

**FEASIBILITY STUDY – RAW WATER FOR AGRICULTURAL IRRIGATION PURPOSES
PROJECT REPORT**

4.0 Review of Existing Irrigation Models

4.1 GENERAL

In this section, several irrigation programs implemented in the Region of Niagara, the Province of Ontario and elsewhere in North America have been reviewed. The objective of this review is to ensure that the experiences gained elsewhere with similar irrigation developments are taken into account in the planning and implementation of this project. Figure 4-1 illustrates the locations of the projects reviewed in this section.

In the following sub-sections, concise descriptions of selected irrigation projects are presented, and relevant aspects of these projects are outlined. This review has highlighted the uniqueness of the irrigation environment in the Niagara Region; therefore, the experience gained from the Municipal Irrigation System in Niagara-on-the-Lake is emphasized, and the need to investigate this system in more detail has become clear. Certain aspects of the irrigation programs and organizations elsewhere, however, are also applicable to the proposed project, and will be considered in the development of alternative solutions during the subsequent sections of this report.

Figure 4-1: Locations of the Reviewed Irrigation Projects



4.2 NIAGARA-ON-THE-LAKE MUNICIPAL IRRIGATION SYSTEM¹⁵

4.2.1 System Description

The Town of Niagara-on-the-Lake (NOTL) is one of the most important high value crop areas of Canada. Most of the land in NOTL is under different tender fruit, grape, greenhouse, or nursery productions. Some of the farms located close to the east and north edges of the Town obtain irrigation water from the Niagara River (downstream of OPG hydro generation plants) or Lake Ontario. Most irrigators, however, participate in an irrigation scheme managed and operated by the Public Works Department of the Town of Niagara-on-the-Lake. This Municipal Irrigation System takes advantage of the natural northerly slope of the land, and supplies water to the municipal drainage system at several locations near the southern edge of the town. The supplied irrigation water is then distributed by gravity through the drainage system (both natural streams and man-made drains) to the scheme participants and currently services the irrigation requirements of some 8,000 acres of high value cropland¹⁶. The individual farmers are responsible for extracting water from these streams and drains and distributing it within their farms. Figure 4-2 shows a typical drain used for both irrigation and drainage in NOTL. Maps of the three sub-systems of the NOTL Municipal Irrigation System are provided in Appendix A.

The NOTL Municipal Irrigation System has been developed in a number of stages. Prior to the drought of 1988, some individual farmers and groups of farmers used a siphon at the Welland Canal and various creeks as sources of raw water for irrigation. In 1988, the Town of Niagara-on-the-Lake developed the Municipal Irrigation System in order to support the town's agricultural sector. A siphon at the Queenston reservoir was constructed in 1988 to supply the Four Mile Creek subsystem. An abandoned pumping station at the outlet of the OPG tunnels, that had been used for supplying municipal drinking water, was brought back into operation to supplement the Four Mile Creek subsystem. A pumped transfer link from the Four Mile Creek subsystem to the Harrison Routh subsystem was constructed in 1990. In 2001, a pumped supply to the Airport Bright Lavigne system was added and the siphon at the Queenston reservoir was enhanced. A new pumping station was constructed earlier this year (2005) at the Niagara River, which added 27,300 m³/day (5000 USGPM) to the Harrison system. The total capacity of the Municipal Irrigation System is currently 81,800 m³/day (15,000 USGPM).

¹⁵ This Section is mainly based on the information provided by Mr. Henri Bennemeer, Town of Niagara-on-the-Lake, Dec to Mar 2005, unless otherwise noted.

¹⁶ The use of the drainage system for the distribution of irrigation water has been questioned by the Niagara Peninsula Conservation Authority (NPCA), due to its impact on the aquatic ecosystem (source: email from NPCA to Stantec, 1 March 2005). A similar view has been expressed by a local environmental group (Source: Trouts Unlimited, Meeting on 18 February 2005).

Figure 4-2: Typical Drainage/Irrigation Ditch in NOTL



The NOTL Municipal Irrigation System operates from mid-May to mid-September. In addition to providing irrigation water for crop consumption, the system provides water for frost protection during May for a number of berry growers.

In general, there is no redundancy in the pumping capacity (i.e., there are no spare pumps to be operated in case one of the duty pumps is non-operational). However, the pumping stations are constructed with expansion possibilities; therefore, additional capacity and redundancy can be added to the existing pumping stations.

In the past, the system has occasionally failed to satisfy demand. It is thought that the additional supply from the Niagara River should eliminate water shortages in the eastern subsystems. The Town of NOTL is considering adding an additional capacity of 43,600 m³/day (8000 USGPM) in the future to eliminate occasional water shortages in the western subsystems.

4.2.2 System Management

The NOTL Municipal Irrigation System is an initiative of the Town of Niagara-on-the-Lake. It has been developed and managed directly by the Town. The direct costs of the system are in principle repaid by the system beneficiaries, the growers using the irrigation water, through a municipal tax based on the acreage under irrigation. However, various stages of the development of the system infrastructure have taken advantage of different assistance programs to partly finance the investments. The Town has also been supporting the program by financial contributions and by providing office and support infrastructure for the management of the system.

The Municipal Irrigation System is managed by the Department of Public Works of the Town of Niagara-on-the-Lake. An “Irrigation Advisory Committee” oversees the operation of the system and advises the Town’s Council on issues related to the development and operation of the system. The Director of Public Works is responsible for the system. In 2002, the new dedicated position of “Irrigation / Drainage Superintendent” was created within the Public Works Department to manage the Municipal Irrigation System.

The rates paid by the users of the Municipal Irrigation System has capital and operations components. Any new participant in the system will have to pay a “catch-up” payment similar to the cumulative capital contributions made over the years by the original participants.

4.2.3 Lessons from NOTL Irrigation System

The following aspects of the NOTL Irrigation System may be applicable to an irrigation system elsewhere in the Region:

- The use of the municipal drain system for irrigation provides a ready distribution system at minimal cost. This approach, however, has definite environmental consequences and water

efficiency shortcomings compared to a pipeline system. Also, the use of municipal drains for irrigation laterals may not be adequate to efficiently service customers at higher elevations.

- The management of the system by the municipality may be an efficient management system. The work of the system manager can be combined with other tasks, and the larger management infrastructure of the municipality (offices, support staff, vehicles) can be utilized. This eliminates a substantial management cost for the irrigation scheme.
- The existing lack of water measurement at the farm gate eliminates any incentive by individual farmers to efficiently utilize water, and may unfairly affect the water supply/delivery to the tail end users of the system.

4.3 NORFOLK WATER SUPPLY ENHANCEMENT PROJECT (WSEP)¹⁷

4.3.1 Project Description

Prior to the year 2000, a significant stress was being placed on small, sensitive streams within Norfolk County, and both agricultural and urban areas were suffering from low water supplies. The Water Supply Enhancement Project (WSEP) was implemented in Norfolk County from July 17, 2000 to March 31, 2003 in response to increasing competition for the limited available water supplies in the county. The purpose of this project was to develop a water conservation program with the local community that would be available to those interested in improving their water supplies for municipal, agricultural, recreational or wildlife uses.

Three primary objectives were set forth:

- 1) To establish a reliable alternate water supply, directing withdrawal away from sensitive streams;
- 2) To store water when in abundance for use during times when it is scarce, by improving the landscape water storage capacity; and
- 3) To make more efficient use of existing water supplies.

Three hundred and twenty-three sub-projects were completed by 254 farmers through the WSEP, representing 21% of the farmers who irrigate in Norfolk County, and 29% of its total irrigated area.

Improvement in the use efficiency of existing water supplies was achieved through 57 equipment-based sub-projects including the acquisition or installation of 24 ginseng broadcast carts, 1 hanging gutter greenhouse irrigation system and 38 new or expanded trickle irrigation

¹⁷ This Section is mainly based on WESP Final Report (WESP, 2003).

systems. These systems resulted in an estimated annual savings of 471,648 m³ (124,596,129 US Gallon, 4585 acre-inches) of water.

Improvement in the storage of water was accomplished by the construction or expansion of 246 ponds, the implementation of eight wetland/drain projects, and the construction of four impoundments and one new dam.

4.3.2 Project Implementation and Management

The Norfolk WSEP formed a team of diverse private and government partners and supporters. This grass roots initiative was lead by the Norfolk Federation of Agriculture (NFA). The Norfolk Land Stewardship Council (NLSC) facilitated the project along with the Long Point Region Conservation Authority (LPRCA) and the Ontario Federation of Anglers & Hunters (OFAH). The project Steering Committee was comprised of all partners in the project. A major portion of the external funding for the project came from the Healthy Futures for Ontario Agriculture (HFOA), a four-year \$90 million funding program aimed at maintaining and building on the success of Ontario's agri-food industry. HFOA encouraged rural water quality improvement and efficient use of water resources.

The project delivery method was through an application process, whereby individual farmers applied for funding to implement sub-projects in line with the objectives of the WSEP. A Peer Review Committee was formed to consider each application and to notify successful applicants of their approved grant amounts. All the members of this committee were farmers. All applications and information discussed by the committee is confidential and continues to be so, as some farmers were irrigating without a Permit To Take Water (PTTW). The committee did not want these farmers to shy away from the project for fear of being fined. All applications required legal legitimacy before approval.

One person chaired both the Steering Committee and the Peer Review Committee.

A Project Coordinator responsible for initial inspections and documentation of the sites was appointed. The coordinator was paid through the Conservation Authority, but reported to the Peer Review Committee. The coordinator also educated farmers on Best Management Practices (BMPs), permits and other project requirements. To encourage the adoption of BMPs, all approved applicants attended a mandatory Environmental Farm Plan workshop. A number of educational communication media (including educational pamphlets, brochures, newsletters, events, etc.) were created and distributed.

Upon the completion of the applicant's sub-project(s), all paid invoices, permits and other requirements were submitted to the project coordinator. Successful applicants received a 50% or 70% grant for each sub-project implemented.

There were four main financial contributing categories, as follows:

Applicants & Partners (NFA, LPRCA, NLSC, OFAH)	\$2,730,000
Other Private Sources (associations and businesses)	\$85,000
Other government programs (ministries and townships)	\$46,000
HFOA	\$2,760,000

The total value of the project was \$5,599,220. The eligible expenses, those expenses that qualified for partial reimbursement by HFOA, were \$4,840,490. Ineligible expenses included coordinator wages, transportation and supply expenses, administrative and project engineering expenses, and other activities indirectly related to a sub-project application. Within the Partners/Applicants funding category, the landowners contributed \$2,025,000 to the cost of the project. HFOA provided \$2,760,000.

This project is complete and thus farmers no longer receive funding assistance. Any costs associated with infrastructure maintenance are the responsibility of the farmer. However, the continued facilitation and cooperation of water users and conservation of water supplies will be the responsibility of the Big Creek Irrigation Advisory Committee (IAC), a peer review and assistance committee responsible for the resolution of water conflicts within the area. Funding through 2005 for this continued facilitation is provided by funds that were allocated for such activities by the WSEP prior to its completion.

4.3.3 Lessons from Norfolk WSEP

The following aspects of the Norfolk WSEP may be applicable to the irrigation programs in the Niagara Region:

- A regional financial incentive and education program can effectively protect sensitive water resources and improve the effectiveness and efficiency of on farm irrigation systems. Whether such a program is launched in isolation or together with a regional water supply project, it is an effective model that should be considered.
- The success of the project may be attributed to its grassroots nature. The farmers themselves identified the problem and they took the lead in the implementation of the solution.

4.4 PROPOSED LEAMINGTON AREA DRIP IRRIGATION PROJECT¹⁸

4.4.1 Description of the Proposed Irrigation System

Leamington is rightly named the "Greenhouse Capital of Canada". Main greenhouse produce crops include tomatoes, peppers, and cucumbers, with some growers harvesting crops such as lettuce, strawberries and raspberries. A successful floral industry, which grows potted plants ranging from chrysanthemums, poinsettias, lilies and roses to bedding plants and nursery products, also exists. Field crops such as processing tomatoes, squash, corn and potatoes are also abundant. Grain crops and fresh fruits such as apples, peaches, pears and plums are well represented in the area as well.

The Leamington Area Drip Irrigation Association (LADIA) retained Stantec Consulting Ltd. to assess the feasibility of providing a raw water supply system for 2,500 acres of existing and potential drip irrigated lands¹⁹. The objective of this study was to determine the costs and benefits of constructing a large-scale drip irrigation system in the Leamington Area, and to expand drip irrigation capabilities. The objective of the project would be to provide water to improve vegetable crop production, and decrease the demand on existing groundwater resources and treated water. Newer technology would allow more efficient use of water, reduce fertilizer run-off and sediment introduction into nearby watercourses while improving crop quality.

The study concluded that the best source alternative to supply the drip irrigation areas was to deliver raw water from Lake Erie to the 2,500 acres of targeted farmland in the eastern portion of Leamington. The required infrastructure to deliver the projected demand includes a pumping station, a system of trunk water mains and secondary supply mains, and a standpipe. Other than mechanical screening for removal of debris and chlorination to safeguard against zebra mussel infestation, the water supply would be untreated. Individual users would be responsible for filtering to meet drip irrigation requirements.

The preliminary design is based on a maximum drip irrigation daily rate of 2.7 mm/d. It is noted that this figure may be high, and it is strongly suggested that further study of the actual amount of water used in drip irrigation be carried out. The initial stage of the project was based on a maximum rate of 32,688 m³/day (5,997 USGPM or 318 acre-inches per day).

¹⁸ The information in this section is based on the "Final Report: Leamington Area Drip Irrigation Feasibility Study" (Stantec, 2004).

¹⁹ LADIA funded 15% of the cost of the feasibility study, while the Agricultural Adaptation Council of Agriculture and Agri-Food Canada provided financial assistance and sponsorship for the remaining 85%.

4.4.2 Proposed System Management

Three governance proposals were considered in the study as follows:

- **LADIA Management:** The Corporation manages and administers the project, charging farmers (shareholders) for capital and operating costs on a monthly or annual basis, while at the same time paying off principal and interest for loans received.
- **Public Sector Management:** LADIA participants petition the Council of Leamington to build the systems as a public works project. The cost of the works would be financed through normal municipal financing and recovered as a rate per acre levied on all participants on an annual basis through tax bills.
- **Private Sector Management:** Private sector financing and management could be solicited by request for proposals. This would increase the rate per acre to allow for a profit to the private sector organization but may be the timeliest means of implementation.

The preferred option, as indicated by LADIA members, is to proceed under LADIA management as an incorporated body, composed of shareholders. Each user owns shares in proportion to the acreages committed to the project.

The total estimated construction costs for an intake in Lake Erie, pumping station, trunk water mains, standpipe and secondary pipelines is \$13,787,000. For a 2,500-acre service area, the capital cost per acre is, therefore, estimated to be \$5,551. Operating costs were estimated to be \$160,000 per year. Considering a 10-year debt-retirement period, the total annual charges are calculated at \$2,206,630. For a 2,500-acre service area, the total estimated annual cost during the first ten years of the project is \$883 per acre. After the repayment of the capital cost, the annual cost per acre is likely to be reduced to \$64 (in 2004 dollars).

4.4.3 Lessons from the Leamington Feasibility Study

The following aspects of the proposed Leamington Area Drip Irrigation Project may be applicable to irrigation programs in the Niagara Region:

- The main financial factor in the feasibility of this project is the cost of the infrastructure. The operating costs seem to be minor compared to the obstacle of securing initial financing and a means of capital cost recovery. A number of alternatives in the Niagara Region, such as gravity-fed systems, seem to be favored due to their lower operating costs. This may be misleading.
- The preferred management alternative was a non-profit corporation owned by the project participants. Each participant having shares in the ownership of the infrastructure in proportion to their serviced area seems to be a logical model for Niagara. Such a system

would allow future expansion of the irrigated land by new landowners buying additional shares and hence providing the funding for system expansion.

- It is noted that the project is based on a drip irrigation demand of 2.7 mm/day, which is considered a conservative demand. This demand is substantially lower than the peak demands calculated for the Niagara Region. This difference emphasizes the need for further investigation of the demand.

4.5 AGASSIZ RESOURCE MANAGEMENT (ARM) LTD., WINKLER, MB

4.5.1 Project Description

Droughts in the 1980s disrupted the potato industry of Manitoba and reduced the supply of potatoes from the south central Manitoba to the province's french fry processors. To prevent similar disruptions in the future, the individual producers experimented with storing spring run-off and using it for supplemental irrigation during the growing season. The Agassiz Irrigation Association Inc. (AIA) and its operating corporation, Agassiz Resource Management Ltd. (ARM) grew out of those initial initiatives to allow a group of farmers to take full advantage of off-stream storage potential. Today ARM operates a series of reservoirs used for retaining snowmelt runoff and providing water in the summer months for irrigation. A pressurized pipeline system distributes this water to the ARM serviced fields.

ARM Ltd. services an irrigated area of approximately 12,000 to 15,000 acres. Figure 4-3 shows an irrigated area south of Winkler, MB, which includes a portion of the ARM infrastructure and serviced lands.

Potatoes are the only crop irrigated by ARM water. The irrigation system follows the crop rotation such that each field is irrigated approximately one year in every three years. Other crops that may be included in the rotation, but are not irrigated, are corn, wheat, canola, and edible beans.

ARM provides storage reservoirs and pipeline delivery systems to the farm-gate. Pumps, sprinklers, or any other means of distributing the water within the farms and applying it to the land are the responsibility of the individual producer.

The climate in Manitoba is highly variable. During some years there has been extensive use of the ARM water, while during other years, there has been no use of the ARM water.

The system is budgeted to supply 25% of crop requirements. A potato crop requires approximately 51 cm (20") of water for its full growth. ARM budgets rainfall to account for 75% of crop requirements. It is estimated that on average 6,170,000 m³ (5000 acre-feet) of water is supplied annually by the ARM system.

4.5.2 System Management

ARM has approximately fifteen shareholders. These shareholders are also the sole users of the water supplied by the system. ARM owns and operates shared storage reservoirs and pipeline delivery systems, acting as the system administrator. Some of the reservoirs are interconnected and share water. The farms are managed by the individual shareholders. There is a Board of Directors, consisting of one representative from each shareholder as well as an Executive Committee made up of the President, Vice President and Treasurer of ARM.

All expenses are in principle paid by the shareholders; however, ARM arranges for financing and seeks and receives alternate funding where available. For instance, ARM receives a 33% rebate on eligible expenses (off-farm infrastructure) from the Province of Manitoba, under Manitoba's Irrigation Development Program. Such contributions reduce the shareholders' burden.

Annual administration fees are charged to cover the costs of accounting and administrators. Some reservoirs are shared between users, and so these costs are divided proportionally between the specific users.

4.5.3 Lessons from ARM

The following aspects of Agassiz initiatives may be applicable to irrigation programs in the Niagara Region:

- The collection and storage of stream and other surface flows during spring to be used for irrigation during the summer months is applicable to the Niagara Region.
- The formation of a company owned by the growers for the purpose of managing a shared irrigation system is a valid management model for the Niagara irrigation infrastructure. In addition to allowing the growers to share certain costs, a larger corporation can tap more effectively into the funding programs available from time to time, as well as, having a stronger position in negotiating loans for the communal system.

4.6 SAN CARLOS AND HOHOKAM IRRIGATION & DRAINAGE DISTRICTS, COOLIDGE, ARIZONA²⁰

4.6.1 Project Description

The San Carlos Irrigation and Drainage District (SCIDD) and the Hohokam Irrigation and Drainage District (HIDD) are in close proximity to each other which allows for the possibility that they could co-divert and distribute waters from the Central Arizona Project (CAP) through a joint use irrigation distribution system. The SCIDD operated and maintained a canal and lateral system to service district lands, while the HIDD did not have its own system prior to the project. The HIDD was formed for the express purpose of supplying CAP water to replace a percentage of the groundwater used for agricultural purposes, as groundwater was the district's only water supply prior to the project. Both the SCIDD and HIDD have completed separate engineering studies regarding the receipt and distribution of their respective CAP annual agricultural water allocations. Stantec prepared a report on the physical plans and cost estimates for the two Districts, to jointly divert and distribute CAP water.

Figure 4-4 shows the layout of the two districts as well as other neighboring lands and infrastructure. Note that the two districts are “checker boarded” with each other. Many of the area farmers own or farm land in both districts.

The SCIDD consists of 50,000 acres of public and private land, of which approximately 94% (47,000 acres) are arable and approximately 92% (45,600 acres) have been irrigated. The SCIDD is the non-Indian half of the San Carlos Irrigation Project (SCIP) which totals 100,000 acres. The project was built with federal funding to be repaid by the farmers over a period of years based on their ability to pay. The water supply is derived from the Gila River then stored in the San Carlos Reservoir, and some supplemental groundwater is pumped from SCIP wells when the surface water supply is low. Historically, the SCIP combined supply of surface and wells has been less than half the supply needed to farm the total service area thereby reducing the district members ability to repay the federal loan funds used to construct the original project.

The HIDD is comprised of approximately 38,300 acres of private land, of which approximately 90% (34,560 acres) are or have been irrigated. Farmsteads, on-farm roads, irrigation ditches, and other similar infrastructure occupy the areas used for non-irrigation purposes.

In 1982, 60% of the total annual cropped acreage of the target lands was cotton. Cotton, small grains, sugar beets and alfalfa are representative crops common to both Districts.

In 1982, surface water was distributed in the SCIDD lands from the San Carlos Reservoir through an irrigation network of unlined canals and laterals. Private pumping, on privately owned land, satisfied distribution requirements in the HIDD.

²⁰ This Section is primarily based on information in the project report by Franzoy, Corey & Associates Consulting Engineers (1982).

This project proposed using selected canals and laterals operated by the SCIDD and lining them with concrete to increase the capacity and accommodate both the SCIDD SCIP water and CAP allocation and the HIDD CAP water allocation.

The project was divided into a phased program, which spanned 10 years, due to the requirement of maintaining the SCIDD's ability to use its existing system while the joint use works were being constructed. This would mostly be accomplished by renovating the existing SCIDD facilities during the winter when the system is dried up for maintenance and irrigation demands are low. Through a lined system, Phase 1 would provide CAP water to nearly 29,000 acres of SCIDD lands and all of the HIDD lands. To divert CAP water to the remaining 21,000 acres, SCIDD would install three links from the CAP turnouts to the district. Some of the SCIDD laterals would be lined under Phase 1. Any remaining SCIDD canals and laterals not lined during Phase 1 would be renovated and lined in two or more following phases.

SCIDD receives an annual allotment of water from the San Carlos Reservoir that was formed by Coolidge Dam. This surface water, along with pumped groundwater, accounts for the project's total annual water supply. Prior to 1982, the Reservoir's supply provided on average, only 50% of the demand estimated at the time of project authorization. Along with few groundwater supply wells, this resulted in SCIDD farmers receiving significantly less than their required amounts of water, and therefore reduced operations.

The HIDD lands have no surface water sources or rights. Groundwater pumping and private on-farm distribution systems delivered all their water requirements.

From 1988 to 2025, the Hohokam CAP allocation averages 40,446 acre-feet. Likewise, the San Carlos allocation averages 25,989 acre-feet.

The maximum year (1988) supply to both districts was nearly 127,000 acre-feet. The maximum monthly supply is approximately 14,000 acre-feet. Therefore, the combined peak design requirement is approximately 7.6 m³/s (270cfs). This results in approximately 3.0 m³/s (105cfs) and 4.6 m³/s (165cfs) for SCIDD and HIDD respectively.

4.6.2 System Management

Both districts operate under the control of Boards of Directors elected by the district constituency. The HIDD has a three person board and the SCIDD has a nine person board. The SCIDD also has a District Manager, office staff, operation and maintenance personnel and legal counsel. The HIDD has only its Board of Directors and legal counsel. Engineering, when needed, is provided by retaining a consulting engineering firm. A joint works system would require mutual cooperation of both districts to effectively operate and maintain such a system. The existing SCIDD operation and maintenance (O&M) staff would be expanded to accommodate both districts. Costs for constructing, operating and maintaining the joint use works would be based on a formula derived from shared system components and their O&M requirements.

Unlike some of the other area CAP irrigation districts, the HIDD does not control or operate any irrigation wells. These wells remain the property of the district members, and subject to the regulations of the Arizona Department of Water Resources (ADWR).

Primarily, the HIDD's agenda is to provide economically affordable irrigation water to member lands. They also provide CAP water from the Colorado River to irrigated farmlands within the District. HIDD began receiving CAP water for distribution in 1988.

The estimated total capital cost to complete Phase 1 of the Joint Use System is \$34,071,000 (1982 US dollars). This is compartmentalized into three categories:

- Joint use components: \$13,608,000
- HIDD use components: \$9,452,000
- SCIDD use components: \$11,011,000

SCIDD non-Phase 1 construction costs were estimated at \$8,280,000. Noted was an expected cost increase of approximately 8%/yr.

In 1982, total estimated joint system operating and maintenance costs equaled \$638,280.

Currently, members of HIDD are billed annually for irrigation taxes, and are billed directly for the water scheduled for delivery to them. The HIDD's annual irrigation tax rate is \$25/yr and CAP water is delivered at a rate of \$32/ac-ft.²¹

Construction Project Implementation

District wide voting was conducted in both districts regarding contracting with the US Government for CAP water and applying for federal funding to construct the infrastructure necessary to take and deliver CAP water. The SCIDD electorate decided not to contract for

²¹ Hohokam Irrigation and Drainage District (HIDD). <http://www.ed2.com/HHK/index.html>

CAP water or participate in a joint use or separate CAP delivery system. The main factor affecting their decision was the projected high cost of CAP water and the repayment of the federal funds advanced to construct the distribution system.

The HIDD voted to proceed with a separate stand alone system. The main factor affecting their vote was the projected increases in energy costs to operate their groundwater wells and the projected continuing decline in the groundwater depth and corresponding increase in energy to pump the water from ever-greater depths. The HIDD system was completed in 1986 and is currently operating.

4.6.3 Lessons from San Carlos and Hohokam Irrigation & Drainage Districts

The following aspects of the proposed San Carlos and Hohokam Irrigation & Drainage Districts may be applicable to irrigation programs in the Niagara Region:

- It is noted that a major component of the project was lining the previously unlined canals. Lining increases the capacity of the canals and reduces transmission water loss. The impact of lining on transmission losses would be less in the Niagara Region compared to Arizona due to lower evaporation and shallower groundwater table. Nevertheless, lining of the drains is an option to improve transmission efficiency as well as reducing environmental impacts of using the drains for irrigation.
- The work on upgrading the existing SCIDD facilities was carried out during winter months. Scheduling upgrading projects outside the irrigation season should be considered if it is decided to upgrade the NOTL facilities.

4.7 CONCLUSIONS

The review of three irrigation programs in Ontario and two elsewhere provided a range of irrigation environments and irrigation solutions that may be replicated in the Niagara Region. The following are general conclusions:

1. The slope of the lands below the Escarpment is a resource for the distribution system. The gentle slope northward facilitates the use of drains as the distribution system, to be supplied at points near the Escarpment. This slope is also a desirable feature for the pipeline distribution system if a supply source close to the Escarpment is selected.
2. The use of the drain system, while cost effective, may have environmental implications, and is likely to be opposed by environmental groups. The environmental and social acceptability aspects of the alternative distribution systems will have to be weighed against their costs in order to provide a preferred distribution alternative. Lined drains are being used in some areas to increase water distribution capacity and reduce system losses, i.e. improve water use efficiency.

3. The preferred alternative should incorporate a method of encouraging efficient utilization of water by the growers. This could include the introduction of more efficient farm-level water application technologies, improved scheduling practices and a form of measurement or control of water taking by individual farmers. It may also require training and regulations or bylaws to enforce good water management.
4. The involvement of the users in the identification of the need for water and development of solutions is crucial to the success of any irrigation project.
5. Several alternatives for the management of the proposed irrigation infrastructure have been encountered. The following is a partial list of the management alternatives:
 1. Management by the municipal authority: This requires a municipality willing to embark on the management of the irrigation system. It may work well in municipalities where farming is a principle activity; otherwise, there may not be sufficient political weight to allow the municipality to commit to managing the system in the long-term. Where the opportunity exists for the municipality to accept this commitment, there is likely to be some cost savings due to sharing some management and administrative costs.
 2. Management by a growers organization: This seems to be a common approach for the management of irrigation systems, especially for the larger systems. It will allow the users to have maximum control over the irrigation system. The real cost of the operation of the system will be larger than the financial cost, since considerable efforts by the shareholders will be put into voluntarily carrying out the tasks of the organization without being financially compensated.
 3. Management by a conventional (profit seeking) company: Under this alternative a private company develop the irrigation system and operate it. This will minimize the time and resource allocation by the farmers or the municipality. The operation may be very efficient, since the operator has strong incentive in achieving high efficiency. However, the cost to the users is likely to be higher than the other management alternatives, since the management company will expect compensation for their efforts (there is no incentive for voluntary work) and profit for their investment and risks. Also, the growers would have minimal control over the affairs of the irrigation system.
 4. Private management by individual users: Under this management option, there will be no organization managing the irrigation system. Each individual user will manage his or her own irrigation system. There may be cooperation between a number of users, but the scope of the cooperation is limited unless it is developed into a formal organization. This type of management is only appropriate for small systems.

The choice of the management system largely depends on the size and type of the irrigation infrastructure. These alternatives will be discussed further once the preferred irrigation infrastructure is identified.