MOIRA RIVER
CONSERVATION AUTHORITY

THE BIG CLEANUP

BAY OF QUINTE REMEDIAL ACTION PLAN

Environment Canada / Environnement Canada

GREAT LAKES CLEANUP FUND

Potter Creek Subwatershed Plan

ECOS GARATECH
CONSULTING ENGINEERS

IN ASSOCIATION WITH

Terraprobe Limited

Anthony Usher Planning Consultant

MICHAEL MICHALSKI ASSOCIATES

EGA

ECOS GARATECH ASSOCIATES LTD.
Consulting Engineers

7955 Torbram Road, Unit 12, Brampton, Ontario L6T 5B9 TEL. (905) 458-4110 FAX (905) 458-1479

November, 1994

File: 1137-16-010

Moira River Conservation Authority
Box 698
Belleville, Ontario
K8N 5B3

Attention: **Mr. E. Margetson, P.Eng.**
Project Director

Reference: **Potter Creek Subwatershed Plan**

Dear Sir:

On behalf of EGA, Michael Michalski Associates, Anthony Usher Planning Consultant and Terraprobe Limited, I am pleased to submit the Potter Creek Subwatershed Plan.

We trust that the Subwatershed Plan's strategies will assist the Conservation Authority, the Township of Sidney and the City of Belleville to foster early, integrated planning for land use and management, surface water management, and environmental protection on an ecosystem basis.

Yours truly,

EGA Consultants

M.D. (Michael) Garraway, C.E.T.
Project Manager

PREFACE

This report was jointly funded through the Moira River Conservation Authority by the Ontario Ministry of Natural Resources, Environment Canada through the Great Lakes Action Plan Cleanup Fund, the Township of Sidney, and participating landowners within the Potter Creek watershed.

The Great Lakes Action Plan Cleanup Fund is part of the Government of Canada's Great Lakes Action Plan. The Fund provides resources to assist in the development of remedial programs to meet Federal responsibilities in Canadian Great Lakes Areas of Concern. The Fund has cosponsored this project to address water quality issues in the Bay of Quinte Area of Concern.

The Moira River Conservation Authority would like to acknowledge the financial contributions of all the funding partners. Also, the Authority and the authors of this report recognize and gratefully acknowledge the time and dedication committed to this project by the participating landowners and the planning staff of the Township of Sidney.

Although the report was subject to review and comment by the funding partners, the opinions expressed are those of the consultants and do not necessarily reflect the views of any of the partners.

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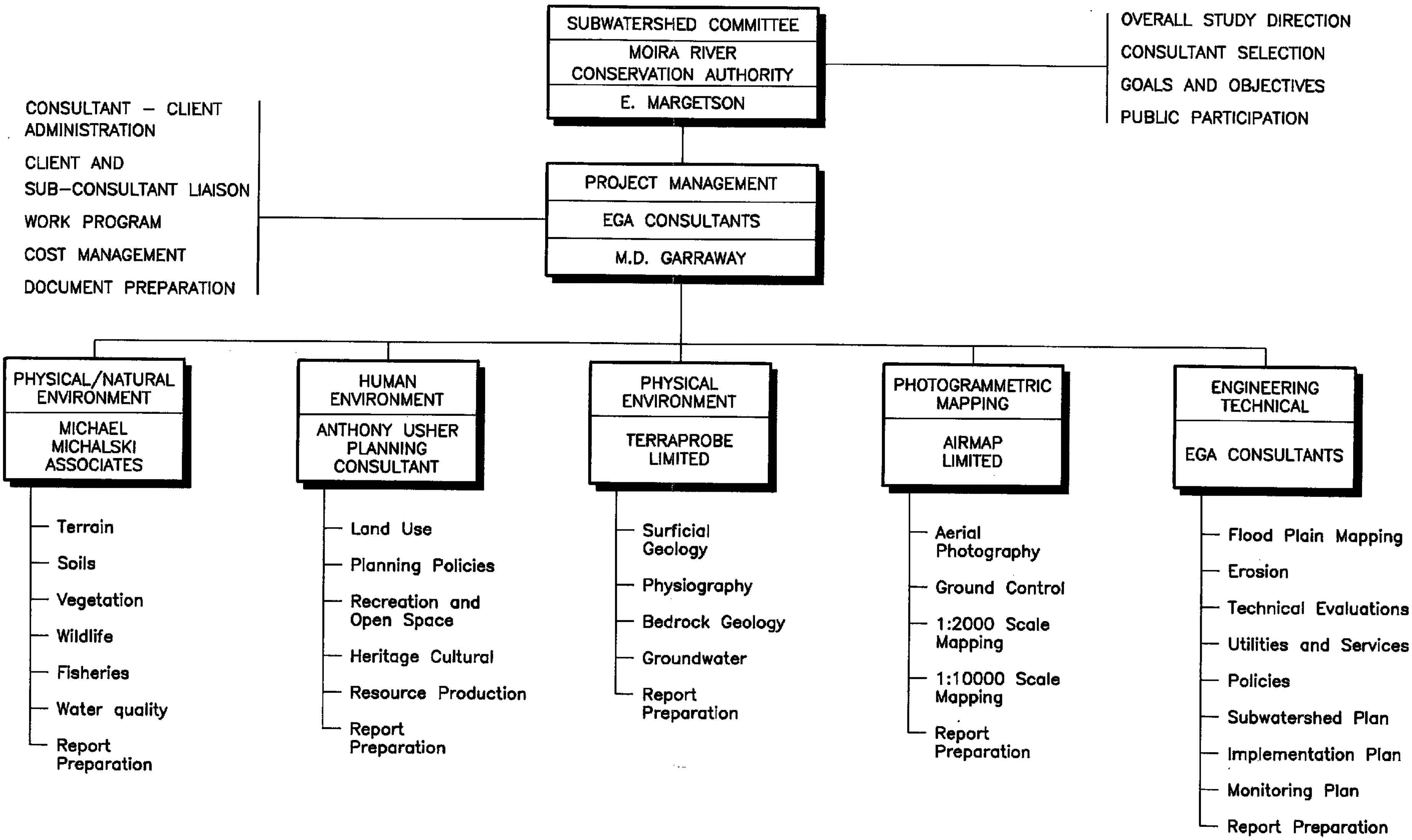


POTTER CREEK SUBWATERSHED PLAN STUDY TEAM FIGURE 1–1

years of land, resource, recreational, and tourism planning experience, including six years as a recreational land use planner with the Ministry of Natural Resources and five years as senior planner with the then Hough, Stansbury + Michalski Limited before commencing his own practice.

Mr. Usher has considerable experience with the environmental and resource aspects of the municipal planning process, both as an advisor to approval agencies on planning policies and as a planner for development proponents.

Municipal - Civil Engineer

Mr. **A. (Tony) Barton**, has been responsible for carrying out the municipal and civil technical reviews.

Mr. Barton, a consulting engineer and a Principal of EGA Consultants, has over 20 years of experience in municipal, civil and environmental engineering fields with Kilborn Limited and EGA Consultants.

His career has included numerous projects in the environmental, municipal, hydrotechnical, transportation, industrial and commercial engineering fields in both the private and public sectors, including overall project coordination, as well as the management of budgets, schedules and personnel.

Hydrotechnical Engineer

Mr. **P.S.H. (Peter) Lim** has acted as Hydrotechnical Engineer. He has specialized in civil engineering projects with emphasis in hydrotechnical engineering, including hydrology, hydraulics, floodplain mapping, flood damage assessment, erosion control, stormwater management, socio-economic analyses and the development of watershed management plans.

Mr. Lim, a Consulting Engineer and Associate of EGA Consultants, has 13 years of experience in hydrotechnical engineering. Mr. Lim possesses a comprehensive knowledge of all aspects of hydrology, hydraulics, computer applications and programming, and storm water management - quantity and quality.

Hydrogeological Engineer

Mr. **P. (Paul) Bowen**, has acted as hydrogeological specialist. He was responsible for conducting the hydrogeological study.

Mr. Bowen, a Consulting Engineer and Principal of Terraprobe Limited, has 14 years experience in geotechnical and hydrogeological studies and programs.

Mr. Bowen has been responsible for coordination and technical direction of geotechnical and hydrogeologic investigations for civil, industrial, environmental, and mining fields. Areas of involvement in hydrogeology include site selection for municipal and hazardous waste management projects, evaluation of groundwater quality and contaminant movement, modelling of contaminant migration, ground water resources development, and ground water control and dewatering.

1.3 WATERSHED DESCRIPTION

The Potter Creek Watershed (Figure 1-2 and Drawing Number 1137-16-01) drains an area of approximately 31 square kilometres. The Watershed, located in the Township of Sidney and the adjoining City of Belleville, has its origin in a predominantly rural area in the Township of Sidney, about 2.7 kilometres south-east of Wallbridge in the vicinity of Tucker's Corners. Three of its tributaries, draining in a south-westerly direction, originate in the City of Belleville.

From its headwaters, the Creek meanders some 5 kilometres in a south by south-east direction, makes an almost 90 degrees turn downstream of County Road No. 22, and flows in a east by north-east direction for about 1.6 kilometres. Here, it turns again and flows in a south by south-west direction for some 4 kilometres, through the property of Loyalist College and the Quinte Conservation Area, and finally discharges into the Bay of Quinte.

The Watershed is bounded to the east by the Moira River System, to the north by the watershed of Palliser Creek, a tributary of the Moira River, and to the west by a watershed emptying into the Bay of Quinte near Bayside.

1.0 INTRODUCTION

1.1 WATERSHED AND SUBWATERSHED PLANNING

Up to the early 1970's, storm runoff from urban developments was viewed as a problem to be removed from areas as quickly as possible and discharged via a suitable outlet into the nearest watercourse. Over time, it became evident that this practice increased flooding and erosion in downstream reaches of watercourses. To mitigate these problems, it became standard practice to control the quantity of storm runoff by providing storage facilities with discharge outlet controls. These facilities, constructed on a development by development basis, were built either on-site with outlet works to the nearest watercourse or on-stream of the receiving watercourse. This concept of every development providing quantity control was often referred to as the "chicken-pox approach" in that, stormwater facilities began to dot the landscape of urban areas of expansion. Many concerns were raised as to the effectiveness of these facilities on an overall watershed basis and the ever increasing number of facilities that would require long term operation, maintenance and monitoring. As a result, many of the regulatory agencies in the early 1980's and in particular, the Conservation Authorities of Ontario, required the preparation of Master Drainage Plan (MDP) for tributaries and in some cases entire watersheds. Master Drainage Plans were to formulate an overall area approach to storm runoff control and to minimize the number of total facilities to maintain pre-development peak flows.

Through the 1980's, public awareness of the need to protect the environment continued to grow. This awareness resulted in new terminology and concepts surrounding such terms as sustainable development, best management practices, ecosystem planning, interdisciplinary study team, holistic or comprehensive strategies to maximize benefits to the natural and human resources on a watershed/subwatershed/ecosystem basis. In the 1990's, these terms and concepts have led to the preparation of Watershed and Subwatershed Plans that address not only flooding and erosion concerns but also groundwater, water quality, fisheries, wetlands, environmentally sensitive areas and wildlife. These interdisciplinary Watershed and Subwatershed Plans and strategies provide water-related environmental input to municipal land use plans specifically, Official Plans, Secondary Plans and Plans of Subdivision.

To date, it is recognized that water management planning is undertaken in two stages. The first stage is the preparation of the Watershed and Subwatershed Plan. These plans are prepared by an interdisciplinary team of specialists under public proponency by either a Conservation Authority or Municipality. The second phase involves the preparation of the Stormwater Management Plan. The Plan is prepared by a qualified consulting engineer under private proponency and submitted to the municipality and regulatory agencies for comment and approval.

Watershed and subwatershed plans are strategies that, when implemented, will achieve a sustainable environment which will maximize benefits to the natural and human resource areas on an watershed/ecosystem basis. An understanding of the biological resources and physical systems, their inter-dependencies and linkages is developed with the participation and assistance of regulatory agencies, municipalities and the public. A strong understanding of the watershed or subwatershed and its priorities will greatly reduce the potential for conflicts between the mandates of different agencies and will facilitate the final permitting process.

The watershed/subwatershed planning process is required to provide:

- Input to municipal land use plans which will ensure protection of the important natural systems and resources in a manner acceptable to regulatory agencies.
- Direction to proponents of development regarding the level and types of control of management actions required.
- Direction to agencies and municipalities regarding protection and preservation of valley systems, wetlands and green space.

- Direction to agencies and municipalities regarding remedial measures, rehabilitation/enhancement programs, and pollution prevention.

- Direction to agencies and municipalities regarding management programs (fisheries, agriculture, public education, etc.)

- An implementation strategy.

- A monitoring strategy.

The level of detail provided under each of these will depend upon the scale of plan being prepared. At the highest level (large watershed plan) the direction provided will be at a policy level. Input to land use planning will include policy requirements, and specification of subwatershed planning areas.

At the most detailed subwatershed plan level the direction provided will be more precise and specify such things as required buffers, BMP type, features and design requirements, and specific stream reaches to be rehabilitated or enhanced. In some instances, where an important natural function could be impaired the subwatershed plan may specify maximum levels of imperviousness, recommend development forms or otherwise restrict the allowable area of development.

1.2 STUDY TEAM

The Subwatershed Committee has assembled a highly successful and experienced Study Team (Figure 1-1) to complete the Subwatershed Study of Potter Creek. Study participants are senior members of their respective firms and have been involved with many similar assignments. Aside from their strong technical background, the Study Team members have excellent communication and reporting skills and have participated in various forums involving the public.

Project Director

Mr. **M. E. Margetson,** on behalf of the Moira River Conservation Authority and the Subwatershed Committee, has provided the project direction for the Potter Creek Subwatershed Study.

Mr. Margetson, a professional engineer for the Moira River Conservation Authority, has been assigned to direct the preparation of the subwatershed plan and related studies in cooperation with adjacent Conservation Authorities within the Quinte Planning Area.

Project Manager

Mr. **M.D. (Michael) Garraway** has provided overall supervision involving the organizational and manpower aspects of the Study Team, the Study Methodology, detailed Work Program, Study Schedule and established Budgets.

Mr. Garraway, Principal of EGA Consultants, has 20 years of experience in civil and environmental engineering fields in both the private and public sectors, including overall project accountability and coordination, as well as management of budgets, schedules and personnel.

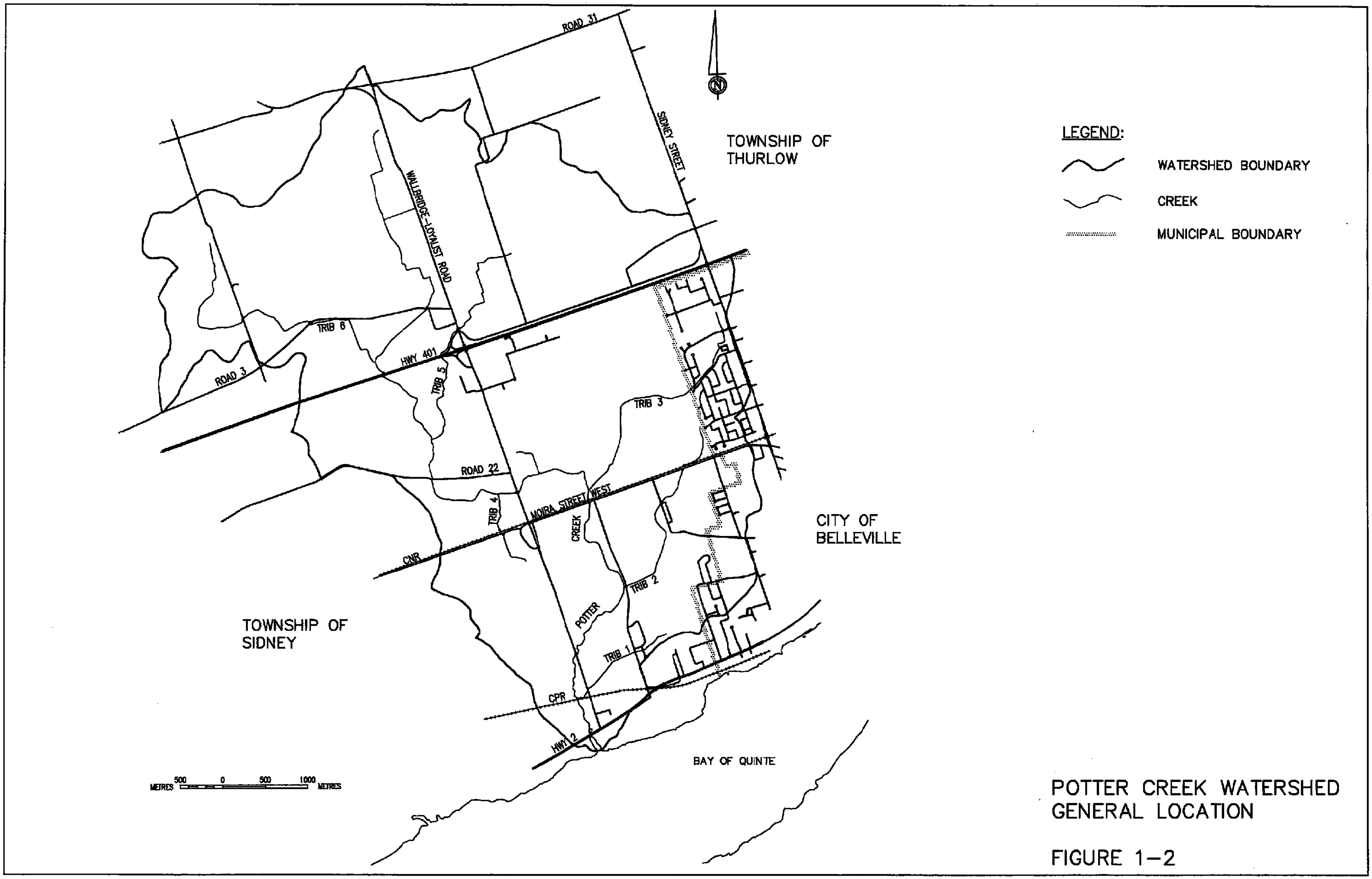
Environmental Specialist

Mr. **M. (Michael) Michalski**, president of Michael Michalski Associates, has acted as environmental specialist and was responsible for all environmental services for the Study.

Mr. Michalski has 28 years of applied environmental research and resource management experience with the Ontario Water Resources Commission, the Ministry of the Environment, Hough, Stansbury + Michalski Limited, and since 1983, his own firm. He has directed or participated in biophysical and wetland evaluations, water quality, limnology, and fisheries analyses, environmental plans, policy formation and impact assessment studies, and site rehabilitation and enhancement projects across Ontario. Many of his assignments require basic environmental analyses which ultimately translate into official plan amendments and subwatershed plans.

Planning Specialist

Mr. **A. (Anthony) Usher**, MCIP, OPPI, Principal, Anthony Usher Planning Consultant, was responsible for the land planning elements of the study, including the implementation of the preferred subwatershed planning strategy. Mr. Usher has 22



POTTER CREEK WATERSHED
GENERAL LOCATION

FIGURE 1–2

The upper one-third portion of the Watershed (north of Highway No. 401) is, for the most part, rural and in agricultural use. Surface relief at the north-west portion is evident by drumlins running in a north-east to south-west direction, consisting of water recharge areas. A part of the natural wetlands has been dedicated for waterfowl habitat. Overburden varies from 2 metres to 3 metres, overlying limestone bedrock.

The land use pattern in the lower two-third of the Watershed (south of Highway No. 401) is a mixture of highway commercial, residential, industrial, institutional and agricultural, with some natural forests and woodlots, and successional woodlots and old field. Subsequent urban growth in west Belleville has encroached on source areas for some of its tributaries. The physiography comprises shallow clay and bevelled till plains, overlying limestone bedrock.

1.4 GOALS AND OBJECTIVES OF THE SUBWATERSHED PLAN

The principal Goals and Objectives of the Study are:

GOAL

To minimize the threat to life and the destruction of property and natural resources from flooding, and to preserve or reestablish, if existing land use is negatively impacting, natural flood plain hydraulic functions.

Objectives

1. To adopt appropriate land use controls and compliance monitoring for controlling or prohibiting development within the natural hydraulic floodplain.

2. To ensure that runoff from developing areas is controlled by establishing existing and target flows for storm water management plans such that flood risks and damages are not increased.

GOAL

To protect, restore, and enhance water quality and water quantity.

Objectives

1. To prevent erosion (sheet and bank) and resultant silt load and sediment accumulation in waterways.

2. To prevent degradation of water quality within the creek and the Bay of Quinte through implementation of recommendations of the Bay of Quinte Remedial Action Plan and the use of Best Management Practices on the land.

3. To minimize and prevent the disturbance of the creek bed and maintain, restore, and enhance a natural vegetative canopy along Potter Creek.

4. To maintain/enhance base flow within Potter Creek.

5. To prevent pollution of groundwater from urban stormwater infiltration and pollution of surface water from direct discharge by establishing parameters and targets which will be implemented within the Subwatershed Plan.

GOAL

To ensure that environmental and resource concerns are fully considered and protected in establishing land use patterns along creek corridors and adjacent to areas of ecological significance.

Objectives

1. To ensure that environmentally sensitive areas, wetlands, woodlots and cultural heritage features are protected from the adverse impacts of any proposed development.

2. To achieve an environmental continuity along Potter Creek and its tributaries through the maintenance and enhancement of vegetative buffers.

3. To maintain and enhance wildlife habitat.

4. To balance the preservation of ecosystems with the needs of the watershed residents.

5. To protect and develop opportunities for recreational linkages along Potter Creek and its tributaries, and between the watercourses and other areas of natural, cultural, and recreational value.

GOAL

To create a demonstration tool, funded by Great Lakes Cleanup Fund, in order to provide Guidance for Subwatershed Plans in the Quinte area.

2.0 PUBLIC, STEERING COMMITTEE AND STAKEHOLDER INVOLVEMENT

The Study Team, Project Committee and the Stakeholders met on three occasions - February 12, 1993, November 10, 1993 and March 22, 1994.

At the February 12, 1993 meeting, the Study Team presented the background information collected and reviewed, the natural system inventory and plans, the results of the completed and on-going technical investigations and projected land use scenarios within the Potter Creek watershed.

The Project Committee, consultants and stakeholders agreed that a single land use scenario could be used for assessing the impacts of future development. The Committee recommended that the Development Strategy consist of Scenario B, with the future urban land community extended west to Wallbridge-Loyalist Road south of Loyalist College. In this way, the urban community's boundaries would more closely approximate those of the Potter Creek Secondary Plan (see Section 5.4).

At the November 10, 1993 meeting, the Project Manager presented the Development Strategy resulting from the February meeting, the policies, guidelines and criteria affecting development, the Constraint Map, the general results of the impacts of development without considering best management practices, the identification of residual issues and best management practices, and a potential Surface Water Strategy.

Although there were no objections to the information and strategies presented, concerns were raised with the potential Surface Water Strategy. It was felt that the Strategy did not consider the manner in which development may proceed given that some lands have already received approval for development, what potential interim measures could be employed that would disappear or "plug into" a long term strategy and the financial scenarios associated with implementing the final Subwatershed Plan.

The Study Team reviewed the concerns and:

- Developed a second Surface Water Strategy to reflect the manner in which development may proceed within the Potter Creek Watershed. The impacts of the Surface Water Strategies were assessed and the final Strategy chosen was a combination of the two considered.
- Did not see a need or benefit to include interim stormwater measures that would either disappear or "plug into" the Surface Water Strategy. Interim measures to be "plugged into" a Surface Water Strategy were seen as undesirable and in fact might provide a convenient opportunity not to implement the optimum strategy.
- Identified, as part of the recommended Subwatershed Plan, the strategies, approaches to implementing the strategies, responsible parties and timing.

At the March 22, 1994 meeting, the Study Team and Project Director briefly re-introduced the Development Strategy development constraints and Constraint Map, and the various subwatershed strategies involving flood and erosion control, urban surface water management strategy, rehabilitation and management of channel systems, land use management, agricultural land management and education.

The Study Team went on to present, in detail, the recommended Subwatershed Plan.

A stakeholder had considerable concern with the extent of the regulatory flood plain north of the CNR and the recommended strategy for new transportation/utility crossings of Potter Creek. The stakeholder believed that the large flood plain along with the requirements for new crossings would preclude the construction of the proposed College Street extension to Regional Road 22. The Study Team and Steering Committee members explained that the flood plain delineation is based on Provincial Policy with specific technical criteria which the Study Team followed with due diligence and that the College Street extension could be implemented if the requirements for crossings could be met.

The Steering Committee and the majority of the stakeholders accepted the plan but had some difficulty in trying to conceive how development agreements could be established among land developers and the Township of Sidney that would allow development to proceed in a timely and equitable manner while at the same time realizing the implementation of the Subwatershed Plan. After considerable discussion, the Study Team agreed to provide typical scenarios that could be adopted to facilitate acceptable development agreements.

On March 30, 1994, the Moira River Conservation Authority held a public meeting from 2:00 p.m. to 4:00 p.m. and 6:30 p.m. to 9:00 p.m. The open house conducted at the Conservation Authority office provided the public with an opportunity to review and comment on the proposed Subwatershed Plan.

On April 5, 1994, the Moira River Conservation Authority submitted a draft of the Potter Creek Subwatershed Plan/Report and drawings to the pertinent review agencies for review and comment.

The responses from the Open House and the review agencies were reviewed by the Study Team, Project Director and the Township of Sidney. The draft report was modified to provide clarification, address issues and most importantly provide a Subwatershed Plan that would be acceptable to the Community.

Copies of comments, letters and reviews are enclosed in Appendix B.

3.0 BACKGROUND INFORMATION

3.1 SURFACE WATER

3.1.1 GENERAL

Potter Creek (Figure 1-2) flows in a southeast direction for approximately 10.6 kilometres from Tucker's Corner, just east of Wallbridge, in the north to the Bay of Quinte in the south. The outlet is located west of the City of Belleville, south of Highway 2 and within the Quinte Conservation Area.

The main watercourse of Potter Creek from the Canadian National Railway to the Bay of Quinte has retained most of its natural setting as a result of being located within the Conservation Authority and Loyalist College lands. The majority of the upstream watercourse and tributaries function mostly as agricultural or urban drains.

Potter Creek has six tributaries of varying length and contributing drainage basin size. Three of the tributaries originate in the City of Belleville between Highway 2 and Highway 401. These tributaries flow in a southwest direction before joining with the main channel of Potter Creek at approximately the Canadian National Railway, Avonlough Road and the Canadian Pacific Railway. The fourth tributary originates in the Quinte Conservation Authority lands and flows northward to join the main stream just west of Wallbridge-Loyalist Road north of the Canadian National Railway. The remaining two tributaries and the main channel drain the northern portion of the Potter Creek Watershed north of Highway 401. Each drainage basin is approximately the same size. A wetland south of Tucker's Corners in the upper reaches of the Potter Creek main channel is managed by Ducks Unlimited.

The Potter Creek Watershed located within the City of Belleville is presently developed. The existing development consists of residential homes with industrial and commercial sectors. During the development of the Tracey Park residential and industrial areas, channelization was undertaken on the Potter Creek tributary in that area.

The Potter Creek Watershed within the Township of Sidney is for the most part agriculturally based with the exception of rural development along major road patterns, the Quinte Conservation area, the Loyalist College development, the Zebedee landfill site and the commercial-industrial development located around Highway 401 and Wallbridge-Loyalist Road.

3.1.2 FLOODING

In November 1977, Totten Sims Hubicki Associates Limited completed a planning study of the Quinte Conservation Area. As part of the study, hydrologic and hydraulic analyses were undertaken to determine the extent of potential flooding within the Conservation Area lands as a result of the Regulatory event, being the 1:100 year return frequency rainfall event.

The Regulatory storm was determined to be 53.5 cubic metres per second (cms) with a resultant flood plain illustrated on Master Plan 1 of the Report. A review of Master Plan 1 reveals flood elevation within the Quinte Conservation Area to be between 79 m at the current location of the Conservation Authority office to 82 m at the upstream crossing at Wallbridge-Loyalist Road.

There were no buildings located within the Regulatory flood plain and the crossings located at Highway 2, Moira Street West and the Canadian Pacific Railway discharged the 100 year flow of 53.5 cms without overtopping of the embankments and roadways.

The study further addressed the potential to construct a weir just upstream of the Canadian Pacific Railway to enhance the aquatic and botanical centres proposed in the planning study. A hydraulic model was prepared to simulate the weir as a constriction to flow and it was concluded that for the less frequent events, the effects of such a structure would be negligible.

3.1.3 EROSION

In 1991, the Moira River Conservation Authority conducted **Vegetation and Wildlife Survey of Potter Creek and South Quinte Conservation Area Marina Inventory**. As part of the survey, the main channel and tributaries were divided into stream reaches. A sketch of each reach was prepared to illustrate erosion sites, stream dimensions, stream vegetative cover and streambed materials. This information was used as a reference in conducting the field reconnaissance of the watercourse and subsequent evaluation of stream erosion along Potter Creek.

3.1.4 STORM DRAINAGE

There have been no Master Drainage or Stormwater Management Plans prepared for any of the existing developments located within the Potter Creek Watershed.

Minor drainage systems consisting of open ditches and storm sewers with catch basins and outlets to the nearest drainage course are common in the developed areas. There are no facilities to intercept the first flush of storm events to potentially improve the quality of storm discharge to the Bay of Quinte.

Major drainage discharges uncontrolled from all areas following the topographic features of the drainage basins. There are no facilities to detain storm discharge to pre-development peak runoff.

3.1.5 WATER QUALITY

The only surface water quality data for Potter Creek have been collected by the Ministry of the Environment and Energy as part of a Bay of Quinte tributary monitoring program. Potter Creek was one of 20 streams sampled.

Weekly samples were collected from a single station between August 31 to December 2, 1987, and from June 17 to October 28, 1991; monthly samples were taken in November and December, 1991, and January and February, 1992.

Parameters analyzed were: ammonia, nitrate, nitrite and total Kjeldahl nitrogen; pH; total phosphorus; dissolved reactive phosphorus; and suspended solids. All results are presented in Table 3.1; no interpretation of the data is provided at this time, pending our review of the Ministry's evaluation.

3.2 GEOLOGY

3.2.1 PHYSIOGRAPHY AND GEOMORPHOLOGY

The majority of the Potter Creek watershed (Drawing Number 1137-16-01 - Topography) lies within a physiographic region known as the Napanee Plain. At the northern limits of the watershed, the ground rises into an area known as the Peterborough Drumlin Field (Chapman and Putnam, 1984). The Napanee Plain is a flat to undulating limestone plain, with a characteristically thin cover of soil. Much of the overburden material in this area was stripped away by the scouring action of the glaciers. Locally, the cover of soil is very thin (less than 2 m), particularly towards the eastern and southern portion of the watershed.

Much of the Napanee Plain is overlain by a thin cover of stoney glacial till. The till is generally derived from the underlying limestone bedrock materials. Towards the southern end of the Napanee Plain, there is often a thin veneer of fine sand or silt materials. These are derived from inundation of the area by former glacial Lake Iroquois.

Towards the northern end of the watershed, there are a number of scattered drumlins. Drumlins are elongated conical hills formed as a result of glacial activity. The drumlins are oriented in a northeast-southwest direction.

Locally, there are deposits of recent alluvial materials found along the creek valley. There is a local deposit of organic or peat soils found near the northern portion of the watershed. These soils appear to have been formed as a result of local ponding of surface water in this area.

3.2.2 LOCAL GEOLOGY - SOILS AND OVERBURDEN

Existing information on soil cover characteristics through the drainage basin consists primarily of descriptions provided in **Soil Survey of Hastings County** (Gillespie, Wicklund and Richards 1962). Other soils information of a general nature is provided for localities within the basin, including the

TABLE 3.1
WATER QUALITY
POTTER CREEK

LOCATION: STATION 8 POTTER CREEK

Date	Time	Ammonia	Chloride	Conductivity	Total Kjeldahl Nitrogen	Nitrite	Nitrate	pH	Total Phosphorus	Dissolved Reactive P	Suspended Solids
17 June 1991	17:30	0.05	87.8	606	0.71	0.006	0.04	7.8	0.056	0.010	<1
24 June 1991	15:00	0.02	81.9	596	2.00	0.002	<0.02	7.7	0.114	0.050	12
2 July 1991	13:20	DRY CHANNEL									
8 July 1991	14:35	0.05	40.7	490	0.72	0.014	0.04	8.0	0.032	0.026	5
15 July 1991	13:50	0.02	36.9	468	0.63	0.002	<0.02	8.2	0.038	0.008	4
22 July 1991	14:15	0.15	43.1	443	2.00	0.004	<0.02	7.8	0.156	0.024	?
29 July 1991	14:00	DRY CHANNEL									
6 Aug 1991	13:35	DRY CHANNEL									
12 Aug 1991	14:20	0.01	26.0	440	0.61	<0.002	<0.02	7.9	0.050	0.024	8
19 Aug 1991	14:30	0.01	46.3	539	0.66	0.004	<0.02	8.1	0.046	0.018	3
23 Aug 1991	13:55	0.03	55.6	554	0.54	0.002	<0.02	8.2	0.042	0.020	5
26 Aug 1991	15:00	<0.01	45.6	514	0.56	<0.002	<0.02	8.3	0.046	0.016	5
3 Sept 1991	13:55	<0.01	44.2	491	0.67	0.002	<0.02	8.0	0.044	0.010	2
9 Sept 1991	13:05	0.24	35.9	467	1.10	0.016	<0.02	7.5	0.140	0.054	27
17 Sept 1991	12:50	<0.01	59.1	580	1.30	<0.002	<0.02	7.9	0.122	0.022	30
23 Sept 1991	19:05	<0.01	44.9	531	0.46	<0.002	<0.02	8.1	0.040	0.028	27
30 Sept 1991	14:30	<0.01	64.7	632	0.53	<0.002	<0.02	8.1	0.022	0.008	2
7 Oct 1991	15:20	<0.01	75.3	606	0.40	0.018	0.28	8.0	0.050	0.040	2
14 Oct 1991	12:55	<0.01	77.7	698	0.46	0.006	0.02	7.9	0.026	<0.002	1
21 Oct 1991	15:05	0.03	77.3	677	1.30	0.022	0.18	8.1	0.144	0.004	61
28 Oct 1991	14:15	0.18	102.1	824	0.38	0.006	<0.02	8.0	0.022	0.004	4
21 Nov 1991	13:25	0.01	115.1	816	0.66	0.040	1.42	8.0	0.026	0.004	14
12 Dec 1991	15:50	<0.01	100.3	866	0.40		7.60	8.0	<0.040	0.010	2
30 Jan 1992	09:50	0.16	188.8	1149	0.60		4.30	7.8	<0.040	0.020	23
24 Feb 1992	11:15	0.28	61.5	496	1.30		2.25	7.8	0.120	0.068	3

TABLE 3.1 (cont'd)
WATER QUALITY
POTTER CREEK

LOCATION: STATION 8 POTTER CREEK

Date	Time	Parameter									
		Ammonia	Chloride	Conductivity	Total Kjeldahl Nitrogen	Nitrite	Nitrate	pH	Total Phosphorus	Dissolved Reactive P	Suspended Solids
31 Aug 1987		0.01	39.8	449	0.65	0.004	0.02	7.7	0.072	0.012	<1
3 Sept 1987		0.02		445	0.37	<0.002	<0.02	8.1	0.024	0.006	1
10 Sept 1987		0.01	79.9	540	0.38	0.002	<0.02	8.1	0.030	0.010	3
16 Sept 1987		0.02	164.0	880	0.46	<0.002	<0.02	8.0	0.018	0.004	
29 Sept 1987		0.01	151.0	880	0.57	0.002	<0.02	8.0	0.028	0.004	9
1987		0.03	259.0	1240	0.54	<0.002	<0.02	8.0	0.024	0.006	3
8 Oct 1987		0.01	92.5	740	0.50		0.16	8.2	0.150	0.056	
15 Oct 1987		<0.01	146.0	890	0.40	<0.002	<.02	8.1	0.182	0.062	
21 Oct 1987		0.02	112.0	793	0.80	0.002	<0.02	8.1	0.060	<0.002	
28 Oct 1987		<0.01	140.0	960	0.38	0.004	<0.02	7.9	0.032	0.006	
4 Nov 1987		0.02	116.0	840	1.90	<0.002	<0.02	8.0	0.014	0.004	
11 Nov 1987		0.03	73.9	730	0.75	0.022	2.48	8.1	0.014	0.002	
18 Nov 1987		<0.01	93.1	730	0.70	0.026	2.97	8.3	0.020	0.018	20
24 Nov 1987		0.01	75.3	780	0.55	0.016	3.28	8.2	0.006	0.002	
2 Dec 1987		0.01	52.9	630	0.67	0.012	5.19	8.1	0.044	0.032	

Quinte Conservation Area Waterfront Study (MIE Consulting Engineers and M.M. Dillon Limited 1990), and the draft **Potter Creek Community: A Secondary Plan** (Township of Sidney Planning Department 1985), although the latter appears to rely mainly on Gillespie, Wicklund and Richards (1962). Marsh substrate data are also included in background information on the Aikins wetland south of Tucker's Corners provided by Ducks Unlimited.

The overburden soil types encountered in the watershed are shown on Drawing Number 1137-16-02 - Surficial Geology. Generally, the watershed area is overlain by drift derived from glacial action. Most of the watershed is overlain by thin deposits of silty and stoney glacial till. Towards the northern end of the watershed, the deposits become thicker and drumlin deposits of washed or sorted glacial till are found.

Towards the southern end of the watershed, a thin veneer or blanket of glacial lacustrine deposits is found. These deposits may comprise fine sand and silt material.

The thickness of the overburden materials was estimated on the basis of local well records. An interpretation of overburden thickness is shown on the accompanying Drawing Number 1137-16-03 - Inferred Overburden Thickness. As noted, the overburden materials are quite thin (less than 2 m) particularly near the southern and southeastern portion of the watershed area. Towards the northern portion of the watershed, the thickness of overburden increases to 10 m or more.

Cross-sections A-A', B-B' and C-C' indicating overburden soil types and thicknesses are illustrated on Drawing Number 1137-16-04 - Hydrographic Cross-Sections. These cross-sections were completed from Ministry of Environment and Energy well records.

While there are local deposits of sandy materials noted, it appears that there are no economic reserves of sand and gravel materials which may be utilized as an aggregate resource.

3.2.3 GEOLOGY - BEDROCK

The overburden materials are underlain by bedrock deposits of the Simcoe Group. These deposits comprise sedimentary rock, consisting mostly of limestone with minor deposits of dolostone and shale. Cross-sections A-A', B-B' and C-C' indicating bedrock topography are shown on Drawing Number 1137-16-04 - Hydrographic Cross-Sections. These cross-sections illustrate that bedrock in the area is generally flat, and dips slightly towards the south towards the Bay of Quinte.

3.3 HYDROGEOLOGY

3.3.1 GROUND WATER OCCURRENCE AND FLOW

The Ministry of Environment and Energy Well Records indicate that there is ground water occurrence in both the overburden and bedrock materials. Well locations, well types, and reference numbers are given on Drawing Number 1137-16-05 - Groundwater Resources - Water Well Locations. Based on the field reconnaissance of the watershed area, it is evident that ground water is first encountered within the upper overburden materials. While no direct measurements were made of ground water levels, it can be expected that ground water levels in the overburden will be generally shallow (i.e., within several metres of the ground surface) throughout most of the watershed area. Locally, such as in the drumlin fields towards the northern end of the watershed, the depth to groundwater can be expected to be deeper.

There is no direct information available for ground water levels within the overburden materials. However, it can be inferred that ground water flow within the overburden will also be a subtle reflection of surface topography. Typically, flow will be towards the south. Locally, ground water flow within the overburden will be directed towards topographic lows or depressions including the channel or valley of Potter Creek, as well as local depression or wetland features such as those found in the northern portion of the watershed.

Most wells in the area draw water from the underlying bedrock aquifer. Therefore, there is direct information available regarding the water levels in the underlying bedrock. The water levels obtained from the well records are plotted on

Drawing Number 1137-16-06 - Groundwater Equipotentials in Bedrock and Cross-sections A-A', B-B', and C-C' on Drawing Number 1137-16-04 - Hydrographic Cross-Sections. It is evident that ground water flow is a subtle reflection of surface topography in this area. Ground water flow in the underlying bedrock is generally directed towards the south, towards the Bay of Quinte.

3.4 BIOLOGICAL ENVIRONMENT

3.4.1 AQUATIC ENVIRONMENT

3.4.1.1 FISHERIES

The Ministry of Natural Resources has no field survey information defining fish species composition and stream habitat for Potter Creek. However, background information on fisheries is provided in **Vegetation and Wildlife Survey of Potter Creek and South Quinte Conservation Area Marina Inventory** by the Moira River Conservation Authority (1991). This report includes details on streambed substrate and bank characteristics along the various reaches of Potter Creek, and notes the occurrences of fish species.

3.4.1.2 WETLANDS

The Ministry of Natural Resources has not evaluated the wetlands within the watershed and has no data relating to their vegetation or wildlife characteristics.

Background information on wetland communities and species composition for the basin is provided in:

- **Vegetation and Wildlife Survey of Potter Creek and South Quinte Conservation Area Marina Inventory** by the Moira River Conservation Authority (1991) for a small riverine marsh-swamp complex along a tributary of Potter Creek, including notes on plant communities, plant and animal species, and substrate; and,
- Background information on the Aikins wetland provided by Ducks Unlimited, including comments on aquatic vegetation and wildlife, nesting and staging habitat, and marsh substrate.

Environment Canada (1985) produced a series of wetland maps at a scale of 1:50,000 for southern Ontario, which show the distribution of wetlands lost prior to 1967, wetlands lost between 1967 and 1982, and existing wetlands (as at 1985). These were also reviewed.

3.4.2 TERRESTRIAL ENVIRONMENT

3.4.2.1 VEGETATION

Vegetation and Wildlife Survey of Potter Creek and South Quinte Conservation Area Marina Inventory by the Moira River Conservation Authority (1991) provides details on riparian plant cover along the various reaches of Potter Creek, and provides lists of all plant species recorded during the survey. General descriptions of the vegetation are provided for specific localities within the basin in **Quinte Conservation Area Waterfront Study** (MIE Consulting Engineers and M.M. Dillon Limited 1990), **Quinte Conservation Area** (Totten Sims Hubicki Associates Limited 1977), and the draft **Potter Creek Community: A Secondary Plan** (Township of Sidney Planning Department 1985).

3.4.2.2 WILDLIFE

Vegetation and Wildlife Survey of Potter Creek and South Quinte Conservation Area Marina Inventory by the Moira River Conservation Authority (1991) provides details on riparian wildlife habitat and wildlife sightings along the various reaches of Potter Creek, and provides lists of all species recorded during the survey. The presence of waterfowl are noted in background information provided by Ducks Unlimited on the Aikins wetland. The Federation of Ontario Naturalists provided data from the Atlas of Breeding Birds of Ontario and the Ontario Rare Breeding Bird Program for the Potter Creek drainage basin. We contacted the data coordinator for the Atlas of Mammals of Ontario for species recorded for the drainage basin; however, information will not be available from this program until 1994. The Ontario Herpetofaunal Survey database provided a list of species recorded for the City of Belleville and environs.

General descriptions of wildlife are provided for specific localities within the basin in **Quinte Conservation Area Waterfront Study** (MIE Consulting Engineers and M.M. Dillon Limited 1990), **Quinte Conservation Area** (Totten Sims Hubicki Associates Limited 1977), and the draft **Potter Creek Community: A Secondary Plan** (Township of Sidney Planning Department 1985).

3.5 HUMAN ENVIRONMENT

3.5.1 EXISTING LAND USE AND DEVELOPMENT

The Potter Creek basin, with a total area of 3090 ha, is divided between the City of Belleville (227 ha) and Township of Sidney (2863 ha). The basin accounts for only a small proportion of both municipalities' areas and populations.

Existing land uses in the Potter Creek basin are shown on Drawing Number 1137-16-07 - Existing Land Use. This information was compiled by field observation in summer 1992, and analysis of aerial photographs taken in 1992.

The map shows the following basic patterns.

- Lands within the City of Belleville are largely developed, primarily for residential and community uses south of Moira Street West, residential uses between Moira Street West and the Ontario Hydro transmission line south of Bell Boulevard, and industrial and commercial uses north of the Ontario Hydro line.

- Lands within the Township of Sidney south of Moira Street West and east of Wallbridge-Loyalist Road support a number of isolated pockets of residential, industrial-commercial, and community uses, interspersed with cultivated and abandoned farmlands.

- Lands south of Moira Street West and west of Wallbridge-Loyalist Road are primarily abandoned farmlands.

- Lands within Sidney north of Moira Street West are primarily cultivated and abandoned farmlands, the major exception being an industrial-commercial node around the intersection of Wallbridge-Loyalist Road with Highway 401.

Belleville has a 1991 census population of 37,243, and is the major urban centre in the Bay of Quinte area. The only major undeveloped area within its boundaries is an eastern fringe recently annexed from the Township of Thurlow. The principal opportunities for redevelopment and intensification are in the downtown. The Potter Creek basin includes the City's largely suburban western fringe.

The only lands within the Belleville portion of the basin that are not yet developed or committed consist of:

- Lands west of Cascade Park, designated as community facility in the Belleville official plan. These are owned by the Hastings County Board of Education for a school site. No school development is planned or expected based on current residential development within Belleville, but the Board will likely retain the site to see if it will be needed to serve future development in adjacent portions of Sidney.

- Vacant industrial lots in the Bell Boulevard area west of Sidney Street. These are gradually being taken up.

- The undeveloped portion of the Reid's Dairy lands east of Sidney Street and between Bell Boulevard and Highway 401. There is no immediate prospect for development of these lands.

Sidney has a 1991 census population of 16,702. The Township's most important centre of population and economic activity is Canadian Forces Base Trenton. Other major population centres are the communities of Glen Miller, Batawa, and Bayside. Much of the population lives in smaller hamlets, subdivisions, and individual residences dispersed across the Township. The principal opportunities for further development are where municipal water or water and sewage services are currently available or could economically be extended: South Sidney (Bayside), Glen Miller (from Trenton), Batawa, and the southern portion of the Potter Creek basin (from Belleville or South Sidney).

The most important urban developments within the Sidney portion of the basin are as follows. There are no site-specific planning applications currently in process for significant new development in the basin.

- Hastings Park subdivision east of Avonlough Road, and Kenilworth Crescent subdivision immediately adjacent to Belleville.
- Ribbon residential development along Bridge Street, Marshall Road, and Moira Street West east of Marshall Road.
- Aldersgate senior citizens residence west of Avondale Road.
- Highway-oriented commercial development along Highway 2.
- Highway-oriented light industrial-commercial development around the Wallbridge-Loyalist Road-Highway 401 interchange.
- Loyalist College.

3.5.2 UTILITIES AND SERVICES

Within the boundary of the City of Belleville, the City of Belleville and the Belleville Utilities Commission (BUC) provide full sanitary and water services to the public and private sectors.

Within the Township of Sidney, the City of Belleville and the BUC provide:

Sanitary sewer services for:

- The sewage pumping station located at Avonlough Road and Bridge Street serving Loyalist College discharging through approximately 760 metres of 150 mm service from Avondale Road;
- Local sewers on Grosvenor Drive and Kensington Crescent;
- Service to Hastings County Home on Dundas Street.

Water services to:

- Over 125 residential properties;
- Towers Mall, Aldersgate Senior Citizens Home, Hastings County Manor, Moody School, and Loyalist College;
- A private water service to the light industrial-commercial development around the Wallbridge-Loyalist Road and Highway 401 interchange.

The existing sanitary and water services within the Township of Sidney and the Potter Creek watershed are shown on Drawing Number 1137-16-08 - Existing Services and Utilities. The major utilities and associated corridors for gas, hydro and oil are also located on Drawing Number 1137-16-08 - Existing Services and Utilities.

In 1985, the Township of Sidney retained Rysco Engineering to prepare a report entitled **South Sidney & Potter Creek Community - Water & Sanitary Services Feasibility - Parts 1 and 2.** The Study provided servicing alternatives for the South Sidney and Potter Creek area inclusive of detailed engineering calculations and capital estimates of cost. Alternatives included new treatment facilities along with pumping stations and distribution networks as well as alternatives to upgrading existing sewerage and water treatment facilities operated by the City of Belleville. The Township has not implemented any of the recommendations contained in the Rysco Engineering report.

3.5.3 MUNICIPAL PLANNING POLICIES

Belleville's Official Plan was approved in 1976. The City is beginning an official plan review which will lead to a new plan. Within the Potter Creek watershed, the plan's designations, which are shown on Drawing Number 1137-16-09 - Official Plan Designations, basically reflect existing uses. All residential development in the basin is classed as either Density 1 (single detached and two-family dwellings only, not more than 19.7 units per gross hectare), or Density 2 (single detached, two- and three-family, and converted dwellings, not more than 24.7 units per gross hectare).

Sidney's new Official Plan was approved in 1993. Key policies of the plan relevant to the future development of the Potter Creek watershed are as follows.

- Priority areas within the Township for the provision of municipal water and sewage services are, first, South Sidney (see below) and the industrial-commercial node around the Highway 401-Wallbridge-Loyalist Road intersection, and second, the Potter Creek area. Growth is to be directed "primarily" to the first priority areas. The plan's development concept is based on an assumed population of 19,117 in 2011, suggesting a total growth of about 2,500 over the next 20 years.

- A Potter Creek secondary planning area is identified, consisting of the lands between Wallbridge-Loyalist Road, Moira Street West, Bay of Quinte, and the City of Belleville boundary, plus the south halves of the first two township lots west of the City boundary and north of Moira Street West. The plan provides interim land use designations for the secondary planning area (see Drawing Number 1137-16-09 - Official Plan Designations), requires that all new development be on municipal water and sewage services, and indicates that preparation of a comprehensive secondary plan must precede any significant development. The interim designations generally recognize existing development, and permit new urban residential development east of Avonlough Road only. An overall maximum density of 25 units per net hectare is indicated for urban residential development.

- A South East secondary planning area is identified, consisting of the lands between Wallbridge-Loyalist Road, Highway 401, Moira Street West, and the City boundary, excepting the southeastern portion included in the Potter Creek secondary planning area as above. The plan provides interim land use designations for the secondary planning area (see Drawing Number 1137-16-09 - Official Plan Designations), requires that all new development be on municipal water and sewage services, and indicates that secondary plan preparation (on a phased basis or for the whole area) must precede any significant development.

- On the northwest, northeast, and southwest corners of the Highway 401-Wallbridge-Loyalist Road interchange and within the area so designated on Drawing Number 1137-16-09 - Official Plan Designations, businesses with minimal water use may be permitted on private services on a long term basis. Much of this area is already developed for this purpose.

- Most of the basin outside the secondary planning areas is designated agricultural. No significant non-agricultural development is permitted.

- Several blocks outside the secondary planning areas are designated rural, primarily at the northern end of the basin. These are poorer quality agricultural lands suitable for small scale non-agricultural rural development. A portion of the rural designation in the northwestern corner of the basin is identified as suitable for consideration of estate residential development on private services, subject to site suitability. Individual estate subdivisions are to be encouraged not to exceed 25 lots, and must average at least 0.8 ha per lot. The lands within the basin designated as having estate residential potential are only a small fraction of the lands so designated in the Township as a whole, and the plan suggests that not more than 240 estate lots be developed in the whole Township without further review.

- Areas designated as environmental constraint consist of the lands assumed to be subject to flooding along Potter Creek. In areas such as this where no engineered floodlines were available, the plan defers to the more detailed mapping of the zoning bylaw. Accordingly, the areas within Sidney shown as environmental protection on Drawing Number 1137-16-09 - Official Plan Designations are those zoned as Environmental Protection in the Township's zoning bylaw, not those designated environmental constraint in the plan; there are considerable differences between the two sets of designations.

The plan indicates that the Potter Creek secondary plan will be prepared "when servicing issues are clarified and development pressures warrant development beyond the infilling level" (section 10.2.4). The South East secondary plan(s) will be prepared "as appropriate and consistent with the growth strategy for employment reflected in [the official] plan".

Also relevant is the South Sidney Secondary Plan, approved by the Ontario Municipal Board in 1992 and now incorporated within the new official plan. The South Sidney secondary planning area includes the lands bounded by the Canadian Pacific rail line, Bay of Quinte, CFB Trenton, and Montrose Road. It also includes existing residential development immediately east of Montrose Road north and south of the CPR, extending east along Moira Street West to within about 300 m of the Potter Creek watershed. The Secondary Plan envisions an increase in population from 5,500 at present, to a target population of 8,000 somewhere between 2011 and 2021. The plan requires that all new development be on municipal water services, and in some areas, on municipal sewage services as well.

Although it is not clearly articulated in the planning documents, the lands between the eastern boundary of South Sidney (Montrose Road area) and the western boundary of the Potter Creek secondary planning area (Wallbridge-Loyalist Road) can be expected to function as a long term undeveloped buffer between the two urban communities. These lands include Quinte Conservation Area and, just west of the Potter Creek watershed, the Bay of Quinte Country Club; both these properties are designated as open space in Sidney's Official plan.

3.5.4 CULTURAL HERITAGE

There is only one known **archaeological** site in the Potter Creek basin. Its approximate (for site protection) location is shown on Drawing Number 1137-16-10 - Resource Production/Recreation/Heritage. This Late Archaic (1000 BC and earlier) site was identified in 1975, at which time it was already disturbed by development.

The lack of known archaeological heritage in the basin may reflect a lack of surveys more than anything else. The Ministry of Culture, Tourism and Recreation identifies the basin as an area of moderate to high potential for further discoveries, and would recommend further assessment prior to any major development.

There are no significant **built heritage** resources in the Belleville portion of the Potter Creek watershed. In the Sidney portion, five significant houses have been identified by local citizens working with the Architectural Conservancy of Ontario; these are shown on Drawing Number 1137-16-10 -Resource Production/Recreation/Heritage. These houses, all north of Highway 401, all predate 1860; the Hartman-McComb house is the oldest dateable house in Sidney (1807). All these houses are of architectural interest; all continue to be used as residences (one is a bed and breakfast), and are in good condition. None is designated under the Ontario Heritage Act.

3.5.5 RECREATION AND OPEN SPACE

The principal public park within the Potter Creek basin is **Quinte Conservation Area**, owned and operated by the Moira River Conservation Authority. Key characteristics of Quinte are as follows.

- The property is 127 ha in area. It includes the mouth of Potter Creek, and the first 1 km of the creek above Highway 2.
- The portion south of Highway 2 is entered from the highway opposite the Conservation Authority headquarters. There are 40 parking spaces, a small number of picnic tables, and privies.

- Within the conservation area, there is no boat launch onto the Bay of Quinte, and driving onto the bay ice is not permitted, but both these activities are possible at the end of the Wallbridge-Loyalist Road allowance immediately to the east.

- Principal uses of the southern portion are for windsurfing access and parking in summer, and ice fishing parking in midwinter.

- The portion north of Highway 2 is entered from the highway at the Conservation Authority headquarters, which are within the conservation area. There are 10 parking spaces, and privies.

- There are about 5 km of hiking/groomed ski trails extending north from the Conservation Authority headquarters through the abandoned farmlands and regenerating forests that characterize the conservation area.

- Use of the northern portion is low.

- No organized programs are provided, though some youth groups do use the property.

- No fees are charged.

A 1977 master planning study recommended intensive recreational development of Quinte (Totten Sims Hubicki Associates Limited 1977). The study was never proceeded with and is not considered to be either feasible or desirable from today's perspective. More recently, a master planning study of the southern portion of the property recommended development of a 112 slip marina, with berthage in the Bay of Quinte proper east of the creek mouth (MIE Consulting Engineers and M.M. Dillon Limited 1990). However, the study's proposals no longer reflect the views of the Authority. The Authority would prefer to see Quinte remain essentially undeveloped and devoted to passive recreation, and also doubts the financial feasibility of a marina, at least at present.

The Conservation Authority does not own any other lands within the Potter Creek basin.

Belleville has four parks within the Potter Creek basin, as shown on Drawing Number 1137-16-10 - Resource Production/Recreation/Heritage. These total 11 ha in area. Centennial Park is dominated by ball diamonds and is the City's premier baseball/softball location. The other parks are neighbourhood parks with limited playground equipment, plus a ball diamond at Cascade Park. All four parks are intensively managed landscapes. Cascade Park includes the watercourse and banks of about 600 m of the only stretch of Potter Creek within the City.

The City has not identified environmental protection as a priority on any of these lands. A parks classification study is expected to be completed during 1993, and will determine management approaches and priorities appropriate for each park.

The northern portion of the Sir James Whitney School property, owned by the Ontario Government, is currently used for soccer pitches and a ball diamond by agreement with the City. The City and the Hastings County Board of Education are currently negotiating a long term lease with the Province, whereby the lands would be considered part of the City parks system and further sports facilities would be developed (Drawing Number 1137-16-10 - Resource Production/Recreation/Heritage).

Within the Potter Creek basin north of the Canadian National rail line, the City feels that the current supply of parkland is adequate. South of the CNR, parklands are considered to be deficient, and the City would like to acquire property in or near the basin over and above the Whitney School agreement.

Belleville's official plan designates the Ontario Hydro right-of-way south of Bell Boulevard as recreational. The intent is to encourage the use of the right-of-way for passive recreation and open space interconnection. No formal recreational use is currently occurring, but a report on a City-wide pathways system is expected to be completed during 1993, and it is expected that the right-of-way will form part of a bikeway system.

Sidney has one park of 0.4 ha within the Potter Creek basin, in the Hastings Park subdivision. The

Township is currently negotiating the donation of about 4 ha south of Tucker's Corners (Drawing Number 1137-16-10 - Resource Production/Recreation/Heritage). This woodlot would remain in its natural state, and serve primarily as an outdoor program base for the Township's Recreation Department.

3.5.6 RESOURCE PRODUCTION

The Ministry of Natural Resources has **Woodlands Improvement Act** agreements with six Potter Creek basin landowners north of Highway 401 (see Drawing Number 1137-16-10 - Resource Production/Recreation/Heritage). These agreements run for 15 years and may only be cancelled by landowners subject to payment of penalties, and represent at least short term commitments to resource production by the landowners. One of the agreement areas consists of the woodlot being acquired by the Township of Sidney.

There are no **pit and quarry licences** in the basin.

The basin's largest wetland, just south of Tucker's Corners, is subject to an agreement between **Ducks Unlimited** (Canada) and the landowners (see Drawing Number 1137-16-10 - Resource Production/Recreation/Heritage). The agreement, concluded in 1985 for a 20 year term, covers 36 ha and involved construction of a dike and dam to maintain water levels suitable for waterfowl production, as well as a borrow ditch to permit agricultural drainage to bypass the wetland.

4.0 NATURAL SYSTEM INVENTORY AND PLANS

4.1 SITE RECONNAISSANCE AND SURVEYS

4.1.1 HYDRAULIC STRUCTURES AND WATERCOURSE

In the summer of 1992, a site reconnaissance and field survey of Potter Creek and major creek crossings were undertaken to:

- Familiarize the Study Team with the study area;
- Establish Manning's "N" values for hydraulic modelling of the watercourse and overbanks;
- Obtain physical dimensions and elevations of the major structures crossing the watercourse to assist in the development of the hydraulic model of the creek system;
- To obtain typical cross-sections of Potter Creek and tributaries for the development of the hydraulic model;
- To obtain photographs to document existing physical conditions.

4.1.2 EROSION

In September 1992 and April of 1993, field reconnaissances were undertaken to identify active erosion sites.

Because of the significant growth in vegetation, the fall reconnaissance revealed only a few active erosion sites. The lack of any high runoff events over the summer and early fall periods enabled the areas experiencing low to moderate erosion rates to improve through natural re-stabilization of the banks with the growth of dense vegetation. As a result, a second field reconnaissance was undertaken in the spring shortly after the spring freshet and before any vegetation began to appear.

For the spring reconnaissance, the main channel and tributaries were divided into identifiable reaches. Sites illustrating low, moderate and high erosion potential were noted and photographed. As suspected, additional active erosion sites were found as a result of bank full flow conditions with little vegetation to protect the channel from higher velocities.

Table 4-1 provides the watercourse reach, photo number and erosion description. A summary of the reconnaissance and typical photographs are presented in Support Document Number 1 - Erosion Field Reconnaissance. The selected reaches and active high erosion sites are shown on Drawing 1137-16-11 - Hazard Lands.

4.1.3 PHYSICAL ENVIRONMENT

4.1.3.1 <u>AQUATIC - WATER QUALITY MONITORING</u>

At monthly intervals, a water quality sampling program was established at six locations on Potter Creek for the following water chemistry parameters:

- conductivity (umhos/cm)
- chloride (mg/L)
- pH
- turbidity (F.T.U.)
- alkalinity (as mg/L $CaCo_3$)
- BOD_5 (mg/L)
- phenol (µg/L)
- total phosphorus (µg/L)
- ammonia nitrogen (mg/L)
- un-ionized ammonia nitrogen (mg/L)
- nitrate nitrogen (mg/L)
- nitrite nitrogen (mg/L)
- total Kjeldahl nitrogen (mg/L)
- copper (mg/L)
- nickel (mg/L)
- lead (mg/L)
- zinc (mg/L)
- iron (mg/L)
- manganese (mg/L)
- aluminum (mg/L)
- arsenic (mg/L)
- cadmium (mg/L)
- cobalt (mg/L)
- chromium (mg/L)

TABLE 4.1
EROSION LOCATION AND DESCRIPTION

REACH ID.	PHOTO NUMBER	EROSION DESCRIPTION
1	107	No Erosion Evident
2	108-110	Bank Erosion - Root Exposure
3		No Erosion Evident
4	111	Under Cutting - Bank Failure
5	112-113	No Erosion Evident
6	2-8	Bank Erosion - Root Exposure, Under Cutting - Root Exposure - Bank Failure
7		No Erosion Evident
8	9-14	Rills, Bank Erosion - Root Exposure
9	24-28	Bank Erosion - Root Exposure, Under Cutting - Bank Failure
10	21,22,29,30	Bank Erosion - Root Exposure, Under Cutting - Bank Failure, Rills
11		No Erosion Evident
12	45-47	Bank Erosion - Root Exposure, Under Cutting - Root Exposure - Bank Failure
13	48-52	Bank Erosion - Root Exposure, Under Cutting - Root Exposure - Bank Failure
14	53-60	Bank Erosion - Root Exposure, Under Cutting - Root Exposure - Bank Failure, Cattle Crossing
15		No Erosion Evident
16	68-72	Bank Erosion - Root Exposure, Under Cutting - Root Exposure - Bank Failure - Tree Failure
17	65-67	No Erosion Evident
18	92-95	Bank Erosion - Root Exposure, Under Cutting - Bank Failure
19	90-91	Under Cutting - Root Exposure - Bank Failure
20	86-89	Bank Erosion - Root Exposure, Tree Failure
21	85	Under Cutting - Root Exposure - Bank Failure - Tree Failure
22	82-84	No Erosion Evident
T 1		No Erosion Evident
T 2		No Erosion Evident
T 3		No Erosion Evident
T 4		No Erosion Evident
T 5.1	62-64	Under Cutting - Bank Failure
T 5.2	61	Bank Erosion - Root Exposure
T 5.3		No Erosion Evident
T 5.4		No Erosion Evident
T 5.5	31-44	Bank Erosion, Under Cutting
T 5.6	15-18	Bank Erosion - Root Exposure
T 5.7	19-20	No Erosion Evident
T 6.1	73-79	Bank Erosion - Root Exposure, Under Cutting - Root Exposure - Bank Failure - Tree Failure
T 6.2	80-81	Under Cutting - Bank Failure, Rills
T 6.3	100-106	Under Cutting - Bank Failure
T 6.4	96-99	Bank Erosion - Root Exposure

- fecal coliform (#/100 mL)
- fecal streptococcus (#/100 mL)
- *Escherichia coli* (#/100 mL)

Concentrations of un-ionized ammonia were estimated from measured free ammonia levels on the basis of pH and water temperature. Nitrogen to phosphorus ratios were determined by summing total Kjeldahl, nitrate and nitrite levels and dividing the total by total phosphorus concentrations.

Locations of the six sample sites are shown in Figure 4-1 and descriptions of the lands draining into each site are as follows:

- PC 30 - tributary to northwestern part of watershed draining predominantly agricultural lands and some upland woodlots
- PC 31 - tributary originates in a large wetland maintained by Ducks Unlimited and drains primarily agricultural land and some rural residential development
- PC 20 - stream originates in a wetland complex and drains commercial, industrial, and rural residential development in the area of Highway 401 and Wallbridge-Loyalist Road, with some agricultural (including livestock) and forested lands
- PC 10 - receives contributions from PC 30, PC 31 and PC 20 plus runoff from agricultural lands
- PC 11 - tributary drains eastern side of watershed including urban lands, successional and agricultural (including orchards) fields and a landfill site
- PC 01- reflects drainage of entire watershed of Potter Creek.

At each site, "grab" samples were collected and delivered to the Ontario Ministry of the Environment and Energy in Kingston for analyses. Temperature and dissolved oxygen readings were taken in the field with a portable YSI metre (Model 54A), calibrated against a wet Winkler analysis undertaken just prior to sample collection.

On August 11, 1992, temperature and dissolved oxygen measurements were taken at four-hour intervals at each station to determine diurnal changes.

4.1.3.2 Terrestrial

Prior to undertaking the field investigation of the landbase, aerial photographic interpretation was conducted in order to become familiar with the general biophysical characteristics of the study area. Black and white stereo pairs taken in the summer of 1992 were used for this purpose. Landbase patterns were marked on mylar overlays, which were subsequently taken into the field for verification of interpreted information.

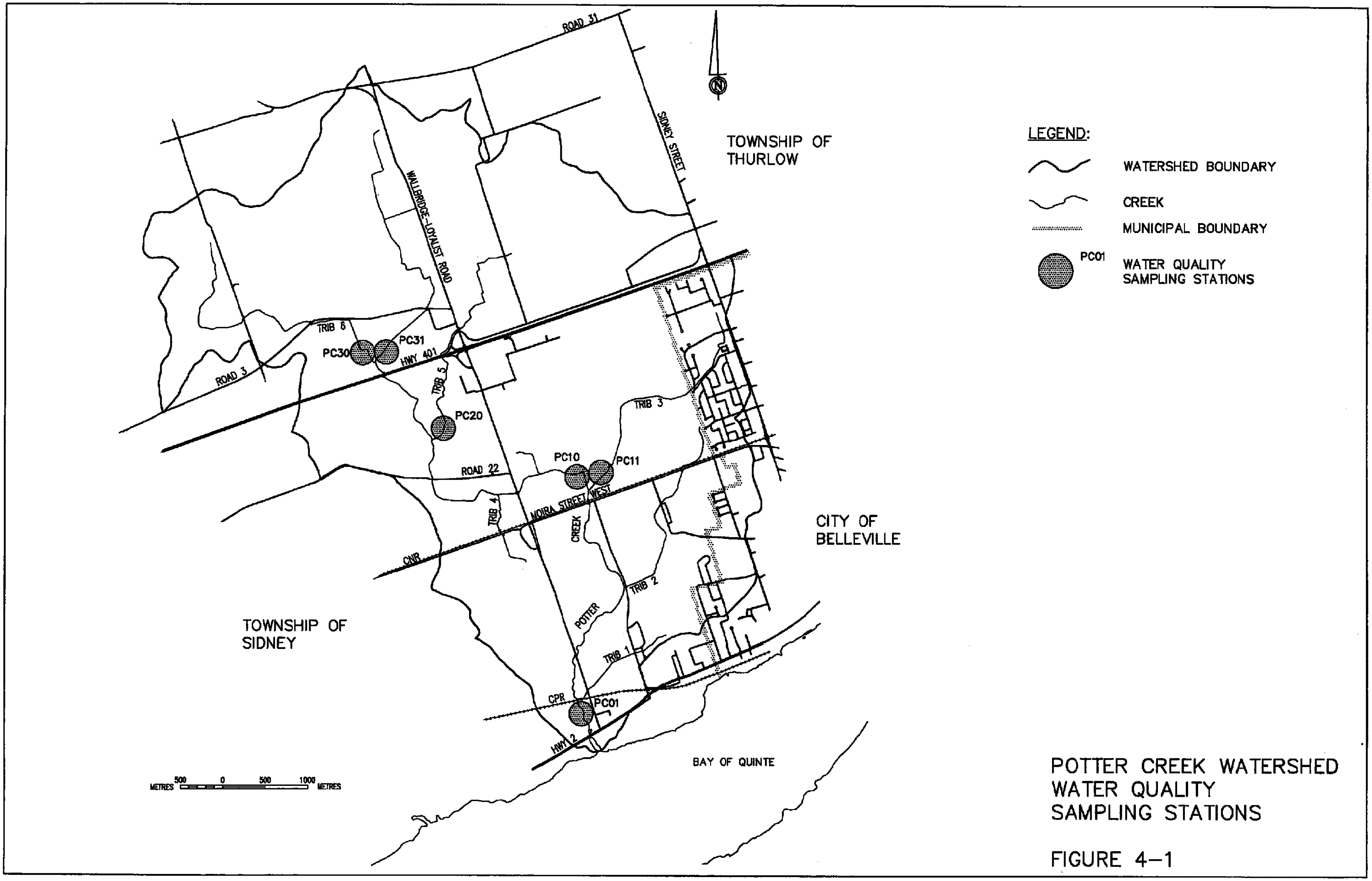
Field data for the land base inventory were collected on August 27, September 9-10, and September 24-25, 1992. The following physical data were recorded at representative check points distributed throughout the drainage basin:

- soil texture, depth, compaction, and colour characteristics to a maximum depth of 1.2 m using a manual soil auger.
- site drainage conditions based on observations of soil moisture through augured profiles, local topography, and indicator plant species.
- slope %, measured directly using a manually held clinometer.

4.1.4 Biological Environment

4.1.4.1 Wetlands

Three wetlands (Drawing Number 1137-16-13 - Resource Features) within the Potter Creek drainage basin were identified for detailed investigation and evaluation according to the Ministry of Natural Resources **System for Evaluating Wetlands in Southern Ontario**. Prior to undertaking the field investigation, aerial photographic interpretation was conducted in order to identify at a preliminary level the physiognomic characteristics and extent of the various plant communities constituting each system. Black and white stereo pairs taken in the summer of 1992 were used for this purpose. Plant community boundaries were plotted on mylar overlays at the



POTTER CREEK WATERSHED
WATER QUALITY
SAMPLING STATIONS

FIGURE 4–1

scale of the photography (1:10,000, or 1 cm represents 100 m). The mylars were subsequently taken into the field for verification of interpreted information.

A qualitative field inventory was conducted on September 24 and 25, 1992. The following information was collected on each wetland:

- overstorey and understorey plant community composition and physiognomy, and notes on dominance (i.e., biomass and abundance) based on subjective observations;
- wildlife sightings, including direct evidence of species (e.g., beaver dams, muskrat houses, etc.), and notes on habitat characteristics and overall quality for various species;
- bottom substrate characteristics;
- extent of open water areas and depth characteristics.

4.1.4.2 FISH AND FISH HABITAT

A fish sampling program was conducted at nine stations (Drawing Number 1137-16-13 - Resource Features) distributed along Potter Creek and its tributaries on November 14-15, 1992. A fish sampling permit was obtained from the Ministry of Natural Resources for the purpose of fish collection-identification. Sampling consisted only of seining and recording the fish species and total numbers caught at each site. In addition to the sample data, notes were recorded on creek and habitat characteristics, including depth, width, flow, bottom substrate, and instream and bank cover characteristics.

4.1.4.3 TERRESTRIAL HABITAT

Field data for the biological features of the drainage basin were collected on August 27, September 9-10, and September 24-25, 1992 at the same check points as the physical data (see Section 4.1.3.2). The following biological information was recorded:

- overstorey and understorey plant community composition and physiognomy, and notes on dominance (i.e., biomass and abundance) based on subjective observations;
- wildlife sightings, including direct evidence of species (e.g., scat, tracks, etc.), and notes on habitat characteristics and overall quality for various species.

Plant voucher specimens were collected to confirm species identities at the Erindale College herbarium, University of Toronto. A complete list of vascular plant species was compiled from all sites visited. In this regard, plant nomenclature is consistent with the following authorities:

- Lycopodiaceae to Aspleniaceae - Britton, D.F. 1984-84. Checklist of Ontario Pteridiophytes. Parts 1 and 2. The Plant Press 2(4) and 3(1).
- Taxaceae to Orchidaceae - Voss, E.G. 1972. Michigan Flora. Part 1: Gymnosperms and Monocots. Cranbrook Institute of Science, and University of Michigan Herbarium. Bulletin 55.
- Saururaceae to Cornaceae - Voss, E.G. 1985. Michigan Flora. Part 2: Dicots. Cranbrook Institute of Science, and University of Michigan Herbarium. Bulletin 59.
- Cornaceae to Asteraceae - Gleason, H.A. 1974. The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada. Vol. 3. Hafner Press, New York.

A photographic record of various representative site conditions was also taken.

4.2 TECHNICAL INVESTIGATIONS AND STUDIES

4.2.1 FLOOD PLAIN MAPPING

4.2.1.1 PHOTOGRAMMETRIC MAPPING

On behalf of the Authority, EGA has arranged for and coordinated the preparation of all photogrammetric mapping. Airmap Limited, a mapping consultant from Ottawa was awarded the assignment of map production involving aerial photography, ground control, aerial triangulation and the preparation of digital topographic datum including digital terrain elevation models.

As defined by the Authority, the photogrammetric mapping is digital 1:2000 fairdrawn type with a 1 metre contour interval and 0.5 metre auxiliary contours.

All work related to the mapping component of the study has been carried out as outlined in **Technical Specifications for Large Scale Topographic Mapping for the Canada-Ontario Flood Damage Reduction Program, Version 3.0** and in **Surveys and Mapping Procedures for Flood Plain Mapping** - Revised 1984.

Specifically, EGA has:

- Determined the extent of mapping required by completing an airphoto interpretation assessment of existing air photos and the 1:25,000 topographic maps.
- Researched all available records of ground control in the study area which were to be included as part of the tender document for topographic mapping.
- Prepared a draft tender document and submitted three copies for the approval to the Study Committee.
- Prepared the final tender document and distributed to selected mapping firms approved by the Study Committee.
- Evaluated tenders and recommended selection of Airmap Limited to the Study Committee.
- Monitored the progress of mapping.
- Reviewed invoices by Airmap Limited and recommending payment, if appropriate, by the Conservation Authority.

EGA has checked the proposed mapping extent and recommended adjustments deemed necessary to provide sufficient mapping coverage to delineate the Regulatory floodline. Also, prior to stereo compilation, EGA obtained aerial triangulation results from the mapping contractor and forwarded them to the Land and Resource Information Branch, Ministry of Natural Resources for record purposes.

EGA completed the field component of the various components of the topographic mapping as outlined in Section 8.04, Surveys and Mapping Procedures (Revised 1984), Technical Guidelines. The Study Team has submitted a report on inspection of horizontal and vertical accuracy to the Study Committee which has informed the members of the results of the checks of various components of the topographic mapping.

EGA prepared digital files for the regulatory floodline, fill line and cross-section locations and attributes. This information has been forwarded to Airmap Limited and added to the digital topographic data base. Airmap Limited has prepared the digital data base files and the final three sets of hard copy flood risk maps. EGA has forwarded the files and the hard copy flood risk maps to the Conservation Authority for record purposes.

The digital data base files are suitable for use with the AutoCAD drafting base software and the SPANS GIS software.

4.2.1.2 <u>HYDROLOGY</u>

4.2.1.2.1 <u>General</u>

Hydrology is the science that deals with the properties, distribution and circulation of water. The circuit of water movement from the atmosphere to the earth and return to the atmosphere through various stages or processes, including precipitation, interception, runoff, infiltration, percolation, storage, evaporation and transpiration, is known as the hydrologic cycle.

In any hydrologic study, quantitative information in the rainfall-runoff relationships of the study area is of prime importance. Natural precipitation varies greatly in time and space, and methods for quantifying it depend upon the technique employed for runoff estimation.

In applying any runoff estimation method, major difficulties lie in considering:

- Regional climatological, hydro-physiographical, and geological differences.
- Differences in basin characteristics such as drainage area size and shape, channel length and slopes, potential storage, etc.
- Changing basin characteristics such as unregulated to regulated and land usage.
- Availability of data.
- Statistical significance.

As defined by the Flood Plain Planning Policy Statement, the Regulatory flood within the Moira River Conservation Authority's jurisdiction is the 100 year flood.

In general, the watershed of Potter Creek, because of its size and location, will produce maximum peak flows and volume of runoff for the Regulatory (100 year) flood and the more frequent return events (eg. 10 year flood) as a result of high intensity rainfall events.

4.2.1.2.2 Procedures

In catchments where no streamflow records are available, flood hydrographs are computed using synthetic unit hydrographs. This procedure involves applying a design storm, determining rainfall-runoff relationships, and routing and summing the individual reach/basin hydrographs to various points of interest.

For this particular study, the computer program QUALHYMO was used to generate the flood flows of the various return frequency events for the Potter Creek watershed.

The Potter Creek watershed (Figure 4-2) was delineated into 17 sub-basins with the aid of the 1:25000 topographic map and the aerial photography. Existing land use plans from the City of Belleville, the Township of Sidney and Drawing Number 1137-16-07 - Existing Land Use in conjunction with the hydrologic soil groups were utilized to determine the weighted Curve Numbers (CN). The weighted Curve Numbers of each sub-basin were used to estimate the minimum value of the air void storage in the soil (SMIN), the maximum air void storage (SMAX) and the initial antecedent precipitation index (API). Based on the land use and with the aid of the air photographs, the percent imperviousness of each sub-basin was estimated.

For each sub-basin the equivalent slope of the flow path was determined with the aid of the 1:2000 and 1:25000 topographic maps. Upon obtaining the equivalent slopes, the times to peak (T_p) were calculated based on the Bransby-Williams, Airport, Kirpich and Williams formulae (see Appendix C).

Initially the INTERHYMO (OTTHYMO-89) program was used to obtain the 100 year and 5 year peak flood flows, providing an indication towards the magnitude of the flood events. Subsequent simulations were carried out using the QUALHYMO program.

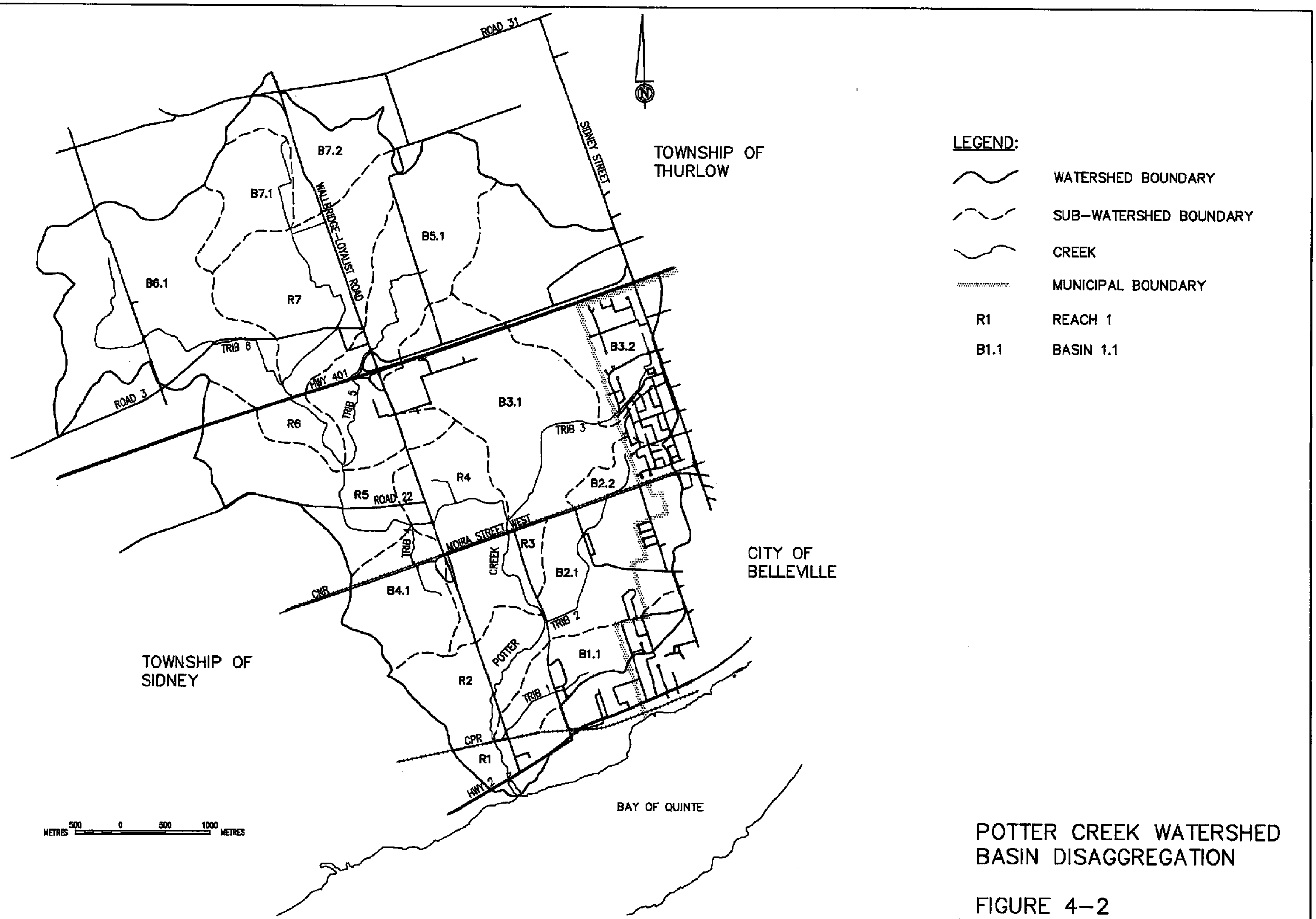
4.2.1.2.3 Hydrologic Parameters

Soils and Land Use

The hydrologic soil cover complex numbers or Curve Numbers (CN), are a function of the soil types and land use classifications. The soil types were categorized into their respective hydrologic soil groups. The existing land use for the Potter Creek watershed was obtained from land use plans of the Township of Sidney and the City of Belleville. Based on the land use, the percent imperviousness of each sub-basin, where significant, was also determined. The Curve Numbers and percent imperviousness of the sub-basins are provided in Table 4.2.

SMIN, SMAX and API

The soil storage component (S) in the Soil Conservation Services (SCS) method is a function of CN. The maximum storage, SMAX, is defined as approximately 1.18*S under Antecedent



POTTER CREEK WATERSHED
BASIN DISAGGREGATION

FIGURE 4–2

TABLE 4.2 CURVE NUMBERS AND PERCENT IMPERVIOUSNESS			
Sub-Basin	Drainage Area (ha)	Curve Number (AMC II)	Percent Imperviousness
Reach 1	57.9	77	21
Basin 1.1	114.5	79	15
Reach 2	140.9	71	---
Basin 2.1	210.4	80	12
Basin 2.2	46.2	77	11
Reach 3	100.9	82	---
Basin 3.1	372.6	81	8
Basin 3.2	332.8	80	13
Reach 4	120.8	80	---
Basin 4.1	129.5	75	---
Reach 5	203.4	80	---
Basin 5.1	321.5	77	---
Reach 6	44.4	79	---
Basin 6.1	405.3	70	---
Reach 7	266.7	76	---
Basin 7.1	104.0	77	---
Basin 7.2	118.9	70	---
Total	3090.4		

Moisture Condition I (AMC I), or S under AMC I is approximately equal to 0.85*SMAX. The minimum storage, SMIN, is defined as approximately 0.15*SMAX under AMC III, i.e. the soil is near saturation. The Antecedent Precipitation Index (API) is a value used to provide an indication of soil moisture conditions prior to a storm occurring. It is assumed that the soil moisture condition is partially saturated under AMC II.

Table 4.3 gives the SMIN, SMAX and API values of the sub-basins.

SVOL, SWILT and SFIELD

The parameter SVOL is the starting groundwater reservoir content. The parameter SWILT is the value of SVOL at wilting point, and SFIELD is the value of SVOL corresponding to field capacity soil moisture condition.

In general, the soils in the watershed are shallow overlying bedrock with a low permeability and drain laterally. As such the SVOL value is small (5 mm) with corresponding small numbers for SWILT (0.5 mm) and SFIELD (1 mm).

TABLE 4.3 SMIN, SMAX AND API VALUES			
Sub-Basin	SMIN (mm)	SMAX (mm)	API (mm)
Reach 1	31.2	208	75.9
Basin 1.1	27.6	184	67.5
Reach 2	41.3	275	104.0
Basin 2.1	26.3	175	63.5
Basin 2.2	31.2	208	75.9
Reach 3	23.1	154	55.8
Basin 3.1	25.2	168	59.6
Basin 3.2	26.3	175	63.5
Reach 4	31.2	175	63.5
Basin 4.1	27.6	226	84.7
Reach 5	43.1	175	63.5
Basin 5.1	32.4	208	75.9
Reach 6	31.2	184	67.5
Basin 6.1	43.1	287	109.0
Reach 7	32.4	216	80.2
Basin 7.1	31.2	208	75.9
Basin 7.2	43.1	287	109.0

Times to Peak

Upon obtaining the equivalent slopes, the times to peak for the sub-basins were calculated using the Bransby-Williams, Airport, Kirpich and Williams formulae for comparison. For pervious areas, the times to peak obtained using the Airport formula were selected and for impervious areas, the times to peak calculated by the Bransby-Williams formula were selected as input data.

Except for a few sub-basins, the times to peak obtained by the Bransby-Williams formula approximately equalled the times to peak using the Williams formula. The Airport formula gave times to peak which were about two times as long as the Bransby-Williams times to peak. As expected, the Kirpich formula resulted in shorter times to peak, as compared to the times to peak derived from the other equations.

The Bransby Williams, Airport, Kirpich and Williams equations are provided in Appendix C. The times to peak of the sub-basins in the Potter Creek watershed are given in Table 4.4. Where applicable, the times to peak of the impervious areas are also given.

TABLE 4.4 TIMES TO PEAK		
Sub-Basin	Times to Peak (Tp)	
	Pervious Areas	Impervious Areas
Reach 1	1.02	0.39
Basin 1.1	1.79	0.45
Reach 2	1.67	---
Basin 2.1	2.03	0.37
Basin 2.2	1.36	0.22
Reach 3	1.48	---
Basin 3.1	3.06	0.65
Basin 3.2	2.11	0.30
Reach 4	2.33	---
Basin 4.1	1.38	---
Reach 5	2.52	---
Basin 5.1	2.92	---
Reach 6	1.61	---
Basin 6.1	2.22	---
Reach 7	2.46	---
Basin 7.1	1.55	---
Basin 7.2	1.18	---

Rainfall Depths and Distribution

The total rainfall depths for the various return frequency storm events for the Potter Creek watershed were obtained from the Belleville meteorological station, Station No. 6150689, recorded and published by Atmospheric Environment Services (AES).

The rainfall depths were reduced by 2% using the Areal Reduction Curves published in the Flood Plain Management in Ontario Technical Guidelines.

The AES 30% Southern Ontario 12-Hour distribution was used to spatially distribute the total rainfall amounts.

The total rainfall depths and the AES 30% Southern Ontario 12-Hour distribution are provided in Tables 4.5 and 4.6, respectively.

4.2.1.2.4 Results

The hydrologic parameters of the Potter Creek watershed were assembled as computer data input and analyzed utilizing the computer program, QUALHYMO, for the 12-hour duration 100, 50, 25,

TABLE 4.5 12-HOUR DESIGN RAINFALL DEPTHS	
Storm Event (yr)	12-Hour Rainfall Depths (mm)
5	49.6
10	55.9
25	63.8
50	69.7
100	75.5

TABLE 4.6 AES 30% SOUTHERN ONTARIO 12-HOUR DISTRIBUTION		
Time (hr)	Rainfall Distribution (%)	
	Incremental	Cumulative
0	0	0
1	15	15
2	25	40
3	22	62
4	14	76
5	12	88
6	8	96
7	3	99
8	1	100

10 and 5 year storm events. A watershed schematic of the QUALHYMO computer model is illustrated in Figure 4-3. The results of the simulations for the various return frequency storm events are summarized in Tables 4.7 and 4.8. Table 4.7 gives the resulting peak inflow for each sub-basin. The final reach routed peak outflows are provided in Table 4.8.

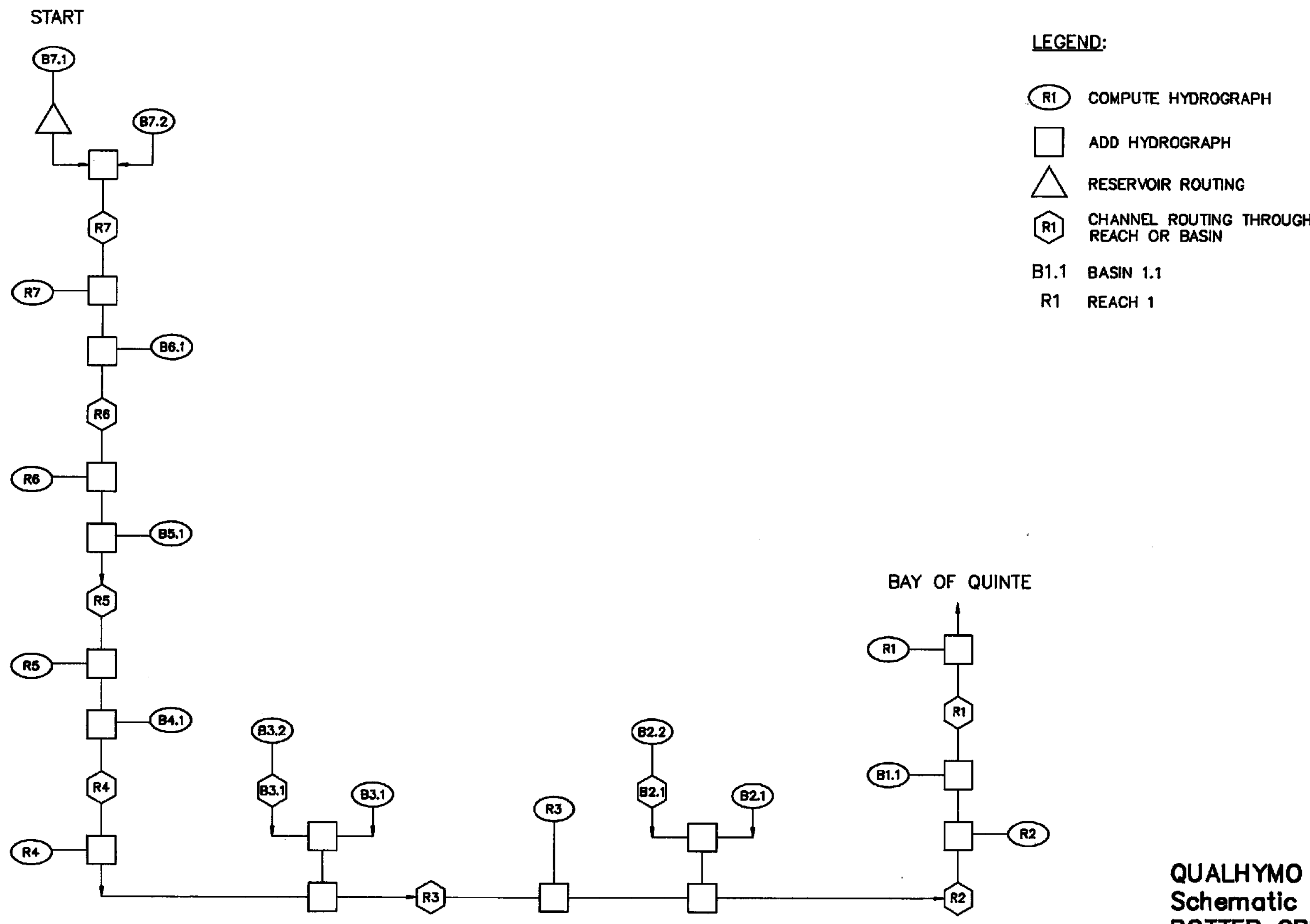
The results of the hydrologic analysis and the methodologies employed were subsequently approved by the Conservation Authority.

The generated peak flood flows were utilized in the assessment of the Potter Creek hydraulic regime.

4.2.1.3 HYDRAULICS

4.2.1.3.1 Hydraulic Model

The floodline, or water surface elevation, for the Regulatory and the lower return frequency flood events is a function of the design flows and the ability of the channel, flood plain and river crossings to carry or pass these flows. In order to



QUALHYMO Model
Schematic
POTTER CREEK

FIGURE 4–3

TABLE 4.7 SUB-BASIN PEAK FLOWS					
Sub-Basin	Peak Local Inflows (cms)				
	100 Year	50 Year	25 Year	10 Year	5 Year
Reach 1	1.32	1.17	1.03	0.84	0.70
Basin 1.1	2.28	2.03	1.78	1.47	1.22
Reach 2	2.07	1.82	1.58	1.28	1.04
Basin 2.1	4.42	3.94	3.48	2.86	2.39
Basin 2.2	1.06	0.95	0.83	0.69	0.57
Reach 3	2.17	1.93	1.69	1.38	1.13
Basin 3.1	5.62	4.99	4.38	3.58	2.97
Basin 3.2	7.23	6.47	5.72	4.75	3.99
Reach 4	2.08	1.84	1.61	1.31	1.07
Basin 4.1	2.28	2.01	1.75	1.41	1.15
Reach 5	3.37	2.99	2.61	2.13	1.75
Basin 5.1	4.48	3.96	3.46	2.80	2.31
Reach 6	0.84	0.74	0.64	0.52	0.43
Basin 6.1	5.44	4.79	4.16	3.36	2.75
Reach 7	3.95	3.49	3.04	2.46	2.02
Basin 7.1	1.87	1.65	1.44	1.16	0.95
Basin 7.2	1.86	1.63	1.42	1.14	0.93

establish the water surface elevations at various locations in the study watershed, a detailed hydraulic analysis must be carried out. The channel and flood plain properties, as well as the characteristics of the various structures along the channel, must be considered in this analysis.

The hydraulic computer program used by EGA Consultants to compute the water surface profiles was developed at the Hydrologic Engineering Center (HEC) by the U.S. Army Corps of Engineers and is commonly known as HEC-2.

The program computes and plots (by printer) the water surface profiles of river channels of any cross-section for either subcritical or supercritical flow conditions. It is capable of analyzing the effects of various hydraulic structures such as bridges, culverts, weirs, embankments and dams. Roughness coefficients can be specified by a number of methods to account for the change in roughness with the depth of flow or the actual location of the flow within the flood plain. Input to the program may be in either Imperial or Metric units.

Hydraulic models of the study reaches (Potter Creek main channel and its six tributaries) were constructed by inputting specific cross-sections along the length of the flood plain into the models.

TABLE 4.8 FINAL ROUTED PEAK FLOWS					
Sub-Basin	Routed Peak Outflows (cms)				
	100 Year	50 Year	25 Year	10 Year	5 Year
Reach 1	39.50	35.37	31.22	25.62	21.69
Reach 2	37.98	34.05	30.07	24.65	20.87
Basin 2.1	5.20	4.64	4.10	3.39	2.85
Reach 3	33.54	30.16	26.62	21.77	18.38
Basin 3.1	11.43	10.23	9.13	7.60	6.41
Reach 4	21.42	19.29	16.97	13.77	11.51
Reach 5	19.53	17.24	15.12	12.21	10.04
Reach 6	12.07	10.63	9.24	7.46	6.16
Reach 7	5.91	5.21	4.53	3.67	3.01

These were taken from digital elevation models (DEM's), supplemented by field surveys and reconnaissance. The characteristics of the main channel and the flood plain, such as the hydraulic roughness, as obtained from field reconnaissance, were also included in the models. All river crossings and hydraulically significant structures and sections were also entered into the models to produce physical representations of the study reaches.

The seven hydraulic models for the Potter Creek main channel and its six tributaries, so established, may also be used to determine the capacity of various structures and channel reaches and to determine the effects of channel improvements, dykes and floodways on the water surface profiles.

4.2.1.3.2 Starting Water Surface Elevation

The hydraulic model for the main channel, starting from the Bay of Quinte, has a starting water surface elevation of 75.03 m. This elevation is the maximum June monthly mean water level for Lake Ontario.

Upon generating water surface profiles along the main channel, the results were utilized to provide starting water surface elevations for the other six tributaries.

4.2.1.3.3 Water Surface Profiles

Detailed hydraulic models were constructed for the Potter Creek main channel and its six tributaries.

Initially, and prior to completing the final hydrologic simulations, water surface profiles were generated to produce stage-discharge rating curves for the creek channels with the structures crossing the watercourses. The stage-discharge rating curves were used to identify reaches that may exhibit critical or supercritical flow patterns, to provide a depth-area and depth-flow relationships that were used in the hydrologic analysis, and to establish the hydraulic performance of the individual bridges and culverts.

Upon completion of the hydrologic component of the study, water surface profiles associated with the Regulatory (100 year) flood and the 50, 25, 10, and 5 year flood events were computed using the developed hydraulic models in conjunction with the HEC-2 computer program.

4.2.1.3.4 Structures

Floodwater unduly confined by structures can cause excessive water pondage. This may result in flooding of upstream properties, over-topping of roadways, excessive scour and erosion and, in severe cases, the loss of a structure. On the other hand, over-design of new structures for the sake of safety can add materially to the initial cost of the structure, and possibly increase downstream damages by increasing flood flows.

Reconnaissance and field surveys within the study limits ascertained detailed information required to analyze the performance characteristics of the hydraulic structures. This information was used as computer input data, not only to determine the extent of flooding for the various flood events but also to analyze the performance of the individual structure.

Water surface profiles were generated with structures crossing the watercourses. The results of the hydraulic analysis for Potter Creek, pertaining to water surface elevations, for the various return frequency flood events are provided in the Support Document Number 3 entitled "HEC-2 Summary Printout and Computer Disks".

The resultant stage-discharge rating curves for the major crossings are provided in the Support Document Number 4 entitled "Bridge Data". The structure performance data for the major crossings are provided in Table 4.9.

The term "structure velocity" given in Table 4.9 is defined as the average velocity of the flow discharging through the structure for an effective flow area.

4.2.1.4 RESULTS

The extent of flooding within the study area of Potter Creek, as a result of the Regulatory (100 year) flood was plotted on the Moira River Conservation Authority's 1:2000 Flood Risk Maps, Sheet Numbers 1 to 26.

At the confluence with the Bay of Quinte, the 100 year lake flood elevation of 75.9 m was superimposed on the backwater simulations. The backwater effect of 75.9 m ends at the downstream side of Highway No. 2.

The results of the hydrotechnical analyses for Potter Creek are:

- In general, the major road crossings can discharge the various flood events without weir flow occurring over the roadway embankment.

  The exceptions are:

  - Marshall Road on Tributary 2 can discharge the 25, 10 and 5 year events without weir flow occurring.
  - Moira Road West on Tributary 4 can discharge only the 5 year event without weir flow occurring.
  - For all the flood events, weir flow over the roadway will occur at Huntingwood Drive on Tributary 5.
  - For the abandoned railway structure on the main channel, the lower overbanks will allow water to spill over.
- Either pressure flow and weir flow conditions or low flow and weir flow conditions will occur for the majority of the pedestrian crossings and farm access crossings on the main channel and its tributaries.
- In reviewing the flood plain of Potter Creek, it was estimated that 10 buildings (structures) are located either within or at the fringe of the 100 year flood plain.

The results of the hydraulic analyses, the 1:2000 scale digital mapping illustrating the Regulatory (100 year) flood plain and the methodologies employed were subsequently approved by the Conservation Authority.

In order to define overall watershed constraints and to assist in the development of the Subwatershed Plan, the Regulatory flood plain was also illustrated on Drawing Number 1137-16-11 - Hazard Lands.

TABLE 4.9
STRUCTURE PERFORMANCE DATA

Location	Flood Event (yr)	Discharge (cms)	Structure Velocity (m/s)	Class of Flow	% Weir Flow Over Roadway	Total Head Loss (m)
<u>Main Channel</u>						
Highway No. 2	100	39.5	3.45	LF	---	1.65
	50	35.4	3.32	LF	---	1.46
	25	31.2	3.18	LF	---	1.26
	10	25.6	2.97	LF	---	0.98
	5	21.7	2.79	LF	---	0.77
Abandoned Railway Crossing (Adjacent CPR)	100	39.3	3.38	LF-WF	18	1.65
	50	34.6	3.22	LF-WF	14	1.50
	25	31.1	3.11	LF-WF	13	1.39
	10	25.5	2.89	LF-WF	8	1.21
	5	20.9	2.69	LF	---	1.06
Canadian Pacific Railway	100	39.3	2.30	LF	---	0.20
	50	34.6	2.24	LF	---	0.20
	25	31.1	2.19	LF	---	0.19
	10	25.5	2.07	LF	---	0.18
	5	20.9	1.92	LF	---	0.17
Wallbridge-Loyalist Road (South of Moira St. W.)	100	38.0	2.66	LF	---	0.43
	50	34.1	2.51	LF	---	0.39
	25	30.1	2.34	LF	---	0.35
	10	24.7	2.10	LF	---	0.29
	5	20.8	1.94	LF	---	0.26
Moira Street West	100	32.6	2.67	LF	---	0.40
	50	29.4	2.71	LF	---	0.39
	25	25.9	2.52	LF	---	0.33
	10	21.2	2.25	LF	---	0.26
	5	17.8	2.03	LF	---	0.21
Canadian National Railway	100	32.6	2.78	LF	---	0.22
	50	29.4	2.68	LF	---	0.21
	25	25.9	2.56	LF	---	0.20
	10	21.2	2.37	LF	---	0.17
	5	17.8	2.22	LF	---	0.16
Wallbridge-Loyalist Road (North of Moira St. W.)	100	21.4	1.82	LF	---	0.18
	50	18.9	1.68	LF	---	0.15
	25	16.6	1.55	LF	---	0.13
	10	13.3	1.34	LF	---	0.09
	5	11.0	1.18	LF	---	0.07
County Road No. 22	100	19.5	1.88	LF	---	0.20
	50	17.2	1.69	LF	---	0.17
	25	15.1	1.51	LF	---	0.13
	10	12.2	1.27	LF	---	0.09
	5	10.0	1.07	LF	---	0.07

TABLE 4.9 (cont'd)
STRUCTURE PERFORMANCE DATA

Location	Flood Event (yr)	Discharge (cms)	Structure Velocity (m/s)	Class of Flow	% Weir Flow Over Roadway	Total Head Loss (m)
<u>Main Channel</u>						
Highway No. 401	100	11.4	1.79	PF	---	0.99
	50	10.0	2.53	LF	---	0.87
	25	8.7	2.40	LF	---	0.76
	10	7.0	2.12	LF	---	0.59
	5	5.8	1.87	LF	---	0.48
Sidney Concession 3 Road	100	5.9	2.28	PF	---	0.52
	50	5.2	2.01	PF	---	0.41
	25	4.5	1.74	PF	---	0.31
	10	3.7	1.48	LF	---	0.21
	5	3.0	1.25	LF	---	0.15
<u>Tributary 1</u>						
Wallbridge-Loyalist Road	100	2.3	3.62	PF	---	2.53
	50	2.0	3.14	PF	---	2.54
	25	1.8	2.83	PF	---	2.54
	10	1.5	2.36	PF	---	2.04
	5	1.2	1.89	PF	---	1.52
<u>Tributary 2</u>						
Avonlough Road	100	5.2	2.11	PF	---	0.69
	50	4.6	1.87	PF	---	0.59
	25	4.1	1.67	PF	---	0.51
	10	3.4	1.38	PF	---	0.43
	5	2.9	1.18	PF	---	0.42
Marshall Road	100	5.2	2.30	PF	---	0.87
	50	4.6	2.04	PF	---	0.78
	25	4.1	2.24	LF	---	0.70
	10	3.4	2.10	LF	---	0.59
	5	2.9	1.99	LF	---	0.51
<u>Tributary 4</u>						
Canadian National Railway	100	2.3	1.90	PF	---	0.92
	50	2.0	1.65	PF	---	0.77
	25	1.8	1.49	PF	---	0.65
	10	1.4	1.60	LF	---	0.44
	5	1.2	1.45	LF	---	0.39
Montrose Road	100	2.3	0.45	PF-WF	91	0.00
	50	2.0	0.68	PF-WF	85	0.00
	25	1.8	1.36	PF-WF	67	0.03
	10	1.4	1.59	PF-WF	50	0.14
	5	1.2	2.73	PF	---	0.27

TABLE 4.9 (cont'd)
STRUCTURE PERFORMANCE DATA

Location	Flood Event (yr)	Discharge (cms)	Structure Velocity (m/s)	Class of Flow	% Weir Flow Over Roadway	Total Head Loss (m)
Tributary 5						
Highway No. 401 Ramp	100	4.5	2.24	PF	---	0.66
	50	4.0	1.99	PF	---	0.50
	25	3.5	1.74	PF	---	0.80
	10	2.8	1.78	LF	---	0.47
	5	2.3	1.57	LF	---	0.38
Highway No. 401	100	4.5	2.56	PF	---	0.86
	50	4.0	2.27	PF	---	0.65
	25	3.5	1.99	PF	---	0.54
	10	2.8	1.59	PF	---	0.38
	5	2.3	1.45	LF	---	0.29
Wallbridge-Loyalist Road	100	2.9	2.28	PF	---	0.89
	50	2.4	1.89	PF	---	0.69
	25	2.1	1.65	PF	---	0.54
	10	1.6	1.26	PF	---	0.33
	5	1.3	1.18	LF	---	0.18
Huntingwood Drive	100	1.8	1.50	PF-WF	Minimal	0.46
	50	1.6	1.42	PF	---	0.38
	25	1.3	1.60	LF	---	0.29
	10	1.0	1.35	LF	---	0.22
	5	0.8	1.17	LF	---	0.18
Tributary 6						
Sidney Concession 3 Road	100	5.4	1.95	LF	---	0.32
	50	4.8	1.78	LF	---	0.28
	25	4.2	1.60	LF	---	0.23
	10	3.4	1.37	LF	---	0.18
	5	2.8	1.19	LF	---	0.15

Abbreviations:

LF-WF - Low flow and weir flow condition.
The water level is below the low chord of the structure and is flowing over the roadway embankment.

PF-WF - Pressure flow and weir flow condition.
The water level is above the low chord of the structure and is flowing over the roadway embankment.

PF - Pressure flow condition.
The water level is above the low chord of the structure but not over the roadway embankment.

LF - Low flow condition.
The water level is below the low chord of the structure.

4.2.2 FILL LINES

Certain areas, outside the Regulatory flood plain itself, may not be suitable for development because of the potential risk of erosion and/or slope failure. In other areas, some regulation is required to ensure that development does not infringe on the valley and materials are not deposited in the Regulatory flood plain.

In consultation with the Conservation Authority, guidelines were adopted in order that EGA could delineate the fill line for the Potter Creek watershed. The guidelines as established by the Conservation Authority are defined as follows:

- The fill line will be plotted as a dashed line and will be located outside the Regulatory flood plain. It will exclude, wherever possible, existing buildings while at the same time ensuring a margin of safety for future development.

- The fill line will be plotted as a dashed line and should not follow identifiable features such as fence lines, roadways, bush lines, etc. unless it is determined that this feature would satisfactorily address setback criteria without over-regulating the subject lot.

- The fill line, in areas where distinguishable features and steep slopes are not prevalent, will have a minimum setback of 15 metres from the Regulatory flood line.

- The fill line, in areas of steep slopes (greater than 15%), will be set back a minimum of 10 metres inland from the crest of the slope or top of valley bank where the slope is deemed to be stable through site inspection or geotechnical data available.

- The fill line, in areas of steep slopes (greater than 15%) deemed to be unstable, will be set back a minimum of 10 metres plus three times the height of the slope measured from the toe to the crest of the slope. Where this line exceeds a concrete existing feature, i.e. road, then the fill line will follow the existing feature to negate over-regulation of the subject lot.

  An unstable slope may be determined by:

  - geotechnical and hydrotechnical data available.
  - visible evidence of toe erosion and/or seepage zones along the slope.
  - sparsely vegetated or recent rotational failure consistent with existing soil conditions.
  - a history of slope instability on the site or adjacent sites.

- The fill line, in certain areas, may be a combination of any of the above.

Using these guidelines, EGA defined the extent of the fill lines on the Authority's 1:2000 Flood Risk Maps, Sheets 1 through 26. The Authority reviewed the delineation and altered the fill line for the Aikins wetland. The wetland was recognized as a special case with a specific guideline defined as follows.

- The fill line encompassing the Aikins wetland, Sheets 24 to 26, has been extended beyond the minimum 15 metre setback where steep slopes are not prevalent so that all low lying areas within the study limit are adequately protected.

In order to review overall watershed constraints and to assist in the development of the Subwatershed Plan, the fill line has also been illustrated on Drawing Number 1137-16-11 - Hazard Lands.

4.2.3 EROSION

The reaches of Potter Creek were classified into low, moderate and high potential erosion sections based on the field reconnaissance described in Section 4.1.2. Table 4.10 provides the reach, active erosion description and erosion potential. The reach locations and observed significant active erosion sites are shown on Drawing Number 1137-16-11 - Hazard Lands.

A review of the hydraulic computer simulations for ranges in runoff values revealed the following:

TABLE 4.10
EROSION DESCRIPTION AND POTENTIAL

REACH ID.	PHOTO NUMBER	EROSION DESCRIPTION	EROSION POTENTIAL
1	107	No Erosion Evident	LOW
2	108-110	Bank Erosion - Root Exposure	MODERATE
3		No Erosion Evident	LOW
4	111	Under Cutting - Bank Failure	LOW - MODERATE
5	112-113	No Erosion Evident	LOW
6	2-8	Bank Erosion - Root Exposure, Under Cutting - Root Exposure - Bank Failure	LOW - MODERATE
7		No Erosion Evident	LOW
8	9-14	Rills, Bank Erosion - Root Exposure	LOW
9	24-28	Bank Erosion - Root Exposure, Under Cutting - Bank Failure	LOW - MODERATE
10	21,22,29,30	Bank Erosion - Root Exposure, Under Cutting - Bank Failure, Rills	LOW - MODERATE
11		No Erosion Evident	LOW
12	45-47	Bank Erosion - Root Exposure, Under Cutting - Root Exposure - Bank Failure	HIGH
13	48-52	Bank Erosion - Root Exposure, Under Cutting - Root Exposure - Bank Failure	MODERATE - HIGH
14	53-60	Bank Erosion - Root Exposure, Under Cutting - Root Exposure - Bank Failure, Cattle Crossing	MODERATE - HIGH
15		No Erosion Evident	LOW
16	68-72	Bank Erosion - Root Exposure, Under Cutting - Root Exposure - Bank Failure - Tree Failure	MODERATE - HIGH
17	65-67	No Erosion Evident	LOW
18	92-95	Bank Erosion - Root Exposure, Under Cutting - Bank Failure	LOW - MODERATE
19	90-91	Under Cutting - Root Exposure - Bank Failure	MODERATE
20	86-89	Bank Erosion - Root Exposure, Tree Failure	LOW - MODERATE
21	85	Under Cutting - Root Exposure - Bank Failure - Tree Failure	HIGH
22	82-84	No Erosion Evident	LOW
T 1		No Erosion Evident	LOW
T 2		No Erosion Evident	LOW
T 3		No Erosion Evident	LOW
T 4		No Erosion Evident	LOW
T 5.1	62-64	Under Cutting - Bank Failure	LOW - MODERATE
T 5.2	61	Bank Erosion - Root Exposure	LOW - MODERATE
T 5.3		No Erosion Evident	LOW
T 5.4		No Erosion Evident	LOW
T 5.5	31-44	Bank Erosion, Under Cutting	LOW - MODERATE
T 5.6	15-18	Bank Erosion - Root Exposure	LOW - MODERATE
T 5.7	19-20	No Erosion Evident	LOW
T 6.1	73-79	Bank Erosion - Root Exposure, Under Cutting - Root Exposure - Bank Failure - Tree Failure	MODERATE - HIGH
T 6.2	80-81	Under Cutting - Bank Failure, Rills	LOW - MODERATE
T 6.3	100-106	Under Cutting - Bank Failure	MODERATE
T 6.4	96-99	Bank Erosion - Root Exposure	LOW - MODERATE

- During full bank flow conditions, velocities can range from 0.5 m/s to 1.5 m/s. Depending upon channel slope, watercourse substrate, bank vegetation and cover and geometry and alignment of the watercourse, low to moderate erosion, as observed, can be expected along much of the watercourse.

- During a Regulatory (100 year) storm event, velocities in the range of 2 m/s can be expected. Erosion of the channel and possibly the embankments along the steeper sections of the watercourse can occur.

- Velocities at the major road and railway structures crossing the watercourse can be in the order of 1.3 m/s to 3.5 m/s. Erosion will occur at the outlet of these structures if protection measures have not been provided to both the embankment and downstream channel for approximately 5 to 10 metres.

In order to establish the rate or change in the erodability of the watercourse, a monitoring program would have to be established for selected reaches and specific sites.

4.2.4 HYDROGEOLOGY

4.2.4.1 GROUNDWATER RECHARGE AND DISCHARGE

There is no direct information available to precisely define areas of ground water recharge and discharge within the watershed. However, on the basis of topography, soil types, and water levels within wells, approximate areas of recharge and discharge can be defined. The inferred areas of ground water recharge and discharge are shown on Drawing Number 1137-16-12 - Inferred Zones of Groundwater Recharge and Discharge in Surficial Geologic Units. It is inferred that ground water recharge occurs over most of the watershed. In particular, recharge will occur in the higher grounds at the north end of the watershed (in the vicinity of the drumlin features), and in the large flat lying areas found in the central and southern portions of the watershed. The surface area contributing to groundwater recharge is greater than the topographic characteristics contributing to the direct discharge of surface runoff. The inferred drainage groundwater drainage boundary is illustrated on Figure 4-4.

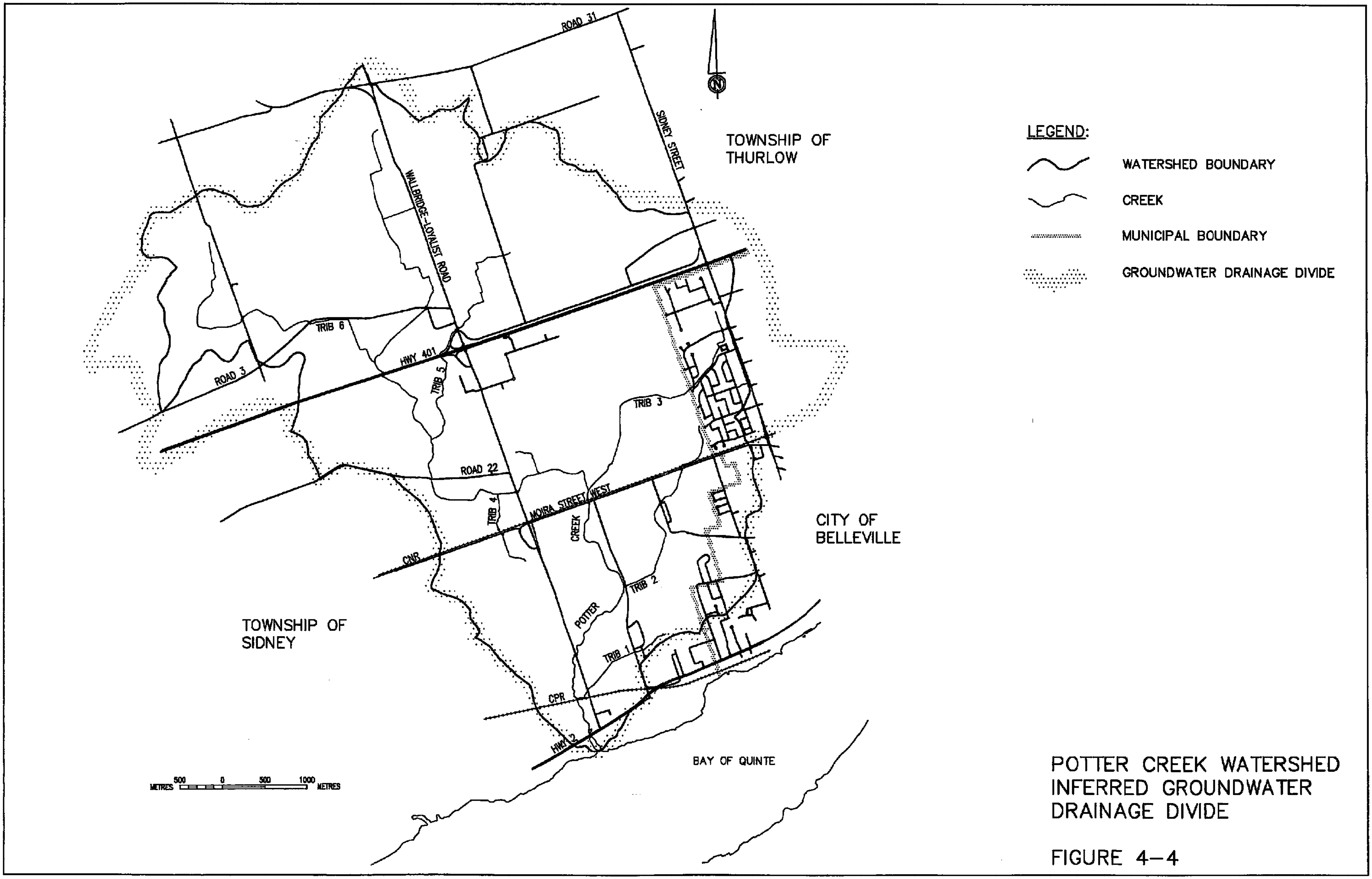
Ground water discharge will occur locally into low lying areas such as the creek valley, and into local depressions such as noted at the northern end of the watershed. It is expected that the largest volume of groundwater discharge will occur from the overburden materials into the creek valley or watercourse. There will also be ground water discharge from the bedrock materials into the watercourse, particularly near the southern end of the watershed where the cover of overburden is thin. The remainder of discharge from the bedrock materials will occur directly into the Bay of Quinte.

Further study would be required to precisely define areas of ground water recharge and discharge. This would include installation of monitoring wells to establish ground water levels and gradients. However, it is evident that much of the watershed provides ground water recharge both to the overburden and underlying bedrock materials.

4.2.4.2 GROUND WATER QUALITY

There were no direct measurements made of ground water quality in the study. The available well records give some indication of the gross ground water quality. For those records where water quality was reported, 91 percent indicated fresh water. The remaining wells indicated sulphurous or mineralized water. Discussions with local Health Unit authorities indicated that there is no widespread report of bacteriological or other contamination in wells in the watershed area. There was no information available regarding the levels of nutrients (such as nitrogen or phosphorus) in the shallow groundwater. Similarly, there was no information available regarding the presence of contaminants such as chloride (such as from road salt), or herbicides or pesticides in the shallow groundwater.

It can be expected that the chemical water quality within the overburden and bedrock materials will be a reflection of the minerals comprising these materials. Typically, the water will be hard and



POTTER CREEK WATERSHED
INFERRED GROUNDWATER
DRAINAGE DIVIDE

FIGURE 4–4

high in calcium and magnesium minerals.

4.2.4.3 GROUND WATER RESOURCES

The Ministry of Environment and Energy records for wells within the watershed area were reviewed to determine the nature and use of the local groundwater resource. Table 4.11 provides a summary of information obtained from all of the well records reviewed. A summary of the well record data for each Concession within the watershed area is given in Appendix D.

Drawing Number 1137-16-05 - Groundwater Resources - Water Well Locations provides a plot of selected wells found in the watershed area.

In summary, records were found for approximately 580 wells within the watershed area. Approximately 72 percent of these wells were completed in the bedrock materials. This indicates that the bedrock is the most important local aquifer zone. This is a result both of the relatively thin cover of overburden found over most of the watershed, and the relatively low yields which can be expected from the glacial till materials which comprise the overburden.

Most wells were relatively shallow in depth, with over 93 percent being completed to depths of less than 30 m. Again, this is a reflection of the relatively shallow depth to the aquifer zone (bedrock) through most of the watershed area.

Almost all of the records (97 percent) indicate that the wells are small diameter (100 to 250 mm) drilled wells. However, it can be expected that shallow dug wells may be found in the rural portions of the watershed area. Typically, records are not available for these types of wells.

The majority of wells (82 percent) are used for domestic or stock purposes. The majority of wells (68 percent) were test pumped at relatively low rates of less than 45 Lpm (10 gpm). There were few reports (less than 5 percent) of wells which were test pumped at moderate to high rates (92 Lpm or 20 gpm).

This information suggests that there are low to moderate yields of water available from the bedrock materials which underlie the watershed area.

Records were found for only two wells designated as municipal in use. These wells were drilled in Sidney Township and pumped at rates of about 900 Lpm (200 gpm) for one hour. These wells are indicated as Well No. 42 on Drawing Number 1137-16-05 - Groundwater Resources - Water Well Locations.

4.2.4.4 CLIMATE AND WATER BUDGET

Most of the Potter Creek watershed is situated within a climatic region known as the South Slopes. The South Slopes area is characterized by temperate and moist climate conditions. Climate data for a weather station in Belleville were obtained from Environment Canada. These data are averaged over the period 1866 to 1990. Following is a brief summary of climate data:

Mean daily temperatures	7.5°C
Total annual precipitation	852 mm
Annual rainfall	701 mm
Annual snowfall	151 mm
Mean annual potential evapotranspiration	610 mm
Mean annual actual evapotranspiration	500 mm
Mean annual moisture deficiency	110 mm
Mean annual water surplus	350 mm

The above water balance figures are based on a soil moisture storage of approximately 100 mm using a Thornthwaite water balance method. In summary, the water balance indicates that approximately 350 mm of water is available for run-off and infiltration. All infiltration occurs from November to April, at the time of the year when there is no significant evaporation or evapotranspiration. In the summer months, the rate of evaporation and evapotranspiration exceeds the available rainfall and there is a net deficit of water (i.e., water is withdrawn from storage in the soil).

TABLE 4.11
SUMMARY OF MOEE WATER WELL RECORD INFORMATION
POTTER CREEK

Total # of Wells	TOTAL 580	Percentage of Total
No. of		
Overburden Wells	159	27%
Rock Wells	419	72%
Unknown	2	1%
Depth		
<15 m	312	54%
15 - 30 m	227	39%
30 - 61 m	35	6%
>61 m	6	1%
Well Diameter		
Small 100 - 250 mm	564	97%
Large 750 mm	0	
No Data	16	3%
Water Quality		
Fresh	480	83%
Salty	7	1%
Sulphur	28	5%
Mineral	2	1%
Dry	54	9%
No Data	9	1%
Water Use		
Domestic/Stock	477	82%
Commercial	15	3%
Industrial	13	2%
Irrigation		
Municipal	12	<1%
Dry	54	9%
Public Supply	3	<1%
No Data	7	1%
Not used	9	2%
Pumping Rate (litres per minute)		
< 23	173	30%
23 - 45	216	38%
46 - 68	19	3%
69 - 91	54	9%
> 92	29	5%
Dry	54	9%
No Data	35	6%

On the basis of the water balance data, an approximate water budget for the watershed was prepared. A conceptual model for the water budget is indicated on the accompanying Figure 4-5. It is noted that this water budget is based on long-term or average flows within the watershed. It is not applicable to short-term events.

As illustrated by the model, the total flow within the watershed is an average of 350 mm per year over the watershed area. A large percentage of this total flow (250 to 300 mm per year or 70 to 85 percent) is the result of direct surface runoff or very shallow (within 1 or 2 m of the ground surface) ground water contribution. This type of runoff will be seasonal in nature, and dependent on individual storm events.

The ground water contribution to the watershed (from the intermediate to deep ground water system found several metres or more below the ground surface), is on the order of 50 to 100 mm per year, or 15 to 30 percent of the total flows. It can be expected that higher ground water baseflow contributions will be found in those areas where the stream intersects the bedrock materials or more pervious soil materials such as sand or silt.

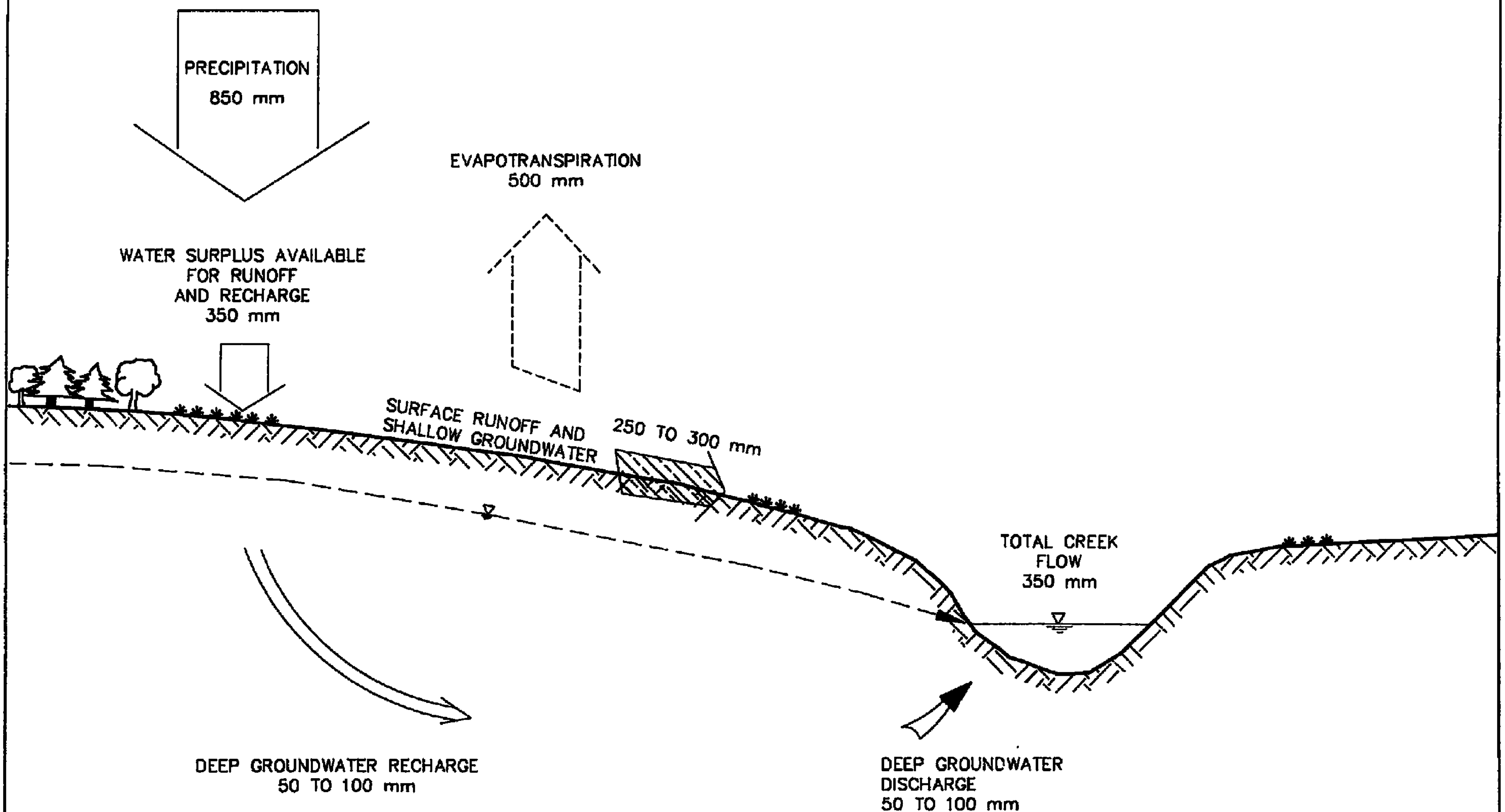
It is noted that the groundwater base flow contribution is relatively small (15 to 30 percent) on an average annual basis. However, when considered monthly or seasonally, the ground water flow contribution is much more significant. For example, in the drier summer months, ground water flow may contribute up to 50 percent or more of the flow within the creek.

The above estimates are generalized in nature. They illustrate the relative contribution of ground water and surface water flow to the watershed. More specific site studies and modelling of the watershed would be required in order to refine these estimates.

4.2.4.5 SUMMARY

The following general conclusions are made with respect to the ground water conditions and ground water resources within the Potter Creek watershed:

- There appear to be no important granular (sand and gravel) resources found within the watershed area;
- The most important aquifer zone within the watershed is the underlying limestone bedrock. The limestone bedrock is an important ground water resource used in the rural (unserviced) areas of the Township;
- The bedrock aquifer provides low to moderate yields of groundwater suitable for individual domestic supply. The potential for developing a large capacity communal supply appears to be limited;
- There is no direct information available regarding chemical ground water quality within the watershed. However, the relatively shallow soil cover over the bedrock aquifer (particularly in the southern end of the watershed) suggests that it may be susceptible to contamination from surficial sources such as fertilizer application, road salt, and spills or leaks from industrial or commercial activities;
- Most of the watershed area provides ground water recharge. There is no single significant area of ground water recharge within the watershed. Ground water recharge occurs over a relatively broad scale. Most ground water discharge occurs at the Bay of Quinte or locally within the creek valley or channel;
- Most of the surficial soil materials which cover the watershed are of relatively low permeability. Therefore, there is a relatively small volume of ground water recharge;
- On the basis of simplified water balance, it appears that the ground water contribution to baseflow ranges from about 15 to 30 percent, on an average annual basis. During the summer months, the ground water baseflow may comprise 50 percent or more of the flow within the creek;
- There is a wetland area situated south of Tucker's Corners, near the northern end of



CONCEPTUAL WATER BUDGET

FIGURE 4–5

the watershed. It appears that this wetland is formed mainly as a result of imperfect surface drainage. While there is some ground water contribution to this wetland, it is expected that most of the contribution is a result of direct surface runoff and drainage.

4.2.5 PHYSICAL ENVIRONMENT

4.2.5.1 AQUATIC WATER QUALITY

Tables 4.12 through 4.18 (Appendix E) present the raw water chemistry data, while Table 4.19 (Appendix E) summarizes the information as expressed as seasonal averages. In Table 4.20, information is presented on fecal coliform, fecal streptococcus, *E. coli*, total phosphorus, chloride, and conductivity during dry and wet weather. Table 4.21 shows diurnal water temperature and dissolved oxygen concentrations on August 11, 1992.

The following key points are noted.

- The Ministry of Natural Resources has classified cold water streams as those capable of supporting salmonid fish species which have a summer maximum temperature of less than 21°C (Ministry of Natural Resources 1988). Conversely, the Ministry has defined warm water streams as those being too warm to support substantial salmonid stocks; maximum temperatures in these streams are above 21°C. On the basis of these criteria, Potter Creek has potential to sustain both warm and cold water species (Tables 4.12 through 4.19).

- On reviewing the dissolved oxygen data collected as part of the monthly sampling program (Tables 4.12 through 4.19), Potter Creek appears to be suitable to both coldwater and warmwater species of fish. However, on July 2 at Station PC 10 (Table 4.14), and on a number of occasions on August 11/12 in the middle reaches of the creek (PC 10 at 10:00 a.m., 10:00 p.m., 2:00 a.m. and 6:00 a.m., and PC 11 at 6:00 a.m.), dissolved oxygen concentrations were not high enough to support either warm or coldwater fishes.

- A definite trend to increased concentrations of some parameters including conductivity, chloride, total phosphorus, and *E. coli*, fecal coliform and fecal streptococcus was evident for stations in the middle of the watershed (i.e., PC 10, PC 11 and PC 20). Generally, concentrations of these parameters were higher during and following rainfall events than in dry weather (Table. 4.20), suggesting sources of contamination in the Highway 401 and Wallbridge - Loyalist Road area, and in and downstream from the northwest part of the City of Belleville.

- Regarding phosphorus, Wong and Clark (1975) and Painter, Wong and Clark (1976) concluded that the headwaters of rivers and streams in southern Ontario which have total phosphorus concentrations of 0.030 mg/L or less do not support problem species of aquatic plants, but rather a diverse and biologically healthy community structure. While the 0.030 mg/L value corresponded to relatively clear waters, these scientists could not support this value as being an objective for providing both desirable plant biomass and dissolved oxygen concentrations for cold and warm water fish. However, in the absence of better data, the Ministry of Environment and Energy's guideline for total phosphorus in rivers and streams has been set at 0.030 mg/L, given that excessive plant growths should be eliminated at concentrations less than this limit (Ontario Ministry of the Environment 1984). The Bay of Quinte Remedial Action Plan Coordinating Committee has determined that concentrations of total phosphorus need to be reduced from about 40 µg/L to 30 µg/L to restore and maintain the trophic state of the bay. At concentrations of 30 µg/L, phytoplankton (i.e., free-floating algae) densities will be sufficiently low that most of the taste and odour problems associated with the bay's drinking water will be resolved. As indicated in Table 4.20, seasonal average concentrations were

TABLE 4.20 Average concentrations for selected water quality parameters under dry (NR = no rainfall) and wet (R = rainfall) conditions at six sampling locations on Potter Creek, 1992.

	PC - 01		PC - 10		PC - 11		PC - 20		PC - 30		PC - 31	
	NR	R	NR	R	NR	R	NR	R	NR	R	NR	R
Fecal coliform (#/100 mL)	150	125	333	1,780	47	2,900	65	2,400	10	10	70	-
Fecal streptococcus (#/100 mL)	587	1,767	190	797	170	713	160	737	270	465	80	665
E. coli (#/100 mL)	210	390	393	1,820	103	820	45	1,500	60	-	80	-
Total phosphorus (µg/L)	25	57	46	46	68	99	44	89	18	10	14	29
Chloride (mg/L)	76	59	86	102	74	61	268	258	14	30	20	48
Conductivity (umhos/cm)	644	597	690	770	667	641	968	1,150	519	671	504	663

TABLE 4.21 Temperature (° C)/dissolved oxygen concentrations (mg/L) at four stations in Potter Creek at four-hour intervals between 10:00 a.m., August 11 and 10:00 a.m., August 12, 1992. All data were collected by the Moira River Conservation Authority; on August 11/12, there was insufficient water flowing at PC 30 and PC 31 to collect data.

Location	Time						
	10:00 a.m.	2:00 p.m.	6:00 p.m.	10:00 p.m.	2:00 a.m.	6:00 a.m.	10:00 a.m.
PC 01	19/7.1	22.5/8.2	21.5/6.1	19.0/5.6	17.5/5.9	16.5/6.0	16.0/8.0
PC 10	18/2.1	21.0/6.0	20.5/4.2	18/2.5	16.0/2.6	15.0/3.0	15.5/5.2
PC 11	20.0/5.2	23.0/12.2	22.5/11.2	21.5/9.0	19.5/4.1	18.0/1.0	18.0/4.4
PC 20	17.5/5.8	18.0/5.8	17.5/4.9	16.0/5.7	15.0/6.0	14.0/6.2	15.0/8.2

below the above-noted guidelines established for the Bay of Quinte in upstream reaches of Potter Creek's watershed (i.e., Station PC 30 and PC 31); however, at all other locations, the guidelines were exceeded, and in some cases substantially so (i.e., Stations PC 10, PC 11 and PC 20). Where concentrations have exceeded the Ministry's 0.030 mg/L guideline (as determined by annual mean concentrations), a Policy 3 designation may be applied by the Ministry (Ontario Ministry of the Environment 1984); the relevant aspects of this policy are as follows:

> "The Ministry will require that all reasonable and practical measures be taken to reduce waste loadings. Where new or expanded discharges are proposed, no further degradation will be permitted and all practical measures shall be undertaken to upgrade water quality."

- **Ammonia nitrogen** enters surface waters directly from municipal and industrial effluents, agricultural runoff and atmospheric precipitation. Indirectly, it can also input, via chemical and biological transformation of nitrogenous material in soil and water, nitrogen fixation of dissolved oxygen in water, and excretion of ammonia by biota. Aquatic ammonia is in constant equilibrium with its ionized ammonium form, a relationship which is highly temperature and pH dependent. Un-ionized ammonia is the form most toxic to aquatic biota, and the Ministry of Environment and Energy has indicated that concentrations should not exceed 0.02 mg/L for the protection of aquatic life (Ministry of the Environment 1984). Transformation of all ammonia nitrogen readings in Tables 4.12 through 4.19 to the un-ionized form by incorporating temperature and pH effects generates values which do not exceed the Ministry's objective at any of the sampling sites.

- **Total Kjeldahl nitrogen** is a measure of ammonia plus organic nitrogen. This latter parameter is not a concern to aquatic life or human health, so no guidelines have been proposed; its role is mainly related to the supply of ammonia resulting from the hydrolysis of organic compounds. Concentrations at the six locations in Potter Creek (Tables 4.12 through 4.19) are quite typical of other small streams and creeks which drain to the Bay of Quinte and which have mixed land uses.

- **Nitrate nitrogen** is the principal form of nitrogen in natural waters, and results from the complete oxidation of other nitrogen compounds, particularly ammonia. A numerical limit has not been established by the Province of Ontario for nitrates in surface waters, although it is recognized that elevated levels may contribute to nuisance vascular and algal plant growth; as noted below under ratios of nitrogen to phosphorus, nitrogen does not limit plant growth in study area lakes. Nitrate nitrogen is not toxic to fish at concentrations normally found in lakes and streams; in this regard, toxicity information provided in the **Canadian Water Quality Guidelines** (1987), indicate an acute lethal concentration of 5,800 mg/L for chinook salmon and 6,000 mg/L for rainbow trout, and some mortality of rainbow trout eggs at concentrations as low as 5 mg/L. As noted in the Tables 4.12 through 4.19, nitrate nitrogen levels were always substantially lower than the above-noted concentrations.

- **Nitrite nitrogen** in surface waters is much less stable than nitrate nitrogen, and is usually found in minute quantities; it is an intermediate product of both nitrification and denitrification. According to the Canadian Council of Resources and Environment Ministers (1987), nitrite nitrogen is much more toxic to aquatic life than nitrate nitrogen. The Province of Ontario has no guideline or objective for nitrite nitrogen, although the most recent **Canadian Water Quality Guidelines** (1987) set a limit of 0.060 mg/L for protecting aquatic life. This limit was exceeded on one occasion at PC 10 (July 2), and on four occasions at PC 11 (July 2, September 1 and 21, and October 21).

- **Total nitrogen to total phosphorus ratios** less than 10 indicate nitrogen limitation, whereas ratios greater than 10 reveal a phosphorus limited system. The total nitrogen to total phosphorus ratios throughout Potter Creek confirm that phosphorus is the key element limiting algal and vascular aquatic plant growths; these results are consistent with the findings of the Bay of Quinte Remedial Action Plan Stage 1 and Stage 2 reports.

- **Alkalinity** is a measure of a system's carbonate-bicarbonate capacity to buffer or neutralize water against acidification. If a stream has a high alkalinity level, it can resist pH changes caused by acid inputs. Surface waters having low alkalinities can experience pH depressions during the spring snowmelt or following heavy rains, times when large acid loads can enter a lake. A system with zero alkalinity is an acid lake. A negative alkalinity reading means that the water contains mineral acidity; such waters usually have a pH less than 5.0, and if they have any fish at all, they will be hardy, acid-tolerant species like yellow perch. As a system acidifies, sensitive species such as bass and trout will probably not reproduce, although some adult fish may still survive until they die of old age or other causes.

  The neutralizing capacity of surface waters is dependent on a number of factors. For example, systems in limestone regions usually have a very high alkalinity, since bicarbonate alkalinity results as limestone slowly dissolves in water. Alkalinity can also be generated in soils; accordingly, groundwater and soil runoff inputs to some lakes can be an important supply of neutralizing capacity. In some cases, alkalinity levels can be reduced by naturally occurring acids; such acids are formed during the decomposition of leaves and other organic material. The presence of these acids is usually observed as a brown coloration in water, and can be quite noticeable in areas with extensive swamps or bogs. Examples of systems with large amounts of acid neutralizing capacity are the Great Lakes, the Kawarthas, the Rideaus, and surface waters located in limestone bedrock formations. Lakes and streams in the Canadian Shield typically have low acid neutralizing capacities. This region is underlain by granite, and has many exposed rock outcrops; granite is insoluble and can supply little alkalinity. The soils are usually shallow and sandy or acidic; these soils are not the result of acid deposition, but are formed by the decomposition of organic material such as forest litter. Runoffs from these soils do not contribute any neutralizing capacity; accordingly, most systems on the Shield have low alkalinity levels.

  Potter Creek with average alkalinities would be classified by the Ministry of Environment and Energy (Ministry of Environment 1989) as a level 5 system. This means it is not sensitive to acid loadings, and is capable of withstanding heavy acid inputs during spring runoff without biological damage. The creek contains sufficient buffering capacity to neutralize acid rain for an indefinite period of time.

- **Chloride** is a major inorganic ion which occurs in variable concentrations in natural water, typically in the one milligram per litre range. This chemical species is released to surface waters naturally during weathering of sedimentary rocks and soils or anthropogenically from hydrolysis of chlorine - disinfected waters and runoff from salted roads. The Ontario Drinking Water Objective for this parameter is 250 mg/L; in this regard, concentrations above 250 mg/L may impart an undesirable taste to the water and to beverages prepared using water. Regarding biological implications, elevated levels may cause a shift in aquatic life; for example, levels of 400 mg/L have been reported to be harmful to trout and levels of 4,000 mg/L have affected bass, pike and perch (Ministry of the Environment 1978). As indicated in Tables 4.12 through 4.19, such concentrations were never attained in Potter Creek; nevertheless, the elevated concentrations detected in the middle and lower reaches of the watershed in comparison to upstream concentrations indicate the effects of land use changes and/or contaminant loadings.

- **pH** is the chemical short form referring to the concentration of hydrogen ions in a solution. The more hydrogen ions, the lower is the pH, and vice versa. Because the pH scale is a logarithmic scale, there is a tenfold difference between one number and the next one to it. Therefore, a drop in pH from 8 to 7 indicates that the acidity is ten times greater at pH 7 than it is at pH 8; from 8 to 6, it is one hundred times greater, and so on. Guidelines of pH based on recreational uses of surface waters have been set by the Ministry of Environment and Energy (Ministry of the Environment 1984); in this regard, the pH should be within the range of 6.5 and 8.5. For protecting aquatic life, the Ministry has no specific guideline or objective; however, in general, the pH of water should not vary beyond the range of pH 6.5 - 9.0 (**Canadian Water Quality Guidelines** 1987). The pH values reported for Potter Creek comply with both sets of objectives (see Tables 4.12 through 4.19).

- **Conductivity** is a measure of the quantity of dissolved substances in water. The major contributing ions are calcium, magnesium, sodium, potassium, bicarbonate, sulphate and chloride. These ions are leached from rocks and soils in a stream's watershed; leaching occurs at the surface of rock and soil particles. Accordingly, more solution is produced by finely divided clay soils having high surface areas than by coarser sands. Organic soils, made up largely of peat, contain much more leachable material than mineral soils. Conductivity readings in the upper reaches of Potter Creek are somewhat lower than in lower stretches, and particularly at PC 20. These differences are consistent with the chloride results and reflect the effects of land use changes/contaminant loadings in middle and lower portions of the watershed.

- **BOD_5** in water is the amount of oxygen required to oxidize organic matter by aerobic microbial decomposition to a stable inorganic form. BOD_5 is not a pollutant itself, but can become a problem at high concentrations by depressing dissolved oxygen to levels which can affect aquatic organisms. While no specific objectives or guidelines for BOD_5 have been established for aquatic life, a concentration of 4 mg/L is considered reasonably clean, and waters having levels greater than 10 mg/L are considered polluted (McNeely et al 1979). As noted in Tables 4.12 through 4.19, BOD_5 was almost always less than 10 mg/L at all sampling sites, reflecting a clean water system. However, on July 2, concentrations of 9.0 mg/L and 7.5 mg/L were reported for PC 10 and PC 11 respectively, suggesting upstream contamination.

- **Phenols** can affect freshwater fish adversely by direct toxicity to fish and fish-food organisms, by lowering the amount of available oxygen because of the high oxygen demand of the compounds, and by tainting of fish flesh. As well, chlorinated phenols present problems in drinking water supplies because they are not removed efficiently by conventional water treatment, and can be chlorinated during the final water treatment process to form persistent odour-producing compounds. The Ministry of Environment and Energy has set 2.0 µg/L as a maximum acceptable concentration for drinking water. From the perspective of fish and wildlife, there is no objective, although a limit of 1.0 µg/L has been suggested because it is near the threshold concentration for fish flesh tainting. As noted in Tables 4.12 through 4.19, this value was exceeded on only one occasion in Potter Creek (i.e. PC 10 on July 2).

- **Microbiological** water quality indicators are groups of bacteria whose densities in water can be related quantitatively to the presence of sewage or fecal matter, and therefore, to the risk of contracting a disease from the pathogens contained therein. Fecal coliform has historically been considered to be one of the indicators (Ontario Ministry of the Environment 1984). In this regard, a hazard exists if the fecal coliform geometric mean density for a series of water samples exceeds 100/100 mL.

  Fecal streptococcus is used in conjunction with fecal coliforms to indicate the nature of the potential fecal sources. If the ratio of the geometric mean densities of fecal coliform to fecal streptococcus at the point of discharge exceeds 4, the source of the discharge is likely to be human in origin. A ratio of less than 0.7 suggests that the source is probably of non-human origin. Ratios between these values are difficult to interpret, and could be mixtures.

  As noted above, the Ministry of Environment and Energy has historically relied on fecal coliform as an indicator of sewage pollution. However, as a result of an extensive literature review, it was decided that *E. coli* should replace fecal coliform as an indicator for detecting sewage pollution. Further, the Ministry recommended that the Maximum Acceptable Concentration (MAC) of *E. coli* be 100 organisms/100 mL. In advancing this recommendation, the Ministry acknowledged that there were few data to support either the present Ontario level of 100 fecal coliform/100 mL (geometric mean), or the proposed federal level of 200 *E. coli*/100 mL.

  On the basis of the above, a health hazard existed at all but the two upstream sites on more than one occasion in 1992.

- **Heavy metals** were not sampled in sufficient quantity in 1992 to permit reasonable interpretation; with additional data anticipated in 1993, further comments will be provided in subsequent submissions and final reports.

4.2.5.2 SOILS AND SITE DRAINAGE

The distribution of broad soil textural classes is presented on Drawing Number 1137-16-14 - Upper Soil Types according to descriptions provided in Gillespie, Wicklund, and Richards (1962) and on soil profile notes recorded during the 1992 field investigation (see Appendix F for specific profile descriptions at field check points). In addition, the specific soil series represented in the basin according to Gillespie, Wicklund, and Richards (1962), and their respective physical characteristics, are shown on Table 4.22.

As indicated, there is a moderately wide variation in soil cover through the basin in terms of texture, depth over bedrock, and internal drainage characteristics, reflecting a diversity of parent materials. This in turn has significantly influenced the land use pattern in the basin, particularly the cultivated lands, old fields, and large woodlands, which are closely associated with specific soils and their respective topographic and drainage characteristics.

The most vigorous relief in the Potter Creek drainage basin occurs in the northern portion (especially the northwest) where steep-sided drumlins and drumlinoid landforms predominate. The deep soils associated with these features consist primarily of well-drained sandy loams developed from glacial till (Bondhead sandy loam), which, consequently, often contain rocks and small boulders through the profiles, including the surface horizon. However, veneers of finer-textured silts and clays also occur in some localities on these landforms. Most of the drumlinized landscape retains hardwood forest cover, particularly on the most steeply sloping areas, and supports the most extensive woodlands in the basin; however, the

TABLE 4.22	Soil series characteristics for the Potter Creek drainage basin. Source: Gillespie, Wicklund, Richards (1962).		
Soil Series	Texture	Drainage	Parent Material
Cramahe	gravelly sand	good to excessive	gravel
Bondhead	sandy loam (includes steep phase)	good to excessive	glacial till
Tioga	sandy loam	good	outwash
Berrien	sandy loam	imperfect	sand over clay deposits
Otonabee	loam (includes steep phase)	good	glacial till
Farmington	loam	variable	shallow soils over bedrock
Solmesville	clay loam	imperfect	clay overlaying loam till
Lindsay	clay loam (includes shallow phase)	poor	clay overlying loam till
Elmbrook	clay	imperfect	lacustrine deposits
Sidney	clay	poor	lacustrine deposits
Waupoos	clay	good	clay overlying loam till
Muck Deposits	organic	poor to very poor	post-glacial organic

woods have been cleared and the soils cultivated where the topography is less vigorous. Elsewhere in the basin, sandy loams (also including the Tioga and Berrien series) occur in smaller, isolated pockets in areas of subdued relief, and typically are, or have been, cultivated.

Deep, well-drained loams developed from glacial till deposits (Otonabee loam) are similar in distribution to the last-mentioned sandy loams, and also are generally either cultivated or support old fields. However, one of the loam series (Farmington) is a shallow soil developed over bedrock; it is typically less than 30 cm deep, and is often marked by limestone exposures. This series occurs only in the southern portion of the drainage basin, and supports an extensive old field-successional forest complex.

Finer-textured soils are widespread through the basin, especially in the level to undulating central and southern portions, and form the base for much of the farming activity. The profiles of these soils show a moderate degree of variation, reflecting differing parent materials. Some of the soil series (Solmesville and Lindsay clay loams and Waupoos clay) have developed from clay deposits overlying loam till and occasionally show moderate to high stone content (including the surface horizon) with layers of sandy loam, while others (Elmbrook and Sidney clay) are derived from uniform glaciolacustrine sediments. Due to the density of the subsoils, the internal drainage characteristics of these various series range primarily from imperfect (i.e., slightly impeded infiltration) to poor (slow infiltration promoting high water tables and/or ponding in depressions); nevertheless, a few areas are well-drained. Poor drainage characteristics are particularly conspicuous in the northeastern portion of the drainage basin where impoundment of a broad, shallow depression has resulted in the development of a wetland on formerly cultivated land.

Other soils reported for the drainage basin include muck and gravelly sand, each from a single locality. The former occurs toward the north end of the basin in a broad depression where Potter Creek has been impounded, and now supports an extensive wetland. The organic horizon varies from shallow to deep, and overlies dense, impermeable clay. A small area of gravelly sand is reported by Gillespie, Wicklund, and Richards (1962) and Ostry and Singer (1981) for the extreme southwestern portion of the basin; only a small portion of this old beach deposit lies specifically within the basin.

4.2.6 BIOLOGICAL ENVIRONMENT

4.2.6.1 AQUATIC HABITATS

4.2.6.1.1 Wetlands

According to Environment Canada (1985), approximately 45% of the Potter Creek drainage basin originally consisted of wetlands; however, most of these complexes were lost prior to 1967 primarily to cultivation and, to a lesser extent, urban development. These wetlands were situated mainly on the broad, shallow clay and clay loam plains in the central and northern portions of the basin, and in lowlands along Potter Creek and its tributaries. Between 1967 and 1982, a small percentage (approximately 1%) of additional wetland area was lost to urban development in the eastern part of the basin. According to Snell (1987), losses of original wetland due to cultivation are on the order of 60% to 80% for Sidney Township in general.

Wetlands identified for the Potter Creek drainage basin now occur in scattered localities, and include moderately extensive swamp-marsh systems, as well as small, local lowland forest stands. A number of plant community types are represented in these wetlands, including wet lowland forest, tall lowland thicket, wet meadow, emergent marsh, and floating-submergent aquatics. The compositional characteristics of these community types are summarized below.

Lowland forest stands occur on depressions where site moisture conditions vary from seasonally to permanently wet. Overstorey composition consists of trees typical of wet-mesic and wet sites, with the main species being green ash, black ash, white elm, bur oak, balsam poplar, silver maple, red maple, and white cedar. The understorey shrub and herb strata are relatively diverse, and include such species as highbush cranberry (*Viburnum trilobum*), nannyberry (*Viburnum lentago*), bittersweet (*Solanum dulcamara*), Virginia creeper (*Parthenocissus inserta*), wild grape (*Vitis riparia*), wild black currant (*Ribes americanum*), rue (*Thalictrum dioicum*), field horsetail (*Equisetum arvense*), ostrich fern (*Matteuccia struthiopteris*), healall (*Prunella vulgaris*), jewelweed (*Impatiens capensis*), fowl manna grass (*Glyceria striata*), false nettle (*Boehmeria cylindrica*), wood nettle (*Laportea canadensis*), one-sided aster (*Aster lateriflorus*), sedges (*Carex gracillima, Carex stipata, Carex bebbii*), jack-in-the-pulpit (*Arisaema triphyllum*).

Lowland tall thicket communities are commonly dominated by willows, the most common of which are slender willow (*Salix petiolaris*) and large pussy willow (*Salix discolor*). Other shrubs noted include red-osier dogwood (*Cornus stolonifera*), silky dogwood (*Cornus obliqua*), and willow (*Salix eriocephala*). Understoreys consist of herbaceous species that are also typical of open lowland forest stands and wet meadows, including sedges (*Carex lacustris*), water horehound (*Lycopus uniflorus*), mint (*Mentha arvensis*), beggar ticks (*Bidens frondosa*), bulrush (*Scirpus atrovirens*), blue vervain (*Verbena hastata*), jewelweed (*Impatiens capensis*), Joe-pye-weed (*Eupatorium maculatum*), and false nettle (*Boehmeria cylindrica*), to name a few.

Wet meadows are plant communities dominated by a continuous cover of grasses, sedges, and hydrophytic forbs in sites characterized by wet soils for at least a portion of the growing season. They may include the scattered occurrence of trees and shrubs. These communities occur primarily as marsh fringes, but also locally along the banks of Potter Creek. Common plant species noted for these communities include bulrushes (*Scirpus atrovirens, Scirpus cyperinus, Scirpus rubrotinctus*), boneset (*Eupatorium perfoliatum*), Joe-pye-weed

(*Eupatorium maculatum*), rice cut-grass (*Leersia oryzoides*), reed canary grass (*Phalaris arundinacea*), sedges (*Carex lacustris, Carex stricta, Carex stipata, Carex vulpinoidea*), creeping bent grass (*Agrostis stolonifera*), sticky willowherb (*Epilobium ciliatum*), water horehound (*Lycopus americanus*), elecampane (*Inula helenium*), swamp milkweed (*Asclepias incarnata*), beggarticks (*Bidens frondosa*), purple loosestrife (*Lythrum salicaria*), marsh fern (*Thelypteris palustris*), and lance-leaved aster (*Aster lanceolatus*).

Marshes are open communities dominated by herbaceous aquatic plant species which are typically immersed for all or most of the growing season. Most of the marsh communities within the study area consist of tall emergents dominated primarily by wide and narrow-leaved cattails (*Typha latifolia, Typha angustifolia*). Other species occurring within this zone include sedge (*Carex lacustris*), soft-stemmed bulrush (*Scirpus validus*), burreed (*Sparganium eurycarpum*), blue flag (*Iris versicolor*), arrowhead (*Sagittaria latifolia*), and water plantain (*Alisma plantago-aquatica*).

Portions of the marshes characterized by stagnant open water zones are often covered by free-floating aquatics such as duckweed (*Lema minor*) and/or water-meal (*Wolffia punctata*). Other floating and submergent aquatics in these areas include coontail (*Ceratophyllum demersum*), pondweeds (*Potamogeton natans, Potamogeton gramineus, Potamogeton epihydrus*), water-weed (*Elodea canadensis*), and floating heart (*Nymphoides cordata*).

Three wetlands in the Potter Creek drainage basin were evaluated according to the **System for Evaluating Wetlands in Southern Ontario** (Ministry of Natural Resources 1992), including: a 42 ha wetland developed by Ducks Unlimited, identified as the Aikins Project and located in the northern portion of the basin on the west side of Wallbridge-Loyalist Road; a 38 ha wetland located on the east side of Huntingwood Road; and a 4 ha wetland located along a tributary of Potter Creek just southwest of Marshall Road. The evaluation was based on data collected in the field, information provided by government agencies, faunal atlas databases, background information in published reports, and observations provided by the Quinte Field Naturalists.

The component scores resulting from the evaluation process were as follows:

Component	Wetland		
	Aikins	Huntingwood	Marshall
Biological	90	88	75
Social	58	57	60
Hydrological	231	204	150
Special Features	156	25	62
Total Scores	535	374	347

Based on the **Guidelines for Wetland Management in Ontario** (Ministry of Natural Resources 1984), the Aikins and Huntingwood wetlands would be classified as Class 3, which require 600 to 649 total points, or one out of four components that scores higher than 200 points. In this regard, the hydrological component for both of these wetlands was greater than 200. The Marshall wetland would be classified as Class 7 (i.e., less than 450 total points and less than two of four components with 100 points or more). In accordance with the **Wetlands Policy Statement**, the Aikins and Huntingwood wetlands would both be classified as provincially significant.

4.2.6.1.2 Fish And Fish Habitat

According to streambed data (Table 4.23) recorded by the Moira River Conservation Authority (1991) throughout the basin and information noted during the 1992 fish sampling program, Table 4.24, the fish habitat conditions along the various reaches of Potter Creek and its tributaries vary widely in terms of riparian cover, bottom substrate, and depth-width characteristics (see Figure 4-6 for reach locations used in defining stream geomorphology and Drawing Number 1137-16-13 - Resource Features for fish sample stations). Several combinations of streambed substrates occur along the length of the courses, ranging from predominantly fine-textured silts and/or clays, to clay with low to moderate mixtures of gravel and boulders, to mixtures of

TABLE 4.23 Summary of stream survey data for all reaches of Potter Creek and its tributaries; data collected in the summer of 1991. Source: Moira River Conservation Authority (1991).

Reach (date of survey)	Length (km)	Average Width (m)	Depth (m)	Bottom Substrate (% composition)	Terrain Characteristics (% composition)	Stream Cover (% composition)	Instream Cover (% composition)
1A (July 17-18)	1.5	1.2	0-.67	cobble (10) gravel (15) sand (30) silt (30 clay (15)	cultivated pasture (35) upland hardwood (30) swamp hardwood (15)	dense (60) partly open (40)	none (80) boulders (5) logs (10) plants (5)
1B (July 23-25)	0.8	1-4.5	0-0.01	gravel (50) muck (50)	cultivated (50) upland hardwood (50)	dense (100)	none (20) boulders (50) logs (15) organic (5) plants (10)
1C (July 26)	1	0.3-4.5	dry	clay (30) sand (30) gravel (40)	pasture (25) upland hardwood (25) cultivated (50)	partly open	none (50) logs (10) plants (30) boulders (10)
2A (July 29)	1.6	1-7.5	0-1	boulder (10) cobble (10) gravel (10) silt (30) clay (35) detritus (5)	cultivated (60) pasture (5) upland hardwood (30) swamp hardwood (5)	dense (30) partly open (50) open (20)	none (50) boulders (20) logs (10) organic (50) plants (15)
2B (July 26)	1	0.6-4.5	dry	clay (40) silt (40) cobble (20)	upland hardwood (20) cultivated (30) pasture (50)	partly open (100)	none (40) logs (15) plants (20) boulders (25)
2C (June 17)	1	0.6-1.8	0-0.15	bedrock (15) boulder (5) cobble (10) gravel (5) sand (65)	cultivated (50) pasture (35) upland hardwood (15)	partly open (100)	none (45) undercut banks (5) boulders (40) plants (10)

TABLE 4.23 (cont'd) Summary of stream survey data for all reaches of Potter Creek and its tributaries; data collected in the summer of 1991. Source: Moira River Conservation Authority (1991).

Reach (date of survey)	Length (km)	Average Width (m)	Depth (m)	Bottom Substrate (% composition)	Terrain Characteristics (% composition)	Stream Cover (% composition)	Instream Cover (% composition)
2D (June 14)	0.5	0.6-2.1	0.02-0.2	boulder (20) gravel (30) cobble (15) sand (35)	lawn (15) upland hardwood (30) cultivated (55)	partly open (100)	none (60) boulders (20) organic (10) plants (10)
2E (June 10/13)	1.2	0.6-3	0.08-0.3	cobble (5) muck (95)	cultivated (25) pasture (65) upland hardwood (10)	partly open (40) open (60)	none (30) boulders (5) organic (5) plants (60)
2F (June 12)	0.8	0.15-1.5	dry	clay (100)	pasture/meadow (100)	dense (10) open (90)	none (20) plants (80)
2G (June 7/13)	0.42	0.6-3	0.15-0.3	muck (100)	upland hardwood (85) cultivated (15)	partly open (100)	logs (20) organic (50) plants (30)
2H (June 6-7)	0.8	0.3-4.5	0.1-0.6	bulder (5) cobble (5) gravel (15) silt (15) clay (15) muck (45)	cultivated (100)	open (100)	none (20) boulders (10) logs (5) organic (10) plants (50) undercut banks (5)
2I (July 2-3)	1	1.3-15	0-0.2	bedrock (25) boulder (20) cobble (30) gravel (10) muck (15)	cultivated (20) pasture (35) upland hardwood (20) lawn (25)	partly open (100)	none (10) undercut banks (5) boulders (55) organic (20) plants (10)
2J (July 3/16-17)	1	18	0-0.6	bedrock (5) boulder (5) sand (10) gravel (30) cobble (50)	lawn (2) pasture (3) open marsh (10) upland hardwood (25) upland conifer (60)	partly open (100)	undercut banks (5) boulders (20) logs (5) organic (50) plants (20)

TABLE 4.23 (cont'd) **Summary of stream survey data for all reaches of Potter Creek and its tributaries; data collected in the summer of 1991. Source: Moira River Conservation Authority (1991).**

Reach (date of survey)	Length (km)	Average Width (m)	Depth (m)	Bottom Substrate (% composition)	Terrain Characteristics (% composition)	Stream Cover (% composition)	Instream Cover (% composition)
2K (August 22)	1	1.3-60	unknown	boulder (10) cobble (10) gravel (10) sand (30) silt (15) muck (15) detritus (10)	upland hardwood (70) pasture (20) lawn (10)	partly open (100)	none (20) boulders (10) organic (10) plants (60)
3A (August 20)	0.8	1.3	dry	boulder (5) cobble (5) sand (10) gravel (20) silt (60)	upland hardwood (15) pasture (35) cultivated (50) open marsh	dense (15) partly open (35) open (50)	none (30) boulders (10) logs (10) plants (50)
3B (June 21)	0.5	0.6-2.4	0-0.15	cobble (25) gravel (25) muck (50)	cultivated (20) pasture (60) impervious (20)	open (100)	none (20) plants (35) undercut banks (5) boulders (5) organic (35)
3C (june 18)	1	0.3-6	0-1	boulder (20) cobble (20) gravel (40) sand (20)	cultivated (10) pasture (40) meadow (10) upland hardwood (40)	dense (45) partly open (40) open (15)	none (35) undercut banks (15) boulders (35) logs (5) plants (10)
3D (August 20)	1	1.8	dry	boulder (5) cobble (5) sand (10) gravel (20) silt (60)	lawn (5) shrub-marsh (10) upland hardwood (15) pasture (30) swamp hardwood (40)	partly open (100)	none (50) logs (5) organic (5) undercut banks (10) boulders (10) plants (20)

TABLE 4.23 (cont'd) **Summary of stream survey data for all reaches of Potter Creek and its tributaries; data collected in the summer of 1991. Source: Moira River Conservation Authority (1991).**

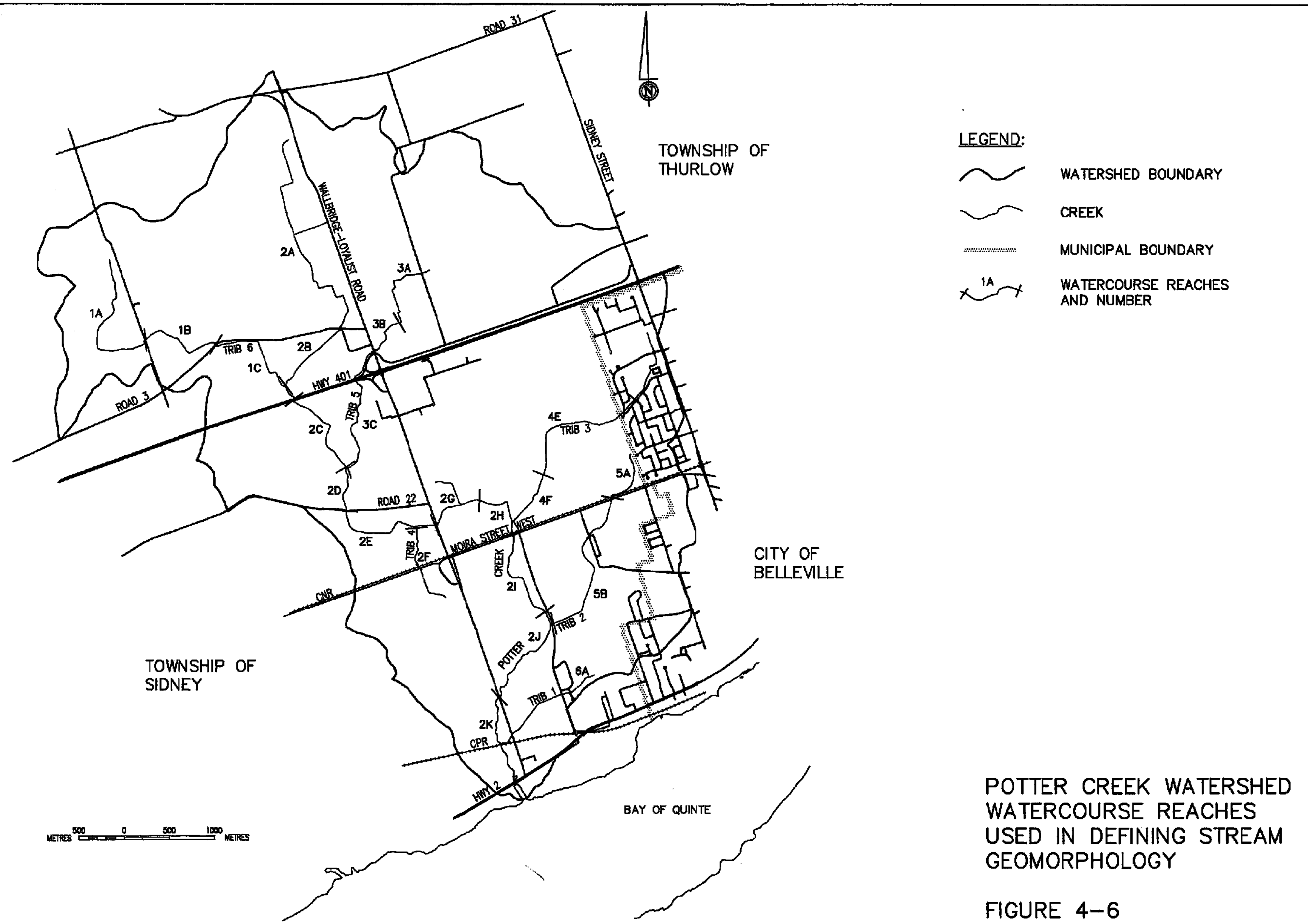
Reach (date of survey)	Length (km)	Average Width (m)	Depth (m)	Bottom Substrate (% composition)	Terrain Characteristics (% composition)	Stream Cover (% composition)	Instream Cover (% composition)
4A (August 6)	1.8	1-3	0-0.15	bedrock (10) boulder (10) cobble (20) gravel (10) clay (40) silt (10)	pasture (25) upland hardwood (70) impervious (5)	partly open (75) open (25)	none (35) organic (5) boulders (20) plants (40)
4B (August 6)	1.2	1.8	1.3-1.8	boulder (20) cobble (25) gravel (10) clay (45)	pasture (60) upland hardwood (40)	open (80) partly open (20)	none (30) undercut banks (20) boulders (20) plants (30)
4C (August 22)	0.4	1.8-24	0-0.2	clay (100)	upland hardwood (20) pasture (80)	open (100)	none (55) organic (10) plants (35)
4D (June 24)	0.8	1.3-4	0.12-0.2	gravel (20) muck (80)	pasture (10) upland hardwood (5) impervious (10) lawn (75)	open (100)	organic (60) plants (40)
4E (June 24)	1.5	2.4-4.5	0.2-0.3	gravel (5) clay (35) silt (60)	pasture (10) cultivated (30) upland hardwood (60)	open (90) partly open (10)	logs (5) plants (5) organic (90)
4F (June 25)	0.5	1.8-9	0-1	boulder (5) gravel (5) silt (20) clay (70)	cultivated (20) pasture (30) upland hardwood (35) swamp hardwood (10) open marsh (5)	partly open (100)	none (20) undercut banks (20) logs (10) organic (20) plants (30)
5A (June 26-27)	0.8	1.8	dry	silt (30) clay 70)	cultivated (5) pasture (20) upland hardwood (35) open marsh (40)	dense (20) open (80)	none (15) logs (10) organic (5) plants (70)

TABLE 4.23 (cont'd) **Summary of stream survey data for all reaches of Potter Creek and its tributaries; data collected in the summer of 1991. Source: Moira River Conservation Authority (1991).**

Reach (date of survey)	Length (km)	Average Width (m)	Depth (m)	Bottom Substrate (% composition)	Terrain Characteristics (% composition)	Stream Cover (% composition)	Instream Cover (% composition)
5B (May 29/31, June 27, August 1)	1.5	0.6-1.8 (channel) 60 (wetland)	0-0.12	cobble (5) gravel (5) silt (30) clay (60)	cultivated (5) pasture (5) shrub-marsh (10) upland hardwood (15) swamp hardwood (20) open marsh (45)	dense (10) partly open (40) open (50)	none (10) boulders (5) plants (85)
6A (August 22)	1	1.6	0.02-0.04	sand (40) silt (40) clay (20)	cultivated (80) lawn (10) impervious (10)	open (100)	none (15) plants (85)
7A (August 19)	0.8	1-15	0-0.3	boulders (10) gravel (10) sand (20) silt (40) muck (10) detritus (10)	upland hardwood (25) hardwood swamp (15) pasture (40) meadow (10) impervious (10)	dense (30) partly open (60) open (10)	none (45) boulders (10) logs (10) organic (20) plants (15)

TABLE 4.24
SUMMARY OF FISH SAMPLING RESULTS AND FISH HABITAT SURVEY
Survey was conducted on November 14 to 15, 1992, by Michael Michalski Associates.

Station	Depth (m)	Width (m)	Substrate	Site Description	Fish Species (number caught)
1	0.5-1.5	several	clay with a few rocks	beaver pond located in lowland deciduous forest. Pond fed by two small streams, each 2 m wide and <1 m deep. Turbid water, low flow.	brook stickleback (3)
2	>2.0	15-20		dredged channel through a marsh. Turbid water with low flow. No macrophyte growth.	brook stickleback (4) emerald shiner (12)
3	>2.0	15-20		dredged channel through a marsh. Turbid water with low flow. No macrophyte growth.	brook stickleback (5) emerald shiner (55)
4	1	3	clay and stone	just downstream of beaver dam. Steep banks with riparian tree cover.	brook stickleback (1) emerald shiner (4)
5	0.3-0.5	5	organic sediment	creek at this locality flows from urban area to rural-forested lands. Abundant macrophyte growth covered with algae. Low flows. Steep bank with no overhang.	brook stickleback (4) central mudminnow (1) fathead minnow (3) banded killifish (2)
6	1-1.5	8-10	rock	creek surrounded by agricultural land with no tree canopy. Steep banks with herbaceous overhang. Moderate to low flows.	no fish caught
7	1.5	10	bedrock	creek flows through forested area with continuous canopy, and some overhang on banks. Moderate to low flows.	brook stickleback (3) banded killifish (2)
8	0.2	2	mixture of rock, sand, and gravel	creek flows through a forested area with good canopy. A fallen tree has caused the formation of an 8 m wide pool, with patches of emergent vegetation. Gradual slopes along the banks.	banded killifish (3)
9	1	5-12	rock	creek flows rapidly. Numerous small islands and emergent vegetation at this locality. Sparse tree cover and little canopy or overhang.	no fish caught



POTTER CREEK WATERSHED
WATERCOURSE REACHES
USED IN DEFINING STREAM
GEOMORPHOLOGY

FIGURE 4–6

sand, silt, clay, and rock with scattered logs, to mainly organic, to predominantly rock rubble and/or bedrock. Similarly, a diversity of riparian vegetation cover types occur, ranging from narrow bands of tall grasses and forbs (separating the creek from cultivated lands), to broad tall thicket margins, to continuous lowland deciduous forest canopy cover, to dense emergent marsh and wet meadow communities.

Creek depth-width characteristics are correspondingly variable, ranging from confined, narrow (≤1 m) and shallow (<0.5 m) channels, to moderately broad (15 m) and deep (>2 m) channels, particularly where the creek is locally impounded by beaver dams or flows through wetlands. The creek has also been straightened for much of its length, especially in intensively cultivated portions of the basin, as well as in urbanized areas.

Regardless of the varied habitats outlined above, the watercourse is generally suitable for only a limited number of fish species owing primarily to a combination of no/low flow characteristics and warm water temperatures during the dry summer period. During this time, many sections of the creek, particularly in the mid- and upper reaches, are either dry or consist primarily of stagnant, shallow pools. In this regard, many parts of the creek are dry by mid to late June (see Table 4.22); however, these conditions may be quickly reversed by summer storms producing high runoff volumes. For example, on a site visit on September 9, 1992, one section of a tributary to Potter Creek was dry (the rock rubble and limestone bedrock were completely exposed), but was 30 cm deep with good flow on a subsequent visit on September 24, 1992.

All of the fish species noted for Potter Creek and its tributaries in background information sources and the 1992 fish sampling program are listed in Appendix G. As indicated, only eight species have been recorded to date for Potter Creek, and these include coarse fish such as carp brown bullhead, and small forage fish such as creek chub and emerald shiner. It is likely, however, that some Lake Ontario species occur in the mouth of Potter Creek and possibly in immediate upstream reaches.

Of the fish species identified, two merit comments: redside dace identified by the Moira River Conservation Authority and the banded killifish reported by Michael Michalski Associates. The redside dace is considered nationally and provincially vulnerable by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Scott and Crossman (1973) reported it as a small minnow found only in clear streams draining to western Lake Ontario. More recently, it has been found in the northern reaches of the Little Rouge River and in most other tributaries draining to the Rouge (Metropolitan Toronto Region Conservation Authority 1991 unpublished data). The redside dace prefers cool, flowing waters with a gravel bottom, and is apparently quite sensitive to turbidity. Accordingly, its presence has been considered as an indicator of good water quality conditions having potential to support cold water species.

In some areas, the presence of the banded killifish can fulfil Environmentally Sensitive Area requirements (i.e., Metropolitan Toronto and Region Conservation Authority). Of interest however, is that this species tolerates rather poor water quality conditions. For example, Scott and Crossman (1973) noted that ". . . macrophytes provide excellent cover for banded killifish . . . and are very tolerant of poor aquatic conditions."

4.2.6.2 <u>TERRESTRIAL HABITATS</u>

4.2.6.2.1 <u>Vegetation</u>

Regional Characteristics

Although a number of different authorities have mapped the vegetation of Ontario, they generally describe the same overall pattern; however, there are some subtle variations among these descriptions. Depending on the particular authority, Belleville and environs are included in either the deciduous forest region, or the Great Lakes-St. Lawrence forest region (or some comparably termed regions); the former is indicative of vegetation that is considered to have more southern floristic affinities, while the latter denotes somewhat more northern floristic affinities.

Rowe (1972), for example, classified the vegetation of Canada into eight major forest regions, or formations, based on the presence and distribution of certain dominant tree species. These formations are considered to reflect direct responses to broad climatic regimes. Within each region, a number of distinct sections were delineated according to local patterns in tree composition associated with physiographic and geological features. On this basis, Rowe (1972) includes the study area in the deciduous forest region of Ontario. The main body of this formation lies directly north of Lake Erie; however, Rowe (1972) also shows a narrow band extending eastward along the north shore of Lake Ontario as far as Belleville. A comparable vegetation zone is described by Hills (1960); however, he calls it the Lakes Erie-Ontario site region.

Maycock (1979), and Soper and Heimburger (1982), conversely, ascribe the aforementioned deciduous forest region to a more limited geographical area, extending it eastward along the north shore of Lake Ontario only as far as Toronto; such limits are more consistent with the Carolinian floristic region (Scoggan 1978). According to Soper and Heimburger (1982), the study area, therefore, belongs within the Great Lakes-St. Lawrence forest region, which Maycock (1979) calls the southern deciduous-evergreen forest region.

This is somewhat of an academic point because the character of the vegetation does not change abruptly from one region to another, and there are many species and plant communities common to both regions. Rowe (1972), for example, indicates that the dominant trees of the deciduous forest region are various hardwood species, the primary of which include sugar maple (*Acer saccharum*), beech (*Fagus grandifolia*), basswood (*Tilia americana*), red oak (*Quercus rubra*), white oak (*Quercus alba*), and bur oak (*Quercus macrocarpa*). The natural distributions of all of these species extend well into central Ontario, and Rowe (1972) also notes their prominence in the Great Lakes-St. Lawrence forest region immediately to the north. A number of trees which are most abundant to the south, but which occur also sporadically in central Ontario, include black walnut (*Juglans nigra*), butternut (*Juglans cinerea*), shagbark hickory (*Carya ovata*), bitternut hickory (*Carya cordiformis*), and silver maple (*Acer saccharinum*).

Maycock (1979) provides a more detailed review of vegetation patterns within the formations based on compositional trends with respect to environmental gradients (i.e., site moisture, soils, and microclimate). The patterns are quite complex, owing to a number of factors, including the diversity of plant species and their varying distribution patterns within the regions, and the wide variety of sites available for plant growth; these can lead to local variations in vegetation cover within the formations. At a basic level, however, the most frequently occurring forest community types within the Great Lakes-St. Lawrence forest region (or southern deciduous-evergreen forest region) include:

- various combinations of white pine (*Pinus strobus*), sugar maple, red oak, white oak, and beech on drier sites;
- eastern hemlock (*Tsuga canadensis*), sugar maple, basswood, ironwood (*Ostrya virginiana*), white ash (*Fraxinus americana*), white birch (*Betula papyrifera*), and yellow birch (*Betula alleghaniensis*) on mesic sites; and,
- eastern white cedar (*Thuja occidentalis*), black ash (*Fraxinus nigra*), green ash (*Fraxinus pennsylvanica*), white elm (*Ulmus americana*), balsam poplar (*Populus balsamifera*), and red maple (*Acer rubrum*) on wetter sites.

Apart from the forest cover component of the vegetation of this region, however, a wide range of minor plant communities occupy marginal sites (i.e., too open and dry, or too wet to support forest growth) or secondary successional sites. Included in this category are:

- old fields dominated by a wide variety of native, naturalized, and weed species, such as Canada goldenrod (*Solidago canadensis*), New England aster (*Aster novae-angliae*), blue grass (*Poa compressa*), and St. John's wort (*Hypericum perforatum*);
- dry upland thickets dominated by species such as staghorn sumac (*Rhus typhina*), gray dogwood (*Cornus racemosa*), and

common juniper (*Juniperus communis*);

- wet lowland thickets dominated by various willows (*Salix discolor, Salix eriocephala, Salix petiolaris*), speckled alder (*Alnus rugosa*), and red-osier dogwood (*Cornus stolonifera*);

- wet meadow communities dominated by grasses such as reed canary grass (*Phalaris arundianacea*), and Canada blue joint (*Calamagrostis canadensis*), and sedges (*Carex retrorsa, Carex lacustris, Carex stricta*);

- emergent aquatic communities dominated by wide-leaved cattail (*Typha latifolia*), narrow-leaved cattail (*Typha angustifolia*), soft-stem bulrush (*Scirpus validus*), and giant reed (*Phragmites australis*); and,

- floating and submergent aquatic plant communities dominated by water lily (*Nymphaea odorata*), yellow pond lily (*Nuphar variegatum*), duckweed (*Lemna minor*), pondweeds (*Potamogeton gramineus, Potamogeton pectinatus, Potamogeton natans*), and elodea (*Elodea canadensis*).

Site Characteristics

As noted above, variations in vegetation cover can occur within a forest region that are distinctive to particular localities. In this regard, eastern red cedar (*Juniperus virginiana*) is largely absent from the interior of southern and central Ontario, but does occur along the shores of Lake Erie, Lake Huron, and in a narrow band across central Ontario from Georgian Bay along the Palaeozoic-Precambrian bedrock contact zone to the Napanee plain on the north shore of Lake Ontario (Hosie 1973). In these areas, it characteristically colonizes dry, open sites, and is most prominent on poor farmland and limestone plains. This is certainly true of Belleville and environs, where red cedar dominates many young upland forest communities on secondary successional sites (e.g., abandoned fields).

Much of the natural plant cover in the Belleville environs has become highly fragmented and much disturbed by various anthropogenic activities. As a result, the dominant plant communities are cultivated and abandoned fields, and young forests which have developed on secondary successional sites. Native plant communities are generally restricted in area and typically occur on sites which were too difficult to clear and cultivate, such as on river valley walls, steep, rolling till deposits, and permanently wet areas.

All vascular plant species recorded for the drainage basin to date are listed in Appendix H. The total number of species is 305, of which 219 (72%) are native to Ontario, while 86 (28%) are non-native. This ratio of native to non-native plant species is consistent with the provincial average in which non-native species constitute 27% of the flora (Kaiser 1983).

A number of representative examples of distinct plant community types were identified during the field inventory, including dry old field/thickets (which include weed communities on disturbed sites), successional forest stands, woodlots (which consist of both upland and lowland hardwood forest stands), and wetland complexes consisting of lowland forest, lowland thickets, wet meadows and marshes. The following summaries present the respective compositional and physiognomic characteristics of these types, while their distributions are shown on Drawing 1137-16-13 - Resource Features.

Old Field Communities

Old fields are defined as plant communities dominated by a continuous, dense cover of native, naturalized, and weedy graminoids and forbs on secondary successional sites, with low cover provided by shrubs and trees. A wide variety of native and non-native species were noted for these communities; among the most common herbaceous plants are meadow fescue (*Festuca pratensis*), Canada blue grass (*Poa compressa*), timothy (*Phleum pratense*), couch grass (*Agropyron repens*), Canada goldenrod (*Solidago canadensis*), gray goldenrod (*Solidago nemoralis*), heath aster (*Aster ericoides*), New England aster (*Aster novae-angliae*), Queen Anne's lace (*Daucus carota*), awnless brome grass (*Bromus inermis*), redtop (*Agrostis gigantea*), St. John's wort (*Hypericum perforatum*), chickory (*Cichorium intybus*), hawkweed (*Hieracium caespitosum*), mullein (*Verbascum thapsus*), rough-fruited cinquefoil (*Potentilla recta*), white sweet clover (*Melilotus alba*), yarrow (*Achillea millefolium*), ragweed (*Ambrosia artemisiifolia*), common milkweed (*Asclepias syriaca*), butter and eggs (*Linaria vulgaris*), and evening primrose (*Oenothera parviflora*).

As noted above, woody species also occur in field communities, occasionally forming thickets. Among the most frequently occurring of these, however, are shrubs such as common buckthorn (*Rhamnus cathartica*), gray dogwood (*Cornus racemosa*), and prickly-ash (*Zanthoxylum americanum*), and tree seedlings and saplings, including eastern red cedar, green ash, and white elm.

Successional Forest Communities

A significant proportion of the vegetation cover of the drainage basin, particularly in the southern half, consists of young forest growth typical of the early stages of successional development. Such stands have regenerated on formerly cleared lands, and are dominated by a variety of shade intolerant pioneer tree species. Canopy cover in these stands varies from open and discontinuous, to continuous and very dense. The most abundant tree species in these communities is eastern red cedar, which occasionally forms almost monospecific stands. Other trees attaining prominence, either with red cedar or alone, include white elm, green ash, and, more locally, trembling aspen. The understorey stratum consists of the common old field species noted above; however, the ground cover is sparser overall, especially where tree cover is dense.

Woodlots

Mesic upland hardwood forest stands cover only a small proportion of the drainage basin, occurring only sporadically in the southern half, but being somewhat more common in the northern half, especially on areas of more vigorous relief. Tree species noted for these stands include sugar maple, ironwood, beech, red oak, white ash, basswood, bitternut hickory, shagbark hickory, butternut, and bur oak. White pine and white cedar also occurred as minor components of these communities; cedar also dominated some upland forest stands, notably on steep valley slopes.

The understoreys of the mesic hardwood stands are relatively rich, and consist of species indicative of mesic, forested sites, including choke cherry (*Prunus virginiana*), climbing bittersweet (*Celastrus scandens*), zig-zag goldenrod (*Solidago flexicaulis*), large-leaved aster (*Aster macrophyllus*), false lily-of-the-valley (*Maianthemum canadense*), false Solomon's seal (*Smilacina racemose)*, blue-stem goldenrod (*Solidago caesia*), poison ivy (*Rhus radicans*), sedges (*Carex pedunculata, Carex pensylvanica, Carex convoluta, Carex gracillima*), enchanter's nightshade (*Circaea quadrisulcata*), bottle-brush grass (*Elymus hystrix*), spinulose wood fern (*Dryopteris carthusiana*), false helleborine (*Epipactis helleborine*), blue cohosh (*Caulophyllum thalictroides*), May-apple (*Podophyllum peltatum*), to name a few.

Riparian Cover

Riparian plant cover includes the vegetated areas occurring directly along the banks of Potter Creek and its tributaries. This cover does not conform specifically to one of the plant community types identified above owing to its variable composition and physiognomy. A broad mixture of species from old fields, forest communities, wet meadows, and marshes constitutes this cover. Species noted for these habitats include such plants as red-osier dogwood (*Cornus stolonifera*), Virginia creeper (*Parthenocissus inserta*), wild grape (*Vitis riparia*), Canada goldenrod (*Solidago canadensis*), green ash (*Fraxinus pennsylvanica*), white elm (*Ulmus americana*), balsam poplar (*Populus balsamifera*), red maple (*Acer rubrum*), rush (*Juncus dudleyi*), sedges (*Carex lacustris, Carex stricta, Carex stipata, Carex vulpinoidea*), creeping bent grass (*Agrostis stolonifera*), sticky willowherb (*Epilobium ciliatum*), water horehound (*Lycopus americanus*), elecampane (*Inula helenium*), swamp milkweed (*Asclepias incarnata*), beggarticks (*Bidens frondosa*), purple loosestrife (*Lythrum salicaria*), marsh fern (*Thelypteris palustris*), lance-leaved aster (*Aster lanceolatus*), bulrushes (*Scirpus atrovirens, Scirpus cyperinus, Scirpus rubrotinctus*), boneset (*Eupatorium perfoliatum*), Joe-pye-weed (*Eupatorium maculatum*), rice cut-grass (*Leersia oryzoides*), reed canary grass (*Phalaris arundinacea*), and cattails (*Typha latifolia, Typha angustifolia*).

4.2.6.2.2 Wildlife And Wildlife Habitat

General Characteristics

All incidental wildlife sightings and observations of wildlife activity, habitat type, and diversity were noted during the field inventory. These records, in combination with data collected by the Moira River Conservation Authority, provide a reasonably thorough impression of the wildlife characteristics of the Potter Creek watershed.

Although much of the basin has been cleared for cultivation, overall, the compositional and physiognomic diversity of the plant communities through the basin is relatively high. In combination with their associated range of physical site conditions, these conditions provide a moderately broad spectrum of cover, breeding, and foraging habitats for bird, mammal, and herptile species. While open habitats (i.e., fields and meadows) predominate, there remains a moderate degree of plant community intermingling in a number of localities, which create varied edge conditions further contributing to habitat potential for some wildlife species.

The various species noted during the field investigation, either by direct sighting or by evidence (e.g., dams, tracks, scat, etc.), as well as recorded by the Moira River Conservation Authority and other sources (i.e. bird and herpetofaunal atlases), are listed in the Appendices. While the lists contain numerous species, they are still undoubtedly incomplete, and reflect only part of the total resident and migratory fauna which are likely to occur in the basin. Regardless, the varied faunal composition evident in the lists is indicative of and consistent with the diverse habitat conditions available to wildlife populations in this basin.

Birds

According to habitat descriptions provided in Cadman, Eagles, and Helleiner (1987), the basin is well-suited to a wide variety of species which prefer an abundance of forest edge conditions and young successional woods, interspersed with old fields and meadows. Such species include kestrel, wild turkey, mourning dove, flicker, blue jay, common crow, veery, grey catbird, brown thrasher, cedar waxwing, and cardinal. Similarly, the broad areas of open field and meadow through much of the basin are the preferred nesting/foraging habitats of species such as harrier, red-tailed hawk, killdeer, eastern kingbird, savannah sparrow, bobolink, and brown-headed cowbird.

Certain species recorded for the Potter Creek drainage basin show greater affinities for large wooded areas, particularly deciduous forests, such as occur in the northern portion. Examples of such species include black-capped chickadee, hairy woodpecker, downy woodpecker, pileated woodpecker, white-breasted nuthatch, ruffed grouse, great horned owl, red-shouldered hawk, eastern wood peewee, and warbling vireo.

The lands immediately adjacent to larger water courses, as well as wetlands with emergent marshes intermingled with open waters, are preferred by great blue heron, green-backed heron, swamp sparrow, mallard, belted kingfisher, blue-winged teal, sora, common moorhen, tree swallow, and red-winged blackbird.

A number of bird species listed in Appendix I, are common to urbanized areas in addition to their normal occurrence in rural landscapes. These include nighthawk, ring-billed gull, chimney swift, purple martin, American robin, and European starling.

Mammals

The same association with cover conditions also applies to mammals. The abundant old field and meadow communities dotted with thickets and young successional forest stands provide ideal cover for small mammals (see Appendix J) such as meadow vole, deer mouse, eastern cottontail, striped skunk, and woodchuck. Forested lands, particularly the extensive tracts in the northern portion of the basin, are well-suited to white-footed mouse, snowshoe hare, eastern chipmunk, red squirrel, gray squirrel, short-tailed weasel, and porcupine, while a broad spectrum of plant communities would likely be utilized by white-tailed deer, coyote, red fox, and raccoon.

Wetlands and riparian zones also represent habitats for muskrat and beaver, as well as foraging areas for various species such as raccoon and skunk. Areas of forested and agricultural lands situated along Potter Creek and its tributaries have been, and are being, dammed by beaver. In these localities, the raised water levels has resulted in the mortality of trees, as well as the creation of wetlands which have been colonized by emergent aquatics and hydrophytes. Among the more significant mammals recorded for these habitats is river otter.

Herptiles

Only 10 herptile species have been recorded for the Potter Creek drainage basin; however, it is most likely that several others occur at this locality, given the range of available habitats. All of the species listed in Appendix K are widespread throughout southern Ontario, and are commonly associated with the wetland and riparian habitats and/or fields and meadows.

Within the basin, the shallow, open waters of the Aikins wetland are well suited for species such as painted turtle, snapping turtle, and bull frog, although the last was noted for other similar localities. Species such as American toad, leopard frog, and garter snake occurred throughout the basin in a variety of habitats ranging from forest to open field, but appeared to be most common in riparian zones where green frog was most abundant. Only one gray tree frog was noted in a hardwood forest; however, this species and others such as spring peeper would be more conspicuous when calling in spring. Spring peepers are especially common during this period in various ponded environments including swamps, marshes, and even flooded roadside ditches.

According to Weller and Oldham (1986), among the other species that probably occur in this area in comparable habitats are midland chorus frog, wood frog, Blanding's turtle, northern water snake, northern redbelly snake, and northern brown snake. In addition, map turtle has been reported for the Moira River basin; consequently, this species may also occur in appropriate habitats in the Potter Creek basin, such as marshes.

5.0 FUTURE LAND USE AND SERVICING

5.1 PROSPECTS FOR DEVELOPMENT

The Township of Sidney does not see any prospects for planning and development in the Potter Creek secondary planning area for well over a decade, for the following reasons.

- There is no prospect of providing municipal water and sewage services in the foreseeable future.
- There is no significant landowner interest in development in the area.
- There does not appear to be any pent-up demand for residential development in the area.
- South Sidney will remain the Township's first priority. It is anticipated that South Sidney will accommodate all residential growth in the Township for at least the next 15 years.
- Population growth in the entire Greater Quinte area was only just over 4,000 between 1986 and 1991.

The Ministry of Municipal Affairs, in concert with the four municipalities of the Greater Quinte area (Belleville, Sidney, Thurlow, and Trenton), commissioned a Growth Management Report for the area (M.M. Dillon Limited and Clayton Research Associates 1990). The study projected urban growth and land consumption over the next 20 years, and developed options to accommodate the projected growth.

The study identified a preferred growth option, which was intended to accommodate growth for the next 30 to 40 years. Within the Potter Creek basin, the future development areas identified consisted of:

- Residential development east of Avonlough Road and south of the Ontario Hydro right-of-way south of Highway 401, ultimately extending west to Wallbridge-Loyalist Road;
- Industrial-commercial development between the Hydro right-of-way and Highway 401, west to Wallbridge-Loyalist Road.

No development was anticipated north of Highway 401 or west of Wallbridge-Loyalist Road, other than immediately around the intersection of those two arteries. The study noted, "This portion of the growth option impacts on no environmentally sensitive or protected resource areas in any way although growth should avoid the [Zebedee] landfill site . . . ." (M.M. Dillon Limited and Clayton Research Associates 1990, p. 44).

The Growth Management Report did not include development of South Sidney as part of its preferred growth option. As a result, the Township of Sidney disassociated itself from the preferred option, and as the Township points out, the Ontario Municipal Board's subsequent approval of the South Sidney Secondary Plan effectively supersedes the Growth Management Report's recommendation. With regard to the Potter Creek basin, these events can only have the effect of reducing future development demands on the basin from those anticipated in the Growth Management Report.

Before preparing specific land use scenarios for purposes of this study, we reviewed historic and projected population and development trends for Sidney and the overall Greater Quinte Area, in order to determine the range of possibilities that could reasonably be expected in the Potter Creek basin over the 50 year horizon of the Subwatershed Plan. This analysis relied on census data, the Growth Management Report, and a report on anticipated land requirements in Sidney prepared in support of the South Sidney Secondary Plan (Totten Sims Hubicki Associates 1991). Our detailed analysis, and supporting data, are presented in Appendix L. Highlights of this analysis are as follows.

- The current (1991) population of Greater Quinte is about 78,000. Provided that drastic and unanticipated demographic, economic, and social changes do not come to pass in Ontario and Canada, a population of about 114,000 would represent the high end of a realistic range of populations in 2041.

- There are about 30,000 households in Greater Quinte today (1991); a 2041 population of about 114,000 would translate into about 52,000 households. In other words, under the most optimistic scenario, there would be about 22,000 additional dwellings required in Greater Quinte by 2041.

- During the 1980s, about one eighth of the new dwellings in Greater Quinte were built in Sidney. If Sidney's share were to increase to one quarter over the next 50 years, then Sidney would gain about 5,500 additional dwellings. (The South Sidney background study anticipates only about 2,400 additional dwellings in the Township between 1991 and 2021.)

- If 5,500 additional dwellings were developed over the next 50 years, South Sidney, the Township's first priority, is expected to account for about 2,000. Extrapolating from the South Sidney background study suggests that at least 1,000 additional dwellings would be developed in Glen Miller, Batawa, and the Township's hamlet and rural areas over a 50 year period. This would leave a demand for no more than about 2,500 dwellings in the urban portions of the Potter Creek basin.

- The South Sidney background study projects that between 1991 and 2021, 92 ha of industrial-commercial land would be required in the Wallbridge-Loyalist Road area, and another 41 ha in "Potter Creek" (it is not clear exactly what area is being referred to).

5.2 Land Use Scenarios

The population and development analysis in Section 5.1 provides an estimate of the amount of land required for industrial-commercial development in the Potter Creek basin, and an estimate of the number of dwellings for which there may be a demand under optimistic conditions. To translate the number of dwellings into a requirement for land for residential development, some assumptions regarding residential density are required.

We believe that a gross density of 12 dwellings per hectare of land allocated for urban community development will result in a fairly generous estimate of residential land requirements. We believe that 40% is a reasonable estimate of the portion of the lands allocated for urban community development that will be needed for road allowances, flood protection, environmental and transportation setbacks, parks and open space, local commercial and institutional uses, and so on, or that would remain in existing developed residential lots. This would result in a net density of 20 dwellings per hectare of land within residential lots, for an average lot size of 500 m². This density would be able to accommodate the mix of dwelling types and lot sizes that would be expected in a suburban community of this nature, ranging, for example, from town houses on 8 m x 30 m lots, to executive homes on 15 m x 60 m lots. These densities are in the same range as current average residential densities in the Greater Quinte area. A movement towards greater intensification as a planning and development strategy, and/or a shift in demand towards more smaller and fewer larger lots, could result in a significant increase in densities from the figures presented here.

Drawing Number 1137-16-15 - Land Use Scenarios shows two scenarios prepared for the consideration of the Study Committee, as follows. The scenarios were limited to the area south of Highway 401, east of Wallbridge-Loyalist Road, and west of the City of Belleville, because:

- As will be demonstrated, there is no evidence that there would be any need for major development north of Highway 401 or west of Wallbridge-Loyalist Road, and it is assumed that Sidney's current planning policies would continue to apply in those areas;

- The Belleville portion of the basin is already by and large developed, and is not likely to experience significant redevelopment.

Scenario A is a moderate development scenario, as follows:

- Residential development extending west from Belleville to a line bounded by the existing development north of Highway 2, Avonlough

Road, the southeast branch of Potter Creek, Marshall Road, and Moira Street West, for a total area of 129 ha, or about 1,550 homes. (The calculated area includes some lands not in the Potter Creek basin and excludes the two major existing subdivisions.)

- Industrial development extending west from Belleville, north to Highway 401, south to the Ontario Hydro right-of-way, and west to Wallbridge-Loyalist Road and the area already developed for industrial purposes, for a total area of 184 ha.

Scenario B is a high development scenario, as follows:

- Residential development extending west from Belleville to a line bounded by the existing development north of Highway 2, Avonlough Road, and Moira Street West, for a total area of 202 ha, or about 2,420 homes.

- An additional area for residential development, consisting of the parts south of Potter Creek of the two original township lots between Highway 401 and Moira Street West immediately west of the City boundary, for a total area of 68 ha or about 820 homes.

- Industrial development extending west from Belleville, north to Highway 401, south towards Potter Creek, and west to Wallbridge-Loyalist Road and the area already developed for industrial purposes, for a total area of 274 ha.

The following should be noted regarding the scenarios:

- The urban community area under Scenario B is pretty much the same area designated as urban residential within the Potter Creek secondary planning area in Sidney's official plan.

- The industrial area under Scenario B, plus the existing and approved industrial area southeast of Wallbridge-Loyalist Road and Highway 401, is the same area designated as business within the South East secondary planning area in Sidney's official plan.

- The 3,240 homes projected under Scenario B is more than the number likely to be demanded in urban portions of the Potter Creek basin over the next 50 years, as indicated in Section 5.1.

- The 274 ha of industrial land set aside under Scenario B is over twice the area of industrial land estimated as required in the Potter Creek basin over the next 30 years, as indicated in Section 5.1.

In our opinion, the analysis in Sections 5.1 and 5.2 also clearly demonstrates that:

- There will be no requirement for lands north of Highway 401 or west of Wallbridge-Loyalist Road for urban purposes, other than immediately around the interchange of those two arteries, for the next 50 years;

- Given the existing agricultural and rural development policies of the Township of Sidney, development north of Highway 401 and west of Wallbridge-Loyalist Road over the next 50 years can be expected to be limited to a modest number of estate residences in the northwestern corner of the basin, and the occasional farm or rural residence or small business along existing roads.

5.3 SERVICING

Presently, there is no overall strategy to provide sanitary and water services to South Sidney, Montrose and Potter Creek areas. Furthermore, there are no existing systems which can provide the water and sanitary services without the Township of Sidney considering:

- The implementation of new water and sewage facilities;

- The use of alternate technologies such as Rotating Biological Contactor plants (RBC); or

- The establishment of a joint servicing agreement with the City of Belleville to expand the City's existing facilities to accommodate future increases in population within the Township of Sidney.

Given the fact that all future development will require full servicing, it is apparent that a great deal of work and studies must be undertaken to resolve the servicing issues prior to the realization of any new major development taking place within the Township.

An insight to servicing alternatives and associated costs for the Montrose and Potter Creek areas, excluding the commercial-industrial area around Wallbridge-Loyalist Road and Highway 401, is provided in a report entitled **South Sidney & Potter Creek Community - Water and Sanitary Services - Parts 1 & 2**, 1985, by Rysco Engineering on behalf of the Township of Sidney. Although this report no longer reflects the planning direction of the Township, it does provide the information to confirm the lack of current facilities to service new development and that the cost for new facilities, whether undertaken by the Township or jointly with the City of Belleville, will be in the order of $25,000,000 to $30,000,000.

5.4 PREFERRED DEVELOPMENT SCENARIO

Scenarios A and B as described in Section 5.2 were reviewed with the Study Committee. The Study Committee and the consultants agreed that a single scenario could be used for assessing the impacts of future development. The Committee recommended that this projection of land use consist of Scenario B, with the future urban community extended west to Wallbridge-Loyalist Road south of Loyalist College. In this way, the urban community's boundaries would more closely approximate those of the Potter Creek Secondary Planning Area.

With this modification to Scenario B, the projected future urban community would extend over 323 ha excluding the two major existing subdivisions, and could accommodate about 3,880 homes at a gross density of 12 dwellings per hectare. The projected future industrial area would remain at 274 ha in size.

6.0 POLICIES, BAY OF QUINTE RAP AND WATERSHED CONSTRAINTS

In developing a Subwatershed Plan it is imperative to address the overall watershed goals and objectives, current government policies, regulations and guidelines, resource potential, desired uses and public opinion, and any problems and constraints.

The goals to be used in formulating the Potter Creek Subwatershed Plan were discussed in Section 1 of this report. The following sections outline the existing policies and regulations, recommendations of the Bay of Quinte Remedial Action Plan (RAP) directly related to the Potter Creek watershed and the watershed's potentials and constraints.

6.1 POLICIES

Over the years the federal, provincial and municipal governments have adopted policies, guidelines, processes and "How-To-Do-It" manuals that are intended to minimize the negative impacts of development on the natural and human environments. The following outlines the most pertinent of these which are relevant in developing the Subwatershed Plan.

In June 1993, the Commission on Planning and Development Reform in Ontario submitted its final report recommending a comprehensive set of provincial policy statements under the Planning Act to replace the existing patchwork. Implementation of the Commission's recommendations could significantly alter some of the following.

6.1.1 FLOOD PLAINS

Flood plains along Potter Creek, as elsewhere in Ontario, are regulated in accordance with a **Policy Statement on Flood Plain Planning** issued under Section 3 of the Planning Act, by the Ministers of Natural Resources and Municipal Affairs. This document contains eight policies which have the following objectives:

- To prevent loss of life;
- To minimize property damage and social disruption;
- To encourage a coordinated approach to the use of land and the management of water.

The policies deal with the following:

- **General** - that all land use planning take regard of the implications of actions with respect to flood susceptibility.
- **Regulatory Flood** - defines the regulatory flood standard in different areas of the province, defines a minimum requirement and procedures for changing the standard. In Eastern Ontario including the Moira River watershed, the regulatory flood is the 100 year flood.
- **Official Plans** - indicates the need to include flood plains and restrictive policies in official plans or zoning documents.
- **One Zone Concept** - indicates that a single zone defined by the regulatory flood line is the normal flood plain policy for the province.
- **Two Zone Concept** - indicates that in some cases a two zone floodway/flood fringe approach may be used to permit some development in the flood fringe.
- **Special Policy Area Concept** - indicates that in some special cases controlled development may be permitted within the flood plain under the auspices of a Special Policy Area designation.
- **Floodproofing** - defines need for floodproofing and special consideration for access when development is permitted within a flood plain.
- **Public Safety** - defines certain uses such as hospitals, schools, emergency services and activities associated with hazardous materials which are not permitted regardless of the other policies.

The implementation of this Policy by the municipalities in consultation with the Moira River Conservation Authority (MRCA) restricts development potential along the main watercourse and tributaries of the Potter Creek watershed.

The guidelines that will henceforward be used to determine the extent of hazard lands along Potter Creek are defined by the Moira River Conservation Authority in Section 4.2.1 and 4.2.2 and illustrated on the Conservation Authorities Flood Risk Maps, Sheets 1 through 26 and Drawing Number 1137-16-11 - Hazard Lands. It is anticipated that the Township of Sidney will modify the Environmental Protection Zone in its zoning bylaw to reflect these floodlines.

At present, there is no formal provincial policy regarding floodlines along the Great Lakes shore. However, the Conservation Authorities and Water Management Branch prepared a study entitled **1:100 Year Water Levels in the Bay of Quinte** and circulated the findings and recommendations to all Conservation Authorities involved in the Flood Damage Reduction Program (FDRP) digital shoreline mapping projects. For the Bay of Quinte and in particular at its confluence with Potter Creek, the 1:100 year wave uprush was determined to be 75.9 m GSC. The Moira River Conservation Authority has adopted this elevation as the extent of lands subject to flooding along this shoreline reach of the Bay of Quinte.

6.1.2 HAZARD LANDS

Hazard lands are defined as those lands subject to flooding and/or erosion. These lands are protected under the Fill, Construction and Alteration to Waterways Regulations administered by the Moira River Conservation Authority under Section 28(1) of the **Conservation Authorities Act**.

Prior to proceeding with construction or the placement of any waste or fill materials within the hazard lands, a permit must be obtained from the Moira River Conservation Authority.

6.1.3 WATERCOURSES

In addition to the regulations administered by Conservation Authorities, alterations to watercourses are also administered by the Ontario Ministry of Natural Resources under the **Lakes and Rivers Improvement Act**. Approval under this Act is required for dams, diversions, channelization, bridges, culverts, and embankments which may impact a lake or watercourse with respect to water yield, water quality, fisheries and fisheries habitat.

Detailed information on the applicability of the Act is contained in **Guidelines and Criteria for Approvals Under the Lakes and River Improvement Act** (Ministry of Natural Resources, 1977).

The Township's Zoning Bylaw requires that development, with the exception of boathouses, be set back 30 m from all shorelines, or 15 m from the boundaries of Environmental Protection Zones along watercourses, whichever is greater.

The Moira River Conservation Authority, in April of 1993, passed a Policy governing **Setbacks from Watercourses and Unstable Slopes**. The Policy addresses four main areas as follows:

1. Within Regulated Lands Defined by Fill Schedules;
2. Within Watercourses and Environmentally Sensitive Zones Which Are Not Fill Scheduled;
3. Development Through Infilling Within Fill Schedules Areas and Non-Fill Areas; and
4. Along the Bay of Quinte Shoreline.

Since part of this Study is to define lands along Potter Creek in order for the Moira River Conservation Authority to prepare an appropriate fill schedule, we have assumed that the Potter Creek lands are within the lands defined by fill schedules and are therefore subject to the Authority's Policy under item 1 and the flood plain delineations and fill line regulations contained in Section 4.2.1 and 4.2.2. This excludes Class 1-7 wetlands as a separate Conservation Authority Policy has been developed to address wetland areas.

Aside from the hazard lands defined in the flood plain portion of the Study, the Moira River Authority:

- has established a minimum 15 m no

development vegetation buffer from top of bank;

- requires the creation of a vegetative buffer and/or erosion/sediment controls where no buffer exists;

- requires that no stormwater management facilities be placed within the 15 m buffer, and;

- vegetation and construction mitigation will be established on a site by site basis.

Along the Bay of Quinte shoreline, the Moira River Conservation Authority has adopted the draft Great Lakes-St. Lawrence Flood and Erosion Policy Statement which states:

- where grades are flat, a 30 m setback from the static 1:100 year floodline plus wave uprush will be applied.

The fill line criteria outlined in Section 4.2.2 have been applied in delineating the flood hazard areas along the Bay of Quinte at the confluence of Potter Creek. The criterion in areas where steep slopes are not prevalent is a 15 m set back from the 1:100 year flood elevation plus wave uprush.

Although the Moira River Conservation Authority's current Policy and fill line criteria and Sidney's official plan deal with the requirement to establish specific setbacks and buffers, there are inconsistencies in definition which need to be clarified.

6.1.4 GROUNDWATER RECHARGE/DISCHARGE

Protection of the groundwater resource is an important issue in land use planning. Its protection is provided for under various policies and regulations of the Ministry of Environment and Energy, the Ministry of Natural Resources, and the local Conservation Authority. Generally, these policies and regulations strive to properly identify and inventory groundwater conditions, and to protect the groundwater resource by:

- Maintaining groundwater recharge. This is required to ensure that the groundwater resource is not depleted, and is available for water supply (wells), and discharge or base flow to local streams, rivers, and lakes.

- Protecting groundwater quality. A wide range of land development activities can affect groundwater quality. These include sewage disposal (septic tank tile field systems), agriculture (feed lot practices, application of manure, fertilizers, herbicides, and pesticides), and urban development (infiltration of water possibly contaminated as a result of urban runoff).

- Protecting sensitive groundwater regimes or features. Areas of important local groundwater recharge or discharge must be identified and protected. In addition, biophysical features which are directly related to the groundwater or are maintained by the groundwater (such as cold water fisheries, wetlands, and the like) must also be properly identified and protected.

The regulation and protection of the groundwater resource is generally controlled by the **Ontario Water Resources Act** and the **Environmental Protection Act**. A brief overview of the requirements under these Acts is summarized below:

The **Ontario Water Resources Act** requires an approval or permit for:

- taking of water in excess of 50,000 Lpd (whether from groundwater or surface water sources);

- construction of a sewage disposal system; and,

- construction of stormwater drainage works.

The **Environmental Protection Act** is intended to protect the natural environment. Groundwater and surface water are included in the definition of the natural environment. In summary, the Environmental Protection Act provides for regulations for the following:

- discharge of contaminants to the groundwater, and the acceptable level of discharge;
- regulation of the construction of sewage disposal works;
- regulation of the construction of waste management works;
- management and clean-up of spills or leaks;
- provision of powers to a Director of the Ministry of Environment and Energy to regulate discharges to the environment and force clean-up, if necessary.

One of the primary policies for the protection of groundwater quality, under the Environmental Protection Act, is the Reasonable Use Policy. In summary, this policy requires that the quality of groundwater be maintained for its highest or most reasonable use, which generally means drinking water. In some cases, it may also require higher standards of quality where groundwater which discharges to the surface forms an important component of aquatic habitat.

In addition, there are also interim policies or guidelines of the Ministry of Natural Resources and the Ministry of Environment and Energy with respect to the groundwater resource. These include:

- the requirement to maintain ground water recharge, as part of Best Management Practices (BMPs) for stormwater management;
- the requirement to maintain the viability of the groundwater resource for future development or use;
- a long-term prospective with respect to management of the groundwater resource. This includes assessment of the long-term or cumulative impact of development, rather than the short-term or site-specific impacts alone.

6.1.5 FISH HABITAT

The principal policy regarding the protection of fisheries and fisheries habitat is the federal Department of Fisheries and Oceans **Policy for the Management of Fish Habitat** (Department of Fisheries and Oceans, 1986), that guides the administration of habitat protection provisions of the federal **Fisheries Act**. The Ontario Ministry of Natural Resources, which has responsibility for management of most aspects of fisheries in Ontario, implements this policy through a Federal-Provincial Agreement. Under the Fisheries Act, fish habitats are defined as those parts of the environment "on which fish depend, directly or indirectly, in order to carry out their life processes".

The principal objective of the fish habitat management policy is a net increase in the natural productive capacity of habitats for Canada's fisheries resources. Progress towards this "net gain" objective is realized by:

- maintenance of current productive capacity of fish habitats, using a no net loss guiding principle (i.e., each proposed development works or undertaking will be evaluated in the planning phase to determine if its impact on fish habitat would reduce the capacity of that habitat to sustain fisheries resources);
- rehabilitation of the productive capacity of fish habitats in selected areas; and,
- creation and improvement of fish habitat in selected areas.

Any projects which may result in harmful alteration, disruption or destruction of fish habitat are prohibited unless authorized by the Department of Fisheries and Oceans pursuant to Section 35(2) of the Fisheries Act. In keeping with the Department's **Policy for the Management of Fish Habitat** (1986), no authorizations will be issued unless acceptable measures to compensate for the habitat loss are developed and implemented. As well, no authorizations will be issued in cases where the loss of a specific habitat type is considered unacceptable.

In 1992, the Province of Ontario released **Strategic Plan for Ontario Fisheries** (SPOF II) for managing the fisheries resource in the 1990s and beyond. The objectives of the plan are:

- to protect healthy aquatic ecosystems;
- to rehabilitate degraded aquatic ecosystems; and
- to improve cultural, social and economic benefits from Ontario's fisheries resource.

Five "guiding principles" form the foundation for fisheries management under the plan; these are that:

- sustainable development requires that adverse impacts on natural elements such as air, land and water, be minimized to ensure the aquatic ecosystem's overall integrity;
- there is a limit to the natural productive capacity of aquatic ecosystems and, hence, a limit to the amount of fish that can be harvested from them;
- naturally reproducing fish communities, based on native fish populations, provide predictable and sustainable benefits with minimal long-term cost to society;
- good fisheries management is scientifically based and relies on the acquisition and use of the best available knowledge; and
- resource management decisions, including allocation, shall be based on ecological, social, cultural and economic benefits and costs to society, both present and future.

In order to resolve the issues faced by fisheries managers, six strategic management actions were formulated, which are to:

- ensure that benefits are sustained by protecting and rehabilitating aquatic ecosystems;
- inform and involve the public in decision making and program delivery to foster stewardship;
- ensure resources are properly valued;
- ensure effective program management and coordination among agencies;
- acquire and communicate essential knowledge for timely and effective resource management decision-making; and
- enforce firmly and effectively.

Direction '90's (1991) establishes sustainable development as the cornerstone of the Ontario Ministry of Natural Resources's resource management activities. The concept relies on an integrated management approach which considers the full range of environmental, social and economic factors when natural resources are used. Management principles include:

- connectedness of all life within the natural world, including humans;
- preservation of biodiversity;
- integrated resource management;
- preventing negative environmental impacts in new resource situations;
- "precautionary principles" in resource use, due to incomplete understanding of ecosystem function;
- encouragement of research and innovation in sustainable development of natural resources; and
- fairness and involvement to humans affected by sustainable development.

6.1.6 WETLANDS

Provincially significant wetlands in Ontario are protected in accordance with the **Wetlands Policy Statement** under the **Planning Act** (Ministry of Natural Resources and Ministry of Municipal Affairs, 1992). In Southern Ontario, provincially significant wetlands are those classified as Classes 1 - 3 using the provincial evaluation system (Ontario Ministry of Natural Resources, 1984). The wetlands policy can be applied to Classes 4 - 7 wetlands as deemed appropriate by regional and local municipalities. It is important to recognize that, because of the way wetlands are rated and scored in several different categories, Classes 4 - 7 wetlands can still be important in relation to one or more of their specific components (e.g. biological, hydrologic, etc.)

In general terms, the policy provides that:

- All planning jurisdictions including municipalities, planning boards and resource management bodies within the Province shall protect **Provincially Significant Wetlands.**

- Where **Provincially Significant Wetlands** have been identified, all planning jurisdictions, including municipalities and planning boards, shall incorporate policies and protect **Provincially Significant Wetlands** in official plans, zoning by-laws and other development decisions under the **Planning Act.**

- All planning jurisdictions, including municipalities and planning boards are encouraged to protect other **Wetlands** that are not provincially significant.

Within the Great Lakes - St. Lawrence Region, which includes the Potter Creek watershed, the policy states that:

- **Development** shall not be permitted within **Provincially Significant Wetlands.**

- On **Adjacent Lands, Development** may be permitted only if it does not result in any of the following:

  - loss of **Wetland Functions;**
  - subsequent demand for future **Development** which will negatively impact on existing **Wetland Functions;**
  - conflict with existing site-specific wetland management practices; and,
  - loss of contiguous **Wetland Area.**

  This shall be demonstrated by an **Environmental Impact Study (EIS),** prepared in accordance with established procedures, and carried out by a proponent addressing the preceding points.

- On **Adjacent Lands**, established **Agricultural Activities** are permitted without an **EIS.**

For the purpose of this policy statement, **Adjacent Lands** are defined as:

- those lands within 120 metres of an individual Wetland Area; and

- all lands connecting individual Wetland Areas within a Wetland Complex.

Agricultural Activities means ploughing, seeding, harvesting, grazing, animal husbandry, buildings and structures associated with these farming activities. This includes such activities on areas lying fallow as part of a conventional rotation cycle.

Development means:

- the construction, erection or placing of a building or structure;

- activities such as site grading, excavation, removal of top soil or peat and the placing or dumping of fill;

- drainage works, except for the maintenance of existing municipal and agricultural drains.

The Moira River Conservation Authority, in April 1993, adopted a **Wetland Policy:**

- To support the Provincial Wetlands Policy Statement.

- To support the objectives of the Bay of Quinte Remedial Action Plan through a "no net loss" approach to wetland habitat areas.

- To protect all fragile ecosystems contained within or adjacent to wetlands from irreparable damage due to development, land use changes, or other activities.

- To undertake subwatershed and master drainage planning which will recognize the hydrologic, social, educational and ecological functions of wetlands.

- To liaise with other resource planning agencies, environmental interest groups, developers and consultants, and public interests in regards to the protection and preservation of wetlands.

- To actively promote wetland protection through Conservation Authority programs.

- To discourage the draining of wetlands in rural and urban areas.

- To acquire, when possible, wetlands for the benefit of public education.

- To encourage passive recreational pursuits in wetlands which will not negatively impact their areas and/or functions.

- To actively pursue the registration of fill lines around classified 1-7 wetlands in the watershed in order to review and assess potential impacts of development in accordance with the Fill, Construction and Alteration to Waterways Regulation.

- To encourage watershed municipalities to recognize Class 1-7 wetlands in their Official Plans and Comprehensive Zoning By-Laws where applicable.

Specific policies relating to plan input and review and land use planning procedures for development proposals within and adjacent to wetlands are:

- No development within a Class 1-7 wetland.

- Existing land use practices such as agriculture will be recognized on adjacent lands of Class 1-7 wetlands, but infilling or expansion of workable lands will not be supported.

- All Class 1-7 wetlands, in accordance with fill schedules, will have a 120 m adjacent lands zone where permit approval will be required for any proposed development. Land use changes, i.e. zoning and official plan amendments, will be reviewed within the context of this policy.

- In the absence of fill schedules, impacts within the 120 m adjacent lands will be assessed on a site-by-site basis.

- Proposed development within the 120 m adjacent lands will require an **Environmental Impact Study (EIS)** for Class 1-3 wetlands and may require an **EIS** for Class 4-7 wetlands. This assessment will be based on recognized engineering and/or ecological principles, to determine if the wetland will be negatively altered either in area and/or function due to the proposed development.

- A 30 m vegetative buffer from the edge of the wetland boundary within the 120 m adjacent lands will be enforced to protect the wetland from nutrient loading and surface runoff which would impact on area and/or function. If this vegetative buffer does not naturally exist or has been cleared/altered due to construction activities, unless otherwise determined by an **EIS**, it will be a requirement to establish such a buffer as part of permit approval.

- Passive recreational pursuits, wildlife conservation and nature appreciation that do not negatively impact the area and/or function of the wetland will be allowed and encouraged within the 30 m buffer zone. Structures, walkways, etc. associated with these activities will be reviewed on a site-by-site basis and may require an **EIS**. Any major proposals will have to comply with policies set forth in this document.

- The 30 m no development vegetative

buffer may be reduced if an environmental impact assessment proves that a lesser buffer will be sufficient in protecting the wetland from negative impacts of the development.

- Development within headwaters wetlands, even if they are not classified, will be prohibited unless it is proved through recognized engineering and ecological principles that no impact to the subwatershed will occur, or in accordance to a completed subwatershed plan.

- All wetlands within the Bay of Quinte shoreline under the jurisdiction of the Conservation Authority will be subject to these noted policies.

- Development proposals within the 120 m adjacent lands will adhere to approved procedures regarding sediment and erosion control, stormwater management and construction site best management practices (BMPs).

- The Conservation Authority may request that an applicant complete a specific impact assessment to address retention and phosphorus loading from a septic system where proposed within the 120 m adjacent lands but above the 30 m vegetative buffer zone, in accordance with the **EIS** criteria.

Development means:

- the construction, erection or placing of a building or structure.

- activities such as site grading, excavation, removal of top soil or peat and the placing or dumping of fill or alteration to existing ground contours.

- drainage works, major maintenance of existing municipal and agricultural drains.

Description of an **EIS** may be found in the yet to be completed Moira River Conservation Authority's **Implementation Guidelines for Wetland Fill Line Mapping**. Until the Authority guidelines are completed, the province's **Wetlands Policy Statement Implementation Guidelines** will be referenced.

Within the Potter Creek watershed there are three small wetland areas. These are shown on Drawing Number 1137-16-13 - Resource Features. As described in Section 4.2.6, the Aikins wetland and the wetland located east of Huntingwood Road would be classified as Class 3 Provincially significant based on the **Guidelines for Wetland Management in Ontario** (1984). The wetland east of Avonlough Road would be classified as a Class 7 wetland.

None of the above wetlands are identified in the Township of Sidney's Official Plan, because they have not been evaluated by the Ministry of Natural Resources. Sidney is bound by the **Wetlands Policy Statement** with respect to Provincially significant wetlands. However, while the official plan permits the Township to protect locally significant wetlands in its zoning bylaw, it does not require it to recognize or protect any such wetlands.

6.1.7 WOODLOTS

Woodlands Improvement Act agreements have legislative sanction and as noted in Section 3.5.6, they represent at least short term commitments to resource production.

The Ministry of Natural Resources seeks to protect significant woodlots in plan review. However, there is no formal provincial policy supporting this initiative.

Under the **Trees Act**, counties and separated cities or towns have the power to pass bylaws to restrict tree cutting. Neither Hastings County nor the City of Belleville have such bylaws.

The Township of Sidney does not have any policies regarding the protection of woodlots as such; however, its official plan does include some policies on trees and landscaping which have some relevance. In this regard, the policies state:

- Special attention shall be paid to fostering the growth of trees and the provision of landscaping. Trees along the roadways will generally be protected and where trees have to be removed they will be replaced as soon as possible. In new developments, trees and landscaping will be required to be provided by the developers. In general, a program of tree planting, preservation and landscaping will be encouraged so that all areas are provided with trees and other vegetation to provide a high standard of amenity and appearance.

- When considering a development proposal, the municipality may request that the owner enter into an agreement whereby:

  a) Only trees which directly impede the construction of buildings and services may be removed and where any trees must be so removed, the developer shall replace them, in reasonable time, by trees of sufficient maturity;
  b) A reasonable minimum number of trees and other suitable vegetation per lot to the satisfaction of the municipality shall be provided by the developer regardless of the state of the area prior to being subdivided or developed.

As well, the Township's official plan prohibits vegetation removal on estate residential lots, outside those portions required for the building envelope, driveways, and sewage and stormwater systems.

6.1.8 AGRICULTURE

The **Food Land Guidelines** of 1978 remain the Ontario Government's policy on agricultural land use planning. The objectives of this policy are to protect the agricultural land base and avoid having uses incompatible with farming located in agricultural areas.

The guidelines define high priority agricultural lands, and require municipalities to identify and protect those lands in their official plans, with the exception of:

- lands already developed;
- lands needed for another use, where the need could be documented and justified in accordance with criteria established in the guidelines.

For the Potter Creek watershed, high priority agricultural lands essentially consist of lands predominantly of soils classes 1 through 4 as defined by the Canada Land Inventory of Soil Capability for Agriculture. Almost all of the watershed is in classes 1 through 3.

The City of Belleville portion of the watershed was by and large fully serviced and developed during the period in which the Food Land Guidelines were being incorporated into municipal plans. In any case, all lands within the City were anticipated as being required for urban development.

In the Township of Sidney, the official plan by and large continues the agricultural policies of its predecessor (1980) plan, and designates all lands that are not already developed as agriculture, environmental protection, or open space, with the following exceptions (see Drawing No. 1137-16-09):

- lands south of Highway 401 and east of Wallbridge-Loyalist Road, all of which are designated for non-agricultural development;
- lands designated as rural west of Wallbridge-Loyalist Road and north of Highway 401.

The lands in the southeast portion of the watershed were designated for non-agricultural development on the basis of anticipated urban development needs adjacent to Belleville. The rural lands in the northwest portion were so designated on the basis of relatively poorer soil capability and topographic limitations, which justified permitting low intensity rural non-farm development.

Therefore, the agricultural designations in the Township of Sidney's Official Plan, and the plan's prohibition of significant non-agricultural development on those lands, fulfil the requirements of the **Food Land Guidelines**.

6.1.9 HERITAGE AND RECREATION

None of the known heritage resources in the watershed is formally designated in any way. However, as noted in Section 3.5.4, the Ministry of Culture, Tourism and Recreation would recommend prior archaeological assessment in any area subject to major development, and would likely require such an assessment as a condition of planning application approval.

Moira River Conservation Authority and municipal park lands are generally identified in the official plans as recreation or open space. However, their policy status derives primarily from their public ownership and the extreme unlikelihood that they would ever be put to any other use.

6.1.10 SURFACE WATER MANAGEMENT

Developers and various government agencies, in particular, the Ministries of Natural Resources and Environment and Energy have recognized the significant impacts caused by stormwater runoff from urban areas. To address the lack of provincial policy dealing with stormwater the two ministries have jointly released the **Interim Stormwater Quality Guidelines for New Development**, June 1991. This document provides guidance to proponents of development and to municipal and provincial review and approval staff. While the guidelines allow for flexibility, especially when stormwater quality is being addressed within an integrated resource management context, such as a subwatershed plan, the effect of the guidelines is to ensure that stormwater runoff from new development is not permitted to be discharged uncontrolled and untreated into any water body.

The guideline document differentiates between cold-water and warm-water fisheries. Cold-water streams should include a 30 m buffer along the watercourses and water quality treatment should be provided for a volume of runoff generated by a 25 mm rainfall. For warm-water streams these figures are reduced to 15 m and 13 mm respectively. In either case, sediment controls are to be in place during all phases of development and construction. Additional water quality requirements may be established if the uses of the stream included swimming or drinking water supply. Field work and review of all available background information indicate that Potter Creek is a warm-water stream with no swimming or drinking water uses. The Moira River Conservation Authority, as part of its fill regulations, also requires minimum 15 metres setback from the floodline or top of valley, depending upon the slope and stability of the watercourse embankment. Where the setbacks overlap, the buffer creating the maximum setback is applied.

In April 1992, the Ministry of Environment and Energy commissioned a study to produce a planning and design manual for BMPs. The project's Advisory Committee noted that in order for the manual to be useful, it must reflect each agency's orientation so that the manual becomes a Provincial document rather than a single agency's product. To achieve this, the committee held meetings and sponsored a Guidelines Workshop in August and September of 1992 with all the regulatory agencies (Ministries of Environment and Energy and Natural Resources and Conservation Authorities) as well as municipalities, the Ministry of Transportation and the Department of Fisheries and Oceans. In March 1993, a workshop summary was released to present stormwater quality guideline strategies. The summary discusses strategies for multi-purpose pond design, planning and approval process, baseflow maintenance, reasonable use and compliance criteria, and maintenance requirements.

The proposed strategy for a multipurpose design pond is:

- Subwatershed planning should determine the baseflow, and other environmental, requirements to meet watershed objectives. As a result, subwatershed planning would determine the need for alternative development forms and standards (ditch and culvert servicing, roof leaders to rear yard swales, site planning, etc.) in addition to, or in preference to, end of pipe BMP's.

- Combined water quantity/quality/erosion wetlands/ponds would be acceptable given that they are designed to minimize resuspension during large flow events.

- Research monitoring on selected sites

should be performed on several combined water quantity/quality/erosion ponds and several first flush water quality ponds to determine the potential for resuspension of accumulated pollutants and to compare the effectiveness of combined facilities to first flush facilities in terms of long term pollutant removal.

- Written technical and/or economic justification would be required to locate BMP's in the floodplain as opposed to tableland.

- BMP's which are allowed in the floodplain should meet certain requirements:

  - The cumulative effects resulting from changes in floodplain storage, and balancing cut and fill, do not adversely impact existing or future development.

  - Effects on corridor requirements and functional valley land values must be assessed. BMP's would not be allowed in the floodplain if detrimental impacts could occur to the valley land values or corridor processes.

  - The BMP's must not affect the fluvial processes in the floodplain.

  - The BMP's outlet invert elevation should be higher than the 2 year floodline and the overflow elevation must be above the 25 year floodline.

  - An online stormwater quantity facility would be acceptable if designed such that the bank full flows, and hence fish movement, are not impeded/obstructed, and that the requirements noted above are met. An online facility could only be proposed in the context of a subwatershed plan.

The impaired state of the Bay of Quinte ecosystem has resulted in the Bay of Quinte Remedial Action Plan (RAP), which is taking a holistic approach to evaluating problems, their causative factors, and the measures required to restore and protect the ecosystem. One such measure will require Bay of Quinte municipalities to incorporate stormwater management treatment as a requirement for new urban development. To assist in implementing this requirement, an Inter Agency Storm Water Management Working Committee consisting of the Ministry of Environment and Energy, the Ministry of Natural Resources and the Quinte Conservation Authorities was formed to define stormwater management design criteria/guidelines, construction mitigation plans, implementation plans and administration plans (i.e. **Bay of Quinte Stormwater Management Implementation Strategy**).

The following stormwater design criteria, developed by the Inter Agency Storm Water Management Working Committee, were developed primarily in response to the designation of the Bay of Quinte as a bathing beach and the resulting quality criteria that would be applied to stormwater treatment facilities. The Moira River Conservation Authority summarized the strategy briefly as follows; in the absence of subwatershed planning, all new municipally serviced development of an area greater than 1 hectare within municipalities fronting the Bay of Quinte must meet the very stringent quality criteria.

STORMWATER DESIGN CRITERIA/GUIDELINES

General

- Integrate with watershed plan(s) or master drainage plan.

- The retention of existing tree cover or natural vegetation and the provision of significant grassed areas to facilitate absorption of surface water, where infiltration will not contaminate groundwater.

- Developments which have significant impact on surface drainage shall provide comprehensive drainage plans showing methods of mitigating impacts on adjacent or affected properties, as well as the subject property.

- Alternatives and preferred options will be outlined with respect to constraints, objectives, findings, recommendations, and rationale for the selected stormwater management scheme.

- Study area watershed parameters and the development parameters for both pre and post conditions will be defined and delineated.

- Maintenance requirements will be defined for all stormwater management facilities, natural or mechanical.

- Erosion and sedimentation control plans will be provided for major and minor stormwater management system which addressed bank stability, energy dissipators at outlets, and effective construction practices to control on and off site impacts during and after site alteration.

Water Quality

- Stormwater quality management facilities shall be designed to achieve the following event mean concentrations on the basis of flow proportional sampling:

  - Suspended solids not greater than 25 mg/L

  - *Escherichia coli* (*E. coli*) not greater than 100/100 mL

Note: In 1992, the Ministry of Health recommended that *E. coli* replace fecal coliform as the indicator organism for sewage pollution of recreational waters, and that the Maximum Allowable Concentration (MAC) for this organism be 100/100 mL. In terms of background, the Provincial Recreational Water Quality Guideline Committee noted, "There is little epidemiological evidence conclusively linking specific levels of organisms in recreational waters with the burden of illness. However, a number of organisms have been identified as markers for sewage pollution. Fecal coliform (FC), although an appropriate marker, is much less specific than *E. coli* (EC). Studies have shown that in rural recreational waters EC can represent more than 90% of the FC count. However, in urban areas, EC may constitute as little as 30% of the FC count. *E. coli* is known to better identify actual sewage pollution than FC. There are studies to show that interference from *Klebsiella* bacteria can result in false positives for fecal contamination. This has been found to be especially true in water contaminated by discharge from pulp mills. . . . It was concluded therefore that EC is a better indicator organism for measuring sewage pollution in waters. . . The Committee considered the MAC of EC which might be the most appropriate cut-off with respect to the potential burden of illness. There are few data to support either the present Ontario level of 100 FC/100 mL or the federal level of 200 FC/100 mL (the new federal standard is proposed at 200 EC/100 mL) as the upper limit. In the absence of definitive data to support a change in the MAC, the Committee recommended that the MAC should remain at 100 organisms/100 mL. This level is subject to further consideration depending on Federal Government standards and any additional epidemiological evidence relating bacterial indicators to disease. Therefore, no change in the MAC of 100 is recommended at this time, although a review of the MAC should be undertaken once the federal guideline is in place."

- Specific parameters for fishery concerns may include:

  - Dissolved oxygen to be not less than 5 mg/L (5 ppm) in summer and 4 mg/L in winter

  - Emulsified oils not to exceed 0.05% of the 96 hour LC 50

  - pH to be greater than 6.2

  - Concentration of hexane

extractable substance (exclusive of sulphur) in air dried sediments not be increased above 100 mg/kg on a dry weight basis

- No discharge temperatures in excess of 20° C

Note: Compliance with suspended sediment and *E. coli* concentration objectives should achieve desired nutrient and toxin reductions. The 25 mg/L suspended sediments is also necessary to achieve effective ultra-violet disinfection.

- Stormwater quality management facilities shall be sized so as to permit not more than four bypass events during the body contact recreation season.

  Note: Sizing of a facility is normally carried out using continuous simulation. The facility is online and should have an inlet bypass once it is full.

- If a stormwater quality management facility is designed and approved with effluent disinfection, the disinfection component need only be operated during the body contact recreation season. The remainder of the works must, however, be maintained operational year around.

- Pond design must include a specific sediment storage volume. The operation of the facility must also reflect the necessity of assessing the sediment quality in compliance with Ontario Regulation 347 and disposing of sediment in a suitably approved site.

- Municipal ownership and operating responsibility will be mandatory for all stormwater quality management facilities. As the operating authority for the works, the municipality will be responsible for the certificate of approval, compliance reporting, and the preparation and submission of annual reports (which would address operation, maintenance and monitoring with recommendations to address any identified deficiencies, problems, non-compliance situations, etc.)

Water Quantity

- No increase in flood risks. Applies to all peak return events from a 2 year return event to regulatory event.

- Stage-discharge relationships for all stormwater management facilities designed for the regulatory event.

- Drainage facilities and systems designed for a stormwater management scheme shall be designed so that flooding regulations as set out in the Provincial Floodplain Policy are not violated.

- Overland flows, depths, and velocities supplied at key points on roads and at outfall of major system for regulatory event.

- Elevations of the hydraulic grade line at critical points for minor system design storm and regulatory event.

- Define impacts on groundwater discharge or recharge areas and provide measures to mitigate or minimize impacts to groundwater flow (hydrogeologic report may be requested).

Preliminary Stormwater Management Plans

The following guidelines outline the basic requirements for the preparation of a preliminary stormwater management plan.

General Requirements

- Identify existing topographic features. In many cases, existing topographic mapping such as Ontario base maps or that prepared for a draft plan of subdivision may be adequate.

- Identify existing drainage basins and vegetative characteristics on and off site that should be considered.

- Identify historic runoff characteristics of the drainage basin.

- Identify associated water/habitat sensitivity in the potentially affected area. The Ministry of Natural Resources should be contacted in this regard.

- Establish stormwater management quantity and quality criteria that must be applied to the site development to prevent negative environmental impact. Criteria may vary depending on urban or rural development, site-specific concerns, or the availability of a master drainage plan for the watershed.

- Identify proposed stormwater management measures required to accommodate the development and confirm how the proposed post development conditions (volume, peak, quality) will equal pre-development conditions for all storms up to and including the 100 year storm event. This should include a description of the proposed major and minor storm management systems but not the actual design of any stormwater management structures or works.

- Conceptually show significant stormwater management measures on a plan which also indicates the proposal. Additional sketches as needed should be included.

- Identify construction mitigation measures necessary to control on and off site impacts (e.g. erosion control, siltation control) both prior to and after the initiation of any site alteration, as well as, a contingency plan to address the failure of these measures. The design must address winter stabilization of the site and spring runoff volume conditions.

Design Criteria

The **Bay of Quinte Stormwater Management Implementation Strategy** should be reviewed for specific design criteria for both a preliminary and final stormwater management plan. Generally, urban development over an area of one hectare will require designed quality control to protect and restore Bay of Quinte water quality. Site conditions with respect to habitat sensitivity will dictate other criteria in either rural or urban developments.

Furthermore, the Township of Sidney's Official Plan;

- requires that a master drainage (subwatershed) plan be prepared prior to development in the Potter Creek secondary planning area;

- sets out policies for the development and implementation of this plan; and

- sets out policies for stormwater management within all new development in the Township.

6.1.11 SERVICING AND UTILITIES

The **Wetlands Policy Statement** regarding approval process for utilities/facilities states that:

> New utilities/facilities shall be located outside **Provincially Significant Wetlands** wherever possible. Approval authorities shall consider alternative methods and measures for minimizing impacts on **Wetland Functions** when reviewing proposals to construct transportation, communications, sanitation and other such utilities/facilities in **Provincially Significant Wetlands.**

The Township of Sidney's Official Plan outlines:

- that development in the Potter Creek and the South East Secondary Plan Areas will proceed on municipal water and sewage systems. The Township is reviewing the feasibility of using municipal water supply and rotating biological contactor (RBC) plants for the industrial/commercial areas in the vicinity of Highway 401 and Loyalist-Wallbridge Road.

- that the estate residential development in the northwest portion of the watershed will be able to proceed on private services subject to demonstrating to the Township, the Ministry of Environment and Energy and the Hastings and Prince Edward Health Unit, that there is adequate on-site supply of potable groundwater, and that soils and lot sizes are adequate for the required sewage disposal system.

6.1.12 TRANSPORTATION

A Ministry of Housing (now Municipal Affairs) policy of 1978, **Land-Use Policy Near Airports,** requires that land uses near airports be compatible with anticipated aircraft noise levels. The policy indicates the uses that are acceptable at various Noise Exposure Forecast (NEF) values. NEF values are mapped periodically by the airport operator.

Current NEF values for Canadian Forces Base (CFB) Trenton are shown in the Township of Sidney's Official Plan, and extend into the southern portion of the Potter Creek basin. In accordance with provincial policy, the plan provides that:

- Within areas with a NEF value of 35 or more, residential or community facility development dependent on the outdoor environment will not be permitted. In the watershed, this applies only to a small area between Wallbridge-Loyalist Road, Hastings Road 22, and Moira Street West.

- Within areas with a NEF value of 28 to 35, residential and community facility structures must meet Ministry of Environment and Energy standards for acoustic insulation and ventilation. In the watershed, this applies to a large area south of Highway 401 and west of Wallbridge-Loyalist Road, and to much of the area designated industrial southeast of the Wallbridge-Loyalist Road - Highway 401 interchange.

As large scale residential or community facility development will not occur in the above areas, the requirements of the NEF policy would appear to be met.

In addition, to minimize bird hazards, the Township of Sidney's Official Plan prohibits development of waste disposal sites, sewage treatment lagoons, and open water reservoirs within:

- 8.05 km of the centre of CFB Trenton;

- corridors 1.61 km wide extending 8.05 km from the ends of CFB Trenton's runways.

This area includes much of the central and western portion of the watershed.

The Department of National Defence has proposed a **Zoning Regulation for the Trenton Airport** (CFB Trenton) under the Aeronautics Act (Canada). The draft regulation states:

> "In order to minimize bird hazards to aviation, no owner or occupier of any lands in respect of which regulations apply shall permit those lands or any part thereof to be used as site for:
>
> (a) a sanitary landfill site;
> (b) a food garbage disposal site;
> (c) a sewage lagoon; or
> (d) an open water storage reservoir."

National Defence describes its intent in regulating a Bird Hazard Zone as to encompass the same area defined in the official plan. However, the proposed Trenton Airport Zoning Regulations include maps delineating a considerably larger area, that would include all of the watershed between Highway 401 and Moira Street West, as well as much of the area north of Highway 401 and the westernmost part of the area south of Moira Street West. The bird hazard zone, as defined by National Defence, is illustrated on Drawing No. 1137-16-16 - Constraint Map. Revised draft regulations will be circulated during 1994.

The differences between the official plan and the Trenton Airport Zoning Regulations will need to be addressed. For purposes of this study, we have assumed that the boundary established by National Defence will take precedence over the boundary defined by the Township of Sidney.

Another Ministry of Housing (now Municipal Affairs) policy of 1979, **Guidelines on Noise and New Residential Development Adjacent to Freeways,** indicates that residential development should be located far enough away from freeways that outside sound levels after noise attenuation measures will not exceed 55 decibels (dBA). The policy specifically prohibits residential development where outside sound levels after attenuation will exceed 70 dBA.

Since neither the Sidney nor Belleville official plans permit large scale residential development anywhere near Highway 401, the requirements of the provincial freeway noise policy would appear to be met.

In accordance with the current policies of the national railways, the Township of Sidney's Official Plan restricts residential development adjacent to the Canadian Pacific and Canadian National lines as follows.

- Development within 100 m of rights-of-way is prohibited, except where a noise and vibration impact study can demonstrate that impacts can be satisfactorily mitigated.
- Development between 100 m and 300 m from rights-of-way must demonstrate through an impact study that noise and vibration impacts can be satisfactorily mitigated.
- Setbacks, buffering, and fencing may also be required to address safety concerns.

Within the Township of Sidney, east of Wallbridge-Loyalist Road, both rail lines adjoin extensive undeveloped lands with residential development potential. For the purposes of this study, we will assume that residential development within 100 m of either rail line would not be desirable.

6.1.13 WASTE MANAGEMENT

In accordance with current policies of the Ministry of Environment and Energy, the Township of Sidney's Official Plan requires that development be set back at least 100 m from an open or closed waste management site. Within 500 m of an open or closed site, development is subject to demonstration to the satisfaction of the Township and Ministry that the development is compatible and can proceed safely. The lands surrounding the Zebedee waste management site, all of which are otherwise potentially developable, are affected by this policy.

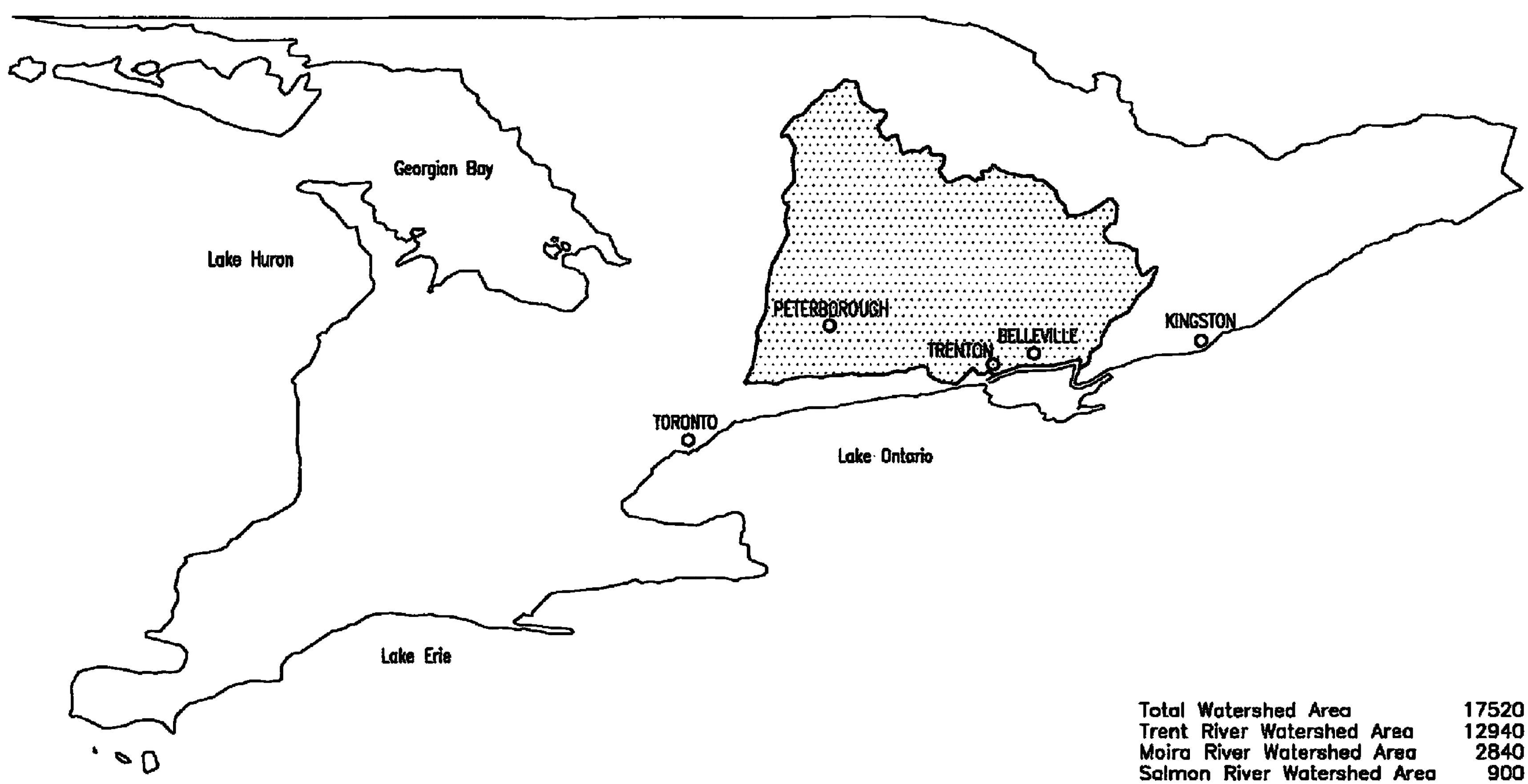
6.2 BAY OF QUINTE REMEDIAL ACTION PLAN

The Bay of Quinte is a long, narrow inlet of water in the northeast corner of Lake Ontario. It is comprised of three smaller, interacting segments: the upper, middle and lower bays. Four major tributary systems -- the Moira, Napanee, Salmon and Trent Rivers -- drain into the bay. The Quinte watershed is 17,520 square kilometres, the largest in southern Ontario (Figure 6-1).

The area's primary industry is agriculture. The area's major processing industries include three paperboard mills, a single wood procession operation, a tire manufacturing plant, as well as a cement production plant. Dairy processing and some manufacturing in the municipalities of Belleville and Trenton, as well as tourism and commercial fishing are other important industries. The Bay of Quinte is used to supply drinking water, receive liquid municipal and industrial wastes, and provide recreational opportunities.

The Bay of Quinte was identified in 1985 by the International Joint Commission as a Great Lake "Area of Concern". Ten beneficial uses of water, defined in Annex 2 of the 1987 revised Great Lakes Water Quality Agreement (GLWQA), are impaired. The impaired uses have been grouped into four general problems: eutrophication, bacteriological contamination, persistent toxic contaminants, and destruction of fish and wildlife habitat and wetland. The water quality problems are most evident in the upper bay.

A federal-provincial Quinte Coordinating Committee was established in 1986 to develop a Remedial Action Plan (RAP). Two federal agencies (Environment Canada and Fisheries and Oceans Canada) and three provincial ministries (the Ministry of Agriculture and Food, the Ministry of Environment and Energy and the Ministry of Natural Resources) provided direction to the RAP. This technical RAP team was mandated within Annex 2 of GLWQA to define the water quality problems, identify pollution sources, evaluate past pollution abatement actions, assess new and



Total Watershed Area	17520 km²
Trent River Watershed Area	12940 km²
Moira River Watershed Area	2840 km²
Salmon River Watershed Area	900 km²
Napanee River Watershed Area	840 km²
Potter Creek Watershed Area	31 km²

BAY OF QUINTE WATERSHED
FIGURE 6–1 NOT TO SCALE

alternative measures to restore the beneficial uses, select a preferred set of remedial actions, outline a schedule for implementation, identify the implementing agencies or persons, monitor the remedial actions, plus report their findings. The general principles of the Canada-Ontario Agreement further required the RAP team to:

- embody a systematic and comprehensive ecosystem approach to restoring and protecting beneficial uses and
- consult the public.

In 1988, a Quinte RAP Public Advisory Committee (PAC) was formed to achieve the latter requirement. Now, the PAC has 28 members representing a cross section of interests.

The two committees cooperatively have prepared 16 technical reports, two Quinte RAP progress reports, two videos, the **Stage 1 Report - Environmental Setting and Problem Definition**, six **Quinte RAP Update** newsletters, a poster and **Time to Decide - A Discussion Paper**. The Coordinating Committee also released two annual monitoring reports: **1989 Project Quinte Report** and **1990 Project Quinte Report**. The PAC was instrumental in obtaining stakeholder and public assessment of various remedial options and consensus regarding preferred remedial actions; this information was summarized in the **1990 PAC Report**. Cleanup partnerships involving the Coordinating Committee, PAC and others also have been formed. These undertakings have resulted in the remedial action recommendations and priorities described in the **Stage 2 Report**. A water conservation program at Deseronto and Tyendinaga, stormwater quality management for the Quinte shoreline, an education project and a manure holding facility on Cold Creek are examples of action that have been implemented.

The Potter Creek watershed is a subwatershed of the Bay of Quinte watershed. As such, many of the recommendations contained in the **Stage 2 Report** must be considered in the development of the Subwatershed Plan for Potter Creek. Also, the Township of Sidney's Official Plan indicates that provisions for protection of the Bay of Quinte ecosystem, including tributary watersheds, must be in accordance with the RAP.

The Study Team reviewed the list of 80 recommendations and selected 36 of them as being directly related to the Potter Creek watershed. Table 6-1 (Appendix M) provides the list of selected recommendations inclusive of the corresponding recommendation number provided in the **Stage 2 Report**.

6.3 CONSTRAINT MAPPING

By applying the federal, provincial and municipal government and Moira River Conservation Authority policies and guidelines to the Potter Creek watershed, constraints to development were identified and are outlined in the following sections and where possible, illustrated on Drawing Number 1137-16-16 - Constraint Map.

6.3.1 FLOOD PLAINS

The **Policy Statement on Flood Plain Planning** and the official plans of the Township of Sidney and City of Belleville designate and prescribe policies for the Potter Creek flood plain. The flood plain will henceforward consist of the area defined in Section 4.2.1 and illustrated on the 1:2000 Flood Risk Maps, Numbered 1 through 26 and Drawing Number 1137-16-11 - Hazard Lands.

6.3.2 HAZARD LANDS

The guidelines that will henceforward be used to determine the extent of hazard lands (lands subject to flooding and erosion) along Potter Creek are defined by the Moira River Conservation Authority in Section 4.2.2 and illustrated on the Conservation Authorities Flood Risk Maps, Sheets 1 through 26 and Drawing Number 1137-16-11 - Hazard Lands.

6.3.3 WATERCOURSES

The **Lakes and Rivers Improvement Act** ensures that capital works such as storm outlets from adjacent developments, creek crossings for new roads and highways and changes to existing manmade obstructions do not alter the present water yield (stage-discharge-storage relationships), water quality and fisheries and fisheries habitat.

These type of proposals and hydraulic responses must be evaluated and compared to present water yield, water quality, fisheries and fisheries habitat in order for the various review agencies to appropriately respond as to their acceptability.

The Township of Sidney's Zoning Bylaw requires that development be set back 30 m from shorelines or 15 m from watercourse Environmental Protection Zones (i.e., floodlines), whichever is greater.

The Bay of Quinte RAP recommendation No. 67 states that municipalities should provide protection of the shoreline and streambanks by designating through official plans a setback of 15 m or greater as a natural protection zone.

The Moira River Conservation Authority's policy has established a minimum 15 m no development vegetation buffer from top of bank and a 30 m buffer from the 1:100 year flood elevation along the Great Lakes shore.

The Ministry of Natural Resources recommends a 15 m buffer along warm-water streams such as Potter Creek.

Although the Township of Sidney's Official Plan, the RAP recommendation No. 67, and the Conservation Authority and Ministry of Natural Resources policies all deal with the same issue in a similar manner, a single statement should be prepared and used by all parties.

6.3.4 GROUNDWATER RECHARGE/DISCHARGE

Based on the general considerations outlined in Section 6.1.4, the following specific groundwater considerations are made with respect to the Potter Creek subwatershed.

- The limestone bedrock found beneath the watershed area is an important local groundwater resource. It provides potable water to the rural (unserviced) areas of the Township of Sidney, and has a potential for providing supply to individual domestic or small scale commercial/industrial developments. There appears to be limited potential for developing a large scale communal supply within the rock.
- Locally, there is relatively shallow soil cover over bedrock. Soil cover of less than 2 m is noted near the southern and eastern portions of the watershed. This indicates that the groundwater resource in this area will be particularly susceptible to contamination from surface sources, for example, from fertilizer and road salt applications, and spills or leaks from industrial or commercial activities.
- There are no single significant areas of groundwater recharge within the watershed; however, it occurs over a relatively uniform and broad scale. Most groundwater discharge occurs locally within the Potter Creek valley and channel, and at the Bay of Quinte. Surficial soils are of moderate to low permeability indicating that there is limited opportunity for enhanced groundwater recharge in most areas.
- 'The groundwater contribution to base flow appears to be approximately 15 to 30 percent of the total flows, computed on an average annual basis. However, during the summer months, the groundwater base flow may comprise 50 percent or more of flow within the creek.
- While there is some groundwater contribution to the Aikins wetland, most of the wetlands within the watershed are primarily formed as a result of direct surface runoff and drainage.

The following groundwater related constraints pertain to future planning and development in the watershed:

- Development should be conducted in a manner to encourage groundwater recharge; where practical, rates should be maintained at their current levels through the application of appropriate development and storm water management techniques.
- Groundwater quality should be maintained. Discharge of sewage to the subsurface (such as through tile fields, spray irrigation,

or the like) should be carefully evaluated in accordance with Ministry of Environment and Energy policy and guidelines.

- Subsurface disposal of waste should be strictly limited to domestic sewage.

- The groundwater resource is particularly susceptible to contamination in areas of thin soil cover. Development in these areas should be limited to residential uses, and/or dry commercial and industrial uses which do not create or permit storage of materials which may result in contamination. In the event that such land uses are proposed, there must be a requirement to demonstrate that contaminants can be safely contained, monitored, and, if necessary, removed from the groundwater system.

- A natural zone or buffer strip should be maintained adjacent to Potter Creek to ensure natural conditions which encourage the discharge of groundwater (base flow) into the creek.

- All proposed development which may impact on groundwater must be supported by studies which assess the impact of the proposed development on the groundwater resource. The assessment must include the following:

    - impact on groundwater quality;
    - impact on groundwater quantity;
    - impact on groundwater recharge over the site area;
    - impact on groundwater discharge (in areas which include ground water discharge areas);
    - impact on base flow to Potter Creek.

6.3.5 FISH HABITAT

The Federal **Fisheries Act** enables the Ministry of Natural Resources to apply the principle of no net loss of fisheries and fisheries habitat.

Potter Creek supports a warm water fishery and in accordance with Section 6.1.10, a 15 m buffer will be applied to protect the present fisheries and fisheries habitat (this buffer will in any case be exceeded by the other watercourse buffers noted in Section 6.1.3). Alteration, disruption or destruction of fish habitat will not be permitted unless authorized by the federal Department of Fisheries. In this regard, the department will not grant an authorization unless acceptable compensation is provided, which generally means a net gain in fish habitat.

6.3.6 WETLANDS

The Aikins wetland managed by Ducks Unlimited and the wetland located east of Huntingwood Road have been classified by the Ministry of Natural Resources using a 1984 evaluatory methodology as Class 3 wetlands, which means they are significant, as per the Provincial **Wetlands Policy Statement**. The wetland located east of Avonlough Road has been classified as a Class 7 wetland using the same methodology; it is not provincially significant. However, the Moira River Conservation Authority's Wetland Policy has extended the provisions of the Provincial **Wetlands Policy Statement** to include all classes of wetlands.

Accordingly, for all intents and purposes, no development will be allowed in the three wetlands identified within the watershed of Potter Creek. Additionally, development will not be permitted on those lands within the 120 m adjacent lands unless an **Environmental Impact Study (EIS)** can demonstrate no loss of wetlands functions, no negative impact on existing wetland functions, no conflict with wetland management practices and no loss of contiguous wetland area. On adjacent lands, established agricultural practices are permitted without an **EIS**. However, infilling or expansion of workable lands will not be supported by the Conservation Authority.

Furthermore, the Conservation Authority will not permit development within headwaters wetlands, even if they are not classified, unless it is proved through recognized engineering and ecological principles that no impact to the subwatershed will occur, or in accordance with a completed subwatershed plan.

The Bay of Quinte RAP and in particular, recommendation number 64 which states that there shall be no further loss of the integrity of the basin's remaining wetland ecosystems, complement the current policies of the Province and Moira River Conservation Authority.

6.3.7 WOODLOTS

Because **Woodlot Improvement Act** Agreements represent short term resource production commitments by landowners, they are indicated as constraints to development and illustrated on Drawing Number 1137-16-16.

The Province, County of Hastings, City of Belleville, Township of Sidney and Moira River Conservation Authority do not have any policies to protect significant woodlots or restrict tree cutting, other than the Township Official Plan's general and estate residential development policies quoted in Section 6.1.7.

6.3.8 AGRICULTURE

As described in Section 6.1.8, those lands designated agricultural in the Township of Sidney's Official Plan are constrained from any significant non-agricultural development in accordance with the **Food Land Guidelines**.

6.3.9 HERITAGE AND RECREATION

Although there are no designated cultural heritage resources in the watershed, any development near the basin's one known archaeological site would undoubtedly be carefully reviewed by the Ministry of Culture, Tourism and Recreation. Accordingly, the general area of the site is shown on Drawing Number 1137-16-16.

All Moira River Conservation Authority and municipal park lands, including those being acquired, are assumed to be non-developable and are shown.

6.3.10 SURFACE WATER MANAGEMENT

The Provincial **Interim Stormwater Quality Guidelines for New Development** and the Bay of Quinte Inter Agency **Stormwater Management Design Criteria/Guideline and Construction Mitigation Plans** provide guidance to proponents of development and to approval agencies. The effect of the criteria/guidelines is to ensure that stormwater runoff from new development is not permitted to be discharged uncontrolled and untreated into any water body. Therefore, all development must provide controls to effectively achieve Provincial and Bay of Quinte standards.

All receiving water concerns were assessed and Potter Creek is not considered a bathing beach. Therefore, the bacteria guidelines would apply to the Bay of Quinte, and the assimilative capacity of Potter Creek to further reduce bacteria loading above its outlet is realistic and acceptable.

Within the Potter Creek watershed, there are no existing stormwater management facilities that would restrict development and/or changes in land uses or require modification to meet current design criteria and guidelines. In fact just the opposite exists. The Bird Hazard Area Zone as defined in **Trenton Airport Regulations** prohibits open water storage reservoirs. This federal regulation is a constraint to the use of stormwater management facilities involving open water bodies and conflicts with Provincial policies and the Township of Sidney's Official Plan.

Despite the conflict, the Department of National Defence has responded to the concern of the Township by indicating that because of size, type of water body, surroundings (commercial or residential), etc., stormwater ponds are not very conducive to feeding or loafing of large flocks of birds. However, if a very large man-made lake was planned with sizeable areas of shallow water which would attract bottom feeders, to be located outside the suburbs but within the bird hazard area, a re-appraisal in the form of a biological study may be required before the plan would be approved. In other words, the Department of National Defence will not apply the regulation in the strict sense i.e.

absolutely no open water bodies, but rather, it will review the impacts of individual stormwater applications and approve those that do not impose any bird hazards to CFB Trenton.

6.3.11 SERVICING AND UTILITIES

In accordance with the Provincial **Wetlands Policy Statement**, the Moira River Conservation Authority's fill regulations governing hazard lands, watercourse and wetlands, and the Township of Sidney's Official Plan:

- Servicing and utilities must be located outside of wetlands, hazard lands and vegetative buffers.
- Development within the Potter Creek Secondary Plan area will proceed on municipal water and sewage treatment systems.
- Estate residential development in the north portion of the watershed will be able to proceed on private services subject to site studies and approval from the various agencies.

6.3.12 TRANSPORTATION

For the purposes of this study, we will assume:

- that development can, with appropriate study and remedial measures, be located within 300 m of railway rights-of-way;
- however, that residential development within 100 m of either rail right-of-way would not be desirable.

The Ministry of Municipal Affairs's **Land-Use Policy Near Airports** in conjunction with CFB Trenton noise exposure forecasts (NEF) as defined in the Township of Sidney's Official Plan will require residential development to meet Ministry of Environment and Energy standards for acoustics and ventilation in areas between NEF 28 and 35, and will prohibit residential development in areas above NEF 35.

6.3.13 WASTE MANAGEMENT

The National Defence **Trenton Airport regulation** with respect to bird hazards, will not permit, within specified boundaries, a sanitary landfill site, waste disposal sites, sewage treatment lagoons and open water bodies. See Section 6.3.10 for discussion of open water bodies.

In accordance with the Ministry of Environment and Energy, the Township of Sidney's Official Plan requires that development be set back at least 100 m from the boundary of the Zebedee waste management site. In addition, development within 500 m of the site will require studies to demonstrate development compatibility and safety.

6.4 DEVELOPMENT STRATEGY AND IMPACT ASSESSMENT

A Development Strategy was prepared by integrating:

- the preferred development scenario for Sidney Township south of Highway 401 and east of Wallbridge-Loyalist Road, as described in Section 5.4;
- for the rest of the watershed, land uses as designated in the official plans and shown on Drawing No. 1137-16-09;
- the Constraint Map (Drawing No. 1137-16-16).

The Development Strategy is shown on Drawing No. 1137-16-17. The potential impacts of development on watershed conditions were assessed using the Development Strategy.

6.4.1 HYDROLOGY

The Development Strategy was superimposed over existing conditions and the watershed hydrologic characteristics relating to the projected changes in land use were altered.

The QUALHYMO data files representing existing watershed land use were modified to reflect the changes in land use, and hydrologic responses were simulated for the 5, 10, 25 and 50 year storm events and the regulatory (1:100) event.

The results of the hydrologic simulations in comparison to existing conditions are presented in Table 6.2 (Appendix M). Although the comparison revealed significant increases in runoff along the tributaries, the overall increase in the peak discharge and volume of runoff (Table 6.3, Appendix M) at the Bay of Quinte was determined to be in the order of 14 to 21 per cent.

The results demonstrate that large increases in runoff will occur from areas of anticipated urbanization whilst the overall watershed response is moderate due to the majority of watershed lands being retained in their current land uses.

6.4.2 HYDRAULICS

To determine the specific impacts of the changes in the watershed hydrologic response, the peak flows representing the projected land use were inserted into the hydraulic models for Potter Creek and its tributaries.

6.4.2.1 FLOODING

The resultant flood elevations determined from the hydraulic simulations as compared to existing conditions are presented in Tables 6.4 to 6.8 (Appendix M). The increases in elevations range from 0.01 m to 0.28 m along the main channel of Potter Creek to 0.01 m to 1.11 m along the tributaries. Even though the elevations are higher along the watercourses, no appreciable lands or additional dwellings would be impacted due to these increases.

A review of the performance of the hydraulic structures (Table 6.9, Appendix M) indicates that with the exception of Wallbridge-Loyalist Road on Tributary 1, Montrose Road on Tributary 4, Wallbridge-Loyalist Road on Tributary 5 and Huntingwood Drive on Tributary 5, all other structures can discharge the increased peak flows for the Regulatory (1:100 year) event.

6.4.2.2 EROSION

The background review and site reconnaissances indicated that erosion is a concern throughout the watershed. The concern focused on streambank erosion and the relationship with increased peak flows, flood elevations and channel velocities.

As noted in Section 6.4.1, increases in peak flows and volumes of runoff can be expected along the developing reaches of the watershed. As such, the rate and frequency of erosion can also be expected to increase.

The resultant average channel velocities for the main channel and the various tributaries determined from the hydraulic simulations as compared to existing conditions are presented in Tables 6.10 to 6.14 (Appendix M).

The increases in stream velocities combined with the increase in the frequency of these occurrences will accelerate the natural erosion process of the watercourses.

6.4.3 HYDROGEOLOGY

The groundwater related impacts of the proposed development scenario were evaluated with respect to the following general requirements:

- protection of groundwater quality;
- maintenance of groundwater recharge and discharge patterns and volumes within the watershed;
- maintenance of availability of groundwater supply for future development and/or for base flow to streams;
- protection of any specific significant groundwater related features within the subwatershed.

For the purposes of this evaluation, the development scenario was divided into three components:

- residential component (southeastern portion of the watershed);
- industrial component (central portion of watershed adjacent to Highway 401);

- isolated rural or estate developments (central and northern portions of watershed).

When considered over the entire watershed area, this potential is minor.

6.4.3.1 Urban Residential Development

Urban residential development will occur on a variety of lot sizes (typically ranging from about 250 to 1,000 m^2; see Section 5.2). Some higher density development may occur. The average net density would be at least 20 dwellings per hectare.

Development will be restricted to the southeastern portion of the watershed, south of the southern Ontario Hydro right-of-way and east of Wallbridge-Loyalist Road. It will be serviced with municipal piped lake water, and with a municipal sewage collection and treatment system, discharging to the Bay of Quinte.

This development is generally located in an area of groundwater recharge.

Since development will be serviced with piped lake water, there will be no direct impact on the quantity of groundwater, such as would be caused by extraction of water from wells. As noted above, sewage will be disposed of through a treatment plant into the Bay of Quinte, therefore, there will be no direct impact on local groundwater quality as a result of subsurface sewage disposal.

The potential impacts of the proposed residential development on the groundwater resource are summarized below:

- A significant potential for reduction in groundwater recharge as a result of covering with hard surfaces (houses and roads);

- A minor potential for impairment of ground water quality as a result of infiltration of urban runoff. The runoff may contain road salt (chlorides), gardening chemicals (fertilizer, herbicides, and pesticides) and oil, grease and heavy metals (from automobiles);

- A potential for reduction in local base flow (groundwater discharge) to Potter Creek.

6.4.3.2 Industrial Development

Future industrial development will be situated in the central and eastern portion of the watershed, around the Highway 401 - Wallbridge-Loyalist Road interchange and between Highway 401 and the urban residential development. The scope and nature of future industrial development have not been determined at this time. However, it is expected that development will generally consist of low density free-standing buildings.

Existing development in this area is served by piped water from the Bay of Quinte, and individual septic tank/tile field systems. The Township of Sidney's Official Plan permits only dry commercial or industrial uses.

South of Highway 401 and east of Wallbridge-Loyalist Road, it is intended to provide full municipal services in future. The nature of these services has not yet been determined. In the meantime, no new development is permitted in this area, except on those lands shown as existing or approved industrial on Drawing Number 1137-16-17.

North of Highway 401 and west of Wallbridge-Loyalist Road, there will be some further dry development on individual services.

It should be noted that the Township of Sidney's Official Plan uses two different definitions of "dry". North of Highway 401 and west of Wallbridge-Loyalist Road, "dry" means "a large quantity of water is not necessary... and the permitted... use does not discharge nor generate large quantities of liquid effluent or liquid waste". To the southeast, "dry" is more strictly defined: "[the uses] do not require water for cooling, washing and processing, and [their] subsurface sewage disposal systems [may be] used solely for the disposal of domestic waste".

Industrial development in this area has the potential to create the following impacts on local ground water resources:

- Significant potential to reduce groundwater recharge, as a result of covering of the land with hard surfaced areas (pavements and buildings).

- Significant potential to cause groundwater contamination in the event that there is improper use or handling of industrial or commercial chemicals or other substances.

- Potential to reduce base flow into the adjacent Potter Creek, as a result of reduction of groundwater recharge. This potential is significant, since the site is situated near the central portion of the main branch of Potter Creek, and the headwaters portion of the eastern branch of the creek.

- Some potential to impact local quality as a result of sewage disposal. However, the requirements for sewage disposal systems (septic tank tile field systems) are strictly governed by the Ministry of Environment and Energy, or its agent, the local Health Department, and proper application of regulations and guidelines will ensure that there is no unacceptable effect on the groundwater system.

- A small potential to impact on the quantity of local groundwater resources as a result of extracting water through wells. Given the relatively good availability of groundwater in the local limestone aquifer, and the relatively low expected density. of development, there is expected to be no significant constraint in this regard.

6.4.3.3 <u>ISOLATED RURAL AND ESTATE DEVELOPMENT</u>

Isolated rural and estate development may occur in the remainder of the watershed. Typically, these developments will consist of lot severances for an individual residence, and/or estate residential type developments in the northwestern portion of the watershed. These developments will be serviced with groundwater supply, and septic tank tile field systems for sewage disposal. Individual systems will likely be used, even though Ministry of Environment and Energy policy encourages the use of communal systems for plans of subdivision such as estate residential developments.

This type of development may present the following potential impacts to the groundwater resource:

- A minor potential to affect groundwater recharge. Typically, these developments are of low density (lot sizes of 0.8 to 1 ha); as a result, there is a relatively small percentage of the land covered by hard surfaces.

- A small potential to impact local quality as a result of sewage disposal. However, the requirements for sewage disposal systems (septic tank tile field systems) are strictly governed by the Ministry of Environment and Energy, or its agent, the local Health Department, and proper application of regulations and guidelines will ensure that there is no unacceptable effect on the groundwater system.

- A small potential to impact on the quantity of local groundwater as a result of extracting water through wells. Given the relatively good availability of ground water in the local limestone aquifer, and the relatively low expected density of development, there is expected to be no significant constraint posed by new ground water supply.

- A moderate to significant potential to alter local groundwater discharge into Potter Creek, and the Aikins wetland. Changes to the river channel and/or drainage patterns around the wetland area may result in a reduction in groundwater recharge. These changes would be most significant in the event of significant grading and/or channelization of the watercourse.

6.4.4 SURFACE WATER QUALITY

6.4.4.1 <u>GENERAL</u>

During the course of the Study, water samples were collected at six locations within the Potter

Creek watershed (see Figure 4-1). The water sampling stations are located: at the downstream side of the Canadian Pacific Railway (PC01, inflow into lower Reach 1); on the main channel upstream of the confluence with Tributary 3 (PC10); on Tributary 3 upstream of the confluence with the main channel (PC11); on Tributary 5 upstream of the confluence with the main channel (PC20); on Tributary 6 upstream of the confluence with the main channel (PC30); and on the main channel upstream of the confluence with Tributary 6 (PC31). The frequency of the water samplings was about once a month from May to October of 1992. The water quality data of the samples taken in 1992 are presented in Tables 4.12 to 4.21. In addition, the Ministry of Environment and Energy collected water samples, taken on the downstream side of the Canadian Pacific Railway, on a weekly basis for the period from August 31 to December 2, 1987 and from June 17 to October 28, 1991, and on a monthly basis from November 1991 to February 1992 (see Table 3.1). The sampling dates included five days on which rainfall occurred: August 31, 1987, September 23, 1991, July 31, 1992, September 21, 1992 and October 21, 1992, based on hourly precipitation data obtained from Environment Canada, Atmospheric Environment Service for the Trenton meteorological station.

Some of the parameters analyzed in the 1992 samples included temperature (T), dissolved oxygen (DO), fecal coliform (FC), fecal streptococcus (FS), *E. coli* (EC), total phosphorus (TP) and dissolved reactive phosphorus (DRP), whereas some of the Ministry of Environment and Energy parameters included TP, DRP and suspended solids (SS).

Table 4.19 summarizes the 1992 seasonal average water quality data for Potter Creek at the six sampling stations. As indicated, concentrations of bacteria and pollutants varied from a Most Probable Number (MPN) of 10 to 400 per 100 mL for FC, from 60 to 317 MPN/100 mL for EC and from 0.014 to 0.081 mg/L for TP at the six sampling stations. The Ministry of Environment and Energy water quality data showed concentrations of 1 to 61 mg/L for SS and 0.006 to 0.182 mg/L for TP at the outlet of Potter Creek (at CPR).

Pollutant concentrations and bacterial counts of the water samples appear to be in the same order of magnitude as compared to numerous studies carried out in Ontario and the United States. In 1976, Qureshi and Dutka (1979) collected and measured bacteria counts from a storm sewer outfall in Burlington, Ontario. The storm sewer system services a 23.3 ha area consisting of a single-family residential section in central Burlington. The water quality data showed that the FC counts varied between 500 to 5,000 MPN/100 mL. Other observations made by the authors were that:

(1) *E. coli* populations showed a consistent distribution pattern during storms;

(2) maximum microbial populations tended to occur during the 60-105 minute period of most storms;

(3) *E. coli* populations increased during late summer and fall;

(4) almost 100% of all storm water runoff and 98-100% of infiltration sample isolates were *E. coli*;

(5) there was no predictable pattern for maximum bacterial population occurrence in storm-runoff waters;

(6) pathogens were isolated; there is no predictable pattern; and

(7) the concept of collecting and treating a specific portion of each storm would not appear to be feasible.

In another study carried out by D'Andrea, Maunder and Snodgrass along the waterfront within the Cities of Scarborough and Etobicoke, samples taken showed that SS concentrations ranged from 65 - 140 mg/L, 80 - 500 mg/L and 60 - 340 mg/L for residential, commercial and industrial areas, respectively. For the same land use, TP concentrations ranged from 0.20 - 0.51 mg/L, 0.12 - 2.9 mg/L and 0.32 - 1.4 mg/L. For FC the event mean concentrations were found to be 260,000 MPN/100 mL (range of 65,000 to 1,400,000), 270,000 MPN/100 mL and 24,000 MPN/100 mL (range of 4,000 to 140,000) sampled from residential, commercial and industrial areas, respectively.

Between March and November 1991, Licsko, Whiteley and Corsi carried out a study to determine the quality of stormwater from residential areas in Guelph, Ontario. The results of the samplings showed that the average SS concentrations were 80 mg/L from roofs, 238 mg/L from street gutters and 240 mg/L from commercial areas. Respectively, maximum SS concentrations of 500 mg/L, 920 mg/L and 1,260 mg/L were sampled. The average TP concentrations were 0.06 mg/L from roofs, 0.18 mg/L from street gutters and 0.21 mg/L from commercial areas. Maximum TP concentrations of 0.51 mg/L, 0.48 mg/L and 1.0 mg/L were measured from roofs, street gutters and commercial areas, respectively. The FC counts varied from 6 - 200 MPN/100 mL (average of 59 MPN/100 mL) from roofs, 50 - 300,000 MPN/100 mL (average of 46,000 MPN/100 mL) from street gutters and 600 - 4,000 MPN/100 mL (average of 1,880 MPN/100 mL) from commercial areas.

6.4.4.2 SCENARIOS MODELLED

The QUALHYMO program was utilized to model the surface water quality of Potter Creek. This allows the modelling of a first-order pollutant and/or suspended solids. The accumulation of the first-order pollutant and suspended solids through time can be expressed by the power-linear or exponential equation, as a function of time, area and land use. The initial build up days and the maximum build up are specified in the model. As a result of rainfall and thus overland runoff, the pollutants are washed off. The washoff method for the pollutant can be defined by an exponential decay function. The rating curve approach, as a function of flow, can be used to model the washoff pollutants and suspended solids.

The water quality data provided in Tables 3.1 and 4.12 through 4.18 were used to calibrate the model. Upon obtaining hourly precipitation data (Trenton) for 1987 to 1992 from the Atmospheric Environment Service, the sampling dates were reviewed to select the dates with precipitation.

In order to calibrate the water quality data measured for existing land use, it was assumed that phosphorus is a first-order pollutant. The water quality data of July 31, 1992 when 22.6 mm of rain fell, were selected for calibration. The parameters in the model were adjusted accordingly to obtain total phosphorus concentrations in order of magnitude as compared to the measured concentrations at the outlet. Upon finalizing the build up and washoff parameters, other rainfall events in 1987, 1991 and 1992 were simulated for total phosphorus. The same calibration procedures were then carried out for FC (1992 data only) and SS (1987 data only).

Since Potter Creek is a warm-water fisheries habitat, pollutant simulations for TP, FC and SS were undertaken for both the existing and proposed (Development Strategy) land use scenarios utilizing a 13-mm rainfall event distributed over 4 hours.

Initial review of the simulation results indicated that the "washed off" FC counts and SS concentrations from the existing rural areas were high, based on the 13-mm rainfall event. Therefore, both the FC and SS calibration universal parameters provided in the **Rideau River Stormwater Management Study** (1991) were utilized, pertaining to the P_{tlim}, k_1, k_2 and k_4 parameters. Due to the size of Potter Creek and the varying land uses, the k_3 parameters for FC and SS were estimated from the regression equations given in the **Rideau River Stormwater Management Study**. The regression equations were obtained based on a function of developed areas (residential area versus total area, and urban (mixture of residential, industrial and commercial) area versus total area). The distribution of the sediment particle sizes and the corresponding settling velocities for suspended solids in urban runoff were also obtained from the **Rideau River Stormwater Management Study**.

6.4.4.3 RESULTS

Table 6.15 gives the results (minimum and maximum simulated values and the event mean concentrations and counts) of the calibration for the rainfall event recorded on July 31, 1992. The TP concentrations and FC counts were measured and simulated at the downstream side of the Canadian Pacific Railway (inflow into Reach 1).

The results of the calibration for the rainfall event recorded on September 23, 1991 at the CPR are

TABLE 6.15 WATER QUALITY CALIBRATION RAINFALL EVENT ON JULY 31, 1992 AT CPR EXISTING LAND USE				
Pollutant	Instantaneous Field Sampling	Simulated Hourly Values		
		Min	Max	Mean
Phosphorus (mg/L)	0.038	0.001	0.060	0.014
Fecal Coliform (MPN/100 mL)	220	34	17,429	1,485
Suspended Solids (mg/L)	N/A	N/A	N/A	N/A

given in Table 6.16 for total phosphorus and suspended solids.

The simulation results of a 13-mm rainfall event for existing land uses and the Development Strategy are tabulated in Table 6.17 for TP, FC and SS.

The results of the calibration and simulation of TP, FC and SS appear to be in the proper order of magnitude, as compared to results from other studies.

The Bay of Quinte RAP calls for a reduction in TP to 0.030 mg/L to restore and maintain the trophic state of the Bay. The simulated event mean concentrations for both existing land uses as well as future land uses meet this objective for the Bay of Quinte.

The instantaneous field recording and the simulated event mean FC count from the Potter Creek watershed for existing land uses and for the Development Strategy exceed the Inter Agency Storm Water Management Working Committee's criterion under the Bay of Quinte RAP of *E. coli* not greater than 100 MPN/100 mL (*E. coli* is a subset of fecal coliform bacteria; accordingly, when interpreting the FC simulations presented here, it is important to know that results are going to be equal to or greater than densities of *E. coli*).

6.4.5 BIOLOGICAL ENVIRONMENT

Some of the policies and guidelines that pertain to the Development Strategy from a natural features perspective include:

- along Potter Creek, a 30 m development setback from shore and/or a 15 m setback from the floodline and/or a 15 m setback from top of bank, whichever is greater;
- along the Bay of Quinte, a 30 m development setback from the flood elevation;
- no net loss of fish, with no authorization for alterations in habitat unless a net gain can be demonstrated;
- no development in wetlands nor on lands within 120 m of a wetland boundary unless an **Environmental Impact Study** is undertaken and satisfies criteria of no loss in surface area, function, etc.; and
- a 30 m no development vegetative buffer zone from the edge of a wetland boundary within which no development is to occur (this may be reduced if an **Environmental Impact Study** proves that a lesser buffer would sufficiently protect a wetland from development impacts).

TABLE 6.16
WATER QUALITY CALIBRATION
RAINFALL EVENT ON SEPTEMBER 23, 1991
AT CPR
EXISTING LAND USE

Pollutant	Instantaneous Field Sampling			Simulated Hourly Values
	Min	Max	Mean	
Phosphorus (mg/L)	0.040	0.001	0.053	0.023
Fecal Coliform (MPN/100 mL)	N/A	N/A	N/A	N/A
Suspended Solids (mg/L)	27	0.3	27.1	5.8

TABLE 6.17
WATER QUALITY SIMULATION
13-MM RAINFALL EVENT
HOURLY VALUES
AT CPR

Pollutant	Existing Development			Development Strategy		
	Min	Max	Mean	Min	Max	Mean
Phosphorus (mg/L)	0.001	0.065	0.017	0.001	0.287	0.020
Fecal Coliform (MPN/100 mL)	1	3,539	399	1	23,141	4,598
Suspended Solids (mg/L)	0.4	2,734.6	367.7	0.2	10,014.0	2,449.7

There would be no changes to existing fish migratory patterns with the Development Strategy in place. While fish stocks are going to have to contend with periodically higher volumes and flows of water than occur at present, especially in reaches that are further urbanized, we are of the opinion that the fish species indigenous to Potter Creek are quite resilient to such changes and would sustain any impacts. The creek would continue to experience dry stream beds during the summer, stagnant conditions, and low dissolved oxygen concentrations, unless rehabilitation measures are undertaken to enhance its productive capacity. As noted in Section 6.4.3, there is a potential for reductions to occur in local base flows; however, in our opinion, the fish habitat impacts will not be any worse than existing conditions, particularly in summer when many stretches of Potter Creek stream bed are essentially dry.

Implementation of various setbacks/buffers along the watercourse, combined with low maintenance landscape management, will lead to improved riparian cover, and in the long term, the vegetation regrowth will have an effect of tempering or reducing stream water temperatures.

There will be no direct impact on the three wetlands resulting from the strategy. However, the wetland east of Avonlough Road could be indirectly influenced by the future urban community through encroachment and general residential activity. Planting of riparian buffers could minimize this effect.

Localized fragmentation of forest cover in the northwestern part of the drainage basin slated for estate residential development could occur with this scenario, as will reduction of the successional forest in the central part of the watershed owing to industrial development. While there will be some increases in vegetative cover within the buffer areas and floodplain, these will be substantially offset by losses elsewhere in the long term resulting from residential and industrial development. In this regard, there are no guidelines in place relevant to vegetation management within proposed development areas.

Associated with the effects on vegetation will be a coincident impact on wildlife habitat and populations. For example, estate residential development within hardwood forests could result in a shift in species composition to those more tolerant of human activity and/or those preferring forest edge conditions over forest interiors.

7.0 SUBWATERSHED MANAGEMENT STRATEGY

The following section identifies those issues that need to be addressed as part of the subwatershed strategy.

7.1 IDENTIFICATION OF ISSUES

7.1.1 HYDROTECHNICAL

7.1.1.1 FLOODING

Section 4.2.1.4 provides the results of the flood plain mapping of Potter Creek. In addition to the lands flooded, four hydraulic structures and 10 buildings are subject to flooding under the regulatory event. The majority of the buildings are non-residential and located on the fringe of the flood plain.

Reviewing the extent of the potential flood damages, it was concluded that flooding along Potter Creek is not a major issue.

7.1.1.2 EROSION

Erosion along watercourses occurs even in the most natural ecosystems. Watershed deforestation, agricultural drainage, livestock watering and urban development have all contributed to an accelerated rate of erosion throughout much of Potter Creek. Section 4.2.1 outlines the extent and locations along Potter Creek that are experiencing erosion problems.

It was concluded that the rate of erosion will continue to increase and the problems will magnify with the continued development of the watershed. Erosion is therefore considered a major issue.

7.1.2 HYDROGEOLOGY

The impacts of existing and projected land uses on the groundwater resource of Potter Creek range from minor to significant.

The most significant issues include:

- Existing agricultural practices that may result in groundwater contamination through the application of fertilizers, manure, and other agricultural chemicals.
- Proposed residential and industrial development that may reduce groundwater recharge and base flow into Potter Creek.
- Existing and proposed industrial development that may cause ground water contamination through improper use or handling of industrial or commercial chemicals and other substances.

7.1.3 PHYSICAL ENVIRONMENT

On the basis of information presented in Section 4.1.3.1, the main issue relating to water quality is a trend to increased concentrations of some parameters (i.e., chloride, conductivity, BOD_5, total phosphorus, *E. coli*, fecal coliform, and fecal streptococci), with impairment most evident in the middle reaches of the watershed, suggesting sources of contamination in the Highway 401 and Wallbridge-Loyalist Road area, and downstream from the northwestern part of the City of Belleville. Total phosphorus concentrations exceed the Bay of Quinte RAP Coordinating Committee guidelines (i.e., 30 µg/L) in lower reaches of Potter Creek. On the basis of ratios of total nitrogen to total phosphorus, the creek is phosphorus limited, confirming that every effort must be made to control artificial loadings of this key trophic state parameter as the watershed is developed and rehabilitated. A health hazard exists at all sampling stations south of Highway 401 based on geometric mean densities of fecal coliform and *E. coli* that exceeded 100/100 mL.

There are two issues relating to soil cover. First, there is limited opportunity for groundwater recharge and/or infiltration in areas having soils with low permeability, for example, where clay subsoils exist. Second, where the landscape has thin soils over bedrock, contamination of groundwater can readily occur, unless pollutants are contained or otherwise removed from the site.

7.1.4 BIOLOGICAL ENVIRONMENT

The main issue relating to fisheries is the impairment of habitat as evidenced by:

- low to zero flows generally throughout the summer in combination with periodic low concentrations of dissolved oxygen in some reaches of Potter Creek; and
- alteration of most of the creek bed to achieve agricultural and urban uses, which has substantially influenced morphometric and flow characteristics, groundwater discharge, and riparian cover.

As noted in Section 4.2.6.1.1, approximately 45% of Potter Creek's drainage basin originally consisted of wetlands; the only issue pertaining to these features relates to maintenance of existing wetland areas, particularly the wetland located east of Huntingwood Road. The entire wetland is dependent on the presence of a beaver dam, which is retained at the discretion of the landowner.

The main issue relating to upland vegetation is its small area and fragmentation, particularly with respect to hardwood forest stands, and a related reduction in groundwater recharge and wildlife habitat. A secondary issue relates to the potential reduction of a significant portion of young, successional forest growth in the southern part of the drainage basin owing to industrial development.

As with vegetation, despite the relatively broad spectrum of cover, breeding and foraging habitats for bird, mammal, and herptile species, overall wildlife habitat has been considerably fragmented, particularly in the central and southern portions of the basin. In this regard, there are two main concerns. First, most of the upland hardwood stands and much of the young successional forest in the basin are slated for development, either industrial or estate residential, and there are no guidelines to integrate and maintain elements of these natural features. Second, there are no directions or initiatives to link individual woodlots/wildlife areas to minimize fragmentation.

7.1.5 HUMAN ENVIRONMENT

Following are the most significant human environment issues that were identified during the course of the study and which the Subwatershed Plan should attempt to address.

- The division of the Potter Creek basin between the City of Belleville and the Township of Sidney is not inherently a concern. However, the differing approaches of the two municipalities have led to problems. One of these is a significant difference in planning priorities. Belleville views the lands in Sidney's Potter Creek secondary planning area as a high priority area for urban community expansion; Sidney does not. Sidney views the lands in the Highway 401 - Wallbridge-Loyalist Road area as a high priority area for industrial development; Belleville does not. Much of this difference can be attributed to the municipalities' opposite views about South Sidney, Sidney's number one development priority.
- While it is ultimately up to the Township of Sidney to set its own development direction for the undeveloped portion of the Potter Creek basin, the effective servicing of that development depends on both municipalities.
- Except for Quinte Conservation Area, recreation and open space lands in the basin are small and isolated. There are no significant open space linkages along Potter Creek or any other natural corridors. As the urban community expands westward over time, recreational linkages within the development area, eastward into the existing community, and westward into Quinte Conservation Area will become extremely important.
- The Department of National Defence's proposed zoning regulation for CFB Trenton prohibits from much of the basin bird-attracting stormwater management facilities. The types of stormwater facilities that would be most environmentally and

aesthetically benign, and would therefore conform with the policies and guidelines of the Province, the Conservation Authority and Sidney's Official Plan, may also attract waterfowl, and therefore must observe this regulation.

7.2 SUBWATERSHED MANAGEMENT PRACTICES, EVALUATION AND SELECTION

7.2.1 FLOOD AND EROSION CONTROL

Flood and erosion control practices can consist of structural and non-structural measures.

Traditional structural flood control measures along waterways include channelization, dyking, diversions, storage and hydraulic structural alterations and replacements. Structural measures utilized on steep slopes along waterways or the Great Lakes shoreline can consist of breakwaters, revetments, heavy civil bank stabilization and structural alterations and replacements. Non-structural measures for either existing flooding or active erosion areas include municipal zoning and regulation, erosion/flood proofing and acquisition of land and buildings.

Flooding along Potter Creek/Bay of Quinte under existing conditions and/or the Development Strategy is not considered to be major and any flood damages to existing structures and buildings can be eliminated through a combination of structural and non-structural measures. The structural/non-structural program would consist of applying flood plain zoning regulations, flood proofing of existing buildings and the alteration and replacement of non-performing structures.

As identified, erosion is a major issue along Potter Creek. Active erosion sites are present throughout the watershed. Fortunately, the majority of these sites can be controlled by using "natural" channel designs. Through a partnership arrangement, Chapters of the Canadian Water Resources Association, the Soil and Water Conservation Society and the American Fisheries Society, the Niagara Peninsula Conservation Authority and the Ministry of Natural Resources prepared a draft document entitled **Guidelines for "Natural" Channel Systems.** Since October 1993, these guidelines have been presented to various interested groups for input and discussion purposes. They follow closely the course materials for rivers and applied fluvial geomorphology, by David L. Rosgen, distributed during the May 1992 American Fisheries Society Geomorphology Course held at the University of Guelph.

There are no active erosion sites along the Bay of Quinte at the confluence with Potter Creek. However, the Ministries of Natural Resources and Municipal Affairs have developed a preliminary draft Great Lakes - St. Lawrence River Shoreline Policy Statement and Implementation and Technical Guidelines, intended to be circulated and issued under Section 3 of the Planning Act. In September and October 1993, the draft Policy Statement and proposed guidelines were presented, at various workshops, to appropriate groups for input and discussion purposes. The Policy Statement and guidelines deal specifically with flood and erosion protection (land use planning and regulation of development), protection (non-structural/structural measures) and emergency response (flood forecasting/warning and flood/erosion disaster relief).

Table 7.1 outlines the Best Management Practices (BMPs) for the control of flooding and erosion, the constraint potential of using the practices, the acceptability of the practices to the Study Team and Project Committee, and the practices selected to address existing and potential flooding and erosion along Potter Creek.

7.2.2 URBAN SURFACE WATER MANAGEMENT

GENERAL

The location of potential extended detention surface water quality/quantity storage facilities and a potential ultraviolet facility are illustrated in the Surface Water Strategy Drawing, Number 1137-16-18. The location and number of facilities are based on current topography and drainage patterns. Final locations, numbers, types, sizes and shapes would be determined as part of the preparation of the stormwater management plans for specific

TABLE 7.1
FLOODING AND EROSION

BEST MANAGEMENT PRACTICE	PHYSICAL CONSTRAINT	ENVIRONMENTAL CONSTRAINT	CONSTRAINT POTENTIAL[1]						ACCEPTABLE TO		SHORT LIST
			LAND USE CONSTRAINTS	LAND REQUIREMENTS	EFFECTIVENESS	CAPITAL COST	MAINTENANCE POTENTIAL	SAFETY LIABILITY	STUDY TEAM	PROJECT COMMITTEE	
A. IN LAND DRAINAGE											
1. STRUCTURAL											
Channelization	NO	L	L	H	H	H	M	L	NO	NO	
Diversion	NO	H	L	H	H	H	M	L	NO	NO	
Dyking	NO	H	H	H	H	H	M	M	NO	NO	
Storage	NO	H	H	H	H	H	M	H	NO	NO	
Structural Alteration / Replacement	NO	L	L	L	H	H	L	L	YES	YES	*
2. NON-STRUCTURAL											
Flood Plain Zoning Regulations	NO	L	N/A	N/A	H	L	L	N/A	YES	YES	*
Flood Proofing	NO	L	L	N/A	H	L	L	L	YES	YES	*
Land / Building Acquisition	NO	L	L	M	H	H	N/A	N/A	NO	NO	
B. BAY OF QUINTE SHORELINE											
1. STRUCTURAL											
Breakwaters	NO	L	L	H	H	H	H	L	NO	NO	
Revetments	NO	L	L	H	H	H	H	L	NO	NO	
Bank Stabilization	NO	L	L	L	H	H	H	L	NO	NO	
Structural Alterations	NO	L	L	L	H	H	M	L	NO	NO	
2. NON-STRUCTURAL											
Flood / Bank Failure Regulations	NO	N/A	N/A	N/A	H	L	N/A	N/A	YES	YES	*
Limit Access	NO	L	N/A	N/A	L	L	L	L	NO	NO	
Vegetative Bank Stabilization	NO	L	L	L	M	M	L	L	YES	YES	*
Flood Proofing	NO	L	L	N/A	H	L	L	L	YES	YES	*
Land / Building Acquisition	NO	N/A	L	M	H	M	N/A	N/A	NO	NO	

1 H - High
M - Medium
L - Low

developments.

Urban development can be sustained within the Potter Creek watershed subject to the implementation of Best Management Practices (BMPs) that achieve the goals and objectives of the subwatershed plan and more specifically, the water quantity and quality criteria established by the Inter Agency Stormwater Management Working Committee.

Surface water management practices for urban development provide the opportunity to deal with potential impacts to the stream with respect to water quantity and quality from both existing land uses as well as proposed residential and industrial developments. The practices, intended to protect the watercourses from negative impacts, alter the timing and results of storm runoff events. The measures control water quantity (peak flows, volume of runoff and base flow) and water quality (suspended solids, bacteria, total phosphorus and other pollutants).

Many practitioners categorize surface water measures as follows:

- on-site or at source,
- end of pipe (these may be off-line or on-line),
- special purpose.

On-site measures may include infiltration such as dry wells, swales for drainage, storage, and drainage buffers, all integrated within a planned development. End of pipe measures generally consist of a type of storage pond to control water quality (sediments, temperature, bacteria, etc.) and water quantity (peak flow and volume of runoff). Ponds may be off-line (inland from and draining into a watercourse) or on-line (instream and therefore forming part of a watercourse). Special purpose measures include items such as oil grit separators for industrial and commercial parking lots, ultraviolet treatment facilities to control bacteria and exfiltration trenches at end of pipe to control water temperature. Other terms often referred to in surface storage best management practices are "dry" and "wet" which refer to the condition of the pond prior to the start of a runoff event. "Extended" detention refers to length of time, between 24 and 72 hours, that runoff is detained in a pond. "Continuous" and "batch" refer to the operation mode of a surface water storage facility. Continuous refers to a constant discharge of either a fixed or varying discharge throughout the runoff event, whilst a batch mode retains a portion of a runoff event for a specific period of time or condition prior to allowing any discharge from the facility.

A list of surface water best management practices, definitions and general practitioner terminology can be found in the report entitled **Stormwater Quality Best Management Practices**, June 1991, Ontario Ministry of the Environment.

DESIGN CRITERIA

For the Bay of Quinte area municipalities, the water quality criteria, as adopted by the Inter Agency Storm Water Management Working Committee under the Bay of Quinte Remedial Action Program (RAP), state that during the swimming season, from June 1 to September 7, the maximum number of exceedences of *E. coli* bacteria exceeding 100 MPN/100 mL allowed is 4. Based on this criterion, the results of the water quality simulations carried out in this study, and various other studies, the study team selected a water quality facility with a batch and dry weather flow through mode of operation and a extended detention time of 72 hours.

Meteorological data from 1987 to 1992 were used to determine the fifth largest rainfall event for each year based on an inter-event time of 3 days. The median of the fifth largest rainfall events was determined to be 21 mm. Therefore, the pond design volume for water quality treatment for a three day batch operation would be the volume of runoff from a 21 mm rainfall event. Should the facility control both water quantity and quality, then additional design volume would be required to control post-development runoff to pre-development flows.

Based on the hydrological simulations of the Development Strategy, the minimum storage requirements for projected residential and industrial areas for water quality treatment should be 12.6 mm and 16.8 mm respectively.

To mitigate potential flooding and erosion, post-development runoff (peak flows or volume or both) should be controlled to pre-development rates for return frequencies ranging from the 2 year rainfall storm up to and including the 100 year storm (regulatory event).

POTENTIAL SURFACE WATER STRATEGY

Having compiled information on the resources of the watershed, undertaken various environmental, engineering and planning assessments and investigations, identified development constraints, assessed the impacts of development and documented the issues and concerns, the study team divided the watershed into five distinctive areas to address in greater detail the surface water management aspects of the issues summarized in Section 7.1. The relevant issues are listed in Table 7.2 and the areas are illustrated in Figure 7-1.

The required storage volume determined at each surface water facility has been given in both ha-m and depth of storage in mm. The volume given in ha-m is the surface area needed to store runoff at a depth of 1 metre for the contributing catchment area. The value given in mm is the required depth over the catchment area to determine the volume of required storage. The values provided in ha-m and mm are equivalent.

AREA 1

Area 1 consists of an existing and approved commercial block, bounded by Wallbridge-Loyalist Road, CPR, Avonlough Road and Highway 2, and an area scheduled for urban development, just north of the CPR and west of Avonlough Road. It has an area of 22.4 ha. Runoff from these areas drains to the main channel of Potter Creek via open ditches and a culvert located at the southwest corner of Wallbridge-Loyalist Road and Highway 2. Development south of the CPR predates the use of best management practices and as such, there are no measures in place to control surface water quantity and quality.

Due to land constraints, costs and associated management problems with retrofitting existing sites with on-site measures, off-line detention facilities were selected as the best surface water management measure to control water quality and quantity from the entire area. Detention **Facility 1** (0.27 ha-m volume, 28.2 mm depth of storage) would be located immediately west of Wallbridge-Loyalist Road and north of Highway 2. Detention **Facility 2** (0.37 ha-m volume, 28.2 mm depth of storage) would be located along an existing channel ditch paralleling the CPR. Because of land constraints and the requirement to meet bathing beach water quality criteria, extended dry facilities with a 48 to 72 hour detention time would be required to control bacteria and hence sediments and total phosphorus.

For the commercial lands not yet developed, consideration should be given to installing oil/grit separators.

A short list of selected surface water BMPs for **Area 1** is presented in Table 7.3.

AREA 2

Area 2 is the basin of Tributary 1 of Potter Creek, excepting that portion which is in **Area 1**. Tributary 1 drains an area of 117.7 ha, will be fully developed, mainly with low to moderate density residential development, and includes existing development within the City of Belleville, and the Aldersgate and Hastings Park subdivisions. The basin east of Avonlough Road is generally flat, whilst the area to the west is characterized by a steep incised valley. Because the valley is incised and because there are no environmental issues related to natural resource features and fisheries within Tributary 1, the most effective management measure selected to control water quantity and quality is a single detention facility (3.6 ha-m volume, 30.6 mm depth of storage). **Facility 3** would be located on-line and immediately upstream of Wallbridge-Loyalist Road. Due to the small contributing drainage area, the pond would be dry prior to the start of a runoff event. The water quality criteria necessitate that an extended period of time, 48 to 72 hours, would be required to control bacteria, sediments and phosphorus loadings.

At source measures to encourage infiltration to achieve groundwater recharge/discharge such as infiltration trenches, wells and basins may not be effective due to the poor permeability of the soils. However, infiltration wells and trenches, roof

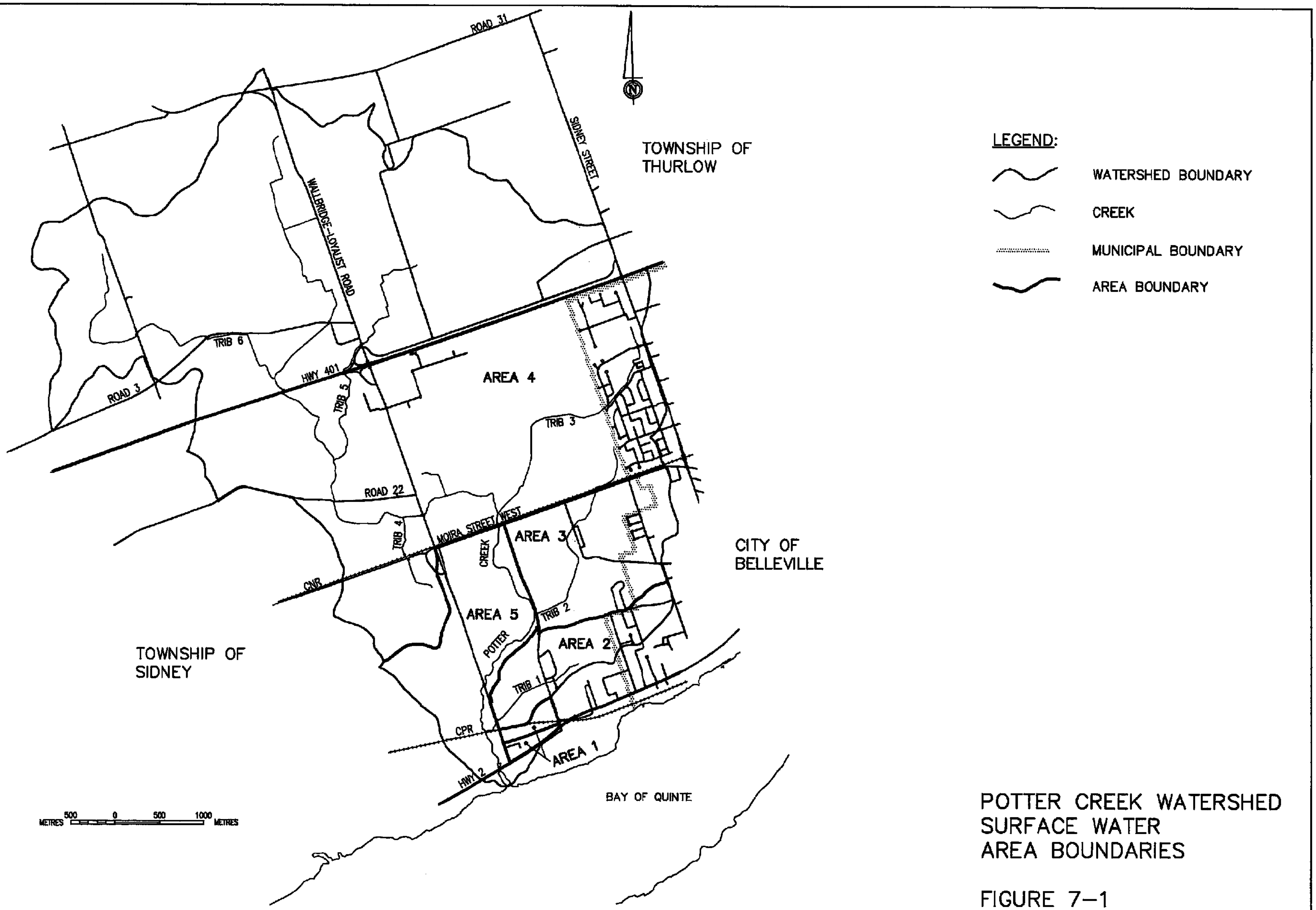
TABLE 7.2
SUMMARY OF SURFACE WATER AND RELATED ISSUES AND CONCERNS

A. Bay of Quinte (Potter Creek Watershed Export)

ISSUE	CONCERN	CRITICAL PERIOD
Water Quality And Basin Loadings	· Suspended Solids · Phosphorus · Bacteria	Spring - Fall Spring - Fall Summer

B. Potter Creek Drainage System

ISSUE	CONCERN	CRITICAL PERIOD
Hydrotechnical - Water Quantity and Erosion	 · Peak Flows · Volume Of Runoff · Velocities	 Spring - Fall Spring - Fall Spring - Fall
- Water Quality	· Sediments · Phosphorus · Bacteria	Spring - Fall Spring - Fall Summer
Hydrogeologic - Groundwater Recharge And Discharge	 · Infiltration · Baseflow · Contamination	 Spring - Spring Spring - Spring Spring - Spring
Biological - Aquatic Habitat	 · Baseflow · Sediments · Stream Morphology	 Spring - Spring Spring - Spring Spring - Spring
- Fisheries	· Aquatic Habitat · Spawning	Spring Spring
Terrestrial - Wetlands	 · Poor Baseflow · Sediments · Water Quality	 Spring - Spring Spring - Spring Spring - Spring
- Woodlots	· Diminished Supply/Fragmentation · Land Use Policies Supporting Further Vegetation Reduction · No Long Term Maintenance/Protection Guidelines	N/A N/A N/A



POTTER CREEK WATERSHED
SURFACE WATER
AREA BOUNDARIES

FIGURE 7–1

TABLE 7.3
BEST MANAGEMENT PRACTICES / SELECTION
SURFACE WATER
AREA 1

BEST MANAGEMENT PRACTICE	ISSUE ADDRESSED[1]	PHYSICAL CONSTRAINT	ENVIRONMENTAL CONSTRAINT	CONSTRAINT POTENTIAL[2]					ACCEPTABLE TO		SHORT LIST
				LAND USE CONSTRAINTS	LAND REQUIREMENTS	CAPITAL COST	MAINTENANCE	SAFETY LIABILITY	STUDY TEAM	PROJECT COMMITTEE	
A. SURFACE STORAGE BMP'S											
1. END OF PIPE OR OFF-LINE											
Dry Pond / Artificial Wetland	SQ, P, S, E	L	L	L	M	M	M	L	NO	NO	
Extended Dry Pond / Artificial Wetland	SQ, P, S, B, E	L	L	L	M	M	M	L	YES	YES	*
Storage In Park	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Storage Tank	SQ, P, S, B, E	L	L	L	L	H	H	L	NO	NO	
B. INFILTRATION BMP'S											
1. ON-SITE OR AT SOURCE											
a) Urban Residential / Industrial / Commercial											
roof leaders to grass area	I, BF, T	L	L	L	L	L	L	L	YES	YES	*
rear lot drainage swale	I, BF, T	L	L	L	L	L	L	L	YES	YES	*
infiltration dry wells	I, BF, T	H	L	L	L	L	M	L	YES	YES	*
infiltration trenches	I, BF, T	H	L	L	L	L	M	L	YES	YES	*
porous pavement	I, BF, T	H	L	L	L	H	H	L	NO	NO	
bottomless catch basins / manholes	I, BF, T	H	L	L	L	M	M	L	NO	NO	
b) Rural Residential / Industrial											
roof leaders to grass area	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
grass drainage system	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
infiltration drainage trenches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
2. END OF PIPE OR OFF-LINE											
Infiltration Trenches / Basins	I, BF, T	H	L	H	M	M	M	L	NO	NO	
C. SPECIAL PURPOSE BMP'S											
1. ON-SITE OR AT SOURCE											
Infiltration Collars	I, BF, T	H	L	L	L	L	L	L	NO	NO	
Groundwater Point Wells	BF, T	H	L	L	L	M	M	L	NO	NO	
2. END OF PIPE OR OFF-LINE											
a) Urban Residential / Industrial / Commercial											
ultaviolet treatment facility	B	H	L	L	H	H	H	L	NO	NO	
b) Urban Industrial / Commercial											
oil /grit separator	S, P	L	L	L	L	H	M	L	YES	YES	*

1 SQ - Stormwater Quantity, P - Phosphorus, S - Sediments, B - Bacteria, T - Thermal Changes
BF - Baseflow augmentation, I - Groundwater Recharge, E - Erosion

2 H - High
M - Medium
L - Low

leaders to grass areas and rear lot drainage swales are practical BMPs to be considered during preparation of stormwater management plans. In this regard, geotechnical site investigations and evaluations may identify suitable sites where infiltration techniques can be employed successfully.

A short list of selected surface water BMPs for **Area 2** is presented in Table 7.4.

AREA 3

Area 3 is the basin of Tributary 2 of the Potter Creek watershed, as far north as Moira Street West. The area drains 228.5 ha, will be fully developed, mainly with low to moderate density residential development, and includes existing development. The wetland east of Avonlough Road has been classified as a Class 7 wetland. The channel reach of Tributary 2 has been identified as having good habitat for the spawning of pike. Considering the natural resource feature of the wetland, and pike spawning potential, it was concluded that surface water facilities cannot be located on-line.

Using the current topography of the basin, four sub-basins were delineated and end of pipe or off-line detention facilities located to service the various development areas. The four ponds would be dry prior to the start of a runoff event and operate in a batch mode for an extended period of time of 48 to 72 hours.

Facility 4 services a 74.0 ha area, requiring a volume of 2.4 ha-m or 32.4 mm depth of storage. **Facility 5** services a 25.1 ha area, requiring a volume of 0.8 ha-m or 33.1 mm depth of storage. **Facility 6** services a 35.4 ha area, requiring a volume of 1.0 ha-m or 29.7 mm depth of storage. **Facility 7** services a 95.7 ha area, requiring a volume of 2.8 ha-m or 29.5 mm depth of storage.

At source measures to encourage infiltration to achieve groundwater recharge/discharge may not be effective due to the poor permeability of the soils. However, infiltration wells and trenches, roof leaders to grass areas and rear lot drainage swales are practical BMPs to be considered during the preparation of stormwater management plans. Site specific investigations may identify suitable sites where infiltration techniques can be employed successfully.

A short list of selected surface water best management practices for **Area 3** is presented in Table 7.5.

AREA 4

Area 4 is the watershed north of Moira Street West, plus those lands west of Wallbridge-Loyalist Road that drain north across Moira Street. The lands within the City of Belleville are virtually completely developed and consist of both residential and industrial developments. Within the Township of Sidney, lands are primarily designated as agricultural or rural, with some existing industrial development around Highway 401 and Wallbridge-Loyalist Road.

South of Highway 401 and east of Wallbridge-Loyalist Road, large scale light industrial development is projected north of Potter Creek and Tributary 3, while mainly low to moderate density residential development is projected southeast of Tributary 3. The Zebedee waste management site constrains how far west residential development can extend. Other significant features located in this portion of the watershed are two Class 3 wetlands, hardwood woodlots and successional forests, and a very large flood plain located immediately north of the Canadian National Railway.

The regulatory flood plain has a surface area of 77 ha with an average overbank flood depth of 0.8 m. Because the area is relatively flat, flooding can occur to the same extent (within 0.3 m) for the more frequent events (i.e., 10 year, 25 year) as compared to the regulatory (100 year) event.

To address physical and environmental constraints, existing and future land uses and potential sequence of implementation, a strategy consisting of storage facilities located on-line and off-line was developed and is described as follows.

Facility 8 is an on-line surface water quantity control facility, requiring a volume of 32.1 ha-m or 11.4 mm depth of storage. The control structure

TABLE 7.4
BEST MANAGEMENT PRACTICES / SELECTION
SURFACE WATER
AREA 2

BEST MANAGEMENT PRACTICE	ISSUE ADDRESSED[1]	PHYSICAL CONSTRAINT	ENVIRONMENTAL CONSTRAINT	CONSTRAINT POTENTIAL[2]					ACCEPTABLE TO		SHORT LIST
				LAND USE CONSTRAINTS	LAND REQUIREMENTS	CAPITAL COST	MAINTENANCE	SAFETY LIABILITY	STUDY TEAM	PROJECT COMMITTEE	
A. SURFACE STORAGE BMP'S											
1. ON-LINE											
Dry Pond / Artificial Wetland	SQ, P, S, E	L	L	L	M	M	M	L	NO	NO	
Wet Pond / Artificial Wetland	SQ, P, S, E	L	L	L	M	M	M	M	NO	NO	
Extended Dry Pond / Artificial Wetland	SQ, P, S, B, E	L	L	L	M	M	M	L	YES	YES	*
Extended Wet Pond / Artificial Wetland	SQ, P, S, B, E	L	L	L	M	M	M	M	YES	YES	
2. END OF PIPE OR OFF-LINE											
Dry Pond / Artificial Wetland	SQ, P, S, E	H	L	L	M	M	M	L	NO	NO	
Extended Dry Pond / Artificial Wetland	SQ, P, S, B, E	H	L	L	M	M	M	L	NO	NO	
Storage In Park	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Storage Tank	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
B. INFILTRATION BMP'S											
1. ON-SITE OR AT SOURCE											
a) Urban Residential / Industrial / Commercial											
roof leaders to grass area	I, BF, T	L	L	L	L	L	L	L	YES	YES	*
rear lot drainage swale	I, BF, T	L	L	L	L	L	L	L	YES	YES	*
infiltration dry wells	I, BF, T	H	L	L	L	L	M	L	YES	YES	*
infiltration trenches	I, BF, T	H	L	L	L	M	M	L	YES	YES	*
porous pavement	I, BF, T	H	L	L	L	H	H	L	NO	NO	
bottomless catch basins / manholes	I, BF, T	H	L	L	L	M	M	L	NO	NO	
b) Rural Residential / Industrial											
roof leaders to grass area	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
grass drainage system	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
infiltration drainage trenches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
2. END OF PIPE OR OFF-LINE											
Infiltration Trenches / Basins	I, BF, T	H	L	L	M	M	M	L	NO	NO	
C. SPECIAL PURPOSE BMP'S											
1. ON-SITE OR AT SOURCE											
Infiltration Collars	I, BF, T	H	L	L	L	L	L	L	NO	NO	
Groundwater Point Wells	BF, T	H	L	L	L	M	M	L	NO	NO	
2. END OF PIPE OR OFF-LINE											
a) Urban Residential / Industrial / Commercial											
ultraviolet treatment facility	B	L	L	L	L	H	H	L	NO	NO	
b) Urban Industrial / Commercial											
oil /grit separator	S, P	L	L	L	L	H	M	L	YES	YES	*

1 SQ - Stormwater Quantity, P - Phosphorus, S - Sediments, B - Bacteria, T - Thermal Changes
BF - Baseflow augmentation, I - Groundwater Recharge, E - Erosion

2 H - High
M - Medium
L - Low

TABLE 7.5
BEST MANAGEMENT PRACTICES / SELECTION
SURFACE WATER
AREA 3

BEST MANAGEMENT PRACTICE	ISSUE ADDRESSED[1]	PHYSICAL CONSTRAINT	ENVIRONMENTAL CONSTRAINT	CONSTRAINT POTENTIAL[2]					ACCEPTABLE TO		SHORT LIST
				LAND USE CONSTRAINTS	LAND REQUIREMENTS	CAPITAL COST	MAINTENANCE	SAFETY LIABILITY	STUDY TEAM	PROJECT COMMITTEE	
A. SURFACE STORAGE BMP'S											
1. END OF PIPE OR OFF-LINE											
Dry Pond / Artificial Wetland	SQ, P, S, E	L	L	L	M	M	M	L	NO	NO	
Extended Dry Pond / Artificial Wetland	SQ, P, S, B, E	L	L	L	M	M	M	L	YES	YES	•
Storage In Park	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Storage Tank	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
B. INFILTRATION BMP'S											
1. ON-SITE OR AT SOURCE											
a) Urban Residential / Industrial / Commercial											
roof leaders to grass area	I, BF, T	L	L	L	L	L	L	L	YES	YES	•
rear lot drainage swale	I, BF, T	L	L	L	L	L	L	L	YES	YES	•
infiltration dry wells	I, BF, T	H	L	L	L	L	M	L	YES	YES	•
infiltration trenches	I, BF, T	H	L	L	L	M	M	L	YES	YES	•
porous pavement	I, BF, T	H	L	L	L	H	H	L	NO	NO	
bottomless catch basins / manholes	I, BF, T	H	L	L	L	M	M	L	NO	NO	
b) Rural Residential / Industrial											
roof leaders to grass area	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
grass drainage system	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
infiltration drainage trenches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
2. END OF PIPE OR OFF-LINE											
Infiltration Trenches / Basins	I, BF, T	H	L	L	L	M	M	L	NO	NO	
C. SPECIAL PURPOSE BMP'S											
1. ON-SITE OR AT SOURCE											
Infiltration Collars	I, BF, T	H	L	L	L	L	L	L	NO	NO	
Groundwater Point Wells	BF, T	H	L	L	L	M	M	L	NO	NO	
2. END OF PIPE OR OFF-LINE											
a) Urban Residential / Industrial / Commercial											
ultraviolet treatment facility	B	H	H	H	H	H	H	L	NO	NO	
b) Urban Industrial / Commercial											
oil /grit separator	S, P	L	L	L	L	H	M	L	YES	YES	•

1 SQ - Stormwater Quantity, P - Phosphorus, S - Sediments, B - Bacteria, T - Thermal Changes
BF - Baseflow augmentation, I - Groundwater Recharge, E - Erosion

2 H - High
M - Medium
L - Low

would be located upstream of the Canadian National Railway and consist of an open bottom structure that would effectively control peak flows and volume of runoff but at the same time, allow fish passage to the upper reaches of Potter Creek. The extent of property flooded during the less frequent events would not inundate any more land than currently identified as hazard lands. It might be possible to construct this structure in conjunction with restoration of the CNR bridge over Potter Creek, and also to incorporate in the work a road bridge on the north side of the CNR (either the College Street extension or a local access road).

Facility 9 is an off-line water quality detention facility. The facility, with a volume of 1.1 ha-m or 12.6 mm depth of storage, would be dry prior to the start of a runoff event and would operate in a batch mode for an extended period of 48 to 72 hours. The facility would operate year round to control surface water quality from the western portion of the existing and projected industrial lands in Sidney Township.

Facility 10 is an off-line water quality detention facility (3.9 ha-m volume, 18.6 mm depth of storage) to service the existing industrial lands located on the southeast corner of Wallbridge-Loyalist Road and Highway 401 and the central portion of the projected industrial lands. The facility would be dry prior to the start of a runoff event and would operate in a batch mode for an extended period of 48 to 72 hours.

Facility 11 is an off-line water quality facility (1.2 ha-m volume, 19.1 mm depth of storage) to service the eastern portion of the projected industrial lands. The facility would be dry prior to the start of a runoff event and would operate in a batch mode for an extended period of 48 to 72 hours.

Facility 12 is an off-line water quality facility (0.9 ha-m volume, 13.7 mm depth of storage) to service the low to moderate density residential development anticipated in Sidney Township north of Moira Street West. The facility would be dry prior to the start of the event and operate in a batch mode for an extended period of 48 to 72 hours.

Facility 13 is an off-line water quality/quantity facility (0.9 ha-m volume, 30.4 mm depth of storage) located on a local drain west of Wallbridge-Loyalist Road off the main channel of Tributary 5. The facility would service the existing and projected industrial lands located on the southwest corner of Highway 401 and Wallbridge-Loyalist Road. The facility would be dry prior to the start of the event and operate in a batch mode for an extended period of 48 to 72 hours.

At source measures to encourage infiltration to achieve groundwater recharge/discharge may not be effective due to the poor permeability of the soils. However, infiltration wells and trenches, roof leaders to grass areas and rear lot drainage swales are practical BMPs to be considered during the preparation of stormwater management plans. Site specific investigations may identify suitable sites where infiltration techniques can be employed successfully.

A short list of selected surface water best management practices for **Area 4** surface water facilities is presented in Tables 7.6 and 7.7.

AREA 5

Area 5 consists of those lands that drain directly into Potter Creek south of Moira Street West. Loyalist College and the Quinte Conservation Area make up most of the lands. Aside from continuing development of the College lands, no major developments are projected in **Area 5**.

Although there are no specific proposals for surface water controls within **Area 5**, the Moira River Conservation Authority and Loyalist College will prepare storm water management plans for any proposed development of their lands. It is envisioned that the successional forest and significant vegetative buffers will be retained along the Potter Creek system, and therefore minimize the degradation of surface water quality from these lands.

In reviewing the short list of BMPs for **Areas 1, 2, 3 and 4**, the extended detention facilities operated in batch mode should achieve a 90 to 99 per cent die-off of fecal coliform (*E. coli*). However, the accumulated fecal coliform (*E. coli*) residue discharged from the ponds including the uncontrolled discharge from **Area 5** may exceed

TABLE 7.6
BEST MANAGEMENT PRACTICES / SELECTION
SURFACE WATER
AREA 4 - FACILITY 8

BEST MANAGEMENT PRACTICE	ISSUE ADDRESSED[1]	PHYSICAL CONSTRAINT	ENVIRONMENTAL CONSTRAINT	CONSTRAINT POTENTIAL[2]					ACCEPTABLE TO		SHORT LIST
				LAND USE CONSTRAINTS	LAND REQUIREMENTS	CAPITAL COST	MAINTENANCE	SAFETY LIABILITY	STUDY TEAM	PROJECT COMMITTEE	
SURFACE STORAGE BMP'S											
ON-LINE											
Dry Pond / Artificial Wetland	SQ	L	L	L	H	M	M	L	YES	YES	
Wet Pond / Artificial Wetland	SQ	M	L	L	H	M	M	M	NO	NO	
Extended Dry Pond / Artificial Wetland	SQ	L	L	L	H	M	M	L	YES	YES	*
Extended Wet Pond / Artificial Wetland	SQ	M	L	L	H	M	M	M	NO	NO	

1 SQ - Stormwater Quantity, P - Phosphorus, S - Sediments, B - Bacteria, T - Thermal Changes
BF - Baseflow augmentation, I - Groundwater Recharge, E - Erosion

2 H - High
M - Medium
L - Low

TABLE 7.7
BEST MANAGEMENT PRACTICES / SELECTION
SURFACE WATER
AREA 4 - FACILITIES 9, 10, 11, 12 AND 13

BEST MANAGEMENT PRACTICE	ISSUE ADDRESSED[1]	PHYSICAL CONSTRAINT	ENVIRONMENTAL CONSTRAINT	CONSTRAINT POTENTIAL[2]					ACCEPTABLE TO		SHORT LIST
				LAND USE CONSTRAINTS	LAND REQUIREMENTS	CAPITAL COST	MAINTENANCE	SAFETY LIABILITY	STUDY TEAM	PROJECT COMMITTEE	
A. SURFACE STORAGE BMP'S											
1. END OF PIPE OR OFF-LINE											
Dry Pond / Artificial Wetland	P, S, E	L	L	L	M	M	M	L	NO	NO	
Extended Dry Pond / Artificial Wetland	P, S, B, E	L	L	L	M	M	M	L	YES	YES	*
Storage In Park	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Storage Tank	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
B. INFILTRATION BMP'S											
1. ON-SITE OR AT SOURCE											
a) Urban Residential / Industrial / Commercial											
roof leaders to grass area	I, BF, T	L	L	L	L	L	L	L	YES	YES	*
rear lot drainage swale	I, BF, T	L	L	L	L	L	L	L	YES	YES	*
infiltration dry wells	I, BF, T	H	L	L	L	L	M	L	YES	YES	*
infiltration trenches	I, BF, T	H	L	L	L	L	M	L	YES	YES	*
porous pavement	I, BF, T	H	L	L	L	H	H	L	NO	NO	
bottomless catch basins / manholes	I, BF, T	H	L	L	L	M	M	L	NO	NO	
b) Rural Residential / Industrial											
roof leaders to grass area	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
grass drainage system	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
infiltration drainage trenches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
2. END OF PIPE OR OFF-LINE											
Infiltration Trenches / Basins	I, BF, T	H	L	H	M	M	M	L	NO	NO	
C. SPECIAL PURPOSE BMP'S											
1. ON-SITE OR AT SOURCE											
Infiltration Collars	I, BF, T	H	L	L	L	L	L	L	NO	NO	
Groundwater Point Wells	BF, T	H	L	L	L	M	M	L	NO	NO	
2. END OF PIPE OR OFF-LINE											
a) Urban Residential / Industrial / Commercial											
ultraviolet treatment facility	B	L	L	L	H	H	H	L	NO	NO	
b) Urban Industrial / Commercial											
oil /grit separator	S, P	L	L	L	L	H	M	L	YES	YES	*

1 SQ - Stormwater Quantity, P - Phosphorus, S - Sediments, B - Bacteria, T - Thermal Changes
BF - Baseflow augmentation, I - Groundwater Recharge, E - Erosion

2 H - High
M - Medium
L - Low

the Bay of Quinte water quality criteria. Due to physical and environmental constraints and high costs of implementation, the practice of using ultraviolet treatment to supplement the batch detention process to eliminate all bacteria cannot be used at all individual sites. As such, a single ultraviolet treatment facility close to the outlet of Potter Creek would in theory offer the best opportunity to control the bacteria residue from **Areas 2, 3 and 4** extended detention facilities and **Area 5**.

7.2.3 REHABILITATION AND MANAGEMENT OF CHANNEL SYSTEMS

Most of the streams in Southern Ontario have been altered by agricultural and urban land use activities. Watersheds have been deforested, marsh lands infilled, and watercourses made straighter, wider and deeper to quickly convey increases in surface runoff. Rivers and streams have been protected with concrete, gabion baskets and rip-rap to counteract the erosional forces of increased channel velocities and discharges.

The Potter Creek channel system has been identified and investigated from watershed, hydrotechnical (profile, cross-section, conveyance, structures, flood plain) and general characteristic (vegetative cover, soils, erosion, water quality, bedforms, riffles, etc.) viewpoints. For the most part, Potter Creek has been altered from its headwaters to its outlet at the Bay of Quinte. Initial changes in the channel systems were made to improve agricultural uses within the basin and more recently, to accommodate residential and industrial development.

In order to achieve a dynamically stable stream system exhibiting healthy ecological functions, a "natural" approach has been selected to rehabilitate, enhance and manage the channel system within the Potter Creek watershed. A document entitled **Guidelines for Natural Channel Systems** outlines design principles, stream evaluation and classification, design approach and implementation. The document, currently under review by public and private groups, defines the interactions between flow characteristics, fish habitat, sediments, bank stability, aquatic habitat, flood plains, vegetative buffers and cover and the effects of land use on the hydrologic, hydraulic, biologic and terrestrial regimes.

The draft design manual for natural channel systems can be used in conjunction with the subwatershed background information to review channels, riparian zones and flood plains and valleys to achieve an appropriate provision for conveyance and storage of water and sediments, flood flow attenuation in flood plains, vegetative zones and bank stability, enhancement of aquatic and terrestrial habitat and improvement of water quality.

The constraint mapping defines generally accepted setbacks or buffers from watercourses (see Section 6.3.3).

In adopting a natural approach to rehabilitating and managing the channel system, it becomes extremely important to maintain the riparian/floodplain zone. This zone is defined as the area that is saturated by groundwater or intermittently inundated by surface water at a frequency (approximately a 20 year return storm event) and duration sufficient to support vegetation typically adapted for life in saturated soils. Peterjohn and Correll (1984) found that in small agricultural watersheds, the first 19 m of a riparian zone captures 94% of phosphorus and 85% of nitrogen, thereby preventing these nutrients from entering the stream system. Good riparian zones and healthy stream systems also maintain a long hydraulic residence time for shallow groundwater moving towards the stream. This in turn aids in denitrification, improves the quality of water entering the stream and provides longer base flow contributions. This is especially true in a low gradient and small stream system such as Potter Creek where in effect, the riparian zone aids local water quality and baseflow maintenance.

To protect and ultimately enhance and manage the channel system and riparian zones, a vegetative buffer equal to the extent of the defined regulatory fill line should be established along the length of Potter Creek and tributaries. Where the regulatory fill lines have not been established, a minimum of 15 m vegetative buffer should be defined until such time as the channel system and riparian/flood plain zones are determined.

To develop an effective rehabilitation and management plan for Potter Creek, it will be necessary to establish the inter-relationships of the channel system relative to existing watershed uses, current channel system degradation and development constraint mapping and surface water strategies. The plan should address:

- Active erosion sites - priorities and streambank protection alternatives;
- Classification of the channel system (reaches);
- Thinning of the stream banks and flushing of the watercourse to increase diversity, bank stability, light penetration and sediment removal;
- Vegetative buffers, covers, riparian zones and linkages along waterways to control erosion, water temperature and nutrient and sediment loadings;
- Aquatic habitat improvement for warmwater species (i.e., the construction of low-flow meandering channels, possibly with plunge pools tied into rock vortex weirs, in combination with discharging a specific volume of pumped groundwater at strategic locations along the length of Potter Creek during the summer months);
- Terrestrial habitat and natural corridor enhancement along the channel;
- Channel alteration to dynamically balance surface water discharge from stormwater facilities; and
- Managing agricultural practices and stock watering to control erosion, nutrient and bacterial contamination of surface runoff.

7.2.4 LAND USE MANAGEMENT

Land use management measures (beyond the channel systems, floodplains and valleys) should protect and enhance specific areas from inappropriate land uses and impacts. These areas would include:

- Existing parklands
- Woodlots/successional forests
- Wetlands
- Green space linkages

The boundaries between different vegetative communities on land and the boundaries between land and water are defined as the zones of transition between adjacent ecological systems. These zones of transition provide the critical linkages that generate pathways of movement of animals and materials between land and water. Rehabilitation and management of the channel system will protect and enhance the longitudinal and lateral linkages between land and water and provide the opportunity to link channel systems with wetlands, upland forests and recreational areas.

Although a great percentage of the watershed has been deforested, there are a number of hardwood woodlots and successional forests scattered throughout. With the exception of one major stand in the southern part of the watershed, the hardwood woodlots are located in the north, whilst the successional forests are in the future industrial lands and the Quinte Conservation Area. As noted in Section 6.1.7, there are no policies, guidelines and/or constraints to protect the remaining forested areas within the watershed. In order to protect the single hardwood woodlot located in the future industrial lands and provide linkages between ecosystems, planning policies will be needed to create and maintain green corridors.

The hardwood woodlot in the future industrial area merits retention and protection as it contains numerous indigenous overstorey and understorey plant species characteristic of deciduous forest communities. It could easily be integrated into the adjacent forest-old field complexes and riparian corridors to create an important east/west corridor having natural feature value.

In addition, applicants within the industrial lands should be required to set aside 10% of their land area such that it could be integrated with successional forest features of adjacent lands, thereby maintaining linkages both east and west and southwards.

Wooded areas in the northern portion of the drainage basin are included in rural, agricultural, and potential estate residential land uses. For those lands within potential estate residential development, a landscape and/or mitigation plan should be prepared based on naturalization principles, which would generally respond to the following guidelines in addition to those already in the Township of Sidney's Official Plan:

- identification and protection of at least 60% of the currently treed area (based on being able to accommodate all development features, including buildings, driveways, septic tank-tile fields, and lawns, within fully treed lots);

- no clearcutting of trees within protected areas, although thinning dense, young tree growth and stems less than 4.0 cm diameter at breast height, as well as trees of poor health, would be permitted;

- no alteration of soil mantles in protected areas.

Appropriate restrictions should be incorporated into subdivision and consent agreements, under the authority of Sections 51(6) and 53(2) of the Planning Act. Prospective owners should be advised of the requirements through agreements of purchase and sale, and provided with copies of the landscape plan.

The Conservation Authority Wetland Policy supported by the Wetlands Policy Statement will protect the three wetlands identified in Resource Features, Drawing Number 1137-16-13.

The Aikins wetland and the wetland located east of Huntingwood Road are Class 3 wetlands (based on the 1984 Ministry of Natural Resources evaluation system) and therefore, Provincially significant. The wetland located on Tributary 2 east of Avonlough Road is a Class 7 wetland.

The two northern wetlands will be subject to the 120 m "Adjacent Lands" provision of the Wetlands Policy Statement. The criteria for classification of wetlands is subject to change, and as such, adjacent land use policies will be relative to wetland significance at the time of development. Regarding the Tributary 2 wetland, the 30 m vegetative buffer may be appropriate, but the width of the buffer may be further evaluated at the draft plan of subdivision stage, by completing an environmental impact study.

Transportation, services and environmental studies need to be carried out to prepare detailed routing plans that would minimize the impacts to sensitive valley lands. For example, the **Hastings-Belleville Transportation Planning Study** proposes the extension of College Street to Road 22 and Bridge Street West to Wallbridge-Loyalist Road. The College Street extension would have to cross the extensive flood plain north of the Canadian National Railway which would have a significant impact on local drainage and flood plain storage and would be in conflict with the alternative surface water strategies. The Bridge Street extension would have to traverse the channel system three times and cross the wetland located east of Avonlough Road on Tributary 2, and would also be in conflict with the surface water strategy for Tributary 2. The proposed extension of Bell Boulevard through the future industrial lands does not conflict with any strategies considered herein. Regardless, all these extensions would require more detailed study in accordance with the requirements of the Class Environmental Assessment for Municipal Road Projects.

In so far as sanitary and water service routes are concerned, the shallow cover of soils and cost of rock excavation will favour the location of major trunk services along the channel system. This approach will undoubtedly be considered along the Potter Creek system and therefore, environmental impacts must be identified in order to select appropriate practices during construction and subsequent rehabilitation that would be effective in restoring the site to natural conditions. The potential impacts and BMPs should be defined as part of any services routing plan.

New road and servicing crossings of Potter Creek and its riparian area can have substantial environmental impacts, particularly in the short term (that is, during and following construction until a site is "greened up"). In general, crossings should be undertaken where Potter Creek and its floodplain are narrow, and where vegetational impacts are low to negligible. As well, design and construction practices must be addressed to ensure minimal disturbance; in this regard, the following guidelines are proposed:

- crossings should be as close to perpendicular to Potter Creek as possible;
- works, grading and landscaping should be designed to minimize physical impacts on the adjacent terrestrial and aquatic environments;
- construction of works, grading and landscaping should be carried out in accordance with best management practices, undertaken at the time of year least disruptive to Potter Creek, its floodplain, fisheries and wildlife, and be completed as quickly as possible;
- works should be designed to include post construction standards including low maintenance landscaping of road shoulders, and low/selective maintenance pruning, that do not degrade or detract from the natural attributes of Potter Creek and its floodplain; and
- appropriate resource protection and streambank rehabilitation measures should be identified and evaluated (e.g. at culvert and overpass entrances to permit unimpeded fish passage, soil stabilization, and revegetation of riparian areas).

The potential short-term effects of creek crossings include diminishment of water quality and related implications to fish and fish habitat. The degree of impacts will depend upon design, weather conditions during construction, and construction practices. If the above guidelines are used, impacts are expected to be short term and minimal. In the long term, water quality during and following most rainfall events will reflect ambient conditions.

There is no question that the continuity of potential wildlife corridors will be disrupted by roads. This can be alleviated to some extent through crossing design, and adaptation of wildlife populations to use of culverts, underpasses, etc. Regardless, some wildlife mortality associated with through traffic can always be anticipated.

7.2.5 AGRICULTURAL LAND MANAGEMENT

There are no policies to prohibit agricultural land uses on or in close proximity to environmentally sensitive lands or waterways.

Agricultural practices that impair water quality include:

- deforesting land and vegetation along channel systems;
- altering waterways to the status of municipal drains;
- installing tile drains that discharge directly into the waterway;
- directly and indirectly discharging milkhouse washwater to surface waters;
- not providing grassed waterways draining farm lands;
- using pesticides and chemicals, if not used in accordance with guidelines and regulations;
- allowing livestock direct access to the stream;
- using conventional tillage - fall tillage with a moldboard plow followed by spring cultivation; and
- not having adequate manure storage and handling facilities.

There are a number of government programs that can be used as a source of information to guide, and some cases to obtain funding for, reduction of inflows of surface water laden sediments, nutrients and bacteria to the channel system. These include Quinte Remedial Plan-Program, Federal Great Lakes Cleanup Program, Land Management Adjustment Program, Private Landowners Assistance Program, Community Fisheries and Wildlife Programs, Ontario Conservation Land Tax Reduction Program, and Environmental Partners Fund.

Individual actions (sponsored by the Remedial Action Plan-Program, the Private Landowners Assistance Program, and the Federal Great Lakes Cleanup Program) involving manure management, cattle access control, erosion control and revegetation and reforestation have been carried out in the Quinte watershed. To formulate an overall strategy, the Ontario Farm Environmental Coalition, which is made up of the Ontario Federation of Agriculture, the Christian Farmers Federation of Agriculture, the Agricultural Groups Concerned About Resources and the Environment, and the Ontario Farm Animal Council, is encouraging farmers to develop and maintain individual environmental farm plans.

A farm conservation, environmental and educational strategy should be developed that would:

- maintain vegetated buffers between agricultural lands and channel systems (see section 7.2.3);
- reforest and revegetate highly erodible and unproductive agricultural lands;
- establish and maintain erosion control works (grassed waterways, etc);
- remove tile drains directly connected to the channel systems;
- change cropping practices to conserve soils by covering the soil with crop residue;
- adopt some form of conservation tillage (chisel ploughing, no-till, etc.);
- maintain proper manure storage and handling facilities;
- install and maintain proper milkhouse washwater treatment systems;
- prevent livestock direct access to the channel system;
- maintain off-line livestock watering ponds; and
- maintain livestock low flow level crossings.

7.2.6 EDUCATION

The Bay of Quinte Public Advisory Committee (PAC) was established in 1988 to facilitate public input and review of the Bay of Quinte RAP. Public participation has made the public aware of the environmental issues, concerns and remedial measures needed to protect, enhance and sustain the Bay of Quinte ecosystems.

The development of a Subwatershed Plan for the Potter Creek watershed is a result of the Moira River Conservation Authority, the Township of Sidney, and the City of Belleville implementing recommendation number 34 of the Bay of Quinte PAC which states "The Province of Ontario's Subwatershed Planning Process should be adopted and employed by Quinte area municipalities to provide direction for the preparation of Secondary Official Plans for areas slated for new development". As such, the project team views the Potter Creek Subwatershed Study as a deliverable under the Bay of Quinte RAP and therefore, recommends that public education about the Potter Creek Subwatershed Plan be undertaken through the RAP organization via newsletters and joint presentations with the Conservation Authority and municipalities.

This approach to education would provide a consistent vehicle to present issues and concerns, implementation measures, successful and not so successful management practices and plans and general information on the health of the Bay of Quinte. Information passed to the public in this manner will become a familiar process and be far less likely to conflict with previously presented materials and plans. In addition, general information released to help protect the Bay of Quinte such as **The Homeowner's Guide to Improving Water Quality** by the Quinte Environmental Resources Alliance becomes associated with all subwatershed plans and therefore, raises the public's understanding that using alternatives to household toxics and providing stormwater management plans for new subdivisions are essential ingredients in achieving a sustainable environment which will maximize benefits to the natural and human resources of the Bay of Quinte watershed.

7.3 CANDIDATE SUBWATERSHED STRATEGY

7.3.1 GENERAL

By integrating the Development Strategy (Drawing Number 1137-16-17) with the various management strategies described above including the Surface Water Strategy (Drawing Number 1137-16-18), together with rehabilitation measures, a Candidate Subwatershed Strategy was developed.

To assess the potential impacts of implementing the Candidate Subwatershed Strategy, the hydrotechnical, hydrogeologic, surface water quality and biological changes were assessed and are discussed in the following sections. The impacts are compared to existing conditions, policies, guidelines and criteria, as well as the Development Strategy, prior to incorporation of best management practices.

7.3.2 IMPACT ASSESSMENT

7.3.2.1 HYDROTECHNICAL

In Section 6.4 the assessment of potential impacts of the Development Strategy (without considering BMPs) was undertaken, to compare peak flows and potential flooding, due to increased water levels, between existing and proposed conditions.

Hydrotechnical analysis, pertaining to reservoir routing of the water quality facilities, was undertaken in order to maintain the post-development peak flows for the 100, 50, 25, 10 and 5 year storm events, to pre-development levels. The reservoir routing analysis was carried out in conjunction with the surface water quality analysis, in order to optimize the configuration of the ponds. The water quality aspect of the ponds required a depth of pond volume equivalent to the runoff from a 21 mm storm event (see Section 7.3.2.4). Additional storage volume was added, as required, to the ponds to provide sufficient storage volume to attenuate peak flows.

To simulate the Surface Water Strategy, the QUALHYMO model was modified to include water quality/quantity facilities (ponds) at the outlets of Tributary 1 (Area 2) and Tributary 2 (Area 3), as well as Facility 8 in Area 4.

The results of the reservoir routing simulations for the 100, 25 and 5 year storm events are provided in Table 7.8. They demonstrate that with the use of water quality/quantity ponds, post-development peak flows can be attenuated to less than pre-development peak flows and subsequently, the existing water surface elevations defining the extent of hazard lands during less frequent events can be maintained and regulated as defined under the Conservation Authority regulations and schedules which are to be established for Potter Creek. The only exception is along Tributary 5 below Highway 401. Flows and surface water elevations can be expected to be greater than existing until they are controlled at Facility 8 in Area 4.

Furthermore, the existing hydraulic structures will either reflect pre-development performance ratings or be able to safely discharge anticipated increases in peak flows, with the exception of the Tributary 5 culvert under Wallbridge-Loyalist Road. During the regulatory storm event, weir flow will occur over the roadway as compared to pressure flow under existing land use conditions.

7.3.2.2 EROSION

By implementing a Channel System Rehabilitation and Management Plan and a Surface Water Strategy and by adopting land use management measures, erosion should be reduced from current rates to levels that would occur in a natural ecosystem.

Although post-development flows should be controlled to pre-development rates from the 2 year to the regulatory (100 year) event, it will also be important to establish, as part of the Channel System Rehabilitation and Management Plan, the release rates from the surface water facilities. Considering that the facilities will be operated in batch mode over a period of 72 hours, it would be desirable to discharge the pond contents as quickly as possible in order to prepare for the next storm events. On the other hand, too high a discharge can lead to unacceptable depths and velocities in the channel and as a result, upset the dynamic balance of the channel system in the form of erosion.

TABLE 7.8 RESULTS OF RESERVOIR ROUTING						
Location	Drainage Area (ha)	Pond Volume (ha-m)	Pond Volume (mm)	Event (yr)	Peak Flow (cu.m./sec.) Existing	Peak Flow (cu.m./sec.) Development Strategy
Reach 4 Outlet (Area 4)	2466.0	69.5	28.2	100	32.6	19.3
				25	25.9	9.4
				5	17.8	6.4
Tributary 2 (Area 3)	228.5	6.3	27.5	100	5.2	4.1
				25	4.1	2.8
				5	2.9	1.6
Reach 2 Outlet	2909.3	--	--	100	38.0	20.2
				25	30.1	11.2
				5	20.9	8.0
Tributary 1 (Area 2)	117.7	3.5	28.0	100	2.3	2.3
				25	1.8	1.4
				5	1.2	0.7
Reach 1 Outlet (Bay of Quinte)	3090.4	--	--	100	39.5	20.9
				25	31.2	11.9
				5	21.7	8.7

7.3.2.3 HYDROGEOLOGY

7.3.2.3.1 Urban Residential Development

With proper mitigating measures, the overall impact of the urban residential development on the local groundwater resource will be small and acceptable. The following measures should be implemented into each proposed development plan:

- Provision of a stormwater management plan to encourage groundwater infiltration. Given the low permeability of the soil types found over most of the area, it is recognized that it will not be practical to maintain groundwater recharge rates at their current levels. However, practical stormwater management techniques which encourage groundwater infiltration must be implemented. These should include but not be limited to:
    - maximization of overland flow of storm drainage through grassed or pervious areas;
    - discharge of roof leaders to grassed areas;
    - consideration of the use of enhanced infiltration methods such as infiltration galleries, ponds, or dry wells where conditions are appropriate.
- Proper treatment of stormwater runoff from paved surfaces to remove suspended contaminants prior to infiltration. (This could include the use of bioengineered areas, vegetated buffer strips and storm septor systems to remove oil, grease and grit).
- An education program to all homeowners to encourage proper application of garden

chemicals and the use of non-chemical gardening methods.

7.3.2.3.2 Industrial Development

With proper mitigating measures, the overall impact of the commercial/industrial development on the local groundwater resource will be small and acceptable.

In order to minimize the impact of development on the groundwater resource, a detailed hydrogeologic evaluation of all proposed development plans should be undertaken. The evaluation should consider the site-specific impact of the development on the local ground water resource including:

- quality;
- quantity;
- interaction of groundwater with surface water and the possible reductions to base flow in Potter Creek; and
- appropriate measures to mitigate impact to a negligible level.

7.3.2.3.3 Rural and Estate Development

With proper site design, the impact of the development will be small and acceptable. Potential impacts can be minimized through the following methods:

- Minimization of site grading and preservation of existing land forms and contours as much as practicable.

- Use of communal water supply and sewage disposal facilities may be encouraged where these can provide a benefit with respect to minimizing lot grading, loss of tree cover, alterations to the local drainage, and capital and long term operating costs.

- A comprehensive hydrogeologic evaluation should be made of any proposed development of more than five dwellings. The evaluation should consider site specific impacts on the local groundwater resource including:
    - quality;
    - quantity;
    - interaction of groundwater with surface water and the possible reductions to base flow in Potter Creek; and
    - mitigation measures to reduce impacts to a negligible level.

These considerations are generally of less importance for individual lot severances or construction of individual dwellings. Nonetheless, lot grading should be minimized as much as practical. A site plan should be submitted indicating the extent of tree clearing, grading, and/or any alterations to the local drainage.

7.3.2.4 SURFACE WATER QUALITY

7.3.2.4.1 General

The degradation of water quality in watercourses and lakes has resulted in the introduction of the **Stormwater Quality Control Guidelines** (1991) and **Stormwater Quality Best Management Practices** (1991) prepared by regulating ministries.

Numerous papers have been published to analyze the performance of stormwater quality control ponds by continuous simulation. Droste, Rowney and MacRae carried out an investigation to determine the sensitivity of the performance of batch and continuous plug flow operation modes of detention facilities on the removal and exceedence basis for fecal coliform (FC) and suspended solids (SS). The pond design variables simulated included mode of operation (batch and continuous flow), pond active storage volume, effluent pipe diameter, detention time in batch mode, number of cells in the pond system, permanent pool size, storm influent quantity and quality characteristics, pollutant removal rate coefficients, and routing dry-weather flow into or around the pond. In summary, the authors noted that:

- a continuous plug flow pond under ideal conditions without short-circuiting or dead volume provides the highest degree of treatment on an overall removal basis for the parameters of concern;

- significant design parameters include size of the active storage volume, number of cells, and size of the permanent pool;

- the batch mode of operation is only marginally inferior in performance to a plug flow reactor in terms of removal (within 2%) while providing a 50% decrease in the number of exceedences;

- the number of cells (between 1 and 5) in the batch reactor did have a tendency to increase removals by up to 5%;

- dry-weather flow rates which fill a pond in less than 5 days will rapidly accelerate the degradation of pond performance;

- pond volumes between 9 and 12 mm of runoff for the entire catchment provide optimal performance based on the treatment indices;

- variability in the FC dieoff rate will not allow the target value of 4 exceedences per summer to be consistently achieved even in the most efficient pond configuration (72 hour batch mode) without disinfection.

Continuous simulation analyses were also carried out by Gordine and Adams based on runoff quantities computed by the coefficient method. Four types of stormwater quality control ponds, namely retention basins (infiltration facilities), extended detention ponds, sedimentation ponds with displacement, and wet settling ponds/tanks, were investigated. The authors concluded that:

- The design storm volume and duration are not sufficient to specify sizing rules for stormwater quality control facilities. Other factors such as, catchment location, land use, configuration of the basin, operation policy, outflow rate, detention time, and type of pollutant, should also be considered.

- In terms of pollutant removal, configuration (surface area and depth) is not a significant factor to be considered in designing a stormwater quality control facility. Shallower ponds with larger surface areas remove pollutants marginally better than deeper ponds, but the advantage is small.

- The performance of detention (settling) ponds strongly depends on the type of pollutant to be removed. On average, long term suspended solids removal ranges from 60% to 70%.

- The performance of the extended detention and wet settling ponds depends on the operation mode, whether the runoff in excess of the pond capacity is routed through the facility (flow-through mode) or discharged into the receiving water body without treatment (bypass mode). The advantage of the flow-through mode may be as high as 8-10%.

- The percentage long term pollutant removal is not sensitive to the land use pattern in the watershed. The pollutant mass loadings are higher from less pervious industrial sites than from residential sites.

- The effects of quiescent detention time and size of the facility on the facility's performance are inter-dependent. In most cases, 24 hours is an optimal quiescent detention period for the larger basins, designed on the basis of a 25 mm rainfall. The smaller facilities, sized on the basis of a 13 mm storm, exhibit an abrupt decrease in performance with increased quiescent detention time.

- A design storm volume of 25 mm may be redundant as in the case of the extended detention pond. The maximal pollutant removal is achieved by a smaller basin.

- The permanent pool is much less efficient in pollutant removal than the working volume of the pond which is drained after a certain period of settling.

- Infiltration basins are the most efficient means of stormwater quality control, providing up to 98% removal. However, they are the most unreliable type of BMP. They are subject to clogging, may cause groundwater contamination, and do not perform well in winter.

Guo and Adams developed three statistical models to determine the long term suspended solids removal of extended detention dry ponds, and wet ponds with and without outlet control. The results of the simulations were compared with those from continuous SWMM simulations and computations using Driscoll's wet pond sizing procedure. The results indicated that:

- Pond surface area and depth have significant impacts on the long term performance of the pond.
- When the discharge rate from the pond is reduced to an extremely small value, the long term removal efficiency of the pond declines, probably due to more spill events resulting from extremely long detention periods.
- The permanent pool volume has a greater effect on the long term performance than the storage volume between the permanent pool and the spillway crest.

The authors recommended wet ponds with large permanent pools for efficient suspended solids control. However, specific criteria such as limitations to bird hazards may limit this recommendation within the Potter Creek drainage basin.

7.3.2.4.2 Scenario Modelled

For simulation purposes, one pond was provided at each outlet for Tributary 1 (Area 2), Tributary 2 (Area 3), and immediately north of the CNR (Area 4).

The QUALHYMO model was modified to incorporate water quality batch ponds at the above three locations. The buildup and washoff parameters for FC and SS determined in Section 6.4.4 were utilized, and input into the model.

Continuous simulation was then carried out for 1987, from June 1 to September 7, based on the Development Strategy.

7.3.2.4.3 Results

Table 7.9 summarizes the results of the continuous simulation. In general, the percentage removal of the simulated pollutants, namely fecal coliform (FC) and suspended solids (SS), are in the order of 85% to 99%.

Due to the extended detention time of 72 hours and a batch mode of operation, untreated portions of runoff may be discharged when the ponds are at full capacity. The simulations showed that FC can be controlled to less than or equal to 4 exceedences (> 100 MPN/100 mL) based on the outflows from the ponds. The number of exceedences for SS are based on 25 mg/L of suspended solids, which is the criterion required to effectively use ultraviolet treatment of FC.

The high number of exceedences of FC and SS noted at the CPR are attributed to the simulation results from the hydrologic Reach 2 and Reach 3. No surface water controls were modelled for these reaches. Reach 2, CPR to the confluence with Tributary 2, is comprised of Quinte Conservation Area and a small portion of the Loyalist College property. The simulated seasonal averages of FC and SS from this reach were 183 MPN/100 mL and 97 mg/L respectively. The majority of the land within Reach 3 is the Loyalist College property. The simulated seasonal averages of FC and SS from this reach were 625 MPN/100 mL and 1,287 mg/L respectively. These results are much higher than expected.

The vegetative buffers around the college are sufficient to reduce the loadings to Potter Creek to minimal concentrations and therefore, the water quality results for these reaches should be considered extremely conservative and kept in perspective when assessing the overall watershed loading to the Bay of Quinte.

The watershed simulated 1987 seasonal average concentrations were 374 MPN/100 mL and 93 mg/L for FC and SS respectively. Disregarding reach 2 and reach 3 results and the acceptable exceedences, the seasonal average for FC would be less than 100 MPN/100 mL. However, no modelling scenario controlled SS to less than 25 mg/L with a maximum of 4 exceedences.

TABLE 7.9
WATER QUALITY SIMULATION
1987 RAINFALL DATA
DEVELOPMENT STRATEGY

Location	Pollutant	Max Mean Inflow	Max Mean Outflow	No. of Event Exceedences
WQ Pond at CNR (Area 4)	FC (MPN/100 mL)	5,928	382	2
	SS (mg/L)	3,545.1	171.3	5
WQ Pond at Outlet of Tributary 2 (Area 3)	FC (MPN/100 mL)	19,005	2,650	2
	SS (mg/L)	11,313.5	1,277.0	9
WQ Pond at Outlet of Tributary 1 (Area 2)	FC (MPN/100 mL)	19,294	2,410	4
	SS (mg/L)	11,452.5	10,187.5	6
Reach 1 Inflow (At CPR)	FC (MPN/100 mL)	N/A	1,209	15
	SS (mg/L)	N/A	1,342.1	26

7.3.2.4.4 Summary

As a result of the continuous water quality simulations, the following is concluded:

- Surface water quality facilities with extended detention times of 72 hours and operated in a batch mode have the potential to achieve FC (*E. coli*) water quality criteria.

- The extended detention required to achieve FC criteria will provide the acquiescent time to control suspended sediments, total phosphorus and metals.

- The surface water facilities cannot achieve the suspended solid discharge rate of 25 mg/L that would enable a single ultraviolet facility to be located downstream of the surface water facilities.

- The simulated water quality results for reaches 2 and 3 are considered too high given the extent of vegetative buffers surrounding the Loyalist College lands. Nevertheless, the results do emphasize that a stormwater management plan for these lands should be developed as part of the overall subwatershed strategy.

Because of the inability to achieve the suspended solids criteria referred to above, as well as high capital and operating costs, the Study Team and Project Committee recommended against a single ultraviolet treatment facility near the outlet of Potter Creek, shown on Drawing Number 1137-16-18. Ultraviolet treatment at the individual detention ponds was already rejected as unfeasible in Section 7.2.2.

7.3.2.5 BIOLOGICAL ENVIRONMENT

The Candidate Subwatershed Strategy essentially complies with all of the existing policies and guidelines relating to principles of ecosystem sustainability in a southern Ontario rural landscape, including those focusing on long term protection and management of wetlands, streams and forests. This strategy permits fish movement throughout the entire stream, except for a short length in the northeastern section. As well, fish habitat improvement, in terms of enhancing Potter Creek's productive capacity through the tactics described in Section 7.2.3, could be implemented by local angler clubs, conservation groups, science clubs, and/or school groups through the Ministry of Natural Resources's Community Fisheries Involvement Program.

Land use changes including agricultural activities and urbanization can substantially increase temperatures in a watercourse. For example, the removal of riparian vegetation can raise summer water temperatures in small streams up to 12°C. Warm urban runoff from small storm events (i.e., < 12 mm) is typically only generated from impervious surfaces during the summer months, as these are often unshaded. In this regard, monitored data suggest that urban runoff can be as high as 28°C, although values in this range only occur about 2% of the time. Best management practice ponds can compound temperature increases since open waters tend to acclimate to air temperatures. Accordingly, the water that is discharged from the various detention ponds to Potter Creek will have an effect of increasing ambient stream temperatures, but only during the period of discharge. Once the ponds have emptied, stream temperatures will return to background levels.

The key question relates to whether or not fish species indigenous to Potter Creek will be affected either by temperature increases, or fluctuations in water temperature. While we did not undertake a quantitative analysis in this regard, we are of the view that most if not all of species found in the creek typically occur in warm water streams and would be quite resilient to change. In defining, rehabilitating and revegetating Potter Creek's riparian area in terms of protecting and enhancing its longitudinal and lateral linkages to connect the main creek with its wetlands, upland forest, and passive recreational areas, opportunities are also provided to reduce temperature impacts from treated stormwater discharge.

Guidelines are provided to protect and manage the remaining woodlots and successional stands within the watershed, such that they will continue to provide wildlife and passive use recreational corridors; to be effective, these guidelines will need to be integrated into municipal planning policies.

7.3.2.6 RECREATION AND OPEN SPACE

The Candidate Subwatershed Strategy would affect Quinte Conservation Area by:

- requiring development of 0.5 ha for Facility 1;
- requiring installation of an ultraviolet treatment facility on Potter Creek, just north of the Conservation Authority headquarters; however, as noted in Section 7.3.2.4.4, this facility is not recommended in any case.

The strategy would, over time, allow for the creation of significant open space linkages along Potter Creek from the Bay of Quinte to Wallbridge-Loyalist Road north of Moira Street West, and along the lengths of Tributaries 2 and 3, subject to:

- the conveyance of floodplain and heritage lands into the public domain, as conditions of development approvals in the future urban community and industrial area;
- the cooperation of Loyalist College in public amenity conservation and development;
- the maintenance and enhancement of Quinte Conservation Area.

Provided the preceding can be achieved, the end result of the strategy should be to create the following open space corridors, generally available for recreational and trail uses:

- from Cascade Park, Belleville, to Bay of Quinte at Quinte Conservation Area, via main branch of Potter Creek;
- from Wallbridge-Loyalist Road north of Moira Street West, to main branch of Potter Creek north of Moira Street West;
- from Morris Drive Park, Belleville, to main branch of Potter Creek at Loyalist College.

Upstream from Wallbridge-Loyalist Road north of Moira Street West, the stream corridor's environmental quality can be expected to improve over time. However, continuous public access cannot be expected in the foreseeable future, as this portion of the watershed will by and large remain in its present agricultural and rural uses.

7.3.2.7 DEVELOPMENT

The Candidate Subwatershed Strategy would require that the following private lands beyond the limits of the Potter Creek floodplain eventually be designated for public purposes.

- Area 1, Facility 2, 0.5 ha.
- Area 3, Facilities 4 - 7, 7.6 ha.
- Area 4, Facilities 9 - 13, 13.7 ha.
- Woodlot south of future industrial area, 4.5 ha.

After floodplains, the above areas, and pockets isolated and rendered impractical for development are withdrawn, the areas remaining for development in the Township of Sidney are as follows:

- Urban residential, 242 ha.
- Industrial development, 229 ha.

Also, as indicated in Section 7.2.4, Facility 8 would conflict with the extension of College Street west to Hastings Road 22 as currently proposed by the Hastings-Belleville Transportation Planning Study.

8.0 SUBWATERSHED PLAN AND IMPLEMENTATION

This section summarizes the various actions which the preceding sections have demonstrated to be feasible and viable components of the Potter Creek Subwatershed Plan. For each recommended action, we identify the approach to be taken, who would be responsible, and suggested timing.

Timing for some actions is indicated as 1994-96 or 1994-99. This is simply meant to suggest that these are priority items which could and should be undertaken during the plan's first two or five years respectively. Timing for planning and zoning amendments is indicated as 1994-99, to allow for the amendments to be incorporated in official plans and zoning bylaws as part of routine updating of those documents.

8.1 FLOOD AND EROSION CONTROL

8.1.1 FLOODPROOFING

RECOMMENDED ACTION

Undertake standard passive floodproofing measures for buildings in the regulated floodplain.

APPROACH

The Moira River Conservation Authority should encourage property owners to employ floodproofing measures to minimize flood damage.

RESPONSIBILITY

- Coordination: MRCA
- Development, ownership, and maintenance: property owners.

TIMING

Depends on property owner initiative.

8.1.2 FLOODPLAIN PROTECTION

RECOMMENDED ACTION

Protect the Potter Creek floodplain through flood and fill line regulations and municipal planning policies.

APPROACH

The flood and fill lines identified in this study will be protected by regulations under the Conservation Authorities Act which are expected to come into force during 1994.

The Environmental Protection Zone in the Sidney Zoning Bylaw should be modified to reflect the area within the flood lines identified in this study.

RESPONSIBILITY

- Flood and fill regulation: MRCA
- Zoning bylaw amendment: Sidney.

TIMING

- Flood and fill regulation: 1994
- Zoning bylaw amendment: 1994-99.

8.1.3 REPLACEMENT OF NONCONFORMING STRUCTURE

RECOMMENDED ACTION

Replace the nonperforming culvert where Wallbridge-Loyalist Road crosses Tributary 5.

APPROACH

This would most logically be done in connection with major repairs to or reconstruction of Wallbridge-Loyalist Road.

RESPONSIBILITY

County of Hastings.

TIMING

Depends on County initiative.

8.1.4 CHANNEL SYSTEM REHABILITATION AND MANAGEMENT PLAN

This action, which would contribute to flood and erosion control, is described in Section 8.3.1.

8.2 URBAN SURFACE WATER MANAGEMENT

8.2.1 COMMUNAL STORMWATER DETENTION PONDS

RECOMMENDED ACTION

Establish specific strategies for urban stormwater management.

APPROACH

A potential system of stormwater detention ponds is described in Section 7.2.2 and illustrated in the Surface Water Strategy Drawing, No. 1137-16-18. This system is put forward as a benchmark strategy against which alternative strategies can be measured. It is not formally recommended at this time.

The pond system is intended to serve common needs for urban stormwater management as effectively and efficiently as possible. It is based on the following principles:

- Except in Area 1 where most development has already taken place, the ponds would need only be developed in accompaniment with the future urban industrial or residential development whose stormwater the ponds would accommodate.
- All land and development costs would be paid by the benefiting developers, except in Area 1 where there will be little or no development requiring further planning approvals.
- If development within an area served by a particular pond is staged, the development of the pond could be correspondingly staged, though all land for the pond would need to be acquired and set aside at the beginning. However, the Facility 8 control structure would have to be fully completed before or at the same time as the first stage of any of the Facility 9-12 ponds. Any extra costs associated with staging of development would be the responsibility of the developers.
- The developers and landowners would have the initial responsibility for the coordination and cooperation among themselves that would be necessary to bring about the most effective and efficient implementation. However, concerns have been expressed that these parties may not be able to achieve the necessary coordination among themselves, and that the assistance of the Township of Sidney may be required. Accordingly, there are three ways in which a coordinated strategy could be implemented, each with pros and cons for the various parties. If desired, different approaches could be used in different areas:
    - the Township could undertake the ponds as public works, and recover its costs through levies on development as it takes place;
    - the initial developers could undertake the ponds, and recover from subsequent developers their prorated shares of the costs through a system of levies that the Township would put in place;
    - coordination and cooperation could be left entirely to the developers and landowners, with no Township involvement.
- All ponds would require approval from the Ministries of Natural Resources and Environment and Energy and MRCA, including approval under the Lakes and Rivers Improvement Act for the on-line Facility 3.

- Facilities 8 through 13 would require approval from the Department of National Defence that they are in compliance with the Trenton Airport Zoning Regulations.

- After any stage of any pond is put in service, the developer would retain ownership and remain responsible for the maintenance and proper functioning of the pond for three years.

The pond numbers, locations, and dimensions shown on the Surface Water Strategy are based on current topography and drainage requirements. These may be subject to change in accordance with site development and stormwater management planning for individual developments.

The approval authorities should be prepared to consider proposals from developers for stormwater management measures other than communal detention ponds, provided that the applicant demonstrates the following to the satisfaction of MRCA and the Township of Sidney:

- the alternative measures would meet the water quality and quantity criteria identified in the Subwatershed Plan;

- the measures would not compromise any other value or component of the Subwatershed Plan;

- the measures would not result in any additional costs accruing to any other developers, present or future, in the Potter Creek or South East Secondary Plan areas;

- measures within the Bird Hazard Zone are in compliance with the Trenton Airport Zoning Regulations.

The Sidney Official Plan should be amended to require that as a condition of approval of development within the Potter Creek and South East Secondary Plan areas, applicants be required to:

- contribute to the development of a stormwater detention pond system in accordance with the preceding approach;

or,

- if proposing alternative stormwater detention measures, undertake independent professional studies in support of their proposals, where deemed appropriate by Sidney and MRCA;

- residential development of five units or less, and other development of properties totalling less than 2,500 m^2, would be exempt from these requirements.

RESPONSIBILITY

- Plan amendment: Sidney

- Development: Facilities 1 and 2, Sidney, and developers if any; other ponds and alternative measures, developers

- Ownership: Facility 1, MRCA conveys to Sidney; other ponds, developers convey to Sidney after three years; alternative measures, property owners

- Maintenance: ponds, Sidney; alternative measures, property owners.

TIMING

- Plan amendment: 1994-99

- Development of Facilities 1 and 2: 1994-99

- Development of other ponds or alternative measures: depends on developer initiative.

8.2.2 BEST MANAGEMENT PRACTICES ON APPROVED COMMERCIAL/INDUSTRIAL LANDS

RECOMMENDED ACTION

Negotiate best possible management practices for stormwater on commercial/industrial lands already approved for development.

APPROACH

Much of the lands shown as existing and approved commercial or industrial on the Development Strategy (Drawing No. 1137-16-17), as well as most of the lands designated industrial and commercial in Belleville, are already developed, and the rest already have the official plan and zoning bylaw designations needed to permit development. Unless applicants wish to propose development that would require reopening of their existing approvals, they would not be subject to the planning policies recommended in Sections 8.2.1 or 8.2.3. Therefore, in conjunction with whatever final approvals are required in each case (site plan control, flood and fill line regulation, building permits, etc.), MRCA and the municipalities should seek applicants' commitments to adopt best stormwater management practices to the greatest extent possible. Practices to be considered should include those listed in Section 8.2.3, as well as contributions to any appropriate stormwater detention ponds that may be developed. In the case of existing development in these areas, if problems are known to exist, MRCA and the municipalities should similarly approach the owners.

RESPONSIBILITY

- Negotiation: MRCA, Sidney, Belleville
- Development: developers/property owners
- Ownership and maintenance: property owners.

TIMING

- Existing development: 1994-99
- New development: depends on developer initiative.

8.2.3 BEST MANAGEMENT PRACTICES IN NEW DEVELOPMENT

RECOMMENDED ACTION

Require best management practices for stormwater in new development.

APPROACH

The Sidney and Belleville official plans should be amended to require that, as a condition of approval of all development within the Potter Creek basin, a stormwater management concept plan be required of all applicants that would, in addition to current official plan requirements, provide for the following to the satisfaction of the Township, MRCA, and the Ministries of Environment and Energy and Natural Resources:

- an erosion and sediment control plan to mitigate construction impacts, incorporating where possible the following best management practices:
    - sediment traps or temporary retention ponds
    - seeding of stockpiled topsoil
    - isolated and controlled stripping of land
    - vegetation screens
    - interceptor swales
    - filtering mediums
    - street cleaning programs
    - scheduled maintenance;
- consideration and incorporation where possible of the following best management practices in the completed development:
    - discharge of roof runoff to grassed areas
    - infiltration dry wells and trenches where soil conditions are appropriate
    - rear lot drainage swales
    - systems for removing oil, grease, and grit from paved surface runoff.

The stormwater management concept plan is intended to indicate in general terms the potential effects of stormwater during construction and once development is complete, and how these will be mitigated so as to meet the water quality and quantity criteria of the Subwatershed Plan. No change is intended to the present practice that detailed technical submissions can be left to the final approval (registered plan of subdivision, site plan control, etc.) stage.

Further details on post-development best management practices are provided in Section 7.3.

RESPONSIBILITY

- Plan amendment: Sidney, Belleville
- Development: developers
- Ownership and maintenance: property owners.

TIMING

- Plan amendment: 1994-99
- Development: depends on developer initiative.

8.2.4 LOYALIST COLLEGE STORMWATER MANAGEMENT PLAN

RECOMMENDED ACTION

Encourage Loyalist College to develop a comprehensive stormwater management plan for its property, incorporating best management practices.

APPROACH

Since much of the Loyalist College property is already developed, and the balance already has the official plan and zoning bylaw designations needed to permit further development of College facilities, preparation of a comprehensive stormwater management plan would be a positive action by the College as an environmentally responsible public agency. The plan would cover all College lands, taking into account their existing development. Practices to be considered should include those listed in Section 8.2.3.

RESPONSIBILITY

Loyalist College in consultation with MRCA and Sidney.

TIMING

1994-99.

8.2.5 CHANNEL SYSTEM REHABILITATION AND MANAGEMENT PLAN

This action, which would contribute to urban surface water management, is described in Section 8.3.1.

8.3 REHABILITATION AND MANAGEMENT OF CHANNEL SYSTEMS

8.3.1 CHANNEL SYSTEM REHABILITATION AND MANAGEMENT PLAN

RECOMMENDED ACTION

Prepare a Channel System Rehabilitation and Management Plan for Potter Creek.

APPROACH

This Plan would set out the design prescriptions and management measures needed to combat degradation and promote rehabilitation and naturalization of Potter Creek. Topics to be addressed would include:

- classification of channel reaches
- streambank erosion and protection
- thinning of streambank vegetation to improve streamflow
- vegetative buffering and enhancement
- aquatic habitat improvement
- terrestrial habitat and natural corridor enhancement
- channel alteration
- management of agricultural practices.

Further details on this Plan are provided in Section 7.2.3.

This Plan would involve all public agencies and interest groups with a stake in improving Potter Creek, and would assign implementation responsibilities among the participants.

RESPONSIBILITY

MRCA, in partnership with:

- Sidney
- Belleville
- Ministry of Environment and Energy (on behalf of Bay of Quinte Remedial Action Plan)
- Ministry of Natural Resources
- Loyalist College
- Agricultural associations
- Angler clubs
- Quinte Field Naturalists.

TIMING

1994-99.

8.3.2 SHORELINE/FLOODPLAIN VEGETATION PROTECTION

RECOMMENDED ACTION

Protect vegetation within the Potter Creek floodplain through flood and fill line regulations and municipal planning policies.

APPROACH

The flood and fill lines identified in this study will be protected by regulation in the near future.

The Sidney Official Plan should be amended to require that as a condition of approval of development of properties wholly or partly within the fill line, vegetation within the fill line not be disturbed unless the applicant can demonstrate to the satisfaction of Sidney and MRCA that the proposed actions:

- are necessary to provide passage, safety, views, or ventilation, and
- will not have significant adverse effects on Potter Creek.

RESPONSIBILITY

Sidney.

TIMING

1994-99.

8.4 LAND USE MANAGEMENT

8.4.1 FLOODPLAIN PERPETUATION AND PUBLIC USE

RECOMMENDED ACTION

To the greatest extent possible in conjunction with new development, perpetuate and make accessible for public use the floodplain of Potter Creek by bringing it into the public domain, where feasible and appropriate.

APPROACH

The lands through which Potter Creek and its tributaries pass below the Wallbridge-Loyalist Road crossing north of Moira Street West either are already in the public domain or will be developed over time. The recommended action will be restricted mainly to this portion of the basin, as there will be little development upstream.

The Sidney Official Plan should be amended to:

- state as a long term objective the acquisition where feasible of the floodplain of Potter Creek as public or institutional open space, and in particular the establishment of a green corridor from Cascade Park, and Morris Drive Park, and Wallbridge-Loyalist Road north of Moira Street West to the Bay of Quinte as described in Section 7.3.2.6, and indicate that best efforts will be made to achieve this objective as a condition of approval of development;

- indicate that the use of the following will be encouraged in order to achieve this objective:
    - donations to Sidney, MRCA, or a land conservancy agency
    - land exchanges
    - dedication for park purposes under the Planning Act
    - acquisition on mutually agreeable terms
    - density transfers
    - credit against development charges
    - other measures as appropriate.

RESPONSIBILITY

- Plan amendment: Sidney
- Ownership: Developers convey to Sidney, or to MRCA or a land conservancy agency if a donation to those bodies
- Maintenance: Sidney, or other recipient.

TIMING

- Plan amendment: 1994-99
- Development: depends on developer initiative.

8.4.2 WETLAND AREA AND FUNCTION PROTECTION

RECOMMENDED ACTION

Protect the basin's three wetlands through municipal planning policies.

APPROACH

The Sidney Official Plan should be amended to designate the three wetlands (see Drawing No. 1137-16-17) as wetland.

The Provincially significant Aikins and Tributary 5 wetlands, and their 120 m adjacent land zones, are subject to the Wetlands Policy Statement under the Planning Act. Any development in the adjacent lands in accordance with the Wetlands Policy requires Ministry of Natural Resources approval. As well, all three wetlands are subject to MRCA's 1993 Wetland Policy (see Section 6.1.6).

RESPONSIBILITY

Sidney.

TIMING

1994-99.

8.4.3 TRIBUTARY 5 WETLAND PERPETUATION

RECOMMENDED ACTION

Seek to perpetuate the Tributary 5 wetland (see Drawing No. 1137-16-17) as a wetland.

APPROACH

The Tributary 5 wetland owes its existence to a beaver dam, which could be removed at any time by the owner of the rural lands on which the dam is situated. Negotiations should be entered into with the owner to seek continued maintenance and protection of this dam.

RESPONSIBILITY

- Negotiation: MRCA, Ministry of Natural Resources
- Ownership and maintenance: property owner.

TIMING

1994-96.

8.4.4 INDUSTRIAL AREA HARDWOOD WOODLOT PERPETUATION AND PUBLIC USE

RECOMMENDED ACTION

Protect the hardwood woodlot in the future industrial area (see Drawing No. 1137-16-17) through municipal planning policies, and to the greatest extent possible in conjunction with new development, perpetuate the woodlot and make it accessible for public use by bringing it into the public domain.

APPROACH

The Sidney Official Plan should be amended to:

- at the development application stage, designate the woodlot as open space;
- state as a long term objective the acquisition of the woodlot, and indicate that best efforts will be made to achieve this objective as a condition of approval of development;
- indicate that the use of the measures listed in Section 8.4.1 will be encouraged in order to achieve this objective.

In the meantime, negotiations should be entered into with the present owner to seek conservation of the woodlot's existing values.

RESPONSIBILITY

- Plan amendment: Sidney
- Negotiation: Sidney
- Ownership: Developers, through development approvals, convey to Sidney
- Maintenance: Sidney.

TIMING

- Plan amendment: 1994-99
- Development: depends on developer initiative.

8.4.5 ESTATE RESIDENTIAL AREA UPLAND FOREST/NATURAL LINKAGE PERPETUATION

RECOMMENDED ACTION

Seek to perpetuate through municipal planning policies substantial upland forest elements and natural linkages in the future estate residential area (see Drawing No. 1137-16-17).

APPROACH

The Sidney Official Plan should be amended to require, in addition to the Plan's existing requirements, the following as a condition of approval of estate residential development within the Potter Creek basin:

- the detailed site development plan required of all applicants for estate residential development provide for the following to the Township's satisfaction:
  - the use of naturalization principles in landscape design
  - identification of protected areas to include at least 60% of the currently treed area
  - no clearcutting of trees and no alteration of soil mantles in protected areas;
- the above conditions of the site development plan be registered on the titles of all lots and blocks created.

Further details on these conditions are provided in Section 7.2.4.

RESPONSIBILITY

- Plan amendment: Sidney
- Development: depends on developer initiative
- Ownership and maintenance: property owners.

TIMING

- Plan amendment: 1994-99
- Development: depends on developer initiative.

8.4.6 INDUSTRIAL AREA UPLAND FOREST/NATURAL LINKAGE PERPETUATION

RECOMMENDED ACTION

Seek to perpetuate through municipal planning policies substantial upland forest elements and natural linkages in the future industrial area.

APPROACH

The Sidney Official Plan should be amended to require the following with respect to industrial development within the South East Secondary Plan area (see Drawing No. 1137-16-17):

- through the South East Secondary Plan or Plans, or in the absence of a secondary plan, through site planning for individual properties:
    - identification of protected areas to include at least 10% of each Secondary Plan area or individual property
    - configuration of protected areas within the Secondary Plan area or individual property to provide maximum linkages with the hardwood woodlot (Section 8.4.4) and with protected areas on adjacent lands;
- as a condition of approval, the site plan required of all applicants for industrial development provide for the following to the Township's satisfaction:
    - designation of the protected areas identified and configured as above
    - the use of naturalization principles in landscape design
    - no disturbance of vegetation and no alteration of soil mantles in protected areas;
- the applicant enter into a site plan agreement with the Township to register the above conditions of the site plan on the titles of all lots and blocks created.

RESPONSIBILITY

- Plan amendment: Sidney
- Development: depends on developer initiative
- Ownership and maintenance: property owners.

TIMING

- Plan amendment: 1994-99
- Development: depends on developer initiative.

8.4.7 URBAN COMMUNITY UPLAND FOREST/OPEN SPACE LINKAGE PERPETUATION

RECOMMENDED ACTION

Seek to perpetuate through municipal planning policies substantial upland forest elements and open space linkages in the future urban community area.

APPROACH

The Potter Creek Secondary Plan should set out conditions of approval for urban community development within the Secondary Plan area (see Drawing No. 1137-16-17) that are appropriate equivalents to those for estate residential and industrial development in Sections 8.4.5 and 8.4.6.

RESPONSIBILITY

- Secondary planning: Sidney
- Development, ownership, and maintenance: to be addressed in secondary plan.

TIMING

Depends on developer initiative.

8.4.8 LOYALIST COLLEGE NATURAL FEATURES PERPETUATION AND PUBLIC USE

RECOMMENDED ACTION

Encourage the continued cooperation of Loyalist College in integrating conservation and public use of its property into strategies for adjacent areas.

APPROACH

For the reasons given in Section 8.2.4, integration of conservation and public use of College lands into strategies for adjacent areas of the basin would be a positive action by the College as an environmentally responsible public agency. At the same time, it is recognized that College uses have first priority on College lands, and that the College needs to have discretion over public uses.

RESPONSIBILITY

Loyalist College in consultation with MRCA and Sidney.

TIMING

1994-99.

8.4.9 WATERCOURSE/FLOODPLAIN PROTECTION AT NEW TRANSPORTATION/UTILITY CROSSINGS

RECOMMENDED ACTION

Protect, through environmental assessment and municipal planning policies, Potter Creek and its floodplain at new transportation and utility crossings and upgradings and/or expansions of existing crossings.

APPROACH

Provincial, provincial Crown agency, and municipal transportation and utility crossings are subject to the planning and approval requirements of the Environmental Assessment Act.

In addition, the Sidney Official Plan should be amended to require that proponents of all transportation or utility crossings of Potter Creek or its floodplain be urged to conform to the following guidelines:

- to the greatest extent possible, crossings be at locations where the floodplain is narrow, and environmental conditions the least sensitive;
- crossings be as close to perpendicular to Potter Creek as possible;
- works, grading, and landscaping be designed to minimize physical impacts on the terrestrial and aquatic environment;
- construction of works, grading, and landscaping be carried out in accordance with best management practices, undertaken at the times of year least disruptive to Potter Creek and its floodplain and environment, and be completed as quickly as possible;
- works be designed to include post-construction standards, such as low maintenance landscaping and pruning, that do not degrade or detract from the natural attributes of Potter Creek and its floodplain;
- appropriate resource protection and streambank rehabilitation measures be undertaken.

Further details on these guidelines are provided in Section 7.2.4.

RESPONSIBILITY

- Plan amendment: Sidney
- Development: depends on proponent initiative
- Ownership and maintenance: property owners.

TIMING

- Plan amendment: 1994-99

- Development: depends on proponent initiative.

8.5 AGRICULTURAL LAND MANAGEMENT

8.5.1 FARM ENVIRONMENTAL/ CONSERVATION STRATEGIES

RECOMMENDED ACTION

Prepare environmental/conservation strategies for individual farm properties outside South East and Potter Creek Secondary Plan areas, where voluntarily agreed to by the owners.

APPROACH

MRCA and the Ministry of Agriculture, Food and Rural Affairs should establish a farm environmental/conservation program specific to the Potter Creek basin whereby the agencies would contact all farm owners to solicit their participation in the program. On the agreement of any farm owner, staff in cooperation with the owner would prepare a strategy that would:

- recommend feasible actions specific to that farm, to conserve agricultural resources, maintain or enhance productivity, and improve environmental conditions both on the farm and in Potter Creek;

- indicate the existing government programs that could provide technical and financial assistance in implementing these actions.

Further details on the kinds of actions that would be considered are provided in Section 7.2.5.

RESPONSIBILITY

- Coordination: MRCA, Ministry of Agriculture, Food and Rural Affairs

- Development, ownership, and maintenance: farm owners.

TIMING

- Program establishment: 1994-96

- Program use: depends on farm owner initiative.

8.6 EDUCATION

8.6.1 SUBWATERSHED RESIDENT INFORMATION/EDUCATION

RECOMMENDED ACTION

No new action specific to the Potter Creek basin is recommended. It is recommended that information and education needs in the basin be met through the continuing implementation of the appropriate recommendations of the Bay of Quinte Remedial Action Plan by the Plan partners across the Quinte watershed.

For further details, see Section 7.2.6.

APPENDIX A

REFERENCES AND ABBREVIATIONS

A.1 REFERENCES

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A.2 ABBREVIATIONS

m	metres
yr, yrs	years
cfs	cubic feet per second
m3/s, cms, m^3/s	cubic metres per second
km	kilometres
sq km, km2, km^2	square kilometres
Ref.	reference(s)
no.	number
CN	curve number (used in hydrology)
hr	hours
SWM	Storm Water Management
trib	tributary
CNR	Canadian National Railway
w/	with
CPR	Canadian Pacific Railway
pre	pre-development
post	post-development
m2/s, m^2/s	square metres per second
ha	hectares
m/s	metres per second
Lpm	litres per minute
gpm	gallons per minute
sq m, m2, m^2	square metres
Lpd	litres per day

Appendix B

Comments, Letters and Reviews