,396,330
Pipe Subtotal					\$8,662,040
Minor Crossing (Small creek, railway)	*150	4	lump sum	\$75,000	\$300,000
	*250	2	lump sum	\$75,000	\$150,000
Minor Crossing Subtotal					\$450,000
Pumping Station	Intake 1	—	--	--	\$397,840
	Booster 1	--	--	--	\$780,080
	Booster 2	--	--	--	\$1,000,000
Pumping Station Subtotal					\$2,177,920
Subtotal					\$11,289,960
Allowance for contingencies, permits, approvals and engineering, etc. (35%)					\$3,951,490
Total Cost (excluding GST)					\$15,241,500

^ denotes a creek crossing

* denotes a railway crossing

bold denotes a QEW crossing

Note: Pumping station costs do not take into account the land costs.

4.3.3 Estimated Time Frame for Implementation

It is estimated that the supplementary technical studies for Phase 3 will commence in 2015 upon completion of the design stage of Phase 2. The pre-design and detailed design will carry on until 2017, when construction will begin. It is estimated that construction could be completed by 2019, and Phase 3 could be commissioned by 2020.

4.4 PHASE 4

4.4.1 Service Area and Demand

Phase 4 proposes to service an area of 1,100 hectares. The average day demand for Phase 4 is 44,120 m³/d.

4.4.2 Infrastructure Components and Opinion of Probable Cost

Table 6 summarizes the infrastructure components proposed in this phase along with their opinions of probable cost.

Table 6: Opinion of Probable Capital Cost for Irrigation Infrastructure for Phase 4

Item	Diameter (mm)	Unit Amount	Unit	Unit Cost	Cost
Pipe	150	17,205	m	\$123	\$2,111,226
	200	2,017	m	\$136	\$274,370
	250	8,748	m	\$150	\$1,313,860
	300	1,095	m	\$169	\$184,650
	350	5,803	m	\$222	\$1,290,760
	400	1,536	m	\$247	\$379,990
	450	12,457	m	\$287	\$3,571,050
Pipe Subtotal					\$9,125,910
Minor Crossing (Small creek, railway)	*250	3	lump sum	\$75,000	\$225,000
	*450	5	lump sum	\$75,000	\$375,000
	^450	2	lump sum	\$75,000	\$150,000
Minor Crossing Subtotal					\$750,000
Major Crossing (QEW, Jordon Harbour)	350	1	lump sum	\$175,000	\$175,000
	400	1	lump sum	\$175,000	\$175,000
Major Crossing Subtotal					\$350,000
Pumping Station	Intake 1	--	--	--	\$397,840
Pumping Station Subtotal					\$397,840

Item	Diameter (mm)	Unit Amount	Unit	Unit Cost	Cost
Subtotal					\$10,623,750
Allowance for contingencies, permits, approvals and engineering, etc. (35%)					\$3,718,310
Total Cost (excluding GST)					\$14,342,100

^ denotes a creek crossing

* denotes a railway crossing

bold denotes a QEW crossing

Note: Pumping station costs do not take into account the land costs.

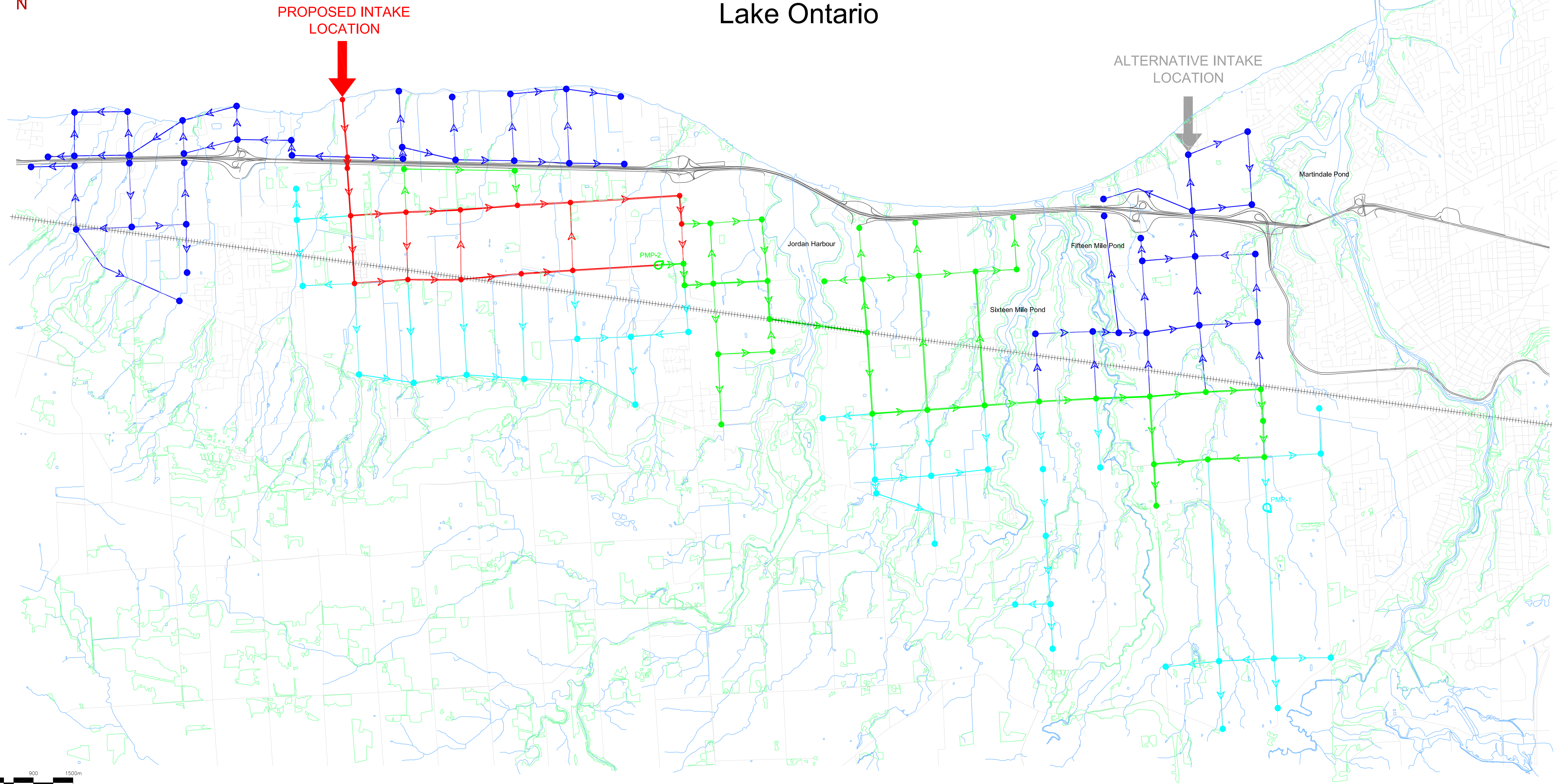
4.4.3 Estimated Time Frame for Implementation

It is estimated that the supplementary technical studies for Phase 4 will commence in 2018 and the pre-design and detailed design will carry on until 2020, when construction will begin. It is estimated that construction could be completed by 2022, and Phase 4 could be commissioned by 2023.

--- STANTEC CONSULTING LTD. ---



Lake Ontario



V:\01611\active\161110526\preliminary\analysis\Distribution_Network\Mapana_Proposed Phasing Plan.dwg
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DECEMBER 2007
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Client/Project
Niagara Irrigation Study Phase 2

Figure No.

1.0

Title

Proposed Phasing Plan for
West District Zone A

Legend

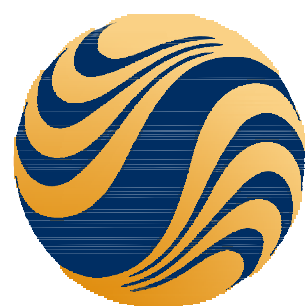
- Node
- Existing Water Course
- Existing Roads
- Existing Train Tracks

Color Coding Legend

- Link: Phase
- PHASE 1
 - PHASE 2
 - PHASE 3
 - PHASE 4

Notes

1. Base features provided by Niagara Peninsula Conservation Authority, 2007.
2. Thicker lines indicate larger diameter pipes (750mmØ to 900mmØ) and constitute the spine of the infrastructure.



Stantec