8.0 Analysis of Infrastructure Alternatives for West Irrigation District – Zone A

8.1 SHORT-LISTED SOURCE ALTERNATIVES

8.1.1 ALTERNATIVE 3: SUPPLY FROM WELLAND CANAL

This alternative will consist of the construction of an intake in the Welland Canal upstream of Lock 6 or Lock 7. There is an existing pipeline (eight feet in diameter) bringing water from upstream of Lock 7 (water elevation 173 m) to the Canadian National (CN) bridge for hydro power generation. This pipeline may potentially supply Zone A from a point in the vicinity of the CN bridge.

Water taken from the Welland Canal will have to be transmitted to West District Zone A across St. Catharines using a pipeline within the Canadian National (CN) Rail corridor.

The water elevation in the Welland Canal at the point of the proposed intake is sufficient to supply a pipeline or open channel distribution system by gravity flow. An intake hydraulic control system (gated intake) will be required to prevent uncontrolled flow into the system.

This source alternative is applicable to both a pipeline distribution system (Alternative 3A, see Figure 8-1) and an open channel distraction system (Alternative 3B, see Figure 8-2).

Significant Issues[25]

The following are some of the main issues regarding the use of this source:

- The use of water from this source may impact the water available for hydro power generation. If the use of this source does result in a reduction of water available for hydro power generation, a loss of hydro generation revenue estimated at $1.10 per cfs-hr [26] (1.1 cents per m^3) should be considered.

- The use of this source may be governed by the Niagara Treaty and as such may require approval through the Department of Foreign Affairs. This may cause delays to the implementation of the project.

- The use of this source will require approval by St. Lawrence Seaway Authority (to install an intake in the canal or connect to the eight-foot hydro power pipe) and the CN Rail (to construct a pipeline in their railroad corridor).

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[25] The issues discussed in these paragraphs are limited to the direct issues related to this source. Issues related to the distribution systems are discussed separately since they are in general not related to a particular source.
[26] Email from Ontario Power Generation (J. Frain) to Stantec (S. Soltani) dated June 9, 2005.

- This source is approximately five kilometers away from the irrigation areas. Furthermore, if an open channel distribution is used, water will need to be transmitted by pipeline another five kilometers to the vicinity of the Escarpment to supply the pipeline feeding the open channels near the Escarpment.
- A major waterway, the Twelve Mile Creek, will have to be crossed by the transmission pipeline from this source.

8.1.2 ALTERNATIVE 4: SUPPLY FROM LAKE GIBSON / LAKE MOODIE

This alternative will consist of the construction of an intake in Lake Moodie. Water taken from Lake Moodie will be transmitted to West District Zone A across the Niagara Escarpment. The exact route of this transmission pipeline will have to decided following a detailed investigation of the alternative routes. A preliminary route is along the existing road from DeCew down the Escarpment.

The proposed intake for this alternative would be located within the property of the Ontario Power Generation (OPG); therefore, OPG's approval will be required for this alternative.

The water elevation in Lake Moodie is sufficient to supply a pipeline or open channel distribution system by gravity flow. An intake hydraulic control system (gated intake) will be required to prevent uncontrolled flow into the system.

This source alternative is applicable to both a pipeline distribution system (Alternative 4A, see Figure 8-3) and an open channel distribution system (Alternative 4B, see Figure 8-4).

Significant Issues

The following are some of the main issues regarding the use of this source:

- The use of water from this source is likely to impact the water available for hydro power generation. If the use of this source does result in a reduction of water available for hydro power generation, a loss of hydro generation revenue estimated at $1.10 per cfs-hr (1.1 cents per m^3).
- The use of this source may be governed by the Niagara Treaty and as such may require approval through the Department of Foreign Affairs. This may cause delays to the implementation of the project.
- The use of this source will require approval by OPG (to install an intake in Lake Moodie) and St. Lawrence Seaway Authority (to use water delivered through Welland Canal).
- The transmission pipeline for this alternative will have to cross the Niagara Escarpment and an ANSI (Life Science) of Regional Significance. Crossing of the Escarpment at this point will require further studies and may have negative environmental impacts during construction that will need to be minimized by special construction methods.
- A major waterway, the Twelve Mile Creek, will have to be crossed by the transmission pipeline from this source. The fish habitat at the point of crossing may be considered “Critical” (Type 1 Fish Habitat).

8.1.3 ALTERNATIVE 5: SUPPLY FROM TWELVE MILE CREEK

This alternative will consist of the construction of an intake in the Twelve Mile Creek downstream of the OPG discharge points. The peak demand of the West Irrigation District is less than 1% of the water diverted to the Twelve Mile Creek by OPG; therefore, this is a secure water source. The water taken from the Twelve Mile Creek will have to be transmitted through some urban area of St. Catharines to reach the West Irrigation District. A preliminary review of the site suggests that the best location for the intake is likely to be close to the CN Rail bridge for a pipeline distribution system (Alternative 5A, see Figure 8-5), and close to the OPG facilities for an open channel distribution system (Alternative 5B, Figure 8-6).

The water elevations in the Twelve Mile Creek downstream of OPG discharge points are generally lower than the irrigated areas; therefore, a major pump house will need to be constructed for this alternative.

Significant Issues

The following are some of the main issues regarding the use of this source:

- The transmission of water through a section of St. Catharines is the only significant non-financial challenge for this source. There are, however, several alternative routes for the transmission line.

8.1.4 ALTERNATIVE 9: SUPPLY FROM LAKE ONTARIO

This alternative will consist of the construction of an intake in the Lake Ontario and the construction of a pumping station close to the shoreline. The preferred location for the intake from a hydraulic perspective will be somewhere in the middle of the West Irrigation District. If a pipeline distribution system is used, the pump can directly feed the distribution system without the need for a significant transmission pipeline length (Alternative 9A, see Figure 8-7). If water were distributed by open channels, a transmission pipeline of approximately 5 km length would be required to transmit lake water to the distribution pipeline near the Escarpment (Alternative 9B, see Figure 8-8).

A special case of Alternative 9 is the construction of the intake in Jordan Harbour. A potential extension of Lake Ontario source water is created by the drowning of the mouth of the Twenty Mile Creek. This area extends up to the CN Rail bridge, providing an advantageous location for the construction of the intake for the West Irrigation District. An intake in this area eliminates some 3 km of pipeline and the need for the large trunk main to cross Queen Elizabeth Way. However, the principal consideration should be to avoid the sensitive environmental areas and fish habitats in this area. If a pipeline distribution system is used, the pump can feed the distribution system at the CN Rail (Alternative 9C, see Figure 8-9). If water were distributed by open channels, the length of the transmission pipeline would be increased by approximately 2 km up to the distribution pipeline near the Escarpment (Alternative 9D, see Figure 8-10).

Significant Issues

The following are some of the main issues regarding the use of this source:

- Intake and pump station will locally disrupt the aquatic environment, but the intake can be located outside sensitive fish habitat areas.
- If the alternative of intake in the Jordan Harbour is selected, there is need for careful consideration of the natural environmental impacts especially during construction. Optimum locations for the intake and pump house should be selected using a detailed survey of the natural environmental features of the area. There may be need for a detailed environmental study, if construction work within ANSI and other sensitive areas cannot be avoided.

8.1.5 ALTERNATIVE 11: SUPPLY FROM OFF-STREAM RESERVOIRS

This alternative consists of constructing on-farm reservoirs with sufficient storage capacity to irrigate the farms during the summer months. The constructed ponds will be filled during spring when stream flows are high. Also farm runoff and tile drainage could be diverted to the ponds. The same pumps and pipelines used for operating the sprinklers and drippers during the summer would be used for filling the ponds during the spring; therefore, there is little requirement for additional pumps and pipes.

Based on the evaporation data for Lake Ontario, we have estimated an evaporation loss of 130 mm of water from these ponds during a ten-year return drought. Evaporation from ponds may be somewhat different from evaporation from the lake, and seepage losses may also be significant. These will need to be investigated in a subsequent study if this alternative is selected. For the purpose of this preliminary study, we will assume that the Off Stream Reservoirs have an efficiency of 90%, which is equivalent to a maximum loss of 0.5 m of water column for a 5 m deep reservoir.

Using the estimated ten-year return annual drought demands in Table 3-7, and assuming a gross storage depth of 5 m for on-farm ponds (net 4.5 m of depth available for irrigation), approximately one acre of pond will be required for every 17 acres of irrigated tender fruit lands (pond area will be equal to 6% of tender fruit irrigated area). Similarly one acre of pond will be required for every 23 acres of irrigated grape land (pond area will be equal to 4% of grape irrigated area).

If farm drainage (tile and/or surface drainage) is diverted to these ponds, they can be substantially smaller than those calculated above.

Significant Issues

The following are some of the main issues regarding the use of this source:

- The location of the ponds should be carefully selected balancing the need to retain premium lands and minimize impact to environmental heritage of the region. Some good land would probably need to be sacrificed for the construction of the ponds.

- Water taking, especially from sensitive streams, will need to be carried out using approved procedures and limits.

8.2 DISTRIBUTION ALTERNATIVES

8.2.1 PIPELINE DISTRIBUTION

A pipeline distribution system allows the efficient distribution of consistent quality water from source to the consumers. A pipeline distribution system in the West Irrigation District will be composed of a trunk main pipeline traversing the potential irrigation areas east-west, and a number of north-south laterals conveying the irrigation water from the trunk main to the consumers. The pipelines will generally be constructed within the road or railroad right-of-way. The preliminary layout of possible distribution systems are shown in Figure 8-1, Figure 8-3, Figure 8-5, Figure 8-7 and Figure 8-9.

The trunk main pipeline for the distribution system will cross at least three major waterways (Fifteen Mile Creek, Sixteen Mile Creek, and Twenty Mile Creek). Furthermore, the distribution pipelines will need to cross a number of lesser waterways. The construction of these waterway crossings may be completed using existing road and railroad bridges. As the pipeline is not likely to be operational and therefore drained during winter, exposed crossing conduits, which are substantially less disruptive than buried pipelines requiring winter protection, will be allowed.

The distribution system will need to cross Queen Elizabeth Way at two locations in order to connect the areas north of this highway to the main system. The crossings may be completed using existing culverts or new jack/bore conduits constructed for the distribution pipeline. The local highway agency will need to be contacted with respect to using an existing drainage culvert for the new crossing pipe.

The pipeline may need to pass by a number of ANSIs and woodlands. The construction impact can be minimized using special construction methods to prevent erosion from open trenches and to minimize other impacts. Alternatively, the more sensitive areas may be avoided, using alternative pipeline routes.

Theoretically, the irrigation conveyance efficiency of a pipeline system can be 100%. However, in practice, some loss is unavoidable. Losses due to pipe and joint leaks normally occur in pipeline systems and increase as the system ages. An irrigation conveyance efficiency of 95% may be reasonable if a good pipeline maintenance program is put into effect. We will use this conveyance efficiency in our preliminary calculations.

The lateral pipeline system will make water available to most users at the farm gate. Water provided to the growers will generally have “residual pressure”. In lower lands and at points closer to the supply source, this pressure may be sufficient to operate low pressure irrigation systems such as drippers, sprayers, and low to medium range sprinklers. The conceptual design, however, is not based on providing a minimum pressure at the farm gate, and it is assumed that the growers will provide the on-farm pressure requirement of the supplied raw water. The system, however, could be designed to provide a minimum pressure to the users at a later stage with minimal modifications, if the cost of the additional system pressurizing justifies the savings of on-farm pumping.

The consistent water quality delivered to the farm gate with piped systems can be an important attribute for growers who operate, or are considering conversion to, drip irrigation or other high efficiency irrigation technologies.

Significant Issues

The following are some of the main issues regarding the use of this type of water distribution:

- There is substantial general disturbance during construction. The significant construction impacts include erosion, stream disturbance, traffic disturbance, and construction noise. Some of these impacts can be substantially mitigated; however, a degree of disturbance will be unavoidable.
- A pipeline irrigation distribution system substantially reduces the number of on-farm pumping requirement compared to the other irrigation alternatives. This will reduce capital, operating and maintenance cost and management effort at the farm level. The pressure provided by the system to the farmers can be increased with relatively minor modifications, allowing elimination of on-farm pumping for low-pressure irrigation systems. This would provide additional incentive for the growers to move toward low-pressure systems such as drippers and spray irrigation.
- The supply of water to the users is secure and the on-going environmental impacts of irrigation water taking can be minimized by improved control over water taking and water distribution.

8.2.2 OPEN CHANNEL DISTRIBUTION

An open channel distribution system allows the use of the existing waterways and ditches for the distribution of irrigation water from the source to the consumers. Some pipeline transmission and distribution to the heads of the open channels along the Escarpment will be necessary. Water supplied to the open channels near the escarpment will flow northward throughout the irrigation areas following the natural slope of the area toward Lake Ontario. There may be need for deepening some of the trenches and installing culverts and pipelines for certain portions of the system. The preliminary layouts of the main pipeline portions of these systems are shown in Figure 8-2, Figure 8-4, Figure 8-6, Figure 8-8 and Figure 8-10.

The trunk main pipeline for the distribution system will cross at least three major waterways (Fifteen Mile Creek, Sixteen Mile Creek, and Twenty Mile Creek). The construction of these waterway crossings may be completed using existing road bridges. The crossing may be completed using existing culverts or new conduits constructed for the distribution pipeline.

The distribution system will need to cross Queen Elizabeth Way at two locations, in order to supply the areas north of this highway. The crossing may be completed using existing culverts or new conduits constructed for the distribution pipeline.

The use of this type of distribution in the West Irrigation District will require consideration of the sensitive natural environmental features of the area. Most natural streams in the area are classified as 'Critical' or 'Important' (Type 1 or Type 2, see Figure 2-3). These should only be used as transmission routes if the introduction of the source water and subsequent water taking by the consumers would have no significant negative impacts to the existing ecosystems. If a drainage channel needs to pass close to an ANSI, the channel may need to be lined, or the section of the system near the ANSI will have to be constructed using a buried pipeline.

The conveyance efficiency of an open channel distribution system is, in general, substantially lower than a pipeline system due to evaporation losses, operational wastes, and tail flows. The conveyance efficiency is highly dependent on the management of the irrigation system. Environmental factors such as temperatures, humidity, groundwater levels also have a major impact on the efficiency of the system (losses in drier years are generally higher than losses during a humid year). We will use a preliminary efficiency of 70% in our calculations. A more accurate estimate may be obtainable by a study of the conveyance efficiency of the existing NOTL system.

Significant Issues

The following are some of the main issues regarding the use of this type of water distribution:

- There is less construction disturbance associated with this irrigation distribution system, but there is potential for ongoing impact during the operation of the system due to introducing substantial quantities of imported water into the waterways. Environmental impacts of using the open channels, especially on the natural watercourses and ANSIs, should be carefully studied.

- The management of water in the trenches is a challenge, as the upstream users can potentially draw more than their fair share, causing the drying of the lower reaches of the system. This problem is likely to be more pronounced during dryer periods. Also, if a natural waterway is used, there is potential for extracting more water by the individual farmers than was added to the waterway, hence causing occasional drying of the natural stream.

- Water quality is likely to deteriorate in the lower reaches of the system due to erosion, evaporation, and drainage from the upstream fields. This represents a significant challenge and added cost to growers who use or would like to use drip or trickle irrigation.

- The implementation of an irrigation project using an open channel distribution system is likely to require more effort and time to carry out environmental studies and address concerns from environmental groups. The inherent lower conveyance efficiency of the system may raise further objections from various stakeholders.

8.3 DISCUSSION OF PROBABLE COSTS

A preliminary cost estimate for alternatives 3, 4, 5 and 9 is shown in Table 8-1.

Table 8-1 Costs of Regional Infrastructure Alternatives for West Irrigation District Zone A (Million Dollars)

Distribution System Type	**Pipeline Distribution Alternatives**					**Open Channel Distribution Alternatives**				
Alternative	**3A**	**4A**	**5A**	**9A**	**9C**	**3B**	**4B**	**5B**	**9B**	**9D**
Figure	8-1	8-3	8-5	8-7	8-9	8-2	8-4	8-6	8-8	8-10
Estimated Quantities										
Net Peak Demand (m^3/d)	174,320	174,320	174,320	174,320	174,320	174,320	174,320	174,320	174,320	174,320
Net Average Annual Demand (m^3/year)	5,205,257	5,205,257	5,205,257	5,205,257	5,205,257	5,205,257	5,205,257	5,205,257	5,205,257	5,205,257
Estimated Efficiency	95%	95%	95%	95%	95%	70%	70%	70%	70%	70%
Gross Peak Demand (m^3/d) (1)	183,495	183,495	183,495	183,495	183,495	249,028	249,028	249,028	249,028	249,028
Gross Peak Demand (acre-feet/d) (1)	149	149	149	149	149	202	202	202	202	202
Gross Average Annual Demand (m^3/year) (2)	5,479,218	5,479,218	5,479,218	5,479,218	5,479,218	7,436,082	7,436,082	7,436,082	7,436,082	7,436,082
Gross Average Annual Demand (acre-feet/year) (2)	4,444	4,444	4,444	4,444	4,444	6,031	6,031	6,031	6,031	6,031
Length of Laterals (m)	91,100	86,600	91,100	89,400	89,400	-	-	-	-	-
Length of Trunk Mains (m)	23,300	23,300	20,800	21,300	19,300	29,500	22,500	21,000	24,500	22,000
Probable Initial Costs										
Laterals	$ 15.9	$ 15.0	$ 15.9	$ 15.2	$ 15.2	$ -	$ -	$ -	$ -	$ -
Trunk Mains	$ 22.3	$ 22.3	$ 18.6	$ 16.9	$ 10.9	$ 34.4	$ 23.9	$ 21.6	$ 23.0	$ 19.0
Pumphouse	$ -	$ -	$ 4.2	$ 5.3	$ 4.4	$ -	$ -	$ 3.8	$ 5.0	$ 4.4
Subtotal of Major Components	$ 38.2	$ 37.3	$ 38.6	$ 37.4	$ 30.5	$ 34.4	$ 23.9	$ 25.4	$ 28.0	$ 23.4
Contingencies (30%)	$ 11.5	$ 11.2	$ 11.6	$ 11.2	$ 9.2	$ 10.3	$ 7.2	$ 7.6	$ 8.4	$ 7.0
Engineering & Studies (15%)	$ 5.7	$ 5.6	$ 5.8	$ 5.6	$ 4.6	$ 5.2	$ 3.6	$ 3.8	$ 4.2	$ 3.5
Probable Infrastructure Cost	**$ 55.4**	**$ 54.1**	**$ 56.0**	**$ 54.2**	**$ 44.3**	**$ 49.8**	**$ 34.6**	**$ 36.9**	**$ 40.6**	**$ 33.9**
Probable Annual O&M Costs										
Energy Costs	$ -	$ -	$ 0.119	$ 0.162	$ 0.128	$ -	$ -	$ 0.104	$ 0.150	$ 0.127
OPA Lost Revenue	$ 0.060	$ 0.060	$ -	$ -	$ -	$ 0.082	$ 0.082	$ -	$ -	$ -
Other O & M (1% of Capital)	$ 0.554	$ 0.541	$ 0.560	$ 0.542	$ 0.443	$ 0.498	$ 0.346	$ 0.369	$ 0.406	$ 0.339
Probable O & M Costs	**$ 0.614**	**$ 0.602**	**$ 0.679**	**$ 0.704**	**$ 0.570**	**$ 0.580**	**$ 0.428**	**$ 0.473**	**$ 0.556**	**$ 0.466**
Probable Annual Costs										
Amortization Period (yrs)	20	20	20	20	20	20	20	20	20	20
Interest Rate	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Annual Capital & Interest Payments	$ 4.4	$ 4.3	$ 4.5	$ 4.4	$ 3.6	$ 4.0	$ 2.8	$ 3.0	$ 3.3	$ 2.7
Probable Total Annual Cost and Payments	**$ 5.1**	**$ 4.9**	**$ 5.2**	**$ 5.1**	**$ 4.1**	**$ 4.6**	**$ 3.2**	**$ 3.4**	**$ 3.8**	**$ 3.2**

Notes
(1) Gross Peak Demand is the demand at farm gate plus distribution system losses.
(2) Gross Average Annual Demand is the average quantity of water expected to be withdrawn from the water source.

The following observations are made from Table 8-1:

- Alternative 9C, Supply from Jordan Harbour with Pipeline Distribution, has substantial cost advantage over the other pipeline distribution alternatives. The other four pipeline alternatives are fairly similar in cost. It should be noted that Alternative 9C may involve disturbing an ANSI, a critical fish habitat, and/or other sensitive environmental features.

- Alternatives 3B, Supply from Welland Canal with Open Channel Distribution, and 9B, Supply from Lake Ontario with Open Channel Distribution, have definite cost disadvantage over the other three open channel distribution alternatives. The cost disadvantage is due to the long transmission lines to convey water from sources at substantial distances to the discharge points along the Escarpment.

- OPA estimated lost revenue due to the use of water for irrigation rather than hydro power generation (in Alternatives 3A, 4A, 3B and 4B) is consistently less than the estimated cost of energy for pumping the irrigation water (in Alternatives 5A, 9A, 9C, 5B, 9B and 9D). It should be concluded that the use of a pump alternative rather than a gravity flow alternative will most likely result in a net increase in demand for electricity from non-hydro power generation facilities. Furthermore, there will be additional burden on the power distribution network. Nevertheless, the use of pumping supplies may be justified due to substantial reduction in the length and diameter of the water transmission trunk mains.

A major component of the cost of the trunk mains is for the conveyance of water east-west across a fairly long system area. The advantage of Alternatives 9C, Supply from Jordan Harbour with Pipeline Distribution, and 9D, Supply from Jordan Harbour with Open Channel Distribution, are due to the source being located in the hydraulic centre of the service area.

In order to investigate the impact of east-west length of the system on the cost, we further divided the West Irrigation District into two subsystems, East Side and West Side. The preliminary dividing line was set at the Twenty Mile Creek. Certain alternatives short-listed for the West Irrigation District were clearly not applicable to one of these subsystems. Alternatives 3B, Supply from Welland Canal with Open Channel Distribution, and 9B, Supply from Lake Ontario with Open Channel Distribution, were not considered for the East Side due to the long supply lines and the availability of other viable sources near the Escarpment. Similarly, a supply from the Welland Canal, Lake Gibson/Lake Moodie, or the Twelve Mile Creek for the West Side would require transmission through the East Side, which we are attempting to avoid in this exercise. Therefore, Alternatives 3A, 4A, 5A, 3B, 4B, and 5B were not considered for the West Side.

Table 8-2 and Table 8-3 illustrate the cost of the different alternatives for providing irrigation water to the East and West sides of the West Irrigation District Zone A.

Table 8-2 Costs of Regional Infrastructure Alternatives for West Irrigation District Zone A - East Side (Million Dollars)

Distribution System Type	**Pipeline Distribution Alternatives**					**Open Channel Alternatives**		
Alternative	**3A**	**4A**	**5A**	**9A**	**9C**	**4B**	**5B**	**9D**
Estimated Quantities								
Net Peak Demand (m^3/d)	92,802	92,802	92,802	92,802	92,802	92,802	92,802	92,802
Net Average Annual Demand (m^3/year)	2,771,095	2,771,095	2,771,095	2,771,095	2,771,095	2,771,095	2,771,095	2,771,095
Estimated Efficiency	95%	95%	95%	95%	95%	70%	70%	70%
Gross Peak Demand (m^3/d) (1)	97,686	97,686	97,686	97,686	97,686	132,574	132,574	132,574
Gross Peak Demand (acre-feet/d) (1)	79	79	79	79	79	108	108	108
Gross Average Annual Demand (m^3/year) (2)	2,916,942	2,916,942	2,916,942	2,916,942	2,916,942	3,958,707	3,958,707	3,958,707
Gross Average Annual Demand (acre-feet/year) (2)	2,366	2,366	2,366	2,366	2,366	3,211	3,211	3,211
Length of Laterals (m)	48,600	44,100	48,600	44,100	48,600	-	-	-
Length of Trunk Mains (m)	11,600	11,600	9,100	11,600	6,350	10,800	9,300	10,300
Probable Initial Costs								
Laterals	$ 8.6	$ 7.8	$ 8.6	$ 7.8	$ 8.6	$ -	$ -	$ -
Trunk Mains	$ 8.5	$ 8.5	$ 6.3	$ 8.5	$ 4.6	$ 9.0	$ 7.2	$ 10.0
Pumphouse	$ -	$ -	$ 2.7	$ 2.8	$ 2.8	$ -	$ 2.4	$ 2.8
Subtotal of Major Components	$ 17.2	$ 16.3	$ 17.6	$ 19.1	$ 16.0	$ 9.0	$ 9.6	$ 12.8
Contingencies (30%)	$ 5.2	$ 4.9	$ 5.3	$ 5.7	$ 4.8	$ 2.7	$ 2.9	$ 3.8
Engineering & Studies (15%)	$ 2.6	$ 2.4	$ 2.6	$ 2.9	$ 2.4	$ 1.3	$ 1.4	$ 1.9
Probable Infrastructure Cost	**$ 24.9**	**$ 23.6**	**$ 25.6**	**$ 27.7**	**$ 23.2**	**$ 13.0**	**$ 13.9**	**$ 18.5**
Probable Annual O&M Costs								
Energy Costs	$ -	$ -	$ 0.064	$ 0.068	$ 0.068	$ -	$ 0.055	$ 0.068
OPA Lost Revenue	$ 0.032	$ 0.032	$ -	$ -	$ -	$ 0.044	$ -	$ -
Other O & M (1% of Capital)	$ 0.249	$ 0.236	$ 0.256	$ 0.277	$ 0.232	$ 0.130	$ 0.139	$ 0.185
Probable O & M Costs	**$ 0.281**	**$ 0.269**	**$ 0.319**	**$ 0.345**	**$ 0.300**	**$ 0.174**	**$ 0.194**	**$ 0.253**
Probable Annual Costs								
Amortization Period (yrs)	20	20	20	20	20	20	20	20
Interest Rate	5%	5%	5%	5%	5%	5%	5%	5%
Annual Capital & Interest Payments	$ 2.0	$ 1.9	$ 2.1	$ 2.2	$ 1.9	$ 1.0	$ 1.1	$ 1.5
Probable Total Annual Cost and Payments	**$ 2.3**	**$ 2.2**	**$ 2.4**	**$ 2.6**	**$ 2.2**	**$ 1.2**	**$ 1.3**	**$ 1.7**

Notes
(1) Gross Peak Demand is the demand at farm gate plus distribution system losses.
(2) Gross Average Annual Demand is the average quantity of water expected to be withdrawn from the water source.

Table 8-3 Costs of Regional Infrastructure Alternatives for West Irrigation District Zone A - West Side (Million Dollars)

Distribution System Type	**Pipeline Alternatives**		**Open Channel Alternatives**	
Alternative	**9A**	**9C**	**9B**	**9D**
Estimated Quantities				
Net Peak Demand (m^3/d)	81,518	81,518	81,518	81,518
Net Average Annual Demand (m^3/year)	2,434,162	2,434,162	2,434,162	2,434,162
Estimated Efficiency	95%	95%	70%	70%
Gross Peak Demand (m^3/d) (1)	85,809	85,809	116,454	116,454
Gross Peak Demand (acre-feet/d) (1)	70	70	94	94
Gross Average Annual Demand (m^3/year) (2)	2,562,276	2,562,276	3,477,375	3,477,375
Gross Average Annual Demand (acre-feet/year) (2)	2,078	2,078	2,820	2,820
Length of Laterals (m)	42,691	40,800	-	-
Length of Trunk Mains (m)	13,200	12,950	13,600	13,000
Probable Initial Costs				
Laterals	$ 6.2	$ 6.5	$ -	$ -
Trunk Mains	$ 5.7	$ 6.4	$ 9.1	$ 10.2
Pumphouse	$ 1.8	$ 1.8	$ 1.8	$ 1.8
Subtotal of Major Components	$ 13.7	$ 14.7	$ 10.9	$ 12.0
Contingencies (30%)	$ 4.1	$ 4.4	$ 3.3	$ 3.6
Engineering & Studies (15%)	$ 2.1	$ 2.2	$ 1.6	$ 1.8
Probable Infrastructure Cost	**$ 19.9**	**$ 21.4**	**$ 15.9**	**$ 17.4**
Probable Annual O&M Costs				
Energy Costs	$ 0.036	$ 0.036	$ 0.038	$ 0.038
OPA Lost Revenue	$ -	$ -	$ -	$ -
Other O & M (1% of Capital)	$ 0.199	$ 0.214	$ 0.159	$ 0.174
Probable O & M Costs	**$ 0.235**	**$ 0.249**	**$ 0.196**	**$ 0.212**
Probable Annual Costs				
Amortization Period (yrs)	20	20	20	20
Interest Rate	5%	5%	5%	5%
Annual Capital & Interest Payments	$ 1.6	$ 1.7	$ 1.3	$ 1.4
Probable Total Annual Cost and Payments	**$ 1.8**	**$ 2.0**	**$ 1.5**	**$ 1.6**

Notes
(1) Gross Peak Demand is the demand at farm gate plus distribution system losses.
(2) Gross Average Annual Demand is the average quantity of water expected to be withdrawn from the water source.

Table 8-2 indicates that for the East side the pipeline distribution alternatives are fairly comparable. The definite cost advantage previously observed for Alternative 9C, Supply from Jordan Harbour with Pipeline Distribution, is not there anymore. In the case of the open channel alternatives, Alternative 9D, Supply from Jordan Harbour with Open Channel Distribution, is considerable more costly that the two other open channel alternatives with sources close to the Escarpment.

Table 8-3 illustrates the clear advantage of the Lake Ontario supply over the Supply from Jordan Harbour for the West Side. This advantage is due to the fact that an intake in Lake Ontario can be positioned at the hydraulic centre of the West Side's distribution system. Furthermore, the cost of a pipeline distribution system for this side is only 25% higher that the cost of an open channel distribution system. This increased cost may be acceptable in view of the definite advantages of a pipeline distribution system over an open channel distribution system.

A more important conclusion from Table 8-2 and Table 8-3 is that dividing Zone A into two subsystems will be advantageous. The total cost of the pipeline distribution alternatives for two separate subsystems will probably be 43 to 45 million dollars, substantially less than most pipeline distribution alternatives if the entire zone A were supplied by one distribution system. The only comparable alternative of the latter arrangement is Alternative 9C, Supply from Jordan Harbour with Pipeline Distribution, an alternative with serious potential environmental implications. The total cost of the open channel alternatives will be lower if the West Side were supplied from Lake Ontario and the East Side were supplied from either Twelve Mile Creek or Lake Moodie. The total cost of this combination (4B or 5B for East Side plus 9B for West Side) will probably be 29 to 30 million dollars. Furthermore, the combination of a pipeline distribution alternative for the West Side (Alternative 9A) and an open channel distribution alternative for the East Side (Alternatives 4B or 5B) will probably cost 33 to 34 million dollars, comparable to the less costly open channel distribution alternatives if Zone A were not subdivided.

The above costs should be compared with the cost and land requirements of Alternative 11, Supply from Off-Stream Reservoirs. Table 8-4 shows the calculation of the construction costs and land requirements of providing sufficient volume of off-stream reservoir capacity to provide adequate irrigation during a ten-year return drought.

Table 8-4 Cost of Alternative 11 Supply from Off-Stream Reservoirs for West Irrigation District Zone A

Initial Costs	
Net Annual Irrigation Requirements for Ten-Year Return Drought	8,827,201 m^3
Estimated Storage Efficiency	90%
Gross Storage Volume	9,808,001 m^3 7,954 acre-ft
Unit Construction Cost	$ 250 /acre-in
Construction Cost (million dollars)	$ 23.9 million
Contingencies (30%)	$ 7.2 million
Engineering & Studies (15%)	$ 3.6 million
Probable Infrastructure Cost	$ 34.6 million
Probable Annual O&M Costs	
Energy Costs	$ 0.034 million
Other O & M (1% of Capital)	$ 0.346 million
Probable O & M Costs	$ 0.380 million
Probable Annual Costs and Payments	
Amortization Period	20 years
Interest Rate	5%
Annual Capital & Interest Payments	$ 2.8 million
Probable Total Annual Cost and Payments	$ 3.2 million
Land Requirement	
Total Surface Area of Ponds	1,961,600 m^2 485 acres
Additional land required (e.g. Berms)	10%
Total land for Pond Facilities	533 acres

The total cost of this alternative is highly sensitive to cost of the land. If land were valued at $20,000 per acre, the total cost of supply from Off-Stream Reservoirs will probably be comparable to the cost of a pipeline distribution system.

Table 8-5 summarizes the alternative solutions discussed in the previous sub-section and provides their initial and annual costs per acre. These preliminary results show that the annual costs for all alternatives for irrigating Zone A are one order of magnitude higher that what NOTL irrigation participants are paying at the present time (approximately $28/acre). It should be noted that the NOTL system was constructed over a number of years with substantial contributions from the different levels of government. Nevertheless, any burden significantly higher than the current payment by the NOTL participants is likely to be rejected by the farmers, unless a tangible additional benefit is provided.

Table 8-5 Alternative Infrastructure Solutions for West Irrigation District Zone A[27]

Alternative Infrastructure Solution	Alternatives for East Side	Alternatives for West Side	Initial Cost	Initial Cost Per Acre (1)	Total Annual Cost and Payments per Acre (2)
Two Pipeline Distribution Systems	3A, 4A, 5A, 9A, or 9C	9A	\$43 to \$47 million	\$5,200-\$5,700	\$480-\$550
Two Open Channel Distribution Systems	4B or 5B	9B	\$29 to \$30 million	\$3,500-\$ 3,600	\$320-\$330
Pipeline Distribution System for East Side and Open Channel Distribution System for West Side	4B or 5B	9A	\$33 to \$34 million	\$4,000-\$4,100	\$360-\$370
Supply from Off-Stream Reservoirs			\$35 million + land	\$4,200 + land	\$390 + land

Notes:

(1) Based on service area of 8,300 acres

(2) Based on service area of 8,300 acres. For details of annual payments refer to Table 8-2, Table 8-3 and Table 8-4.

[27] It should be emphasized that the figures shown in this table are preliminary estimates based on the available data. Significant data gaps will need to be addressed before these figures can be relied on for budgeting purposes.