Environment Canada Environnement Canada

Environmental Evaluation of Selected Dyking and Flood Control Structures

THE CANADA-ONTARIO SOUTHWESTERN ONTARIO DYKING AGREEMENT

WATER PLANNING AND MANAGEMENT BRANCH,
ONTARIO REGION,
INLAND WATERS DIRECTORATE,
FEBRUARY 1979.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

During the early 1970s the Great Lakes began their most recent rise-fall cycle, with levels peaking at record levels in 1973-74. These high levels of the Great Lakes, coupled with several severe storms, caused considerable flooding of very productive agricultural lands in municipalities bordering Lake Erie and Lake St. Clair. The existing flood protection was, in many instances, not well constructed and neither the dykes nor pumping schemes had been designed to provide adequate protection from flooding caused by severe storms occurring when lake levels were high.

The Canada-Ontario Agreement for a joint program of dyking and flood control works in southwestern Ontario was implemented to assist farmers in repairing and rebuilding dykes for the protection of their croplands from flooding. The program provides funds for dyke realignment, dyke refurbishing, new dyke construction and construction of associated flood control works. The proposed projects to be examined for environmental impacts in this report are those which could not be completed with the monies allotted under the original agreement, but for which additional funding was requested.

This analysis separates the study area into two distinct segments on the basis of geographical and environmental settings; one lies to the north of the Sydenham River and the other to the south as described in Sections 2 and 4 of this report. In the assessment of environmental impacts, the report groups the projects under review according to their location in one or the other of these segments (see Section 5). It furthermore divides them into two categories according to project type; those which involve raising, refurbishing or construction of dykes and those involving pumping schemes and flood control structures (see Section 3). The report also examines the effects of construction and maintenance measures for each project type. Where possible, impacts are assessed in quantitative terms, but scarce data have made such representation impossible in almost all instances.

The dyking projects in both segments of the study area (i.e., Projects P2-G, P3-B3, P4-B, P4-C) appear to pose no major environmental threat. However, we are not assured of the environmental acceptability of dyke construction, maintenance or emergency maintenance procedures, since sufficient details about these procedures are not available for the analysis. We therefore recommend approval of the projects be contingent upon the resolution of the

issues discussed in Sub-section 5.2 and upon the explication and environmental approval of construction and maintenance plans. Concerns relating to dyke construction and maintenance are discussed in Sub-section 5.5, and Appendix E presents examples of the information regarding construction, operation and maintenance that is required to carry out an analysis of the environmental impacts of these procedures.

We do have serious reservations about the environmental acceptability of the proposed pumping schemes and flood control structures. A preliminary assessment based on available information indicates that among the undesirable impacts anticipated are: change in water quality in relief drains (e.g., possible anaerobic conditions due to stagnation; temperature increases) and subsequent damages to aquatic habitats, in the drainage channels, in dyked marshes into which the channel water is pumped and in marshes near drain outlets. Detailed environmental baseline information is lacking with respect to the study area and the types of proposed pumping schemes and flood control structures as well as the management plans for the proposed pumps and backwater gates. Should additional environmental baseline data and a detailed pumping scheme and flood control structure management plan become available, then we would be able to provide a more precise and quantitative evaluation of the environmental impacts of these projects and to re-assess their environmental acceptability.

Finally, we urge all concerned authorities to take note of the type of wholesale environmental changes which have occurred in this area due to dyking and land drainage for agriculture. It must be recognized that while each individual dyking and drainage project did not necessarily induce large-scale ecosystem deterioration or changes, the cumulative effect of those projects, through the course of time, is exceedingly damaging to our total natural environment, causing extensive and, in numerous cases, irreversible environmental impairments.

We recommend that every caution be exercised to avoid similar occurrences in the future. Moreover, we feel that the implementation of water quality monitoring programs in the study area would generate useful environmental baseline data. They would permit ongoing surveillance of the environmental effects of the proposed projects, which should be aimed at defining the incremental stresses that are being placed on the affected ecosystems and understanding ecosystem response. Such monitoring programs would certainly provide more precise data on which future decisions could rely.

1. INTRODUCTION

During the early 1970s the Great Lakes began their most recent rise fall cycle, with levels peaking at record levels in 1973-74. These high levels of the Great Lakes, coupled with several severe storms, caused considerable flooding of very productive agricultural lands in municipalities bordering Lake Erie and Lake St. Clair. The existing flood protection was, in many instances, poor. Neither the dykes nor pumping schemes had been designed to provide adequate protection from flooding caused by high lake levels or by severe storms, particularly those occurring when lake levels were high.

The Canada-Ontario Agreement for a joint program of dyking and flood control works in Southwestern Ontario was implemented to assist farmers in repairing and rebuilding dykes for the protection of their croplands from flooding. The program provides funds for dyke realignment, dyke refurbishing, new dyke construction and construction of associated flood control works, principally the installation of new pump stations and closure of drain outlets. The proposed projects to be examined for environmental impacts in this report are those which could not be completed with the monies allotted under the original agreement, but for which additional funding was being requested.

It is the objective of this environmental assessment to scrutinize these projects for undesirable environmental consequences and to assess the potential magnitude of such impacts. However, because of the study area's century-long history of land reclamation and dyking schemes, it is important to examine the environmental changes related to this history of dyking and drainage as a foil against which the impacts of the proposed projects can be measured. Consequently, this assessment has a dual focus; it documents, as far as possible, the types and magnitudes of environmental impacts relating to past dyking and drainage schemes; and, then, it examines what incremental environmental effects or stresses might be incurred by the actions and structures involved in implementing the proposed projects.

In the latter context, this assessment specifically addresses additional stresses due to: 1) the raising, refurbishing, and realigning of dykes, 2) improved pumping schemes and flood control structures, and 3) construction and maintenance measures involved in 1 and 2.

Finally, the environmental evaluation addresses the data limitations and other difficulties encountered in completing an assessment of this nature, making the recommendations which, if implemented, would ameliorate such problems.

2. STUDY AREA DESCRIPTION

The study area is divided into two spatially discrete units which are separated by the Sydenham River and are different in their environmental composition. (Refer to Figure A-1, Appendix A.) The largest unit is situated along the easterly side of Lake St. Clair extending from the outlet of the Thames River northward to the outlet of the Sydenham. It is contained entirely within the Township of Dover which, to the south of the Sydenham, comprises approximately 68,000 acres (McGeorge and Barry, 1975). Hereafter, this unit will be referred to as East Lake St. Clair.

To the north of the Sydenham lies the second unit which is referred to as the Sutherland Box. This sub-area is surrounded by water, its boundaries being defined by the Sydenham River and Chenal Ecarte to the south and Running Creek to the north. The Sutherland Box floodplain is divided in half by Baseline Road which follows the township boundary between Dover Township and the Gore of Chatham. The portion of the study area lying in Chatham comprises only about 600 acres of land, which is primarily agricultural (Canada, DFE, Economic Review Committee, 1978).

The entire study area is composed of valuable agricultural land. Crop Insurance Commission data, supplied to the Economic Review Committee, indicate that approximately 80 per cent of the study area is in crops. Further information from this source demonstrates that corn and soy beans account, on the average, for 80 to 90 per cent of the crop acreages with corn representing about 60 per cent and soy beans about 20 per cent of these acreages. Other crops of importance are winter wheat, processing sweet corn, processing peas, and processing tomatoes.

3. DESCRIPTION OF PROPOSED PROJECTS

The environmental study team is charged with the evaluation of the potential environmental impacts resulting from further work proposed under the Canada-Ontario Southwestern Ontario Dyking Project. For environmental impact analysis, the projects for which additional funding has been requested are grouped into four areas of concern. These groupings, coupled with the project code names, are shown in Figure A-1 and can be described briefly as follows:

1) a section of dyke on the north shore of the Thames River (P2-G);
2) the Rankin Creek to Sydenham River section of the Dover Lakeshore Dyke (P3-B3);
3) flood control structures (e.g., drain closures) and pumping works at major drains along the east shore of Lake St. Clair (P3-C1, P3-C2); and
4) dykes forming the Sutherland Box (i.e., along the Sydenham River and Chenal Ecarte - P4-B; along Running Creek - P4-C).

The improvements and changes entailed in the above projects are described in the ensuing discussions.

3.1 Project P2-G - Thames River

This 1-mile segment of dyke lies along the north side of the Thames River. The MacLaren report (1974), indicates that there is no existing dyke at this location and that the land adjacent to the river lies below the 30,000 cfs flood level. However, discussions with the Project Engineer (December, 1977) and examination of topographic maps indicate that earthen embankments topped by roads run parallel to this stretch of the river. Improvements proposed in the MacLaren report (1974) consist of raising these roads along the embankments by 2 or 3 feet to provide the recommended 40,000 cfs flood level protection, and properly aligning dyke profiles. No excavation will be involved at this site.

3.2 Project P3-B3 - Rankin Creek to Sydenham River Section of the Dover Lakeshore Dyke

This dyking project forms part of the larger Dover Lakeshore dyking scheme which extends from the Thames to the Sydenham River along the

Lake St. Clair shoreline and the east bank of the Chenal Ecarte.

Proposed improvements related to the Rankin Creek to Sydenham River project consist primarily of raising, realigning, and refurbishing the existing dykes. The design level to which the dykes are raised is dependent upon the function of the particular segment as defined by McGeorge and Barry (1975), engineering consultants for the St. Clair Region Conservation Authority. For example, the dykes along Lake St. Clair from Rankin Creek north, are to function primarily as inland dykes protecting farmland against high lake water levels; alternatively, those along the river are outside a narrow marsh fringe and act as safeguards against high river levels. It is still not clear as to what the dyke alignment would be in the vicinity of Little Bear Creek outlet; it may be routed along the Chenal Ecarte shoreline rather than behind the shoreline marsh at the confluence of the drainage channels and the Chenal Ecarte, as presently indicated.

Refurbishing involves the addition of a protective stone face to those sections of dyke directly abutting the shoreline, installing filter mats along the whole section, and regressing dyke faces.

Figures A-2, A-3, and A-4 in Appendix A are longitudinal profiles indicating the existing ground surface profile, the profile of the proposed dyke, and precisely what modifications are proposed in each dyke segment. The construction phase is expected to be from early spring to late fall - some construction occasionally continues well into winter.

3.3 Projects P3-C1 and P3-C2 - Pumping Schemes and Flood Control Structures

These projects include the construction of pumping stations in Rivard (Sta. 349+000) and Hind Relief Drains (Sta. 667+000). In addition, they involve flood control structures in the form of concrete dams with automatic backwater gates to be installed at the above stations and at MacFarlane, Boyle, Maxwell Creek, and Little Bear Creek Drains. (See Figure A-5, Appendix A.) These proposed works are recommended by McGeorge and Barry (1975) to ameliorate flooding and flood related drainage problems which occur with the existing artificial drainage system in place.

At present, excess water from agricultural fields enters into high-capacity relief drains by gravity flow from subsurface drainage systems or, in low-lying areas, by pumping from low-capacity pumping schemes. The relief drains discharge directly into Lake St. Clair. Water levels in these relief drains are affected by Lake St. Clair water levels, among other factors. The occurrence of high lake levels in conjunction with wind set-up causes unusually high water levels to occur at the drain outlets. Subsequently, backwater elevations in the relief channels, which drain freely to the lake, are increased, thus having the potential to cause the channel dykes to be breached at low locations or washed out at weak sections. According to the consultant, periodically impaired subsurface drains are another observed consequence of high water conditions in relief channels.

Under the new system, flood control dams with automatic backwater gates would be constructed at the relief drain outlets to prevent high lake levels from entering the channels. (See Figure A-5.) In addition, the proposed pumping stations, when operating at capacity, (i.e., Sta. 349+000 at 500 cfs and Sta. 667+000 at 615 cfs) could maintain the ditch water level approximately 7 feet below normal lake level (EL. 574'). The proposed system will allow some fields to drain freely while others will require intermittent pumping.

There appears to be no clear-cut management scheme accompanying the proposal for the new pumping projects or the existing low-capacity backup systems. Examination of the McGeorge and Barry report (1975) and discussions with the Project Engineer and T. Muir of the Economic Review Committee have revealed only that pumping will occur when need is demonstrated.

3.4 Projects P4-B and P4-C - Sutherland Box

"Farmlands in the Sutherland Box are subject to flooding from:

a) The 1:100 year Sydenham River peak spring flows under existing conditions;

b) The 1:100 year Chenal Ecarte level with ice-jamming under existing conditions;

c) The 1:100 year Chenal Ecarte level without ice-jamming under existing conditions.

Farmlands, between Wallaceburg and Chenal Ecarte, flood under peak spring flow conditions by water overflowing the riverbanks in Wallaceburg and spilling over land and not by the river overflowing the banks adjacent to farmlands." (See M.M. Dillon, 1974, p.47.)

In this project area (see Figure A-1, Appendix A), an extensive private dyking system, which affords partial protection to adjacent farmland, already exists. According to the engineering consultant, lack of an integrated overall system based on uniform design criteria reduces the effectiveness of the present flood protection. The proposed Sutherland Box dyking scheme is an attempt to make the overall system more efficient. The scheme primarily involves the raising and refurbishing of existing dykes. Refurbishing includes stonefacing in some areas, recontouring dyke profiles, installing filter mats, and constructing new roads on top of the dykes (M.M. Dillon, 1974).

Detailed blueprints of construction plans provided by M.M. Dillon have supplied information on the profiles of existing and proposed dykes. Work in project P4-B, along the north shore of the Sydenham River and east bank of the Chenal Ecarte, consists of raising and refurbishing existing dykes, providing toe protection along the Sydenham segment, and minor realigning of the dyke along the Chenal Ecarte section. (See Figure A-6, Appendix A.) Along these segments of dyke, Dillon (1974 & 1977) recommended 582.0 feet G.S.C. as the design top of dyke. Along the south bank of Running Creek and along Concession Road 5-6 (i.e., Project P4-C) a design height of 581.0 feet is considered by the consultant to be adequate. Provision of toe protection along the south bank of Running Creek, where erosion is a serious problem, is the other major work entailed in Project P4-C.

4. EXISTING ENVIRONMENTAL CONDITIONS

It is the intention of this discussion to describe the study area's existing physical resource base, its features of biological and human significance, and the degree and type of development which has occurred within that natural environment.

East Lake St. Clair and the Sutherland Box comprise two spatially discrete units within the study area. As previously noted, these units differ in environmental composition. Consequently, they will be addressed separately in the following description of environmental conditions.

4.1 East Lake St. Clair

East Lake St. Clair is the area which will potentially be affected by the majority of the proposed projects: P2-G, P3-B3, P3-C1, and P3-C2. (Refer to Figure A-1, Appendix A.)

This, the larger of the two study area segments, is contained entirely within the Township of Dover. It is situated along the eastern side of Lake St. Clair extending from the outlet of the Thames River to the outlet of the Sydenham River. According to the engineering consultant, Dover Township, south of the Sydenham, comprises approximately 68,000 acres, which can be divided as follows: 7,500 acres of marshland adjacent to the lake shore and Chenal Ecarte, 18,500 acres of highlands in the easterly corner of the Township, and about 42,000 acres of low-lying land that is pumped for drainage (McGeorge and Barry, 1975).

The highest lands in the township are located near the western boundary of the City of Chatham. The surface slope of the land is generally about 1 foot per mile in a westerly direction toward the lake. Natural drainage in East Lake St. Clair flows toward the lake but is hampered by the flat topography and soil conditions. Consequently, the main natural streams (i.e., Little Bear, Rankin, Maxwell, Cheff's, and Paincourt Creeks) have been widened and deepened to improve their drainage.

Soils in this area consist primarily of poorly-drained loams underlain by blue grey clays. They tend to be very high in organic matter. The nature of the soils, coupled with climatic conditions of this area, has proven very favourable for cash crop farming.

Along the lake/land interface "a shallow marsh extends out from the shoreline for a distance of 2,000 to 5,000 feet. The depth of water of this shallow marsh area is 1 to 2 feet below water level except where traversing streams or dredged cuts extend to greater depth" (McGeorge and Barry, 1975, p.9). A drop-off generally delimits the western boundary of the marsh or shallow lake area. Examination of topographic maps and air photographs indicates that, during times of average or below average lake levels, intermittent barrier beaches extend in a north-south direction along the outer edges of much of the marshy shoreline. Marsh plant growth, shallow water depth, and these barrier formations function to protect the shoreline from erosive wave action.

The marshes in Dover Township, as do most wetlands, support a greater diversity of plant and animal life than other habitat segments in the study unit. Review of numerous scientific studies of these marshes has demonstrated that their biological productivity makes them exceedingly important as staging and nesting areas for migratory waterfowl, breeding areas for muskrat, and spawning and nursery areas for a variety of commercial and sport fish. Appendix B documents their significance in greater detail.

A large portion of the marshes in Dover Township is in the ownership of private hunting clubs (McGeorge and Barry, 1975). Much of the marshland is artificially dyked and virtually all marshes are managed for waterfowl hunting and muskrat production. A study of private and public marshes in the Lake St. Clair area indicates that, typically, over 50 per cent of the marshes are dyked and nearly 80 per cent experience some water level control (Bryant, 1965). Private marshes support hunting and fishing recreation, and the Canadian Wildlife Service (CWS) Marsh is important for scientific studies. Since the existing marshes represent but a small remnant of what was once totally submerged land and because of their importance to migratory waterfowl, the Ontario Ministry of Natural Resources recognizes this marsh region as a sensitive area - a natural habitat which should be protected and maintained (Ontario, MNR, 1975).

Natural streams and drainage channels are also inhabited by some coarser varieties of fish but are of subminimal importance as spawning areas, according to the manager of the Lake St. Clair Fisheries Assessment Unit.

While the natural physical and biological attributes of the study unit and the lake are significant, it must be recognized that they have already undergone massive changes in response to the area's agricultural development. McGeorge and Barry (1975) give an account, similar to the following, of that agricultural history.

Agricultural land drainage in this sector of the study area dates back to the mid-19th century when early settlers began to channelize streams to improve agricultural drainage. During this period, dykes were constructed by individual landholders for flood control in areas prone to spring floods. As settlement increased, individual dykes were joined to form continuous embankments along the shoreline of major drainage channels, rivers, and lakes. Such embankments are particularly in evidence in low-lying and marshy areas along the Great Lakes' shorelines (e.g., the eastern shoreline of Lake St. Clair). The original dykes were earthen structures generally not well constructed in terms of height and stability.

The advent of increased settlement was also accompanied by the installation of artificial drainage schemes and large-scale reclamation. Early drainage works (1880s) used the natural channels as outlets but later, additional channels were constructed to drain the lower-lying areas between the natural streams (e.g., The Hind Relief Drain, Toulouse Drain, Rivard Drain, and McFarlane Relief Drain). The drainage system that was formed comprised large gravity outlets conducting the flow from the higher lands through dyked marsh or low-lying areas. The lower-lying regions were dyked adjacent to the large tributary drains and pumped for drainage where necessary. The township administration now finds itself with some 70 pumping schemes, each embracing from 50- to 2,200-acre areas, the total pumped area comprising 42,000 acres.

Maintenance of this system, according to the Project Engineer (1977), has involved periodic dredging of the drainage and outflow channels. Maintenance of outflow channels consists of dredging using machines on pontoons. Dredge spoil is deposited in marsh beds or on the lake bottom at the sides of the channel or used as borrow material for dyke construction. According to the Project Engineer (1977), maintenance dredging of outflows has been necessary no more frequently than once in 25 years. Dyke maintenance appears to consist merely of emergency measures employed when breaches occur.

4.2 Sutherland Box

This area under consideration is bounded by the City of Wallaceburg on the east, the main Sydenham River on the south, the Chenal Ecarte on the west, and Running Creek to the north. (Refer to Figure A-1.) This unit could potentially be affected by the projects proposed for the banks of those waterways (i.e., P4-B and P4-C).

From Wallaceburg through to the Chenal Ecarte, the land has a very flat gradient of less than .5 foot per mile. Surface materials comprise fluvial overbank sands which lie over lacustrine clays. The thickness of the sand layer usually varies between 3 to 4 feet, thickening toward the west (M.M. Dillon, 1974).

The entire area is cultivated land. There does not appear to be any marshy lands or natural areas of major biological significance contained in this northern sector of the study area. It should be noted, however, that marshes which are extremely important for the staging and production of migratory waterfowl are situated nearby on the opposite bank of the Chenal Ecarte. These include the marshes on St. Anne and Walpole Islands. Some species of duck and whistling swans have been observed by local residents and researchers (Canada, DFE, 1973) in the Chenal Ecarte and, also, feeding on these farmlands north of the Sydenham.

These agricultural lands, like those in East Lake St. Clair, are intensively developed as a result of large-scale dyking and reclamation schemes. Extensive private dyking systems provide partial protection from flooding of the Sydenham River and Chenal Ecarte. A system of large ditches or canals behind the dykes supplies drainage from the farmlands into those same rivers.

5. ENVIRONMENTAL ASSESSMENT OF PROPOSED PROJECTS

5.1 Introduction

The environmental effects of dyking and land drainage on ecosystems are seldom considered and imperfectly understood. Traditional concerns have related to the engineering aspects and effectiveness of dykes and land drainage schemes and have demonstrated a total disregard for the environmental consequences of such projects. Yet, as early as the 1940s, "problems of flooding, low summer flows, falling well levels, and declining numbers of land and water game were identified as related to land and water mismanagement and to misuse of drainage legislation to drain marginal agricultural areas" (Kettel and Day, 1974, p.336). Even in the early 1970s, no mechanism was in place to ensure that drainage and flood control measures did not have unacceptable environmental consequences. As a result, few, if any, documented and factual accounts of environmental consequences of land drainage in southwestern Ontario appear to exist. Appendix C presents, in an historical context, an overview of the general local and regional impacts of dyking and land drainage schemes in Ontario. It also explores the problems that have been encountered in preparing environmental evaluations of such projects.

For the study of environmental impacts, the projects under review are discussed in the context of their geographical and environmental setting, either to the south or north of the Sydenham River, as described in the preceding sections of this analysis. They are furthermore divided into two categories according to project type: those which involve raising, refurbishing, or constructing of dykes; and those involving pumping schemes and flood control structures.

Finally, the effects of construction and maintenance measures are examined for each project type. Where possible, impacts are assessed in quantitative terms, but the scarcity of data has made such representation impossible in almost all instances.

5.2 Project P2-G - Thames River and Project P3-B3 - Rankin Creek to Sydenham River Section of the Dover Lakeshore Dyke

These projects are considered together because they are both situated in the East Lake St. Clair area and the proposed improvements entailed in these dyking projects are similar.

The changes involved in these two project areas are not large-scale new works but adjustments to make existing dykes more effective. The proposed raising, refurbishing, and realigning of these dyke sections, as described by McGeorge and Barry (1975), do not appear to raise major environmental concerns, but minor issues do require resolution. As noted in the Project P3-B3 description (Section 3.2), there is some question as to dyke alignment in the vicinity of Little Bear Creek Outlet (see Figure A-1); it may be routed along the Chenal Ecarte shoreline rather than behind the shoreline marsh at the confluence of the drainage channels and the Chenal Ecarte, as presently recommended in the McGeorge and Barry report (1975). (See Figure A-1 for recommended alignment.) Routing the dyke along the Chenal Ecarte would potentially eliminate access to that marsh or possibly eliminate the valuable wetland altogether. The routing of the dyke along the Chenal Ecarte would make draining of the marsh easier and more probable, and, in addition, problems of water supply and quality would occur in the marsh. Either a more expensive pumping system, to obtain water from the Chenal Ecarte, would be required or drain water would have to be used.

This marsh is privately owned and, as part of the Dover Township marshes, it comprises an important waterfowl and wildlife habitat. The marsh is currently utilized for boating and hunting. Its loss would entail the loss of not only an important habitat, but also of some recreational opportunity. Such a loss is unacceptable environmentally and, for that reason, we recommend that, should the Rankin Creek to Sydenham River project proceed, the dyke at Little Bear Creek Outlet be routed on the inland side of the marsh in question as McGeorge and Barry (1975) recommended.

The other concerns with the proposed dyking projects relate to construction and maintenance aspects. These concerns pertain similarly to all dykes in the study area and are discussed in the assessment of construction and maintenance practices found later in the report (i.e., Sub-section 5.5).

5.3 Projects P3-C1 and P3-C2 - Proposed Pumping Schemes and Flood Control Structures

The proposed construction of pumping stations and gravity gates would have two immediate effects: 1) the average annual relief drain water depth would be reduced; and, 2) the influence of lake level fluctuation or inflow on relief drains would be eliminated.

Lower water levels in relief drains would allow numerous low-lying agricultural fields to drain by gravity into the relief drains, whereas now the runoff is collected behind the dykes and lifted by low-capacity pumps. A portion of the eroded soil, nutrients, and contaminants (i.e., pesticides) previously settled out in these retention areas prior to pumping. Under the new scheme, surface runoff would enter the ditches directly, owing to the elimination of retention ponds. This would likely result in increased silt deposition in the drainage channels.

It has been shown (Bolton, Aylesworth, and Hore, 1970) that nutrients, especially phosphates, and possibly some pesticides, exhibit tendencies to adhere to soil particles or become adsorbed by soil. Subsequently, the increase in silt deposition would result in higher levels of nutrients being exposed to the relief drain waters.

Unfortunately, no data exist pertaining to the quantities and qualities of the flows being experienced at the existing drain outlets. Some general estimates have been made of these aspects by employing precipitation data from Wallaceburg and Chatham and by using the following assumptions:

1) Examination of the 1972 to 1975 flows in the Sydenham River indicates that approximately 20 per cent of the total flow occurs between May 1st and October 31st. It is assumed that this flow is equally distributed temporally during this period.
2) The normal total annual precipitation will be assumed to be 2.58 feet. (See Appendix D.)
3) It is assumed that 50 per cent of the contaminants are released during the May to October period. This figure was calculated by examining the distribution of contaminants in the adjoining Sydenham and Thames watersheds during 1973. (See Appendix D.)
4) Surface runoff has been calculated to be 53 per cent of the total precipitation by employing a hydrograph presented in the McGeorge and Barry report (1975).
5) The uptake of nutrients by the soil will be approximately 40 per cent (Bolton, Aylesworth, and Hore 1970). This figure is somewhat high for nitrogen but will be retained for the purpose

of these calculations. The concentration of contaminants in the groundwater will be 60 per cent of the surface runoff concentration.

6) The recommended fertilizer application rates and present crop type structure presented in Table 5.1 are utilized to calculate the nutrient applications.

Table 5.1

RECOMMENDED FERTILIZER APPLICATION

	Crop Type		Average Basin Application per Acre
	Corn	Soy Bean	
	60% of Acreage	17% of Acreage	
Nitrogen	10 lb*/acre/year	10 lb/acre/year	7.7 lb
Phosphorus	20 lb/acre/year	20 lb/acre/year	15.4 lb
Potash	40 lb/acre/year	40 lb/acre/year	30.8 lb

* Active Component

7) The calculated mean May to October concentrations and losses per acre are as presented in Table 5.2.

Table 5.2

Nutrients	Concentrations	Loss/Acre
Total Nitrogen	2.2 mg/l	2.56 lb/acre
Total Phosphorus	4.4 mg/l	5.17 lb/acre
Potassium	8.8 mg/l	10.34 lb/acre

The nitrogen concentration is somewhat lower than those measured in various field tests, while the phosphorus concentration is significantly higher (Dornbush, Anderson, and Harms, 1966). (See Appendix D.) Both of these concentrations exceed the contaminant concentrations for rivers which the Ontario Ministry of the Environment (MOE) considers unpolluted. Appendix D provides water quality data from the Sydenham and Thames Rivers to illustrate how annual concentration fluctuations occur. Total nitrogen levels have been observed to exceed 8 mg/l during spring runoff.

The calculation of pesticide concentrations is not possible because of the lack of current information regarding their transport. There are indications (Frank, 1978) though that the quantity which eventually reaches the waterways is minimal if proper application procedures are employed. Actual BOD_5 levels are impossible to quantify, even by comparison to adjacent watersheds, since drainage characteristics are not similar.

A major concern to be resolved is the control which would exist to maintain minimum water levels. Depressed water levels in relief drains will result in higher water temperatures produced by atmospheric conditions (Morse, 1972). Insufficient information exists to calculate the anticipated increases in temperature and their distribution in time. The occurrence of elevated water temperatures in conjunction with stagnant water conditions would enhance the growth of aquatic insects, but whether they would increase significantly in number over the current population is not clear.

During high lake levels, the gravity gates would be closed to prevent intrusion of water back into the drainage ditches. This action necessitates the employment of intermittent pumping to maintain low water levels in the relief drains. Under the proposed scheme, stations 349+000 and 667+000 would have pump capacities of 500 cfs and 615 cfs respectively, compared to present maximum mean annual flows of 210 cfs and 180 cfs, respectively. In addition, the Toulouse Relief Drain would be diverted. (See Figures A-7 and A-8 for alteration details.)

Based upon the pump capacities and estimated flows, it is assumed that the pumps would operate approximately 50 per cent of the time. Subsequently, between pump activation periods, the opportunity would exist for quiescent water conditions. Unfortunately, no information exists to predict the length of time of these still conditions, or the potential for developing stagnant water.

Lowered water levels and lack of lake water intrusion into the relief drains, which would decrease drain storage volume, would hamper the drains' ability to dilute contaminated runoff and equalize the quality of effluent being emitted at the pump station.

From a combination of the aforementioned alterations, two significant environmental impacts are expected to result:

1) The current chemical equilibrium of the waters of dyked marshes which receive 100 per cent of their level maintaining water from the relief drains (Mudroch & Capobianco, 1978) will be disturbed. This situation is now being corrected in the CWS National Wildlife Area by the ARDA project. A channel is being opened in order to bring lake water to a new pump site, thus avoiding the environmental impacts identified above.
2) The dynamic nature of the shallow water marshes will make certain that there is no significant buildup of contaminants at the drain outlets, thus ensuring degradation of water quality will be minimal.

Any approval to proceed with projects P3-C1 and P3-C2 should be made with caution, since the magnitude of water quality change necessary to disturb existing wildlife, fish, and other aquatic biota cannot be predicted without further site studies.

A more detailed evaluation of the environmental aspects of the project can be conducted by obtaining information such as the following: the percentage of time the pumps will be operating and prediction of time periods between pump activation; options available to maintain minimum water depths in drains; levels at which backwater gates become operational and type of control, manual or automatic; backup systems available in the event of mechanical failure; capacity of the system to handle the spring runoff; and specific information pertaining to water levels in all drains during minimum pump-induced levels.

5.4 Projects P4-B and P4-C - Sutherland Box

The improvements scheduled for this project area are remedial measures primarily involving the raising and refurbishing of the existing extensive dyking systems. As in the East Lake St. Clair dyking proposal, no large-scale new dyke construction is proposed in this area. No major environmental concerns are raised by the improvements and changes entailed in this proposed dyking project. While no marshes exist within the Sutherland Box, the cornfields in that area, as well as adjacent marshlands and rivers, serve as important feeding, staging, and/or breeding areas for migratory waterfowl. These can potentially be influenced by dyke construction and maintenance in the project area. Thus, the same cautions pointed out with repect to dyke construction and maintenance in the East Lake St. Clair Area shall apply in this situation. (See Sub-section 5.5.)

5.5 Impact of the Construction and Maintenance Schemes related to Proposed Dyking and Associated Flood Control Works

Significant environmental concerns related to any proposed projects are also incurred as a result of the construction practices employed in implementing the projects and the maintenance or management schemes associated with the operational lifetime of those projects. In the instance of the dyking and pumping schemes which are proposed in the study area, meagre information is available pertaining to construction details or the maintenance or management plans for those schemes. None of the reports which describe the proposed projects offer outlines detailing construction timing and methods, or maintenance and management contingency plans. Enquiries about these data needs were addressed to the Project Engineer (1977) who, in turn, consulted the members of the Local Steering Committee and the engineering consultants for the projects. Unfortunately, very little additional information became available as a result of these inquiries. We are restricted, consequently, to expressing the following concerns at this time, based on the limited knowledge we have obtained.

Examination of the consultants' reports and subsequent discussions with persons familiar with the past construction and maintenance techniques have revealed that certain deleterious practices (e.g., use of aquatic dredge spoil from drainage channels and outflows as borrow material for dyking, aquatic disposal of dredge spoil from maintenance dredging of outflow channels, emergency measures, such as utilitzing old cars to breach gaps in the dykes, and herbicide application on grassed dyke slopes) are prevalent. All have the potential for deteriorating nearshore water quality and releasing contaminants into the nearshore or marsh areas. In addition to being harmful to wildlife habitat, the deterioration of water quality may become detrimental to other uses of the water (e.g, swimming and domestic consumption). The magnitude of the environmental impacts associated with such practices are unknown because, apparently, no monitoring of water quality has been carried out in conjunction with these practices.

The CWS studies (Bryant, 1965; Canada, DFE, 1973) indicate that protection from disturbance is important to the species of fish and wildlife that utilize the wetlands as feeding and breeding grounds. Noise, due to construction or to increased water traffic or traffic volume on improved dyke top roads, should also be viewed as potential hazards to wildlife and fish, particularly during breeding and migratory seasons. Construction and maintenance works should be kept to a minimum during these periods. Construction of the proposed projects, apparently, would begin in early spring and be carried as late as possible into the following winter season. Thus, we are concerned that the construction period would conflict with the spring and fall seasons when protection from disturbance is most important.

Finally, it should be reiterated that information pertaining to construction detail for all of the proposed projects, to dyke maintenance plans and, in particular, to pumping scheme management procedures is currently inadequate to provide conclusive environmental assessment. Appendix E has been included as an example of the kind of data that are required to make such an assessment.

6. OTHER CONSIDERATIONS

6.1 Effects of Water Quality Degradation on Wetlands

The conversion of wetlands to agriculture and improvements in land drainage and associated agricultural practices have had considerable environmental impact in the study area. They have contributed to high nutrient concentrations in runoff from the land. "The undeveloped marsh contributes a comparatively small amount of P and nitrate (N) during the spring runoff relative to that lost from cultivated marsh. When undeveloped marsh is dyked and mechanically drained for cultivation, the weight of nutrients lost to the main channel is very much increased because the volume of water pumped off the marsh into the channel is so much more than occurs naturally." (Nicholls and MacCrimmon, 1974, p.31.)

In similar agricultural watersheds throughout southwestern Ontario, the ever-increasing use of new and varied fertilizers and pesticides has been reponsible for the increasing concentrations of nutrients and pollutants in agricultural runoff. Subsequently, there has been deterioration of water quality in the drainage ditches where runoff accumulates, (Bolton et al., 1970; Frank and Ripley, 1977; and Found, Hill, and Spence, 1976). Unfortunately, in the study area, no monitoring of the present or past situation appears to have been done, and there are little or no quantitative data available to describe past or present quality of the effluent or quantity of outflow at any particular point in space or time.

As noted above, nutrients, pesticides, and other pollutants from agricultural fields in the study area enter the environment principally through surface and subsurface runoff, which is collected in a network of drainage ditches. The drainage channels discharge their contents into the nearshore area of Lake St. Clair where open lake marshes occur. Water is also pumped from the nearshore area of the lake or directly from the drainage channel to maintain water levels for dyked marshes, as was the case with the CWS marsh.

At the present time, studies indicate that Lake St. Clair water quality and the water quality in selected marshes in Lake St. Clair has remained reasonably high. However, these studies also indicate that trace metals and pesticides tend to accumulate in sediment particles, in the marshes and mid-lake settling basin, and in the roots and the tissues of marsh plants (Mudroch and Capobianco, 1978; Frank and Holdrinet et. al., 1977 and Thomas, Jacquet and Mudroch, 1975).

It should be recognized that the addition of nutrients, pesticides and other pollutants, which have accrued during a century of agricultural development in the study area, are placing considerable stress on the inherent ability of the natural aquatic ecosystem to maintain equilibrium. For this reason, additional loadings or loadings of increased concentration have the potential for disturbing that equilibrium within the marsh or nearshore aquatic ecosystems. Such disturbances could, for example, bring about the elimination of important food sources for waterfowl in the study area and thousands of migrants could potentially be affected (Canada, DFE, 1973). In the same vein, the elimination of a particular food source or cover or the deterioration of water quality could seriously harm fish production in the marshland shoal areas of East Lake St. Clair.

When pesticides and trace metals accumulate in the aqueous environment in either plants or sediments, biomagnification within the food chain and cumulative uptake with growth becomes a problem. Documentation of this phenomenon is available for mercury in the Ontario environment (Pascoe and Stewart, 1977), but scientis have little similar information for pesticides in palustrine environments. Furthermore, disturbance of the sediments, such as dredging for construction or maintenance purposes, will cause the resuspension of such toxic elements making them available again to non-rooted aquatic flora, aquatic fauna, and to transport.

6.2 Historical Perspective

During the century following initial settlement, the thrust has been toward agricultural production and protection of agricultural land from flooding, with little concern about their environmental implications. For that reason, records of environmental disturbances due to land reclamation and dyking in southwestern Ontario are limited, and useful baseline data on the study area are meagre. However, some observations about obvious stresses and changes in the area's ecosystems can be made.

Dyking was the initiator for some environmental changes but the environmental consequences which accompanied the installation of artificial drainage schemes and large-scale reclamation of land for conversion to agriculture were much more serious and extensive. Perhaps the most notable of the undesirable environmental occurrences has been the elimination of thousands of acres of marshes, especially along the Lake St. Clair shoreline in Dover Twonship and the conversion of these lands to agriculture. In East Lake St. Clair (i.e., Dover Township south of the Sydenham River), approximately 22,500 acres of marshland have been eliminated; only 7,500 acres of a potential 30,000 acres remain (McGeorge and Barry, 1975). All of the marshes in the Sutherland Box have been eliminated, but acreages are not available. Such wholesale elimination of wetlands represents not only a reduction in the production, migration, or wetland habitat for numerous fish and wildlife species but a loss of opportunity for recreation (e.g., fishing, hunting, and viewing), scientific study, and economic activity (e.g., trapping and tourism).

The surviving marshes of the study area are extremely important as fish and wildlife habitats, particularly as staging and feeding areas for migratory waterfowl. (See Appendix B.) Studies and maps of private and public marshes in the Lake St. Clair area indicate that over 90 per cent of the study area marshes are privately owned and that both public and private marshes are managed for waterfowl and muskrat production. Furthermore, over 50 per cent of these wetlands are dyked and over 80 per cent experience some artificial water level control(Bryant, 1965).

Permanent wetlands are quickly disappearing throughout Ontario; all of the marshland on Lake St. Clair, of which the study area marshes comprise 20 per cent, is considered one of the most important remaining examples of the wetland environment in the Province (Ontario, MNR, 1975) and of continental importance for migratory birds (waterfowl). In the local context, the remaining wetlands in the study area are similarly significant because they represent only a small remainder of the original marsh acreage.

Environmental changes imposed by land reclamation and agriculture have been occurring in the study area for over a century. While each individual project has perhaps not had extensive environmental impact, the cumulative effects of a number of projects have induced wholesale local and regional environmental change.

Even now there are only limited scientific attempts to monitor and document the less obvious stresses on the area's ecosystems and how they might affect wildlife habitat and human health and activities. In this light, it is obvious that each proposal must be evaluated with great care to determine if the consequent stresses may upset the system's equilibrium thereby causing irreversible damage to natural and human environment.

Furthermore, the added security of improved flood protection has made this land desirable for intensive agricultural development. Further passage of time might make this land desirable for urban and residential uses. Whereas current legislation prohibits such a change in resource allocation, future pressure for urbanization may not.

BIBLIOGRAPHY

Aus, P.B. "What is Happening to Wetlands," Transactions of the Thirty-fourth North American Wildlife and Natural Resouces Conference, Washington, D.C, Wildlife Management Institute, 1969.

Bolton, E.F, J.W. Aylesworth, and F.R. Hore. "Nutrient Losses Through Tile Drains Under Three Cropping Systems and Two Fertility Levels on a Brookstone Clay Soil," Canadian Journal of Soil Science, October, 1970, pp 275-279.

Bryant, J. "Private Marshes in Southwestern Ontario," Department of Fisheries and the Environment, Canadian Wildlife Service, London, 1965.

Canada, Department of Fisheries and the Environment, Atmospheric Environment Service. Temperature and Precipitation 1941-1970, Ottawa, Queen's Printer, 1971.

Canada, Department of Fisheries and the Environment, Canadian Wildlife Service, Eastern Region. "Lake St. Clair - A Critical Area for Migratory Waterfowl," Ottawa, December, 1973.

Canada, Department of Fisheries and the Environment, Southwestern Ontario Dyking Economic Review Committee. "Cost and Benefits Associated With Selected Dyking and Flood Control Structures," Report for the Joint Federal Provincial Committee on Southwestern Ontario Dyking, February, 1978.

Canada, Department of Fisheries and the Environment, Water Survey of Canada. Historical Streamflow Summary - Ontario - to 1973, Ottawa, 1974.

Day, J.C., R.F. Brady, and M.M. Straite. Outlet Drainage - An Assessment of Environmental Effects.

Dillon, M.M. Ltd. Flood and Erosion Control in the Gore of Chatham and in the Town of Wallaceburg, Report for the St. Clair Region Conservation Authority, March, 1977.

Dillon, M.M. Ltd. Flood and Erosion Control in the Town of Wallaceburg in the Township of Dover, Report for the St. Clair Region Conservation Authority, March, 1977.

Dillon, M.M. Ltd. Flood and Erosion Control Study - Sydenham River and Chenal Ecarte, Report for the St. Clair Region Conservation Authority, Strathroy, July, 1974.

Dornbush, J.N., J.R. Anderson, and L.L. Harms. Quantification of Pollutants in Agricultural Runoff, Environmental Protection Technology Series No. EPA-66012-74-005, Report to the U.S. Environmental Protection Agency, November, 1966.

Found, W.E., A.R. Hill, and E.S. Spence. "Economic and Environmental Impacts of Agricultural Land Drainage in Ontario," Journal of Soil and Water Conservation, 31, January - February, 1976.

Found, W.E., A.R. Hill, and E.S. Spence. "Economic and Environmental Impacts of Agricultural Land Drainage in Ontario," Geographical Monograph No. 6, York University, Atkinson College, 1974.

Frank, Dr. D. Private Communication, Pesticide Control Laboratory, March 1, 1978.

Frank, R., and B.D. Ripley. Land Use Activities in Eleven Agricultural Watersheds in Southern Ontario, Canada 1975-76, Ontario Ministry of Agriculture, Guelph, 1977.

Frank, R., and M. Holdrinet, et al. "Organochlorine Insecticides and PCB's in Sediments of Lake St. Clair (1970 and 1974) and Lake Erie (1971)," The Science of the Total Environment, 8,3, 1977, pp 205-227.

Kettel, G.A., and J.C. Day. "Outlet Drainage in Ontario - A Methodological Exploration," Journal of Environmental Management, 2, 1974, pp 331-349.

Klausner, S.D., P.J. Zwerman, and D.F. Ellis. "Surface Runoff Losses of Soluble Nitrogen and Phosphorus Under Two Systems of Soil Management," Journal of Environmental Quality, 3, 1974, pp 42-46.

McGeorge and Barry Ltd. Preliminary Engineering Report - Flood Control Dyke and Structures on the Easterly Side of Lake St. Clair, Thames River to Sydenham River, Report to the Lower Thames Valley Conservation Authority and St. Clair Region Conservation Authority, Chatham, March, 1975.

MacLaren, J.F. Ltd. Report on the Evaluation of Design Criteria for Dyke and Erosion Control Works on the Thames River from Chatham to Lake St. Clair, Report for the Lower Thames Valley Conservation Authority, May, 1974.

Morse, W.L. "Stream Temperature Prediction Under Reduced Flow," Journal of the Hydraulics Division, ASCE, HY6, June, 1972, pp 1031-1047.

Mudroch, A., and J. Capobianco. "Study of Selected Metals in Marshes on Lake St. Clair, Ontario," Burlington, Canada Center for Inland Waters, 1978.

Nicholls, K.H., and H.R. MacCrimmon. "Nutrients in Sub-Surface and Runoff Waters of the Holland Marsh, Ontario," Journal of Environmental Quality, 3, 1974, pp 31-35.

Ontario, Ministry of Environment. Water Quality Data for Ontario Lakes and Streams, Volume 9, 1974.

Ontario, Ministry of Natural Resources. Lake St. Clair Environmental Atlas, 1972.

Ontario, Ministry of Natural Resources. "Marsh Evaluation and Acquisition for the Chatham District", June, 1975.

Ontario, Ministry of Natural Resources. "Sensitive and Special Regions, Chatham District," Chatham, 1977 (field notes).

Pascoe, D.H., and C.D. Stewart. "Mercury in the Ontario Environment," Environmental Protection Service, Ontario Region, December, 1977, (Draft).

Project Engineer, Private Communication, December 7, 1977, D. Small, Ontario Ministry of Natural Resources.

Soil Science, Society of America, Inc. Pesticides and Their Effects on Soils and Water, ASA Special Publication No. 8, November, 1966.

Thomas, R.L., J.M. Jacquet, and A. Mudroch. "Sedimentation Processes and Associated Changes in Surface Sediment Trace Metal Concentrations in Lake St. Clair, 1970-1974," International Conference on Heavy Metals in the Environment, Toronto, 1975.

Willrich, T.L., Ed., and G.E. Smith. Agricultural Practices and Water Quality, Iowa, Iowa State University Press, 1970.

APPENDIX A

FIGURES

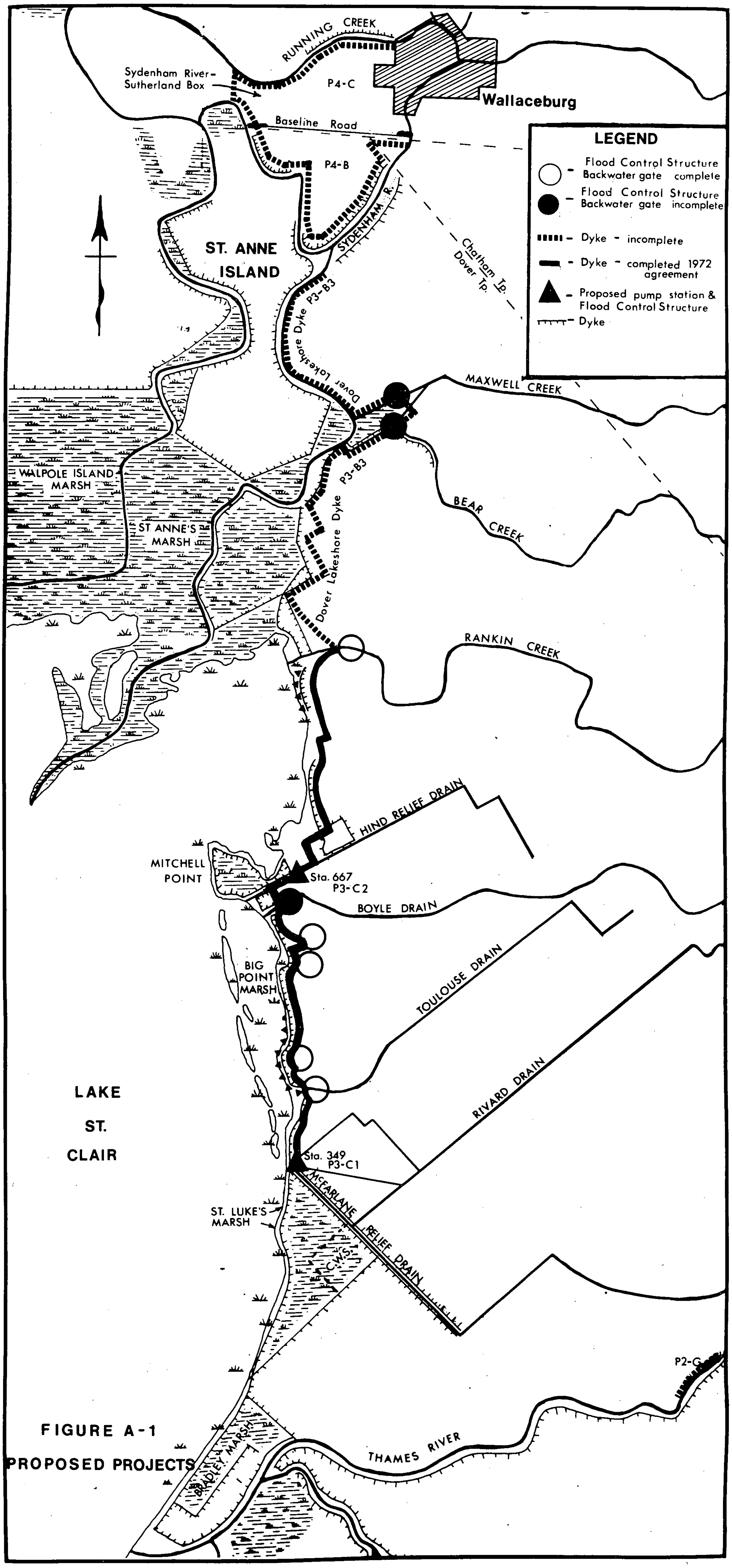
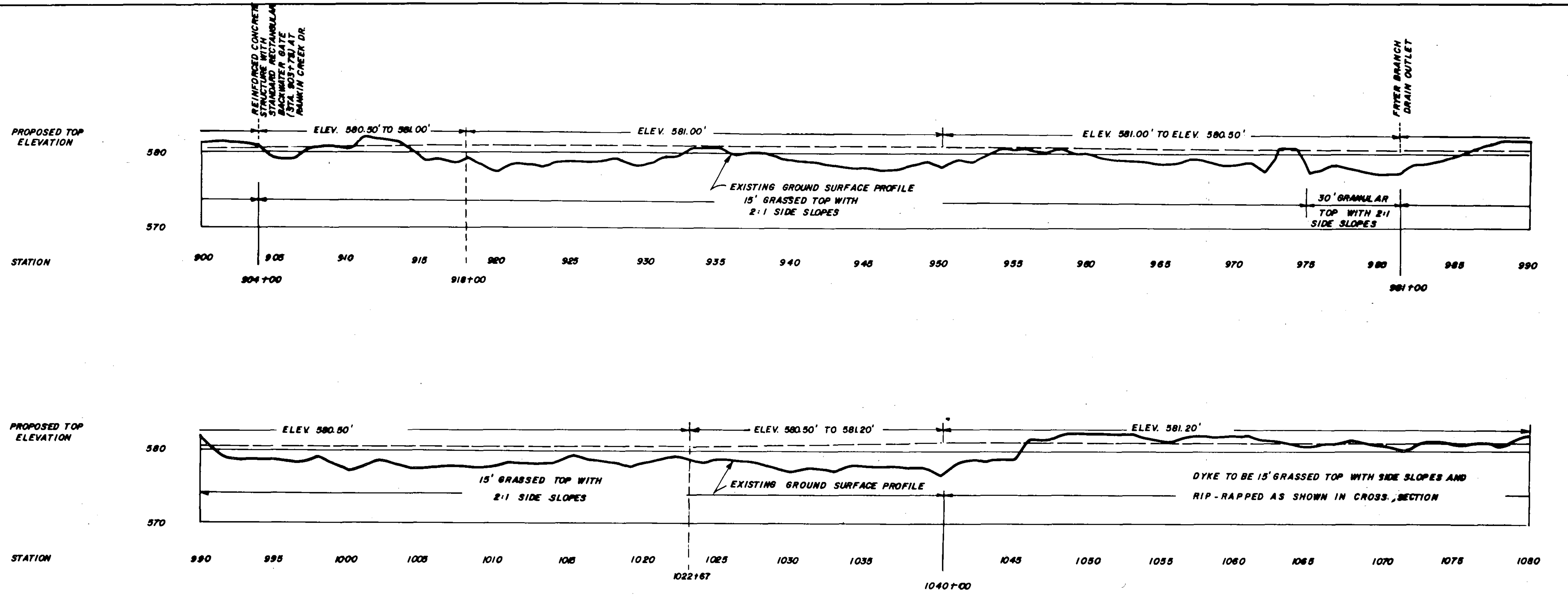
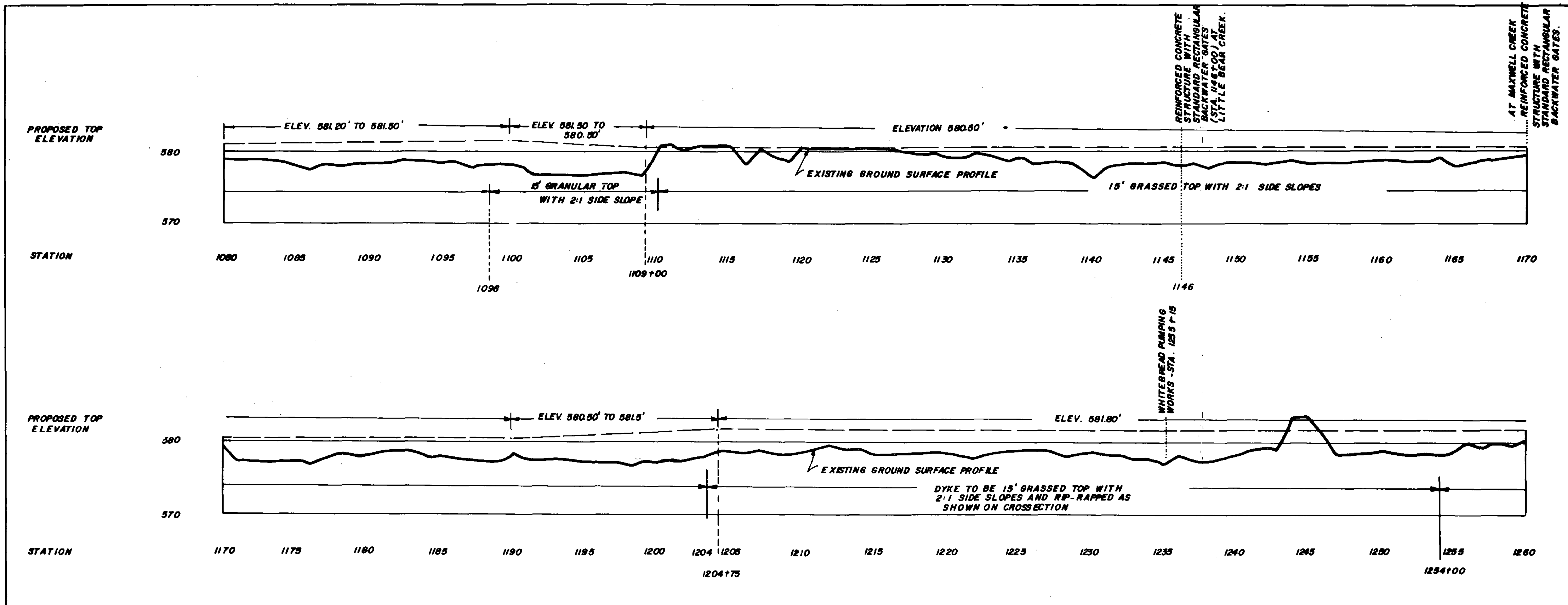


FIGURE A-1
PROPOSED PROJECTS



PROFILE OF PART OF PROPOSED DYKE (STA. 900 TO 1080)

LOWER THAMES VALLEY & ST. CLAIR REGION	CONSERVATION AUTHORITIES
A.R.D.A. PROJECT – TOWNSHIP OF DOVER	FIGURE A-2
McGEORGE AND BARRY LTD.	



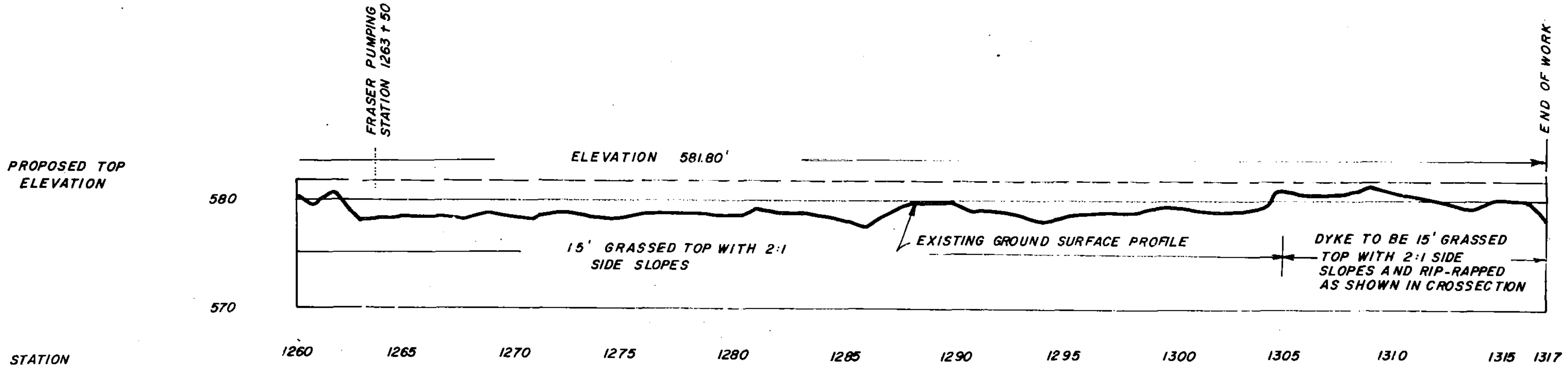
PROFILE OF PART OF PROPOSED DYKE (STA. 1080 TO 1260)

LOWER THAMES VALLEY & ST. CLAIR REGION CONSERVATION AUTHORITIES

A.R.D.A. PROJECT– TOWNSHIP OF DOVER

McGEORGE AND BARRY LTD.

FIGURE A-3



PROFILE OF PART OF PROPOSED DYKE (STA. 1260 TO 1317)

LOWER THAMES VALLEY & ST. CLAIR REGION	CONSERVATION AUTHORITIES
A.R.D.A. PROJECT – TOWNSHIP OF DOVER	FIGURE A-4
McGEORGE AND BARRY LTD.	

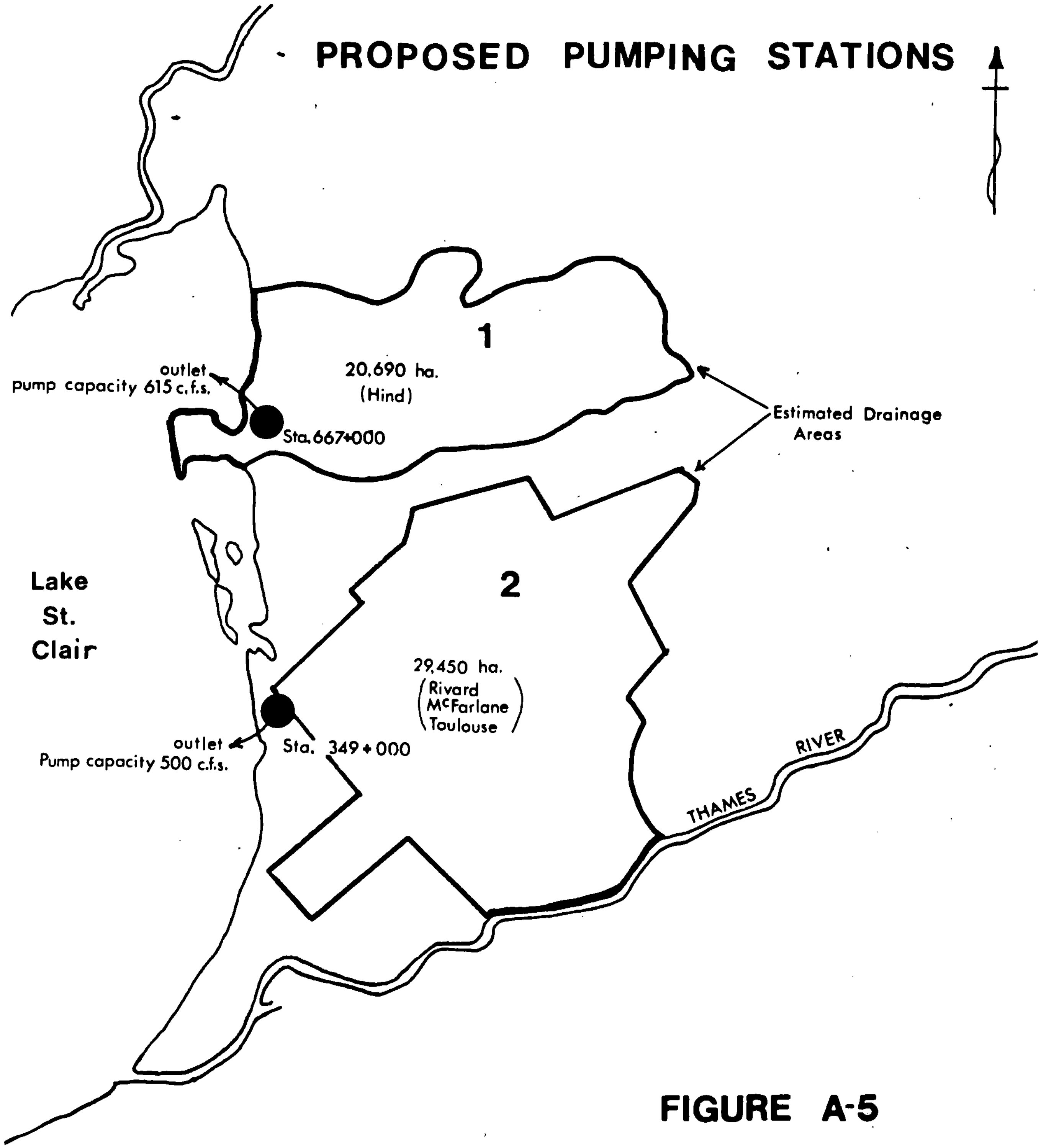


FIGURE A-5

NOTE: Area 1 presently has 13 pumps
Area 2 presently has 58 pumps

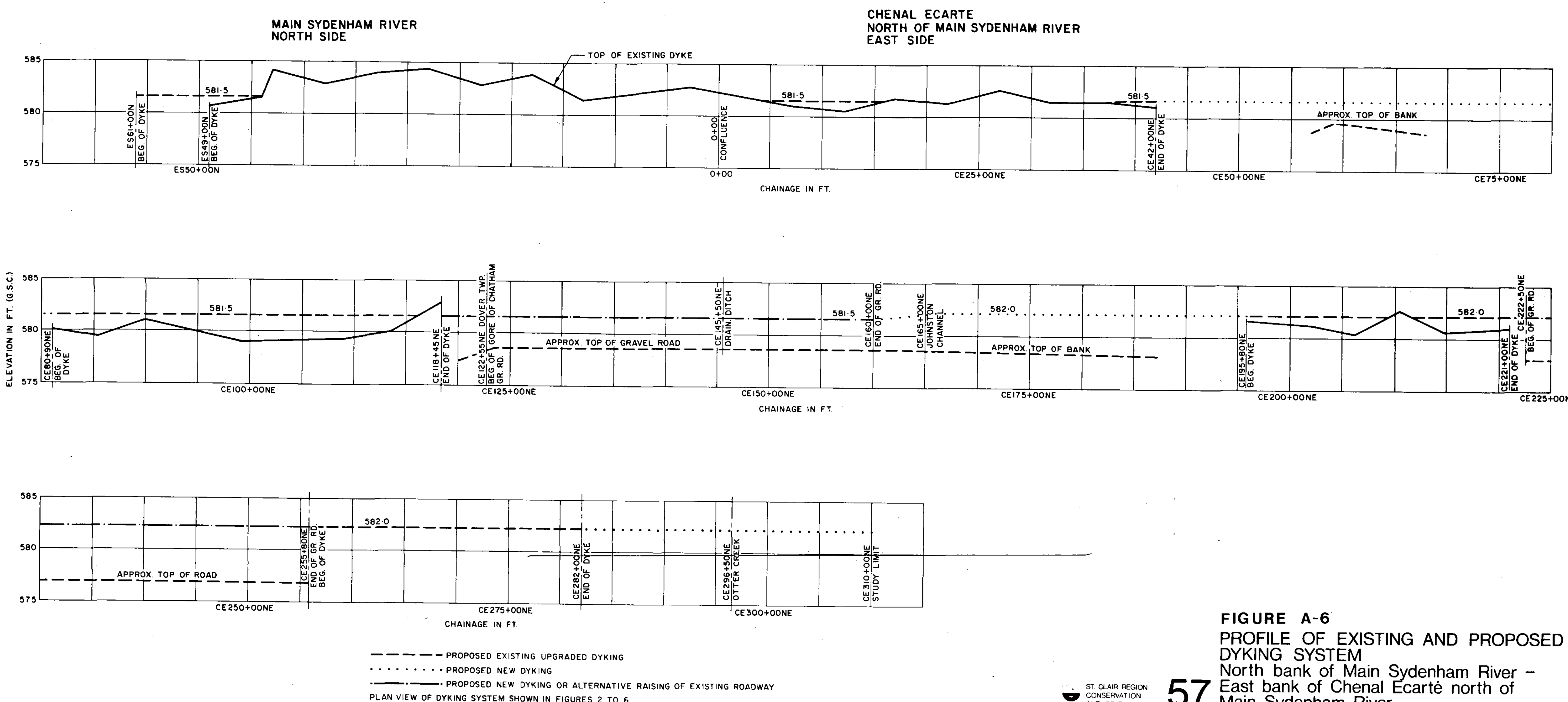


FIGURE A-6

PROFILE OF EXISTING AND PROPOSED DYKING SYSTEM
North bank of Main Sydenham River – East bank of Chenal Écarté north of Main Sydenham River.

ST. CLAIR REGION CONSERVATION AUTHORITY

57

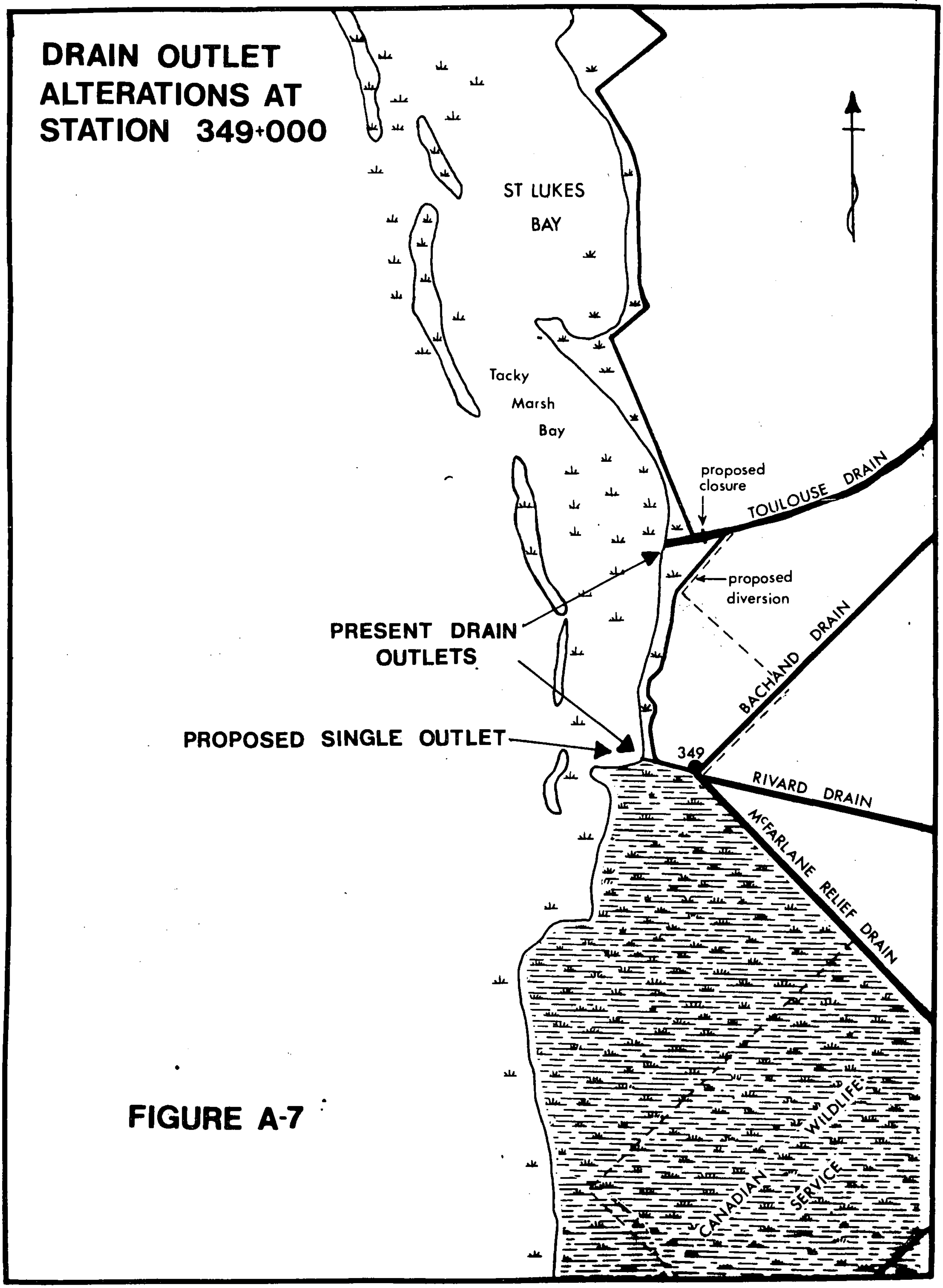

DRAIN OUTLET
ALTERATIONS AT
STATION 349+000
ST LUKES
BAY
Tacky
Marsh
Bay
proposed
closure
TOULOUSE DRAIN
proposed
diversion
PRESENT DRAIN
OUTLETS
BACHAND DRAIN
PROPOSED SINGLE OUTLET
349
RIVARD DRAIN
McFARLANE RELIEF DRAIN
CANADIAN WILDLIFE SERVICE

FIGURE A-7

MAJOR OUTFLOW CHANNELS AT STATION 667+000

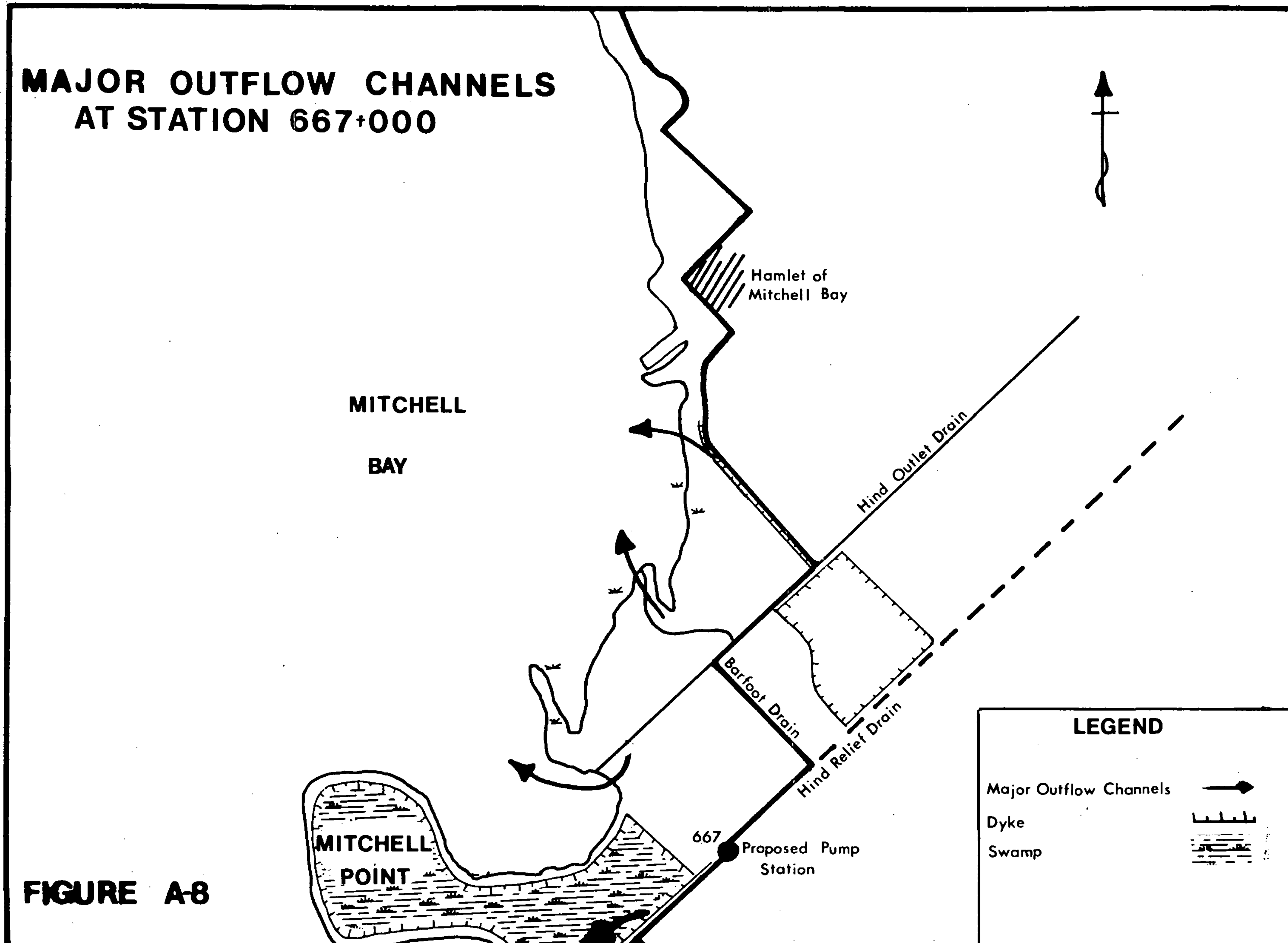


FIGURE A-8

APPENDIX B

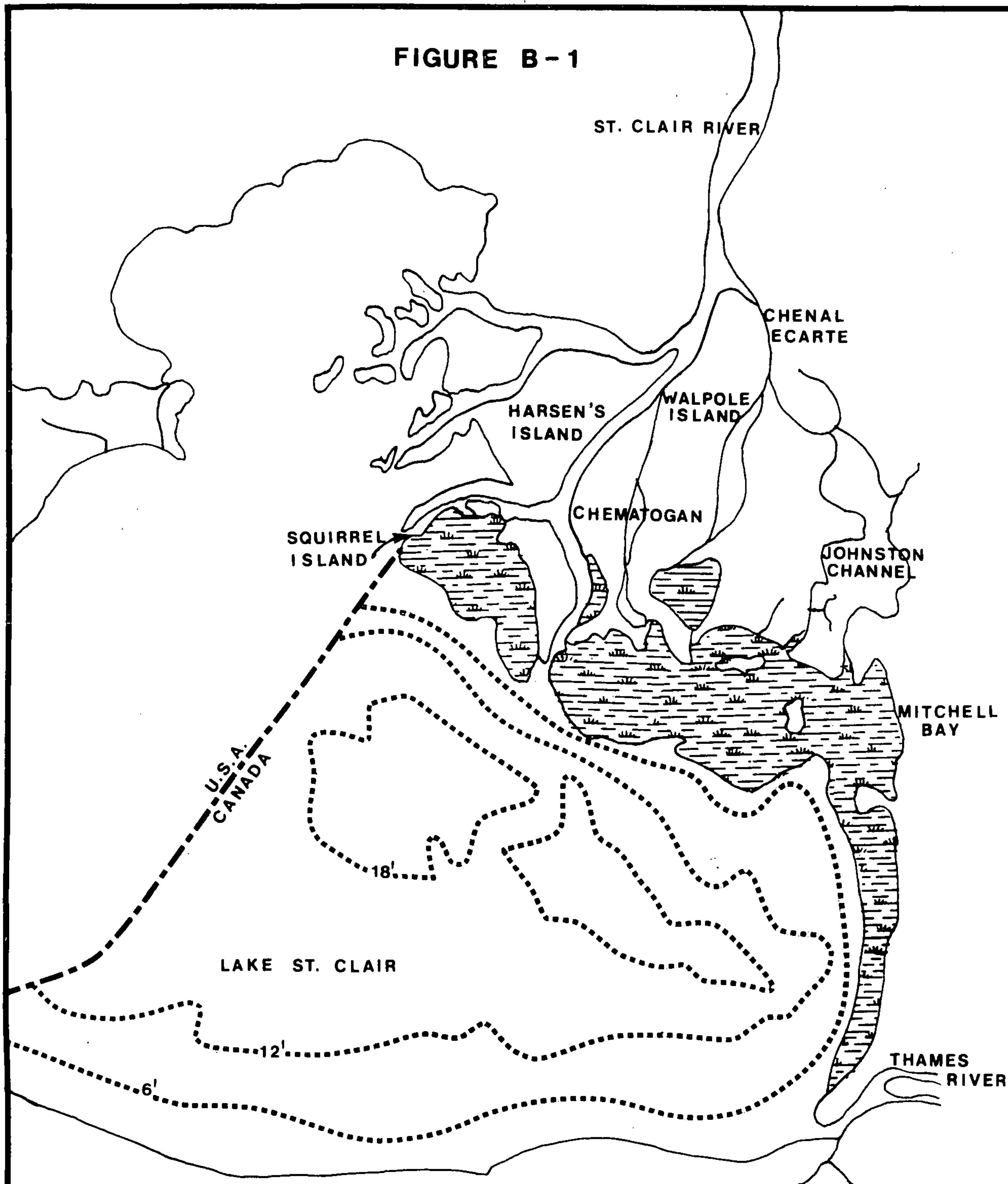
LAKE ST. CLAIR MARSHES

B. LAKE ST. CLAIR MARSHES

The Lake St. Clair marshes (see Figure B-1), of which the marshes in Dover Township comprise 7,500 acres, include extensive areas of marshes extending from Walpole Island in the north, along the eastern shoreline of Lake St. Clair, to Bradley Marsh in the southeast. These marshes comprise 34,000 acres and constitute 50 per cent of the total marsh acreage in the southern Great Lakes system. Their capability for the production of waterfowl ranges from high to moderately high, but more importantly, these marshes represent a critical staging area for migratory waterfowl (Canada, DFE, 1973). Being central to Atlantic and Mississippi flyways, they harbour a significant portion of North America's waterfowl during spring and fall migrations. The stopover period comprises 93 days in the spring (i.e., March 1 to June 1) and 139 days in the fall (i.e., August 16 to January 1) (Canada, DFE, 1973, p.3). The estimated number of birds using the marsh at any one time is over 100,000, a figure which, at peak migration, rises to over 1 million. Table B-1 and B-2, respectively, show waterfowl use of marsh areas and waterfowl days per acre.

CWS biologists believe that among the factors responsible for the use of this area by large numbers of waterfowl are not only geographical location, but also availability of the wide variety of quality duck foods in the bays where diving ducks can feed without disturbance, and the proximity to extensive acreages of corn which provide food for dabbling ducks and whistling swans. The biological productivity of this area can be critically impaired by any measure which may disrupt essential portions of the food chain, even though waterfowl may not be in the area at the time such events occur. The elimination of a particular plant or animal food from a critical feeding area could potentially affect thousands of migrants. There are 3 sectors of the Lake St. Clair marshland which the CWS views as being critical to the well-being of certain species of diving ducks including 2 threatened species (canvas back and redhead). In order of importance the CWS (Canada, DFE, 1973) lists these as Big Point Marsh, Ste. Anne's Bay, and Mitchell Bay. Their relative importance is related more to the protection from disturbance than to major biological differences.

FIGURE B-1



LAKE ST. CLAIR MARSHES

Source: OMNR. Lake St. Clair Environmental Atlas. 1972.

As Figure B-2 indicates, the Lake St. Clair shoreline and marshes are also productive as spawning and nursery areas for a variety of commercial and sport fish. Among the sport fish which have been documented by the Ontario Ministry of Natural Resources (1972) as using the shoals and marshes are yellow perch, yellow pickerel, and small mouth bass, maskinonge, northern pike and panfish. These species spawn in the spring and the young feed on water insects and plankton in the shallows and marshes.

Much of the marshland is artificially dyked and virtually all is managed for waterfowl hunting and muskrat production. Table B-3 demonstrates that over 50 per cent (19,000 acres) of the approximately 34,000 acres of Lake St. Clair marshlands are dyked while nearly 80 per cent (about 29,000 acres) experience some water-level control.

Over 20 private hunt clubs exist in the area. The private marshes provide an average of 5,000 hunter days for waterfowl resulting in an annual kill of over 20,000 birds. Public marshes support less hunting recreation but the annual kill is estimated at over 12,000 birds. (Ontario MNR, Chatham District, September, 1975). The marshes are also significant recreational areas for fishing, wildlife viewing and for scientific study. Since the Lake St. Clair marshland represents but a small remnant of what was once totally submerged land and, because of its importance to migratory waterfowl, the Ontario Ministry of Natural Resources recognizes it as a natural habitat which should be protected and maintained. To ensure this protection, this Ministry has designated these marshes as a sensitive area (Ontario MNR, 1977).

Table B-1

WATERFOWL USE OF MARSH AREAS

Marsh	Dabbling Duck Days	(%)	Diving Duck Days	(%)	Geese Days	(%)	Total	(%)
St. Anne	666,177	(16.4)	890.146	(54.3)	0	(.0)	1,556,323	(25.1)
Big Point	564,094	(13.9)	507,707	(31.0)	98,859	(19.6)	1,170,660	(18.9)
Bradley	890,156	(21.9)	1.243	(.1)	80,087	(15.9)	971,486	(15.6)
O. Smith	614,775	(15.1)	4,712	(0.3)	202,228	(40.1)	821,724	(13.2)
Canada Club	299,166	(7.4)	79,673	(4.9)	1,816	(0.4)	380,655	(6.1)
Dover	305,741	(7.5)	2,138	(.1)	56,983	(11.3)	364,862	(5.9)
Indian Band Marsh	168,777	(4.2)	94,662	(5.8)	42,915	(8.5)	306,354	(4.9)
Mud Creek	195,361	(4.8)	39,553	(2.4)	0	(.0)	234,914	(3.8)
St. Luke	67,377	(1.7)	130	(0.1)	18,900	(3.8)	86,407	(1.4)
Ford-Anderson	77,733	(1.9)	5,300	(0.3)	1,416	(0.3)	84,449	(1.4)
Swan Lake	65,227	(1.6)	8,086	(0.5)	0	(.0)	73,313	(1.2)
Shain	63,141	(1.6)	3,892	(0.2)	0	(.0)	67,033	(1.1)
South of Thames	39,655	(1.0)	800	(0.1)	210	(0.1)	40,665	(0.7)
Balmoral	15,180	(0.4)	344	(0.1)	300	(0.1)	15,824	(0.3)
Seaway Island	12,984	(0.3)	485	(0.1)	0	(.0)	13,469	(0.2)
Snake Island	13,095	(0.3)	104	(0.1)	0	(.0)	13,199	(0.2)
Bingo	6,112	(0.2)	240	(0.1)	88	(0.1)	6,440	(0.1)
Totals	4,064,751		1,639,215		503,802		6,207,768	

Source: Ontario. Ministry of Natural Resources. Lake St. Clair Environmental Atlas. 1972.

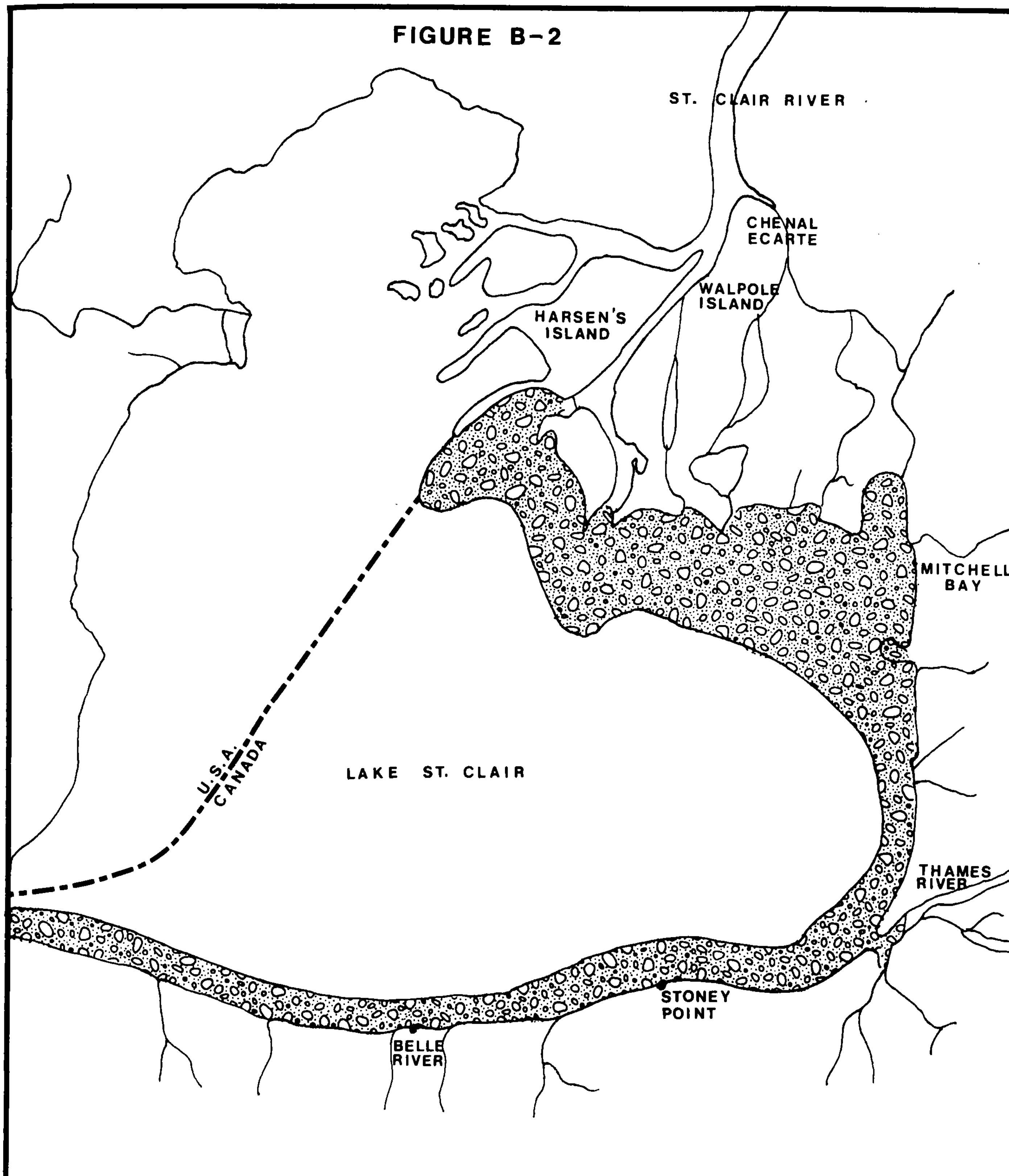
Table B-2

WATERFOWL DAYS/ACRE

Marsh	Acres Surveyed	% of Total Area	Dabbling Duck Days/Acre	Diving Duck Days/Acre	Geese Days/Acre	Total
Bradley	1,360	4.22	654.53	.91	58.89	714.33
Dover	600	1.86	509.57	3.56	94.97	608.10
Big Point	2,190	6.80	257.58	231.83	45.77	534.55
O. Smith	1,700	5.28	361.63	2.77	118.96	483.37
St. Anne	6,180	19.18	107.80	144.04	0	251.83
St. Luke	420	1.30	160.42	.31	45.00	205.73
Shain	500	1.55	126.28	7.78	0	134.07
Mud Creek	2,700	8.38	72.36	14.65	0	87.01
Canada Club	4,780	14.84	62.59	16.67	0.38	79.63
South of Thames	550	1.71	72.10	1.45	0.38	73.92
Ford-Anderson	1,250	3,88	62.19	4.24	1.13	67.56
Indian Band Marsh	5,430	16.85	31.08	17.43	7.90	56.42
Balmoral	300	.93	50.60	1.15	1.00	52.75
Snake Island	275	.85	47.62	.38	0	48.00
Bingo	175	.54	34.93	1.37	.50	36.80
Swan Lake	2,210	6.86	29.51	3.66	0	33.17
Seaway Island	1,600	4.97	8.12	0.30	0	8.42
Total Acres	32,220					

Source: Ontario. Ministry of Natural Resources
Lake St. Clair Environmental Atlas. 1972.

FIGURE B-2



LAKE ST. CLAIR
SPAWNING AREAS

Source: OMNR. Lake St. Clair Environmental Atlas. 1972.

Table B-3

ACREAGES OF PRIVATE AND PUBLIC MARSHES, LAKE ST. CLAIR[a] AND LAKE ERIE, 1964

	Private Marshes With Some Water-level Control			Private Marshes With No Water-level Control	Total Private Marshes	Public Marshes	Total
	Dyked	Other	Sub-total				
Lake St. Clair	19,060	10,356	29,416	3,111	32,527	1,000[b]	33,527

a. Includes marshes in Sombra Township, Lambton County - Dover and Tilbury East Townships, Kent County; and Tilbury North Township, Essex County.

b. Estimated.

Source: Bryant. "Private Marshes in Southwestern Ontario". C.W.S., 1965. p.10.

A P P E N D I X   C

OVERVIEW OF THE GENERAL IMPACT OF DYKING AND LAND DRAINAGE IN ONTARIO - HISTORICAL PERSPECTIVE

C. OVERVIEW OF THE GENERAL IMPACT OF DYKING AND LAND DRAINAGE IN ONTARIO HISTORICAL PERSPECTIVE

Dyking in Ontario has a strong historical affiliation with agricultural development in the Province. Its primary function is flood control and, in this capacity, dyking forms an integral part of numerous agricultural land drainage schemes.

Therefore, in an assessment of the environmental impacts of dyking and flood control projects on agricultural lands, it does not suffice to examine only the direct effects of the construction, operation and maintenance of dykes; the impacts of related improvements in agricultural land drainage schemes should also be studied. For example, increased confidence in the effectiveness of new and reconstructed dykes might result in increased land drainage, implementation of more comprehensive pumping schemes, conversion of more land, possibly marshes, to agriculture, and more intensive farming and settlement in the floodplain.

This overview presents the general impacts of dyking and land drainage at a local and regional scale. It also discusses the problems encountered in the preparation of an environmental assessment of such projects.

C.1 Historical Perspective

Agricultural land drainage in Ontario dates back to the mid-19th century when early settlers began to channelize Ontario streams to improve agricultural drainage. During this period, dykes were constructed by individual landholders for flood control in areas prone to spring floods. As settlement increased artificial drainage and reclamation schemes became necessary. Dykes comprised an essential part of these drainage systems, with the result that individual dykes were connected to form continuous embankments along the shoreline of major drainage channels, rivers and lakes. Such embankments are particularly in evidence in low-lying and marshy areas along the Great Lakes' shorelines (e.g., the eastern shoreline of Lake St. Clair, the southwestern shoreline of Lake Erie in Kent County-Harwick Township and Essex County- Mersea Township). These dykes were generally not well constructed in terms of height and stability.

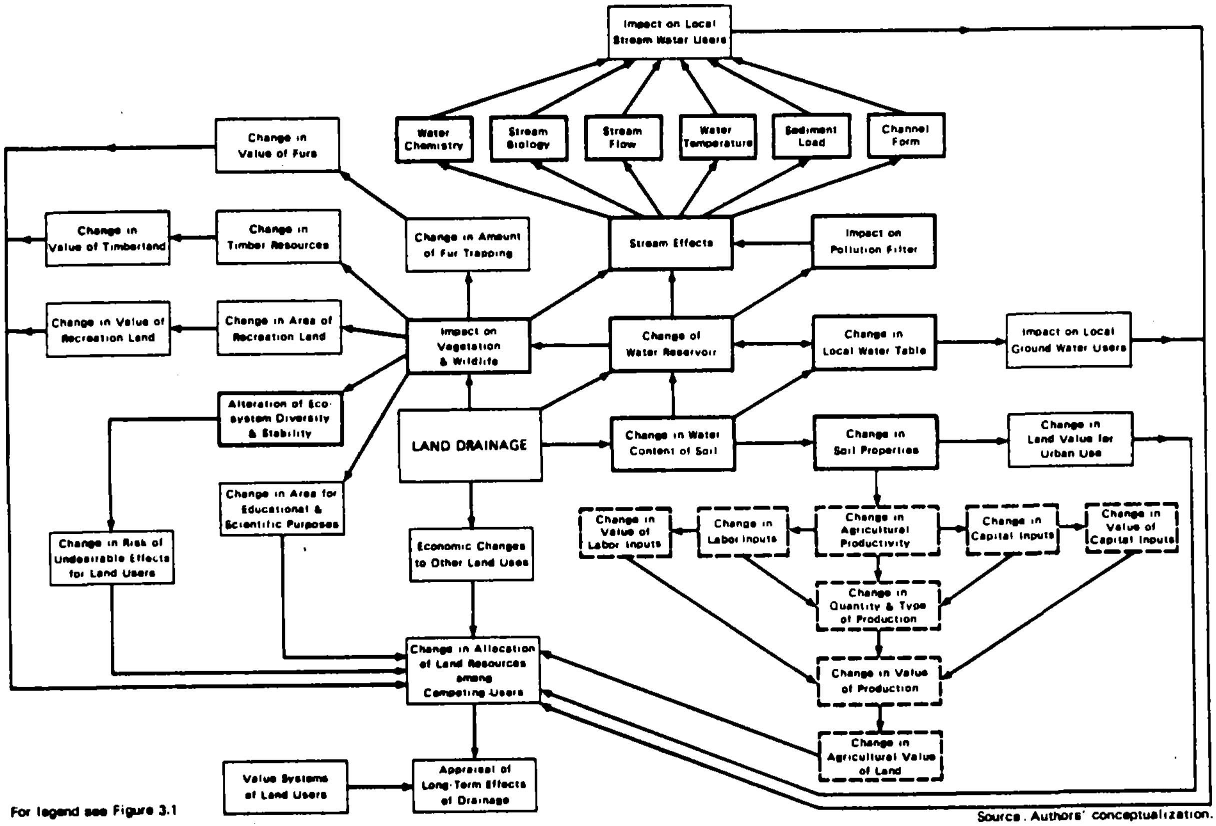
In recent years, it has become apparent with the rise in agricultural land values, that improved flood protection is required. Subsequently, numerous government assistance programs for agricultural land drainage and for the protection of agricultural lands from flooding, have been implemented. These included the Drainage Act, the Tile Drainage Act, A.R.D.A. Drainage Assistance, Special Agricultural Drainage Assistance, Capital Grants for Farm Development Program and the Canada-Ontario Agreement for Dyking and Flood Control Works in Southwestern Ontario. Through the programs, funds were made available for dyke construction, improvement and realignment as well as for the upgrading of agricultural drainage by means of the installation and improvement of tile systems, drainage channels and pumping works. Unfortunately, these same programs did not provide a mechanism to ensure that the drainage and flood control measures, which they assisted, did not have unacceptable environmental consequences. Moreover, while considerable data exist that indicate the direct agricultural benefits attributable to land drainage, comparatively little information is available concerning its effects on the hydrological, biological and social systems.

C.2 Overview of Environmental Impacts

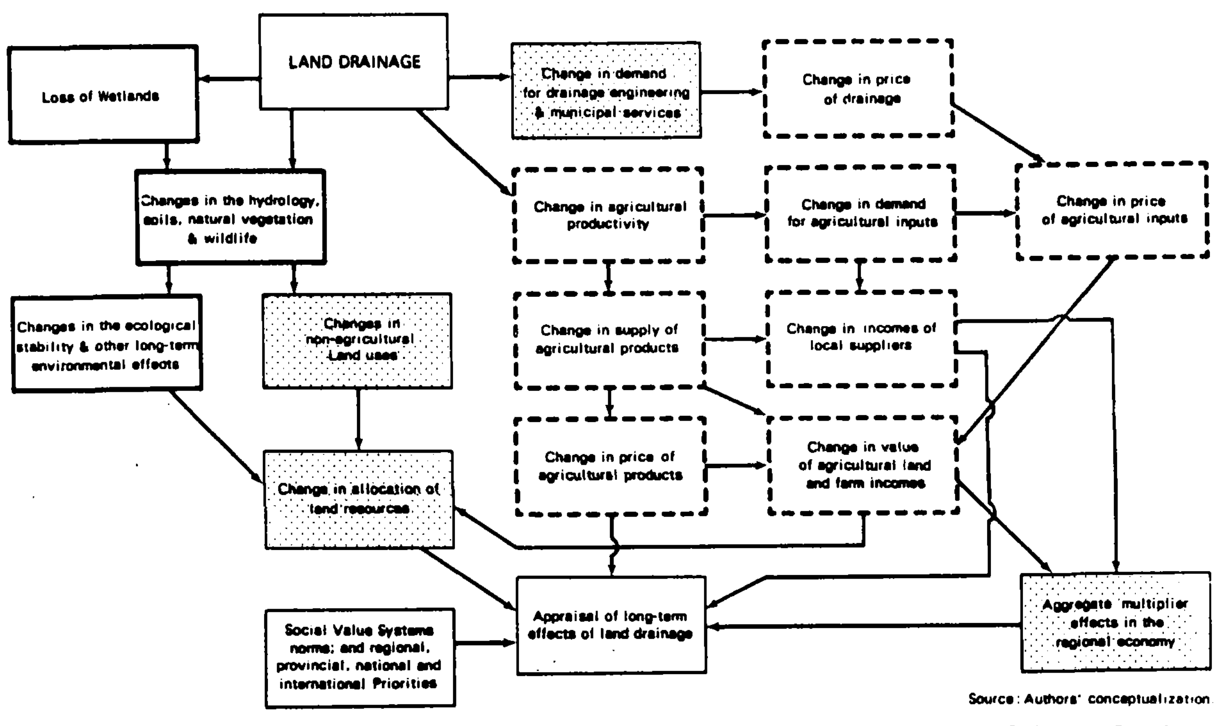
The environmental effects of land drainage on ecosystems are seldom considered and imperfectly understood. Traditional concerns have related to the engineering aspects and effectiveness of dykes and land drainage schemes, and have demonstrated a total disregard for the environmental consequences of such projects. Yet, as early as the 1940s, "problems of flooding, low summer flows, falling well levels and declining numbers of land and water game were identified as related to land and water mismanagement and to misuse of drainage legislation to drain marginal agricultural areas" (Kettel & Day, 1974, p.336).

The relevant literature cited in the preceding bibliography has pointed to a number of studies which examine the general environmental implications of land drainage. Generally, these give speculative accounts about or hypothesize what the expected environmental consequences might be at different geographical scales. Few factual and documented accounts of environmental impacts of land drainage appear to exist. In this literature, no mention has been made of the environmental effects of dyking, not even in the context of its role in agricultural drainage schemes.

Figure C-1



Model of Local Impacts of Land Drainage



Model of Large-Scale Impacts of Land Drainage

Source: Found, W.E., A.R. Hill, and E.S. Spence. "Economic & Environmental Impacts of Agricultural Land Drainage in Ontario." Geographical Monograph No. 6., York University, Atkinson College (1974).

No study was found during the literature search that specifically examined the impacts of dyking.

Most studies advocate that the environmental impacts of land drainage should be treated at two levels of significance:

1) those relating to the local impacts of individual projects; and
2) those of significance over a larger area (e.g., region or province).

C.2.1 Local-Scale Impacts

The complexity of the interrelationships among the physical and biological components of the environment makes local-scale impacts of agricultural land drainage difficult to predict. Figure C-1 presents a "Model of Local Impacts of Land Drainage". The direct, local-scale impacts are also summarized on Figure C-2 in a less complex format.

C.2.2 Large-Scale Effects

Large-scale effects of land drainage are also summarized in Figure C-1, and Figure C-2 presents a model of these impacts.

Regional impacts of land drainage manifest themselves in a number of ways. The two types of effects which tend to result in the most serious large-scale environmental impacts are also, unfortunately, the most difficult to treat scientifically:

1) cumulative effects of a number of individual projects; and
2) effects of projects on downstream residents or communities.

At the large-scale, the aggregate effects of local drainage impacts tend to produce a different set of relationships from those evident at the local-scale. Virtually no scientific endeavours have been made to measure cumulative effects. Literature sources point to the unreliability or total unavailability of relevant data as being the major reasons why scientific analysis has not been attempted.

Impacts of individual projects or of an aggregate of projects may lead to serious environmental consequences on downstream communities. The difficulty lies in proving a cause-and-effect relationship between drainage/dyking projects and downstream damage. In this realm of concern, there is also a paucity of documented evidence and studies. Moreover, mechanisms to compensate downstream communities do not exist.

FIGURE C-2

PHYSICAL | BIOLOGICAL | SOCIAL

Direct Local Impacts

1. Changes in water content of soil leads to changes in soil properties:

   a) availability of capillary water,
   b) soil temperature,
   c) soil aeration, and
   d) possible lowering of groundwater table.

More intensive agriculture.

Competition from other uses (e.g., urban).

Change in allocation of resources

Impact on local groundwater users (e.g., low well levels).

2. Loss of temporary water reservoir or drainage of wetlands lead to changes in:

   a) groundwater levels,
   b) water quality
      i) increased sedimentation, and
      ii) increased nutrient addition, and
   c) magnitude and timing of stream flow.
   d) vegetation and wildlife
      i) less diversity,
      ii) loss of aquatic species, and
      iii) improvement of trees.

3. Direct effects of construction, operation, and maintenance on biological components:

   a) destruction of habitat,
   b) clearing of vegetation,
   c) noise pollution due to construction, maintenance (pumping schemes), and increased traffic on roads or dykes may disturb wildlife and increase tendency for outmigration (temporary or long-term condition)
      i) aquatic life forms may be affected

Short-term increase in sediment load of adjacent waterways.

Change in water temperature along channels or shore where clearing occurs.

Deterioration of local wildlife habitat:
a) loss of shore marshlands vegetation,
b) loss of fish spawning/nursery areas, and
c) loss of waterfowl/wildlife habitat.

Less Diversity at Local Level and Possibly Less Stability.

Loss of recreation opportunities:
a) hunting,
b) fishing, and
c) viewing.

Loss of opportunity for scientific study.

Loss of economic opportunity:
a) trapping, and
b) timber.

4. Change in water quality due to materials used in project (e.g., artificial fill, dredge sediment, weedicide).

Cumulative and Downstream Effects

5. Changes in magnitude and timing of stream flow:

   a) increased spring flooding,
   b) decreased summer flows, and
   c) accelerated soil and bank erosion.

Major changes in resource allocation leading to major changes in composition of the landscape (non-agricultural).

More severe damages due to flooding.

Impact on downstream groundwater uses (e.g., low well levels).

6. Poor water quality due to upstream changes of multiple projects:

   a) increased sedimentation,
   b) increased nutrient content.

7. Loss and deterioration of large areas of wetlands as a result of numerous drainage projects with potentially major impact.

Less Ecosystem Diversity and Stability at a Regional Level.

Major loss of opportunities:
a) recreational,
b) scientific, and
c) economic.

C.3 Conclusion

On the basis of available information and their own expertise, investigators of the environmental effects of land drainage conclude that the most important impacts of agricultural land drainage relate to cumulative effects of several projects and the drainage of wetlands. Large-scale, aggregate effects may ultimately be responsible for changes in the stability of ecosystems and in other major environmental characteristics. The importance of wetlands, as part of the total sustaining environment, is such that the use of a wetland for agriculture will effect substantial changes over a considerable surrounding area, particularly with respect to wildlife (Found, Hill & Spence, 1974). Elimination of wetlands by drainage tends to affect both ecosystem diversity and stability in rural areas.

Finally, most literature souces agree that the following difficulties are most commonly encountered in the endeavours to prepare an environmental assessment of land drainage in Ontario:

1) The unreliability or total lack of relevant baseline data. (Monitoring of the environmental changes that might be attributed to land drainage does not occur.)
2) The lack of methodologies for dealing with the environmental impacts of such projects, in particular, with the downstream and cumulative effects. (A better understanding of the interrelationships between drainage effects and the local-and large-scale ecological elements is required.)
3) The mechanism to ensure that environmental consequences of such projects are studied is inadequate, as is the funding for these environmental assessments.

All studies stress the urgency for environmental monitoring programs for land drainage projects and recommend that environmental impact studies be carried out on all impending projects of this nature.

APPENDIX D

WATER QUALITY DATA FROM AGRICULTURAL BASINS

D. WATER QUALITY DATA FROM AGRICULTURAL BASINS

Table D-1 summarizes water quality measurements conducted on the Sydenham River in the northern portion of the study area, and the Thames River to the south of the study area during 1974. Since the agricultural characteristics of these two areas reflect those of the study area, they will be taken as indicators of water quality conditions in the study area. These water quality data can be projected to indicate probable contaminant concentrations and temporal distribution of pollutants in the study area drainage ditches.

Table D-2 , which is adapted in a modified form from an article by Dornbush (1966), tabulates the nutrient concentrations measured in surface runoff from agricultural field tests in the United States. These figures are presented to illustrate that the estimated nutrient concentrations in runoff are similar to those actually observed.

Table D-3 summarizes the precipitation data for Wallaceburg and Chatham. Since the study area lies between those two locations the average of the precipitation at Wallaceburg and Chatham was calculated to represent the study area precipitation.

Table D-1

WATER QUALITY DATA

RIVER BASIN - SYDENHAM R.

LOCATION CODE - 04-0027-001-83

STREAM - SYDENHAM R.
LOCATION - AT HIGHWAY NO. 40, WALLACEBURG

MILEAGE - 2.8

DISTRICT 1

CURR. NUMB.	SAMPLING DATE DY MO YR	TIME 2400 HRS.	STR FLOW CON CFS	TOTAL COLIFORM / 100 ML	FECAL COLIF. /100 ML	FECAL STREP. /100ML	WAT. TEMP C.	DISS OXYG MG/L	BOD-5 MG/L	TOT. P AS P MG/L	SOL. P AS P MG/L	NH-3 AS N MG/L	TOTAL KJELD MG/L	NO - 2 AS N MG/L	NO - 3 AS N MG/L	TURBDT	COND 25C. UMHO	CHLO RIDE
1014	22 01 74	0950	6	12700	1330	900	2.0	13.4	4.5	0.330	0.140	0.25	1.90	0.041	5.900	90.00	472	29
1060	12 02 74	1015	4	92000	100	10L	1.0	13.7	1.4	0.011	0.011	0.05	0.32	0.008	1.400	11.00	300	18
1111	19 03 74	1020	68	2800	100L	220	2.5	12.6	1.6	0.089	0.058	0.12	0.57	0.024	4.100	37.00	460	19
1155	17 04 74	0850	68	6900	220	110	11.0	10.4	2.0	0.096	0.034	0.08	0.69	0.025	4.500	32.00	488	16
1205	22 05 74	1240	63	250	4L	280	20.0	8.2	3.0	0.300	0.150	0.12	1.30	0.061	3.700	69.00	422	11
1249	18 06 74	1215	6	108000	2900	90	17.9	7.6	1.4	0.083	0.014	0.16	0.80	0.032	1.103	28.00	397	13
1289	18 07 74	1315	6	34000	790	80	23.0	9.0	3.5	0.090	0.003	0.01	0.10	0.018	0.290	20.00	306	13
1335	14 08 74	1320	6	8700	760	28	23.0	7.0	1.6	0.056	0.027	0.12	0.59	0.019	0.200	13.00	320	13
1381	25 09 74	1300	6	27000	800	276	15.0	9.0	1.4	0.046	0.014	0.13	0.53	0.006	0.160	16.00	218	9
1407	22 10 74	1430	6	4500	240	248	11.5	10.4	1.0	0.041	0.014	0.02	0.39	0.005	0.120	6.10	246	10
1446	13 11 74	1235	6	36000	1300	360	9.0	9.6	0.5L	0.036	0.012	0.03	0.58	0.007	0.113	8.20	276	10
1485	04 12 74	1440	6	3200	230	52	3.7	13.5	1.4	0.038	0.017	0.09	0.43	0.009	0.440	22.00	294	21

CURR. NUMB.	SAMPLING DATE DY MO YR	TIME 2400 HRS.	FLOW CFS	ACIDITY CACO3 MG/L	ALKALINITY CACO3 MG/L	HARDNESS CACO3 MG/L	TOTAL IRON AS FE MG/L	DISS. IRON AS FE	PH	COLOUR HAZ. UNIT	PHENOLS PPB	FLUORIDE MG/L	SILICA MG/L	TOTAL SOLIDS MG/L	SUSP. SOLIDS MG/L	SULPHATES AS SO4 MG/L	POTASSIUM MG/L	SODIUM MG/L	TOC MG/L	TC MG/L	COD MG/L
1014	22 01 74	0950												490	160						
1060	12 02 74	1015												170	5						
1111	19 03 74	1020												350	15						
1155	17 04 74	0850												360	10						
1205	22 05 74	1240												390	30						
1249	18 06 74	1215												310	20						
1289	18 07 74	1315												200	25						
1335	14 08 74	1320												230	15						
1381	25 09 74	1300												170	20						
1407	22 10 74	1430												190	15						
1446	13 11 74	1235												170	15						
1485	04 12 74	1440												190	20						

RIVER BASIN - THAMES RIVER

LOCATION CODE - 04-3013-007-82

STREAM - THAMES RIVER
LOCATION - PRAIRIE SIDING BRIDGE

MILEAGE - 9.0

DISTRICT 1

CURR. NUMB.	SAMPLING DATE DY MO YR	TIME 2400 HRS.	STR FLOW CON CFS	TOTAL COLIFORM / 100 ML	FECAL COLIF. /100 ML	FECAL STREP. /100ML	WAT. TEMP C.	DISS OXYG MG/L	BOD-5 MG/L	TOT. P AS P MG/L	SOL. P AS P MG/L	NH-3 AS N MG/L	TOTAL KJELD MG/L	NO - 2 AS N MG/L	NO - 3 AS N MG/L	TURBDT	COND 25C. UMHO	CHLO RIDE
1017	22 01 74	1135	64	11400	1500	440	1.5	13.0	4.5	0.270	0.094	0.31	1.30	0.070	6.800	44.00	625	38
1064	12 02 74	1310	4	44000	2200	230	0.8	13.2	3.0	0.140	0.058	0.21	0.84	0.087	5.900	2.30	640	29
1107	19 03 74	1255	68	206000	5000	1560	3.5	11.6	1.4	0.110	0.083	0.21	0.66	0.056	5.300	17.00	670	26
1159	17 04 74	1050	68	3500	250	10L	12.0	11.2	2.0	0.150	0.071	0.13	0.68	0.055	5.800	32.00	560	22
1209	22 05 74	1500	69	2000	150	150	18.0	9.8	0.5L	0.330	0.094	0.13	0.98	0.081	3.400	80.00	410	13
1253	18 06 74	1415	6	360	16	12	21.0	7.5	1.8	0.150	0.071	0.31	1.10	0.110	2.200	63.00	570	34
1285	18 07 74	1110	6	100	16	0	25.0	8.0	3.5	0.140	0.012	0.12	1.20	0.050	1.400	28.00	500	30
1331	14 08 74	1130	6	2800	16	48	24.0	10.5	4.5	0.078	0.007	0.04	1.10	0.040	1.000	16.00	494	36
1377	25 09 74	1105	6	630	60	1600	16.0	8.5	3.0	0.120	0.029	0.25	1.10	0.064	1.400	18.00	540	37
1403	22 10 74	1240	6	1400	40	368	12.5	10.4	2.0	0.150	0.032	0.06	0.85	0.049	1.500	24.00	600	36
1442	13 11 74	1035	6	3100	210	56	9.8	8.7	2.5	0.140	0.046	0.22	0.93	0.047	1.200	33.00	580	33
1481	04 12 74	1255	6	3600	310	168	1.5	13.7	0.5L	0.120	0.029	0.19	0.70	0.054	4.100	14.00	630	15

CURR. NUMB.	SAMPLING DATE DY MO YR	TIME 2400 HRS.	FLOW CFS	ACIDITY CACO3 MG/L	ALKALINITY CACO3 MG/L	HARDNESS CACO3 MG/L	TOTAL IRON AS FE MG/L	DISS. IRON AS FE	PH	COLOUR HAZ. UNIT	PHENOLS PPB	FLUORIDE MG/L	SILICA MG/L	TOTAL SOLIDS MG/L	SUSP. SOLIDS MG/L	SULPHATES AS SO4 MG/L	POTASSIUM MG/L	SODIUM MG/L	TOC MG/L	TC MG/L	COD MG/L
1017	22 01 74	1135		8	173	294	3.50		7.7	125				460	70						
1064	12 02 74	1310		9	206	308	1.90		7.7	5				440	20						
1107	19 03 74	1255			169	280	1.00		8.0					400	15						
1159	17 04 74	1050		2	191	272	1.50		8.0	30				410	60						
1209	22 05 74	1500		8	153	204	5.00		7.8	20				440	180						
1253	18 06 74	1415		8	175	256	0.95		8.1	25				410	20						
1285	18 07 74	1110			150	240	1.20		7.7	30				340	40						
1331	14 08 74	1130		4	142	212	0.70		8.9	30				360	20						
1377	25 09 74	1105		10	175	240	1.00		8.3	15				430	25						
1403	22 10 74	1240		14	18[illegible]	250	1.10		8.0					420	30						
1442	13 11 74	1035		4	17[illegible]	254	1.30		8.1					420	25						
1481	04 12 74	1255		16	1[illegible]	148	0.55		8.0					470	15						

Source: Ontario. Ministry of Environment. Water Quality Data for Ontario Lakes and Streams. 1974.

Table D-2

SURFACE WATER RUNOFF QUALITY

(After Dornbush, 1966)

LAND USE	NITROGEN	PHOSPHORUS
Farmland	7.0 lb/acre/yr	0.4 lb/acre/yr
Diversified Farming	2.5 - 24.0 lb/acre/yr	0.9 - 3.9 lb/acre/yr
Research Plots	3.1 - 6.4 lb/acre/yr	0.03 - 0.21 lb/acre/yr
Farmland	8.4 lb/acre/yr	0.07 lb/acre/yr
Irrigated Field	3.1 lb/acre/yr	0.07 lb/acre/yr
Research Plots	3.9 lb/acre/yr	1.2 lb/acre/yr
Farmland	1.3 - 20.3 mg/l	0.26 lb/acre/yr
Farmland	12.9 - 33.2 mg/l	---------------

Table D-3

CLIMATIC DATA

ONTARIO

WALLACEBURG — LATITUDE 42 35 N LONGITUDE 82 24 W ELEVATION 580 FT ASL

ELEMENT and STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	YEAR	TYPE
MEAN DAILY TEMPERATURE (DEG F)	24.2	25.8	33.9	46.2	56.7	66.9	71.2	69.8	62.7	53.0	40.6	28.6	48.3	2
MEAN DAILY MAXIMUM TEMPERATURE	30.4	32.7	41.4	55.7	66.9	77.3	81.5	79.9	72.5	62.4	47.2	34.2	56.8	2
MEAN DAILY MINIMUM TEMPERATURE	17.9	18.8	26.3	36.6	46.4	56.5	60.8	59.7	52.9	43.6	33.9	22.8	39.7	2
EXTREME MAXIMUM TEMPERATURE	65	61	85	87	97	101	102	104	99	86	79	65	104	1
NO. OF YEARS OF RECORD	55	54	52	52	54	54	52	50	51	51	51	56		
EXTREME MINIMUM TEMPERATURE	-22	-22	- 7	10	26	34	35	36	28	18	4	-17	-22	1
NO. OF YEARS OF RECORD	53	53	52	51	52	54	54	49	52	52	51	55		
NO. OF DAYS WITH FROST	29	26	24	10	1	0	0	0	*	3	13	26	132	3
MEAN RAINFALL (INCHES)	1.03	1.32	2.01	2.93	3.06	3.00	2.58	3.00	2.66	2.39	2.01	1.42	27.41	8
MEAN SNOWFALL	8.8	7.9	4.9	1.1	T	0.0	0.0	0.0	0.0	0.2	2.4	7.9	33.2	3
MEAN TOTAL PRECIPITATION	1.90	2.08	2.50	3.04	3.06	3.00	2.58	3.00	2.66	2.41	2.26	2.28	30.77	8

WALLACEBURG — LATITUDE 42 35 N LONGITUDE 82 24 W ELEVATION 580 FT ASL

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	TYPE
GREATEST RAINFALL IN 24 HRS	1.75	2.22	1.81	2.11	1.95	2.09	2.32	2.48	3.95	2.80	3.00	1.08	3.95	1
NO. OF YEARS OF RECORD	56	54	50	59	55	61	59	57	61	58	59	56		
GREATEST SNOWFALL IN 24 HRS	10.0	12.0	9.0	5.5	T	0.0	0.0	0.0	0.0	10.0	9.0	8.0	12.0	1
NO. OF YEARS OF RECORD	56	53	51	59	59	61	60	59	61	58	58	56		
GREATEST PRECIPITATION IN 24 HRS	1.75	2.22	1.81	2.11	1.95	2.09	2.32	2.48	3.95	2.80	3.00	1.08	3.95	1
NO. OF YEARS OF RECORD	56	53	51	59	55	61	59	57	61	58	58	56		
NO. OF DAYS WITH MEASURABLE RAIN	4	4	7	10	11	9	8	7	8	8	8	5	89	3
NO. OF DAYS WITH MEASURABLE SNOW	5	5	3	1	0	0	0	0	0	*	1	4	19	3
NO. OF DAYS WITH M. PRECIPITATION	9	8	10	11	11	9	8	7	8	8	9	9	107	3

CHATHAM — LATITUDE 42 24 N LONGITUDE 82 12 W ELEVATION 600 FT ASL

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	TYPE
MEAN DAILY TEMPERATURE (DEG F)	25.0	25.8	34.2	46.2	57.0	67.9	72.1	70.2	63.4	53.3	40.7	28.8	48.7	2
MEAN DAILY MAXIMUM TEMPERATURE	30.8	32.0	41.1	55.1	66.5	77.6	81.8	79.7	72.4	61.9	46.6	34.2	56.6	2
MEAN DAILY MINIMUM TEMPERATURE	19.1	19.5	27.2	37.3	47.5	58.2	62.5	60.7	54.3	44.7	34.7	23.3	40.8	2
EXTREME MAXIMUM TEMPERATURE	62	64	78	85	92	99	104	98	97	87	78	62	104	1
NO. OF YEARS OF RECORD	34	34	34	33	34	34	34	34	34	35	35	34		
EXTREME MINIMUM TEMPERATURE	-10	-19	- 5	12	27	36	44	39	30	21	5	-10	-19	1
NO. OF YEARS OF RECORD	34	34	34	33	34	34	34	34	33	35	35	34		
NO. OF DAYS WITH FROST	28	26	23	9	1	0	0	0	*	2	13	25	127	2
MEAN RAINFALL (INCHES)	1.47	1.34	1.97	2.96	2.81	3.07	2.86	2.93	2.31	2.38	2.01	1.69	27.80	2
MEAN SNOWFALL	9.2	8.5	6.6	1.3	T	0.0	0.0	0.0	0.0	0.4	3.4	8.7	38.1	2
MEAN TOTAL PRECIPITATION	2.38	2.19	2.63	3.09	2.81	3.07	2.86	2.93	2.31	2.42	2.34	2.56	31.59	2
GREATEST RAINFALL IN 24 HRS	1.52	2.53	1.67	1.68	2.48	2.85	3.30	4.23	1.61	2.87	1.81	1.66	4.23	1
NO. OF YEARS OF RECORD	34	34	34	33	34	34	34	33	34	35	35	33		
GREATEST SNOWFALL IN 24 HRS	9.0	8.0	14.5	5.0	0.2	0.0	0.0	0.0	0.0	9.0	6.0	10.5	14.5	1
NO. OF YEARS OF RECORD	34	34	34	33	34	34	34	33	34	35	34	33		
GREATEST PRECIPITATION IN 24 HRS	1.52	2.53	1.67	1.68	2.48	2.85	3.30	4.23	1.61	2.87	1.81	1.66	4.23	1
NO. OF YEARS OF RECORD	34	34	34	33	34	34	34	33	34	35	34	33		
NO. OF DAYS WITH MEASURABLE RAIN	5	5	8	12	11	9	9	9	8	9	10	7	102	2
NO. OF DAYS WITH MEASURABLE SNOW	8	6	5	1	*	0	0	0	0	*	3	6	29	2
NO. OF DAYS WITH M. PRECIPITATION	12	10	12	13	11	9	9	9	8	9	12	12	126	2

Source: Canada. Department of Fisheries and the Environment. Atmospheric Environment Service. Temperature and Precipitation 1941-1970. Ottawa: Queen's Printer, 1971.

APPENDIX E

EXAMPLE OF
CONSTRUCTION, OPERATION AND MAINTENANCE DETAILS

E. EXAMPLE OF
CONSTRUCTION, OPERATION AND MAINTENANCE DETAILS

E.1 Construction Details

The following items should be outlined where applicable:

a) the method and timing of construction for each part of the proposal;

b) dredging requirements; fill, berths, turning basins; dredge spoil disposal;

c) the place and method of acquisition of local building materials (e.g., borrow pits, quarries, water supply, waste water disposal, and any other requirements of the proposed type of development);

d) location of new access roads, and use of existing roads and other transportation facilities;

e) location, duration, size and services of construction camps;

f) interruption to or alteration of natural processes (e.g. river flows, lake levels) and shoreline processes (e.g., erosion and accretion) in terms of timing and other pertinent variables; and

g) any effluents, emissions, noise or aesthetic factors caused by the construction.

E.2 Operation and Maintenance

The following items should be detailed:

a) the important timing and other commissioning details of the proposal; (e.g., estimated life of project);

b) the volume, timing, composition, and other details of effluents, noise and solid waste disposal;

c) estimated spill frequencies based on examination of similar facilities;

d) any interruption to natural processes such as river flows, air movements, ground water regimes, lake levels and the regimes caused by the operation in terms of timing, space and magnitude;

e) anticipated maintenance dredging requirements and disposal procedure;

f) plans for surveillance and monitoring of environmental effects; and

g) contingency plans, supporting physical resources and training programs which are proposed to deal with environmental emergencies.

<u>Source</u>: Environmental Assessment Panel Chairman. "Guidelines for the Initial Environmental Evaluation." October, 1976 pp. 139-141.