Court File No. CV-23-00001165-0000 (Chatham)

ONTARIO
SUPERIOR COURT OF JUSTICE

IN THE COURT OF THE DRAINAGE REFEREE

IN THE MATTER of the *Drainage Act*, R.S.O. 1990, Chapter D. 17

AND IN THE MATTER OF an application by the Corporation of the Municipality of Chatham-Kent for certain orders of the Drainage Referee with respect to construction of the Shaw Branch of the Facey East Drain and By-law No. 93-2021;

B E T W E E N:

CORPORATION OF THE MUNICIPALITY OF CHATHAM-KENT

Applicant

and

CANADIAN PACIFIC RAILWAY COMPANY

Respondent

APPLICATION pursuant to s.106 of the *Drainage Act*, R.S.O. 1990, c D.17

AFFIDAVIT OF SIDNEY VANDER VEEN

I, *Sidney Vander Veen, P. Eng*., of the Township of Mapleton in the County of Wellington, Ontario, MAKE OATH AND SAY:

1. I am a professional engineer licensed in the Province of Ontario and member of the Professional Engineers of Ontario in good standing. Since 2019, I have served as a consultant on drainage matters for R.J. Burnside & Associates, a professional engineering and environmental consulting company with offices across Ontario. From the beginning of 1991 until the end of 2018, I have served as Drainage Program Coordinator for the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA).

2. I have worked in drainage engineering for over 33 years and am familiar with the *Drainage Act* and its application to municipal drainage projects in the Province of Ontario.

3. During my career at OMAFRA, I was responsible for the provincial administration of the *Drainage Act,* the *Tile Drainage Act,* and the *Agricultural Tile Drainage Installation Act.* In this role, I administered the Agricultural Drainage Infrastructure Program, the program that provided grants towards activities performed under the *Drainage Act.* I was also responsible for the administration of the Tile Loan Program and the licensing of tile drainage contractors. I provided training under the *Drainage Act* and the *Tile Drainage Act* to municipal staff, and other agency staff from agencies such as conservation authorities, Fisheries and Oceans Canada, provincial government staff and railway staff. I have also presented on various drainage related topics at several different conferences and conventions. I am a co-author of Ontario Ministry of Agriculture Food & Rural Affairs Publication 852, "A Guide for Drainage Engineers Working under the Drainage Act in Ontario (Publication 852)." I am also a co-author of Publication 859 "A Guide for Drainage Superintendents working under the Drainage Act in Ontario" (Publication 859), Publication 29 "Drainage Guide for Ontario" (Publication 29) and the "Cropland Drainage Best Management Practices" book. Attached hereto as **Exhibit "A"** to this my Affidavit is a copy of Publication 852. Attached hereto as **Exhibit "B"** to this my Affidavit is a copy of Publication 29.

4. I was retained by the Corporation of the Municipality of Chatham-Kent (the "Municipality") to provide assistance to the Court of the Drainage Referee, in compliance with Rule 53 of the *Rules of Civil Procedure,* and as such, have knowledge of the matters hereinafter deposed to save and except where I have indicated that I have obtained facts from other sources, in which case I state the source of the information and I verily believe those facts to be true. Attached hereto as **Exhibit "C"** to this my Affidavit is a Form 53 executed by me. Attached hereto

and marked as **Exhibit "D"** to this my Affidavit is a copy of my CV. I practice in the field of Drainage Engineering and propose to be qualified as an expert in that field.

Overview of the *Drainage Act*

5. Ontario receives an abundance of precipitation that often results in drainage problems. To address this issue, provincial drainage legislation of some form has been in place in the Province of Ontario for more than a century. Most municipal drains were constructed to provide an outlet for the drainage of agricultural land and in many areas drainage of wet land was necessary for the land to be converted to productive acreage. Agricultural land is drained through a combination of surface and subsurface drainage systems. The benefits of agricultural land drainage are extensive including improved crop yields, reduced crop losses due to flooding, less soil compaction, reduced soil erosion and topsoil loss, increased growing season and more. But the improved productivity of agricultural land is dependent on municipal drains to provide an outlet for the private drainage systems. Municipal drains are also used to remove excess water from residential lands, commercial and industrial areas, and other properties, predominantly in rural areas of Ontario.

6. For more than a century Ontario's drainage legislation has fundamentally adopted a similar approach to the current *Drainage Act* to see drainage work constructed and maintained. In general, drainage statutes have contemplated a beneficiary-driven process where costs for the work are shared proportionate to benefits gained from the work.

7. In 1894, "The Municipal Drainage Act" was adopted, which operated to repeal and consolidate certain other provincial legislation dealing with municipal drainage, and to make certain amendments to other legislation, including the "Ditches and Watercourses Act".

8. By 1962-1963, several statutes were in place in Ontario concerning municipal drainage matters. Following provincial review of these various statutes in the early 1960s, these acts were consolidated, with most repealed, resulting in two major drainage statutes, being the "Drainage Act" and the "Tile Drainage Act".

9. The *Drainage Act* was amended in 1975 to introduce several new features into legislation, including the position of drainage superintendent, a technical appeal body called the Tribunal, and the provision of grants toward the municipal cost of employing a qualified drainage superintendent and toward the share of the cost of drain maintenance and repair work levied on land used for agriculture. This amendment also codified the special assessment on road and public utilities that had commonly been used. This special assessment is now known as Section 26 in the current *Drainage Act*.

10. Currently, the Province administers three pieces of drainage legislation, the *Drainage Act*, the *Tile Drainage Act*, and *The Agricultural Tile Drainage Installation Act*. The application in this matter before the Court of the Drainage Referee concerns drainage work to be undertaken under the *Drainage Act*.

11. Municipal drains created through the *Drainage Act* are unlike many other types of infrastructure as, typically, they are the result of one or more property owners petitioning their municipality for a solution to their drainage issues. This invokes the statutory process under the *Drainage Act* which includes multiple meetings, the development of an engineer's report recommending a solution and various appeal rights. It culminates in the passage of a by-law adopting the amended engineer's report before the drainage work is constructed. The result is a communally accepted project that resolves the drainage issues identified in the petition.

12. Additionally, unlike other infrastructure, municipal drains have unique legal existence as they are created by by-law enacted under the *Drainage Act.*

13. Throughout this history of drainage legislation in Ontario, drainage work has also been impacted by federal rail laws. Generally, railways are constructed on a raised bed that elevates the railway above the surrounding landscape. While railways provide crossings for the continuation of flow through watercourses, the raised railway beds act as artificial barriers to surface water flow from the neighbouring lands. For the balance of my career in drainage engineering, the Canadian *Railway Act,* R.S.C. 1985 squarely brought federally operated railways under the provisions of Ontario's drainage laws. Sections 211, 212 and 213 of the *Railway Act,* R.S.C. 1985 dealt with drainage matters, essentially providing that where a municipality or landowner desired to obtain means of drainage through, along, upon, across or under a railway, they could elect to proceed in accordance with applicable provincially legislated processes concerning the drainage matters, provided the railway had the option of constructing the portion of the drain required on railway lands.

14. This gave landowners the same right to cross railway lands as all other lands and provided that federal rail companies would bear the additional costs to the drainage project attributable to the construction and operation of the railway. Through the *Railway Act,* the Federal Government recognized municipal authority to apply provincial drainage legislation to all railway lands and crossings.

15. In my experience, this practice of cooperation concerning drainage work on railway lands has been in place between the Federal and Provincial governments going back through time. Both federal and provincial stakeholders explicitly considered the question of how provincial drainage

legislation and federal rail legislation should work in tandem through the 1974 Ontario Select Committee on Land Drainage. At that time, the Ontario Legislature appointed a Select Committee to review the law relating to land drainage and to prepare a report on land drainage in the Province of Ontario. The Report dealt in some detail with the question of the application of the *Drainage Act* to federal railways. The Report received submissions from federal railway companies including Canadian National Railway and Chesapeake and Ohio Railway. Attached hereto as **Exhibit "E"** to this my Affidavit is a copy of the resulting report, the "Final Report of the Select Committee on Land Drainage".

16. The Report noted that the Canadian Transport Commission had "assured the Committee, at that time, that the Commissioner will make every effort to ensure that railways cooperate with municipal councils and engineers in the construction of drainage works through railways. As a last resort, a formal application may be made to the Commission for approval of the crossing pursuant to the engineer's report". The Report's recommendation concerning railways was that "no change should be made in the present law respecting interprovincial railways, except that railways should be included within the definition of 'public utility'" within the *Drainage Act.*

17. The 1974 Committee concluded that artificial barriers to drainage programs, such as railways, should indeed bear the entire increase in the cost of constructing drainage works through such areas.

18. In my experience, following the repeal and replacement of the *Railway Act* through the consolidated *Transportation Act,* municipalities and federal railway have continued, until very recently, to operate in the same manner as under the *Railway Act.* Publication 852 was published in 2018. This Guide provides specific guidance on the application of section 26 of the *Drainage*

Act to roads and utilities (see pages 71-75 of the Guide). As part of the development of this Guide, a representative from the CN Railway was consulted and to my knowledge, a representative from CP Railway was also consulted. This resulted in the guidance provided on page 290 of the Guide. Effectively, in compliance with section 69 of the *Drainage Act*, municipalities would provide railways with the option to construct the section of drainage work on their right-of-way themselves and in compliance with section 26 of the *Drainage Act*, drainage engineers continue to consistently assess railways for the entire increase in cost of constructing a drainage works through a railway.

Shaw Branch of Facey Drain Engineer's Report

19. I have reviewed the engineer's report for the Shaw Branch of the Facey East Drain, authored by J. M. Spriet of Spriet Associates Limited, dated February 19, 2021. My comments that follow are derived from the content in the report only:

(a) The *Drainage Act* requires the engineer to design a solution to the drainage issue that was identified through the petition process. The engineer designed a pipe municipal drain that was designed to a 38 mm (1.5 in) drainage coefficient. This design standard is consistent with both Publication 852 (see page 181) and Publication 29 (see page 19). The engineer's report incorrectly references the "Design and Construction Guidelines for Work under the Drainage Act". This is no longer a published document; it has been replaced by Publication 852. However, the incorrect document reference has no bearing on the design outcome.

(b) The *Drainage Act* directs the engineer use the principles of the *Drainage Act* to distribute the cost of the proposed drainage project. Like any other property in the watershed of the proposed drain, the engineer has assessed the CP Railway for benefit and outlet liability. In addition, the engineer has also assessed the railway for a special assessment in accordance with section 26 of the *Drainage Act*. Because a crossing of the railway is required, Publication 852 recommends a four-step process to calculate a S. 26 assessment:

(i) Estimate the drainage project cost of crossing the railway right-of-way, as it currently exists.

(ii) Estimate the cost of crossing the railway right of way, assuming the railway did not exist.

(iii) Estimate the additional engineering and other costs (e.g. approvals, geotechnical studies, net HST etc.) associated with constructing a drain through a railway bed.

(iv) Calculate the estimated S. 26 assessment based on adding the costs in (i) and (iii) and deducting (ii).

20. In my opinion, this is the approach the engineer used in calculating the section 26 cost proposed to be assessed to the railway, as shown on page 5 of the engineer's report.

21. I make this affidavit for no improper purpose.

SWORN REMOTELY at the City of Chatham in the Municipality of Chatham-Kent, this the 2nd day of April 2024, in accordance with O. Reg. 431/20, Administering Oath or Declaration Remotely

Commission for Taking Affidavits

Lynn Kalp

Linda Marie Kalp, a Commissioner, etc. in the Province of Ontario, for the Corporation of the Municipality of Chatham-Kent, Expires August 31, 2026

SIDNEY VANDER VEEN

THIS IS EXHIBIT "A" REFERRED TO IN THE AFFIDAVIT OF SIDNEY VANDER VEEN, SWORN BEFORE ME AT THE CITY OF CHATHAM, MUNICIPALITY OF CHATHAM-KENT, PROVINCE OF ONTARIO ON THIS THE 2nd DAY OF APRIL 2024 IN ACCORDANCE WITH O. REG. 431/20, ADMINISTERING OATH OR DECLARATION REMOTELY.

Lynn Kalp

Digitally signed by Lynn Kalp
Date: 2024.04.02 13:51:58 -04'00'

A COMMISSIONER FOR TAKING AFFIDAVITS (or as may be)

Linda Marie Kalp, a Commissioner, etc.
Province of Ontario, for the
Municipality of Chatham-Kent.
Expires August 31, 2026.

A Guide for Engineers working under the DRAINAGE ACT IN ONTARIO

Publication 852

Ministry of Agriculture, Food and Rural Affairs

Ontario

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Food and Rural Affairs

Ontario

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Disclaimer

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Overview of the Guide

Providing engineering services in Ontario under the *Drainage Act, R.S.O 1990* (*Drainage Act, 1990*), as amended, is a complex task of balancing property owner needs, environmental and societal interests, regulatory compliance and protection of the municipal infrastructure. The guide is designed to help engineers navigate through these challenges and opportunities. **It is intended to assist but not regulate the engineer while practicing under the *Drainage Act, 1990.***

In order to work as an engineer, knowledge and understanding of the *Drainage Act, 1990* process, drainage system design and awareness of other legislation and how it impacts drainage design is essential.

The guide is presented in three sections:

- Part A addresses the application of the *Drainage Act, 1990* requirements.
- Part B addresses the technical design components of engineering reports.
- Part C addresses the other applicable regulations, policy and agency interests.

The engineer should always use experience, professional judgment and other available expertise when determining the proper design and construction approach to a drainage project so that it fulfills its intended purpose. A properly engineered and constructed system will provide the needed drainage at an affordable cost while considering drain maintenance and the environmental and societal values. It should also consider potential climate change impacts.

DID YOU KNOW? The Ontario Society of Professional Engineers (OSPE) Land Drainage Committee website (www.landdrainageengineers.com) contains many useful papers and presentations on various aspects of the *Drainage Act, 1990*.

Overview of the *Drainage Act, 1990*

The Province of Ontario's *Drainage Act, 1990*, (the Act) is Chapter D.17 of the *Revised Statutes of Ontario*, 1990 and is administered by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA).

Ontario annually receives an abundance of precipitation, which can result in drainage disputes. Until the *Drainage Act, 1990* was enacted, the only means of resolving these issues was by legal action through common law. These court decisions have established the following common-law drainage principles:

- The courts have defined different principles for water in a natural watercourse and surface water.
- A natural watercourse is a stream of water flowing in a channel with defined bed and banks that flows for sufficient time to give substantial existence (Figure 1). The following principles apply to natural watercourses:
  - Water in a natural watercourse must be allowed to flow.
  - Only a riparian property owner (an owner whose land abuts a natural watercourse) has the right of drainage.
  - Anyone who interferes with the flow of a natural watercourse could be held liable for damages that result either upstream or downstream.

No agency or person is responsible for the management of a natural watercourse.

Figure 1. A natural watercourse.

- Surface water is the flow of water not within a natural watercourse (Figure 2). The following principles apply to surface water:
  - Surface water has no right of drainage; the owner of a lower elevation property can protect their land from surface water by building a barrier to the flow.
  - As long as it is not collected, there is no liability for the flow of surface water.
  - Surface water becomes a liability once it is collected and discharged onto a lower property (Figure 3). To avoid liability, direct any collected surface water to a sufficient outlet (a location where it will do no damage to others).

Figure 2. Surface water flowing across a farm field.

Figure 3. Collected surface water.

Source: Tulloch Engineering, Espanola, Ontario.

These common-law principles continue to apply today. The *Drainage Act, 1990* was enacted to define a procedure that can override the common law and provide property owners with an opportunity to obtain a solution to their drainage problems through their local municipality.

The Act assigns the engineer a central role in the design and development of drainage works through the preparation of an engineer's report.

The Act defines a drainage works as follows:

> *"Drainage works" includes a drain constructed by any means, including the improving of a natural watercourse, and includes works necessary to regulate the water table or water level within or on any lands or to regulate the level of the waters of a drain, reservoir, lake or pond, and includes a dam, embankment, wall, protective works or any combination thereof. (Section 1)*

The local municipality is responsible for implementing the procedure, and costs are assessed to property owners within the watershed. The local municipality is also responsible for the management of the drainage works.

The *Drainage Act, 1990* authorizes the payment of grants for various activities performed under the Act. Specific details of these grants are provided in the Agricultural Drainage Infrastructure Program (ADIP).

The engineer should get a current version of the *Drainage Act, 1990,* its regulations and the OMAFRA ADIP policy. These documents are available at:

Drainage Act, 1990 and Regulations
www.e-laws.gov.on.ca

ADIP Policies
ontario.ca/drainage and search for "ADIP"

Overview of Engineering Services under the *Drainage Act, 1990*

The *Drainage Act, 1990* assigns specific responsibilities to the engineer. The engineer must integrate these responsibilities with technical design and regulatory requirements to develop an engineer's report.

> **DID YOU KNOW?** The *Drainage Act, 1990* defines "engineer" as follows:
> *"Engineer" means an engineer registered under the Professional Engineers Act or a surveyor registered under the Surveyors Act, or a partnership, association of persons or corporation that holds a certificate of authorization under the Professional Engineers Act or the Surveyors Act, as the case may be.* (Section 1)

An engineer practicing under the Act should:

- have a thorough knowledge of the Act and its application
- have technical knowledge of accepted and applied drainage design methods and practices
- review OMAFRA publications and policy with respect to drainage and the Act
- review applicable Ontario case law decisions and the Drainage Engineers' Conference proceedings
- be familiar with other provincial and federal statutes and regulations related to drainage
- be familiar with the common-law provisions related to drainage
- be aware of the effects and impacts of the construction and future maintenance of the drainage works
- use the procedural and policy requirements of the Act to address drainage issues while balancing the interests of the affected parties

The main activity of the engineer under the Act is the preparation of an engineering report for the construction, improvement or reassessment of a drainage works. The municipality may also ask the engineer to:

- assist in the processing of the report
- obtain permits and/or approvals for the construction work defined in the report
- supervise construction of the works
- certify the completion of the work

The *Drainage Act, 1990* specifies that the engineer shall be an independent arbiter between property owners, municipalities and regulatory agencies. Section 11 states:

> *Duties of the engineer The engineer shall, to the best of the engineer's skill, knowledge, judgment and ability, honestly and faithfully, and without fear of, favour to or prejudice against any person, perform the duty assigned to the engineer in connection with any drainage works and make a true report thereon.*

The engineer must not be bound by specific requests, as their unbiased judgment is always necessary.

Engineers may be requested to advise a property owner, a municipality and/or a regulatory agency of any matter related to the Act. They can provide advice on *Drainage Act, 1990* procedures but should be careful about providing legal opinions. Engineers have the opportunity to impress upon stakeholders the need for care while following all legislated and stated policy requirements.

The *Drainage Act, 1990* defines the mandatory process to develop and implement a drainage project. If the process of the Act is not followed in order, anyone involved in the project could challenge the legality of the work. There may be temptation or persuasion to deviate from the process, but the engineer needs to champion the requirements of the Act.

Acronyms

Provincial and Federal Ministries:

DFO - Fisheries and Oceans Canada

ECCC - Environment and Climate Change Canada

MMA - Ministry of Municipal Affairs

MNRF - Ministry of Natural Resources and Forestry

MOECC - Ministry of Environment and Climate Change

MTCS - Ministry of Tourism, Culture and Sport

MTO - Ministry of Transportation

OMAFRA - Ontario Ministry of Agriculture, Food and Rural Affairs

Provincial and Federal Acts:

CAA - Conservation Authorities Act

CEAA - Canadian Environmental Assessment Act

CWA - Clean Water Act

EPA - Environmental Protection Act

ESA - Endangered Species Act

FWCA - Fish and Wildlife Conservation Act

LRIA - Lakes and Rivers Improvement Act

MBCA - Migratory Birds Convention Act

NMA - Nutrient Management Act

NPA - Navigation Protection Act

NWPA - Navigable Waters Protection Act

OHA - Ontario Heritage Act

OWRA - Ontario Water Resources Act

PA - Planning Act

PLA - Public Lands Act

PPCRA - Provincial Parks and Conservation Reserves Act

PPS - Provincial Policy Statement

PTHIA - Public Transportation and Highway Improvement Act

SARA - Species At Risk Act

Other:

ADIP - Agricultural Drainage Infrastructure Program

CA - conservation authority

ECA - environmental compliance approval

IDF curve - intensity-duration-frequency curve

LID - Low Impact Development

OWES - Ontario Wetland Evaluation System

PSW - provincially significant wetlands

WASCoB - water and sediment control basin

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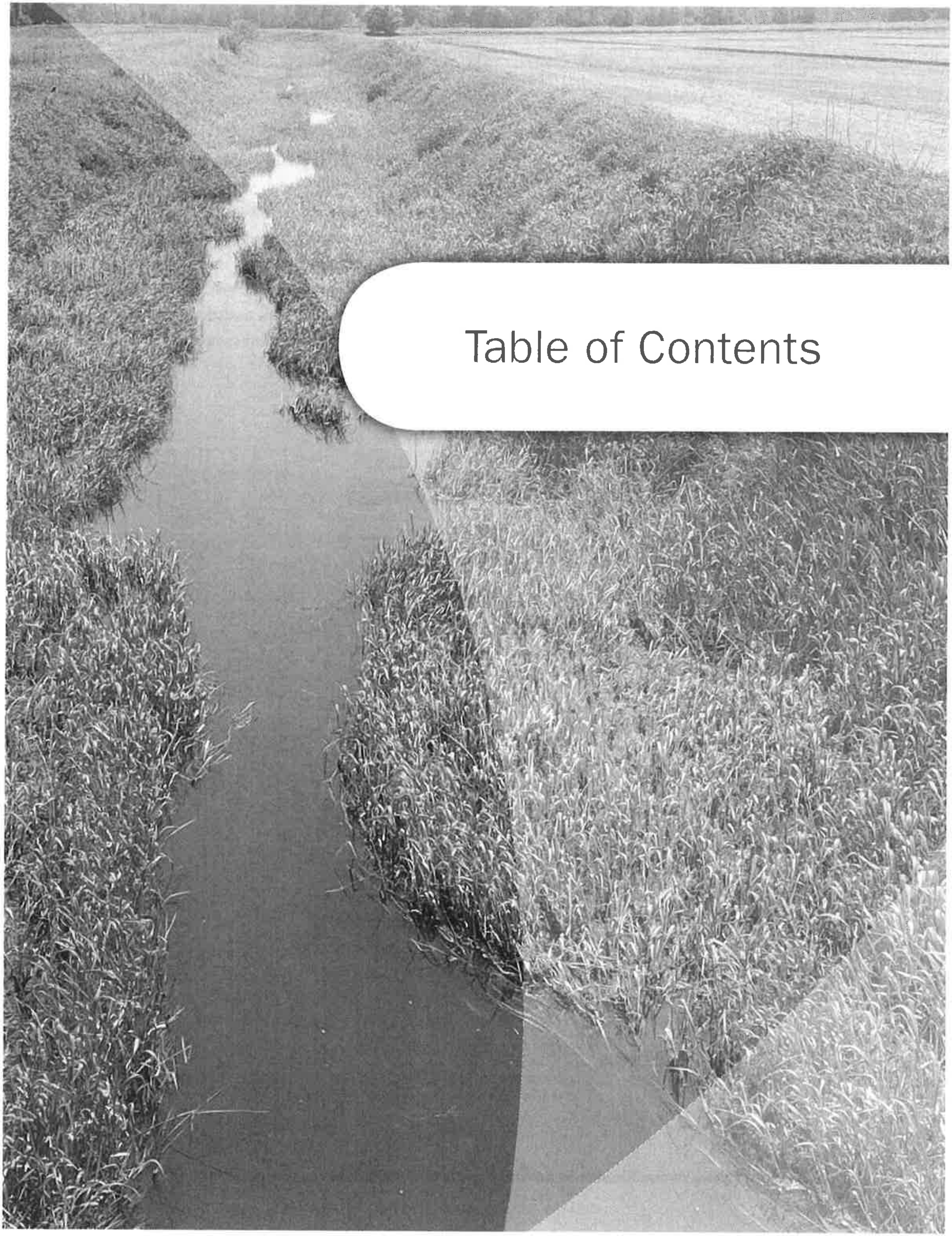

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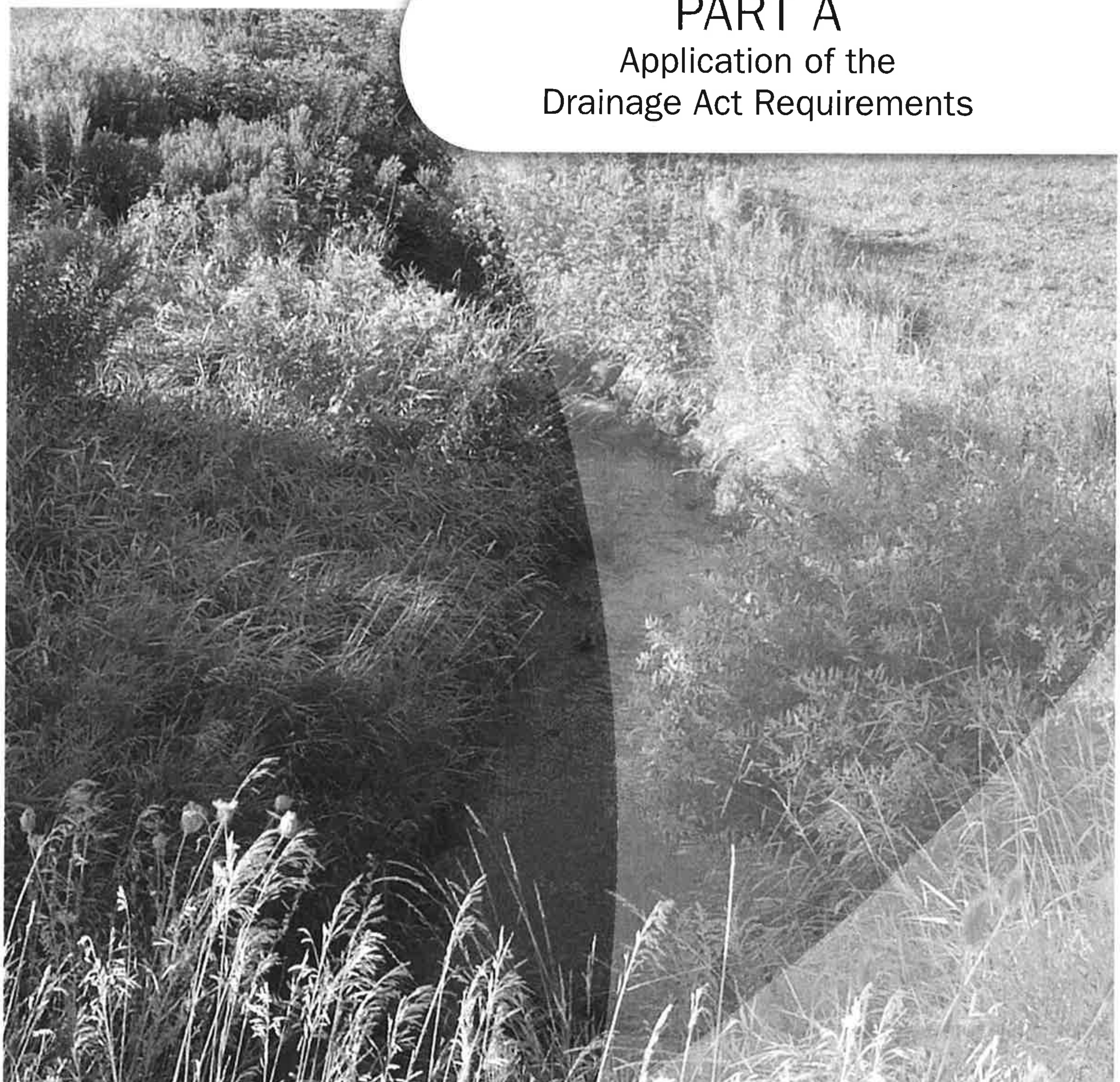
PART A
Application of the Drainage Act Requirements



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APPLICATION OF THE DRAINAGE ACT REQUIREMENTS

CHAPTER 1

INTRODUCTION

Part A provides a summary of the *Drainage Act, 1990* processes and requirements as shown in Figure A1–1. The chapters are arranged chronologically to address the tasks, in the order they are encountered, through project initiation, report preparation, calculation of allowances, cost estimates and assessments, processing the report, appeals and construction. The development and implementation of reports prepared for construction (Section 4) or improvements (Section 78) of a drainage system are covered in Chapters 2–12 (Figures A1–2 and A1–3). Chapters 13 and 14 address other services the engineer may provide. A case study is provided in Chapter 15, which includes details of the allowance and assessment process.

Throughout Part A, all section references pertain to the *Drainage Act, 1990,* unless otherwise identified. When a section reference is made, this means the action is mandated by the *Drainage Act, 1990.*

Drainage act process flow chart (high level)
Project initiation
Appointment of the engineer
Project scope meeting
On-site meeting
Preliminary report (optional)
Survey and site examination work
Final report
Meeting to consider final report
Appeals
Authorizing by-law
Construction
Project finalization

Figure A1–1. Drainage process flow chart (high level).

Petition drain procedure under the *Drainage Act, 1990* (Section 4)

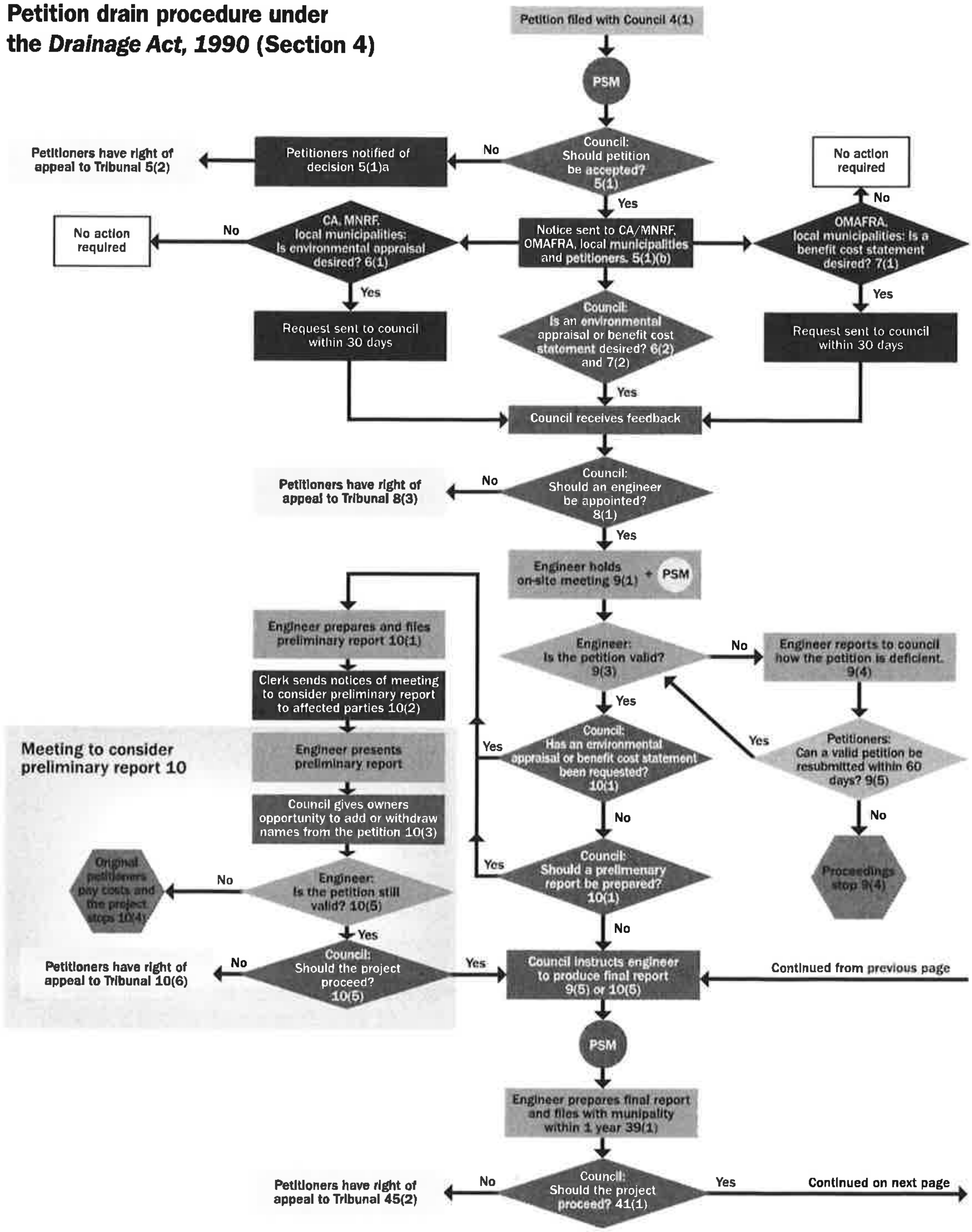


Figure A1–2. *Drainage Act, 1990* process, responsibilities and requirements under Section 4.

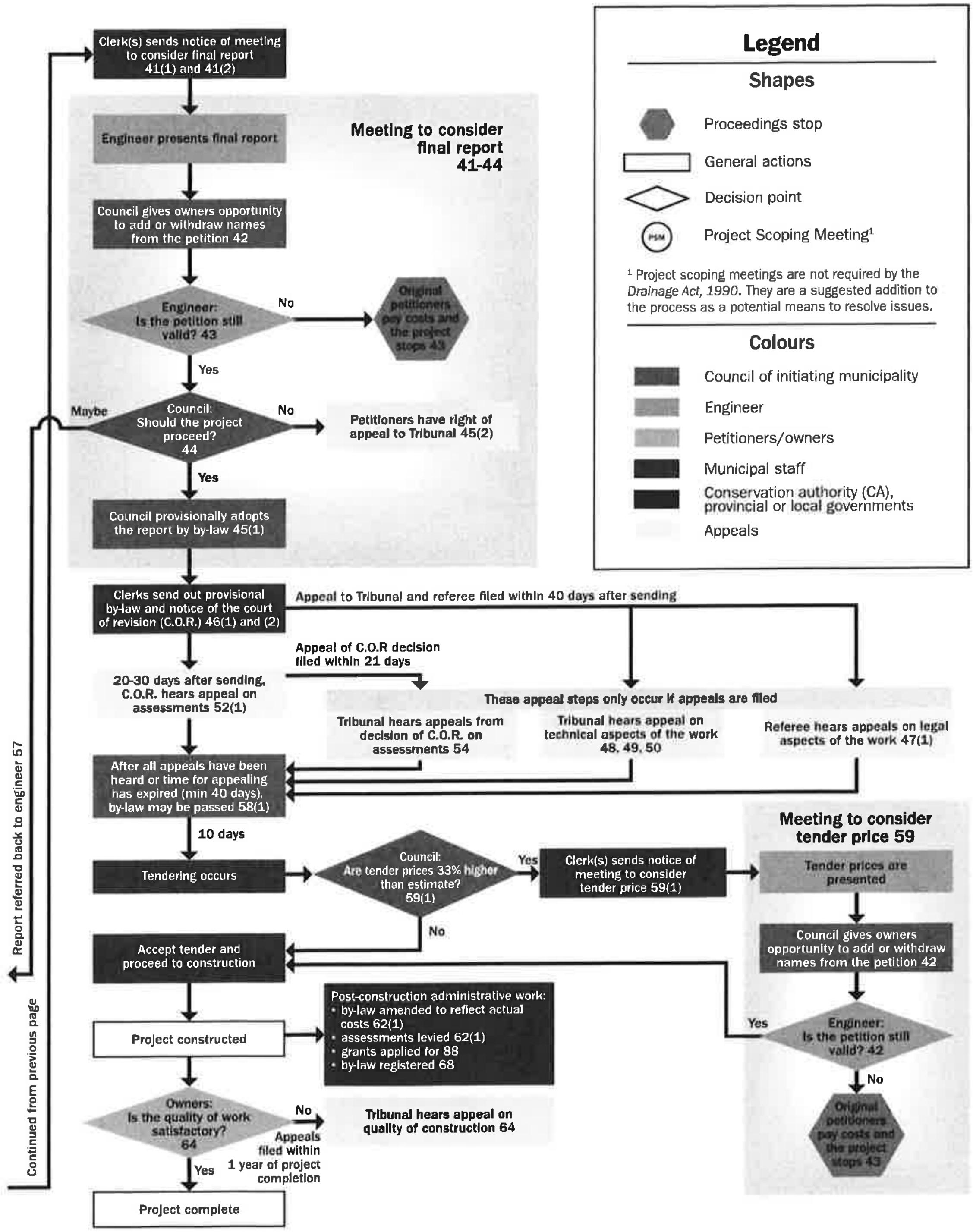


Figure A1–2. ***Drainage Act, 1990*** **process, responsibilities and requirements under Section 4.**

Drain improvement procedure under the *Drainage Act, 1990* (Section 78)

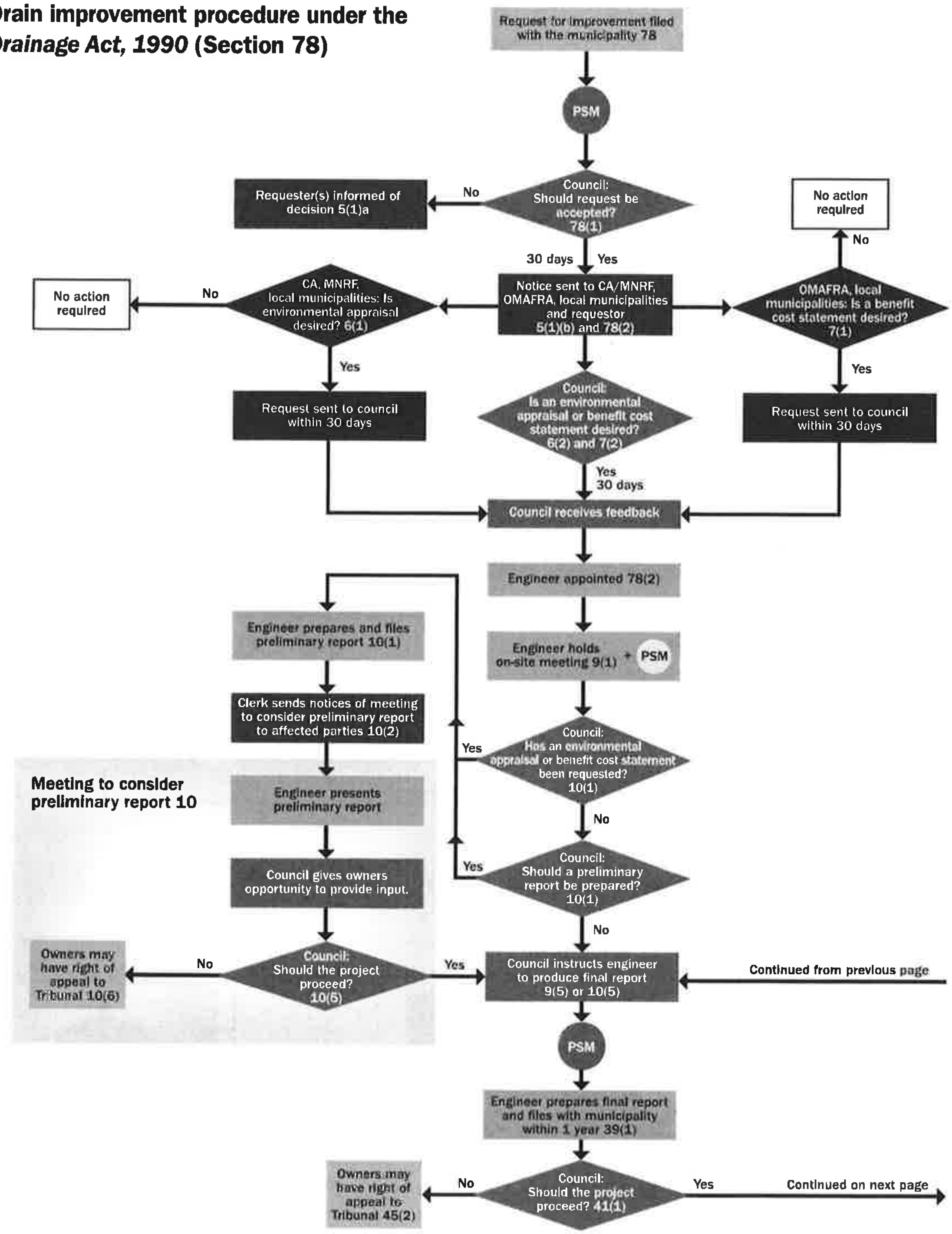


Figure A1–3. ***Drainage Act, 1990*** **process, responsibilities and requirements under Section 78.**

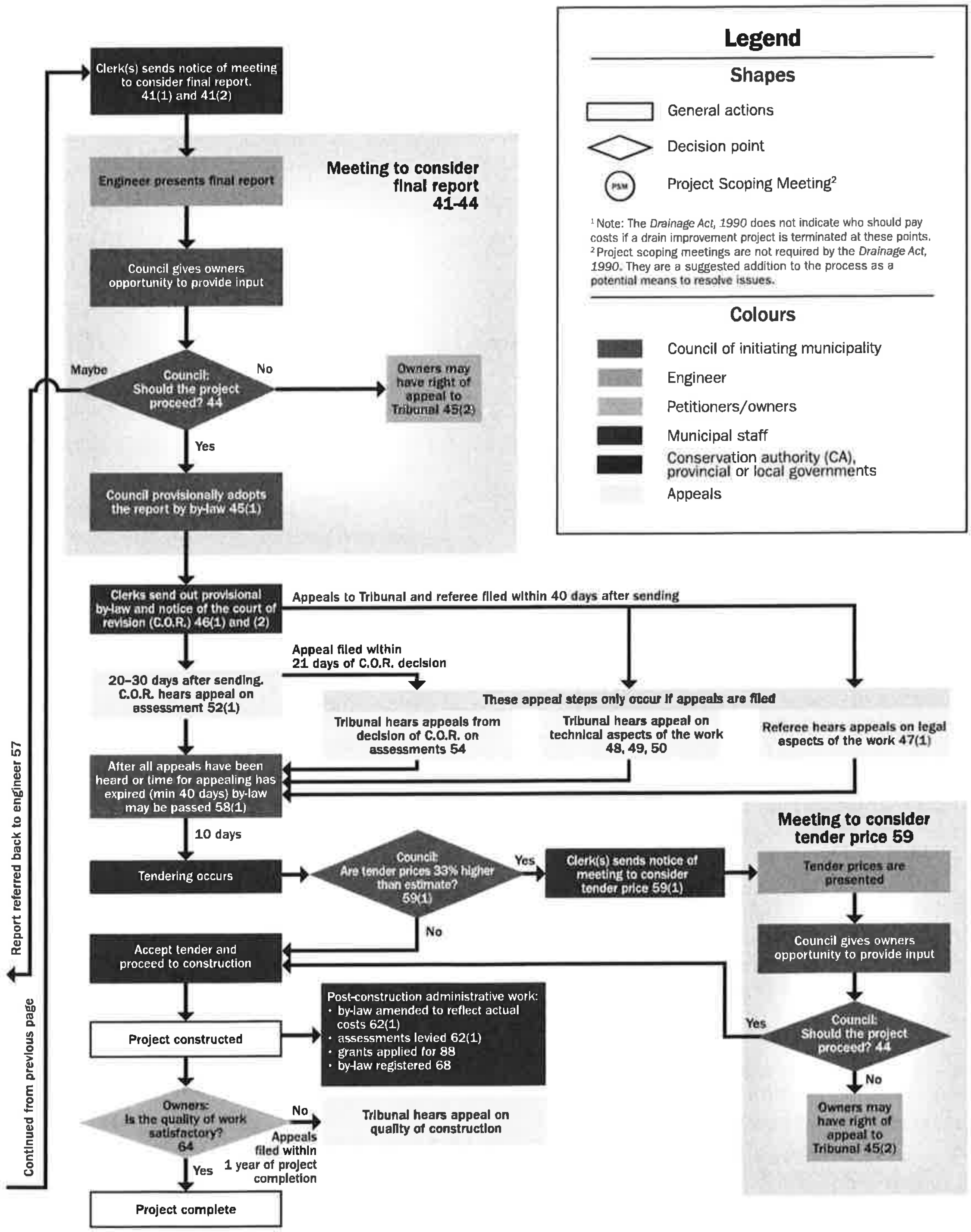


Figure A1–3. *Drainage Act, 1990* process, responsibilities and requirements under Section 78.

CHAPTER 2

APPOINTMENT OF THE ENGINEER

2.1 Introduction

Before the engineer gets involved with the construction (Section 4) or improvement (Section 78) of a drain under the *Drainage Act, 1990,* it is required that they are appointed by municipal council. The appointment to prepare a report must be by by-law or resolution (Section 8(1)).

2.2 Project Initiation

The resolution or by-law provides the appropriate authority to work on behalf of the municipality.

If an engineer is asked to work on a drainage project and there is no resolution or by-law appointing the engineer, request that one is passed before starting any work.

Obtain a copy of the appointing resolution or by-law and the petition (Section 4) or request for improvement (Section 78) from the municipal clerk's office. The original petition or request must remain with the clerk.

The petition is the legal document that initiates the *Drainage Act, 1990* process to design, construct and finance a drain across multiple properties. The form of petition is specified by regulation (Central Forms Repository, www.forms.ssb.gov.on.ca search for "petition drainage").

There are three types of petitions:

- Petition for Drainage Works by Owners — Form 1 (Figure A2–1)
    - This form is completed by the property owner(s) within an area requiring drainage.
- Petition for Drainage Works by Road Authority — Form 2
    - This form is completed by a road authority for a road requiring drainage.
- Petition for Drainage Works by Director — Form 3
    - This form is completed by the appointed Director of the Ontario Ministry of Agriculture, Food and Rural Affairs and can be used to initiate a drainage system for agricultural lands.

Determine if the form of petition used is acceptable prior to acting further on the appointment.

Ontario

Ministry of Agriculture, Food and Rural Affairs

Petition for Drainage Works by Owners
Form 1

Drainage Act, R.S.O. 1990, c. D.17, clause 4(1)(a) or (b)

This form is to be used to petition municipal council for a new drainage works under the *Drainage Act*. It is not to be used to request the improvement or modification of an existing drainage works under the *Drainage Act*.

To: The Council of the Corporation of the Township of North

The area of land described below requires drainage (provide a description of the properties or the portions of properties that require drainage improvements)

N½ Lot 3, Concession 5, North Township.
Lot 2, Concession 5, North Township

In accordance with section 9(2) of the *Drainage Act*, the description of the area requiring drainage will be confirmed or modified by an engineer at the on-site meeting.

As owners of land within the above described area requiring drainage, we hereby petition council under subsection 4(1) of the *Drainage Act* for a drainage works. In accordance with sections 10(4), 43 and 59(1) of the *Drainage Act*, if names are withdrawn from the petition to the point that it is no longer a valid petition, we acknowledge responsibility for costs.

Purpose of the Petition (To be completed by one of the petitioners. Please type/print)

Contact Person (Last Name)	(First Name)	Telephone Number
Smith	John	519-555-1214 ext.

Address

Road/Street Number	Road/Street Name
14138	Concession 5 Road

Location of Project

Lot	Concession	Municipality	Former Municipality (if applicable)
1-3	5	North Township	—

What work do you require? (Check all appropriate boxes)

- ☒ Construction of new open channel
- ☐ Construction of new tile drain
- ☐ Deepening or widening of existing watercourse (not currently a municipal drain)
- ☐ Enclosure of existing watercourse (not currently a municipal drain)
- ☐ Other (provide description ▼)

Name of watercourse (if known)
Webfoot Award Drain

Estimated length of project
4000 to 5000 feet

General description of soils in the area
Clay loam

What is the purpose of the proposed work? (Check appropriate box)

☐ Tile drainage only ☐ Surface water drainage only ☒ Both

Petition filed this 20th day of July, 2015

Figure A2–1.An example of a Petition for Drainage Works by Owners — Form 1.

Property Owners Signing The Petition Page 2 of 2

- Your municipal property tax bill will provide the property description and parcel roll number.
- In rural areas, the property description should be in the form of (part) lot and concession and civic address.
- In urban areas, the property description should be in the form of street address and lot and plan number if available.
- If you have more than two properties, please take copy(ies) of this page and continue to list them all.

Number | Property Description: Lot 2, Concession 5

Ward or Geographic Township: North Township | Parcel Roll Number: 0123-456-789-00000-0100

I hereby petition for drainage for the land described and acknowledge my financial obligations.

Ownership

☐ Sole Ownership

Owner Name (Last, First Name) (Type/Print)	Signature	Date (yyyy/mm/dd)

☒ Partnership (Each partner in the ownership of the property must sign the petition form)

Owner Name (Last, First Name) (Type/Print)	Signature	Date (yyyy/mm/dd)
Smith, John A	John Smith	2015/07/16
Smith, Jane W.	Jane Smith	2015/07/16

☐ Corporation (The individual with authority to bind the corporation must sign the petition)

Name of Signing Officer (Last, First Name) (Type/Print) | Signature

Name of Corporation

I have the authority to bind the Corporation.

Position Title | Date (yyyy/mm/dd)

Number | Property Description: N½ Lot 3, Concession 5

Ward or Geographic Township: North Township | Parcel Roll Number: 0123-456-789-0000-0200

I hereby petition for drainage for the land described and acknowledge my financial obligations.

Ownership

☐ Sole Ownership

Owner Name (Last, First Name) (Type/Print)	Signature	Date (yyyy/mm/dd)

☐ Partnership (Each partner in the ownership of the property must sign the petition form)

Owner Name (Last, First Name) (Type/Print)	Signature	Date (yyyy/mm/dd)

☒ Corporation (The individual with authority to bind the corporation must sign the petition)

Name of Signing Officer (Last, First Name) (Type/Print): Farmer, Ima | Signature: Ima Farmer

Name of Corporation: Fantastic Farms Inc.

I have the authority to bind the Corporation.

Position Title: President | Date (yyyy/mm/dd): 2015/07/18

☐ Check here if additional sheets are attached | Clerk initial

Petitioners become financially responsible as soon as they sign a petition.

- Once the petition is accepted by council, an engineer is appointed to respond to the petition. *Drainage Act*, R.S.O. 1990, c. D. 17 subs. 8(1).
- After the meeting to consider the preliminary report, if the petition does not comply with section 4, the project is terminated and the original petitioners are responsible in equal shares for the costs. *Drainage Act*, R.S.O. 1990, c. D. 17 subs. 10(4).
- After the meeting to consider the final report, if the petition does not comply with section 4, the project is terminated and the original petitioners are responsible for the costs in shares proportional to their assessment in the engineer's report. *Drainage Act*, R.S.O. 1990, c. D. 17 s. 43.
- If the project proceeds to completion, a share of the cost of the project will be assessed to the involved properties in relation to the assessment schedule in the engineer's report, as amended on appeal. *Drainage Act*, R.S.O. 1990, c. D. 17 s. 61.

Figure A2–1. An example of a Petition for Drainage Works by Owners — Form 1.

If the project is initiated by a request for improvement, review the *Notice of Request for Drain Improvement* to determine if the project is listed in Section 78(1.1) (Figure A2–2). If not, inform municipal council that the proposed work cannot proceed.

Notice of Request for Drain Improvement

Drainage Act, R.S.O. 1990,c. D.17, subs. 78(1)

To: The Council of the Corporation of the Township of North

Re: Fake Municipal Drain
(Name of Drain)

In accordance with section 78(1) of the *Drainage Act*, take notice that I/we, as owner(s) of land affected, request that the above mentioned drain be improved.

The work being requested is (check all appropriate boxes):

- [x] **Changing the course of the drainage works;**
- [ ] **Making a new outlet for the whole or any part of the drainage works;**
- [ ] **Constructing a tile drain under the bed of the whole or any part of the drainage works;**
- [ ] **Constructing, reconstructing or extending bridges or culverts;**
- [ ] **Constructing, reconstructing or extending embankments, walls, dykes, dams, reservoirs, pumping stations or other protective works in connection with the drainage works;**
- [ ] **Otherwise improving, extending to an outlet or altering the drainage works;**
- [ ] **Covering all or part of the drainage works; and/or**
- [ ] **Consolidating two or more drainage works.**

Provide a more specific description of the proposed drain improvement you are requesting:

Requesting the relocation of a 300 m section of the ditch municipal drain.

Property Owners:

- Your municipal property tax bill will provide the property description and parcel roll number.
- In rural areas, the property description should be in the form of (part) lot and concession and civic address.
- In urban areas, the property description should be in the form of street address and lot and plan number, if available.

Property Description	
N ½ Lot 3, Concession 5	
Ward or Geographic Township	Parcel Roll Number
North Township	0123-456-789-00000-0000

If property is owned in partnership, all partners must be listed. If property is owned by a corporation, list the corporation's name and the name and corporate position of the authorized officer. Only the owner(s) of the property may request a drain improvement.

0203E (2013/02) © Queen's Printer for Ontario, 2013 Disponible en français Page 1 of 2

Figure A2–2. An example of a Section 78 Notice of Request for Drain Improvement form.

Corporation

Corporate Ownership

Name of Signing Officer (Last Name, First Name) (Type/Print) Farmer, Ima	
Name of Corporation Fantastic Farms Inc.	Position Title President
Signature Ima Farmer I have the authority to bind the Corporation.	Date (yyyy/mm/dd) 2013/07/14

Enter the mailing address and primary contact information of property owner below:

Last Name Farmer		First Name Ima	Middle Initial —

Mailing Address

Unit Number —	Street/Road Number 3254	Street/Road Name Fake Sideroad	PO Box R.R. #1
City/Town Anywhere		Province Ontario	Postal Code NON-ONO
Telephone Number 555-555-5555	Cell Phone Number (Optional) —	Email Address (Optional) ima.farmer@nosupplier.ca	

To be completed by recipient municipality:

Notice filed this ______ day of ______________ 20 ____

Name of Clerk (Last Name, First Name)	Signature of Clerk

Ontario

0203E (2013/02)

Page 2 of 2

Figure A2–2. An example of a Section 78 Notice of Request for Drain Improvement form.

Notify the municipality of acceptance of the appointment:

- Within 10 days, notify the municipality of the name of the individual engineer who will lead the project (if the appointment is a corporation, association or partnership) (Section 8(2)).
- Should there be a change in the designated engineer, notify the municipality within 10 days of the change (Section 8(2)).

Review with the appropriate municipal representatives to determine if:

- Each petitioner, the clerk of any other municipality, the local conservation authority or the Ministry of Natural Resources and Forestry (MNRF) where no conservation authority exists has been notified within 30 days of the council's decision on the petition (Section 5(1)).
- A request for an environmental appraisal has been submitted by a local municipality, a conservation authority or the MNRF within 30 days of their notification by council (Section 6(1)).
- A Benefit cost statement has been requested by a local municipality or OMAFRA within 30 days of their notification by council (Section 7(1)).
- The initiating municipality has obtained or is requesting an environmental appraisal (Section 6(2)) or a benefit cost statement (Section 7(2)).
- The council waited for the expiration of the 30-day period after notifications were issued (Section 5 (1)), prior to appointing the engineer, to allow for responses. If they did not, the engineer is advised to wait for the expiration of the 30-day period before proceeding.
- For projects initiated under Section 78, confirm with the municipality that 30 days have lapsed since the municipality notified the local conservation authority of the council's decision to improve an existing drain (Section 78(2)). Do not initiate any engineering work if:
  - the local conservation authority has not been notified of the project
  - 30 days have not elapsed since the notification of the local conservation authority

The engineer should also advise the municipality to notify the local office of the MNRF.

- A project scoping meeting has already occurred. If it has, request the notes of the meeting. If a project scoping meeting has not happened, discuss with the municipality the option to hold a meeting before proceeding further (Part A, Chapter 3 Project Scoping Meeting).

Review with the appropriate municipal representatives to determine if council has provided any specific instructions to:

- make one report with respect to two or more petitions for drainage in adjoining areas (Section 8(4))
- assess as a block(s), one or more built-up areas in the watershed of the proposed drain
- prepare a preliminary report under Section 10 of the Act. The preliminary report is an optional step in the process, but it becomes mandatory if an environmental appraisal has been requested (Section 10(1)).

CHAPTER 3

PROJECT SCOPING MEETING

3.1 Introduction

The project notification gives property owners and other public agencies very basic information about the general location of the project. It is important for the engineer to proceed with the project by having a basic understanding of the problems of the property owners and the concerns of the affected agencies. Failing to do so can result in significant challenges in the development and acceptance of the engineer's report. The project can become controversial if issues are identified late in the development of the engineer's report. Strong reactions can result because of high costs, delays of the project or other issues.

While it is not required by the *Drainage Act, 1990,* consider having the municipality undertake a project scoping meeting to ensure that all of the issues have been identified early in the process. It provides an opportunity for the municipality, property owners, utilities and regulatory agencies to identify an effective and collaborative solution. If there is no project scoping meeting, collect information at the on-site meeting (Part A, Chapter 4).

3.2 Initiating a Project Scoping Meeting

Project scoping meetings are initiated by the municipality. The decision to initiate the meeting may be influenced by the engineer, environmental agencies, other authorities and property owners.

Consider holding a project scoping meeting for any of the following reasons:

- The construction of a drain is proposed in a regulated wetland.
- A proposed drain improvement project will modify an existing drain in a wetland.
- The project involves species at risk and/or their habitat.
- The project involves significant fish habitat.
- The project requires significant road authority, public utility and/or railway involvement.
- Conflicting urban or other municipal land uses are involved.
- The costs are expected to be large due to the size of the project.
- The project may affect or be affected by the provisions of the *Lakes and Rivers Improvement Act, 1990* (dams), *Heritage Act, 1990* (heritage sites) or other legislation.
- The project may be in an area of Indigenous interests.
- The project may be in an area where an archaeological study is required.
- The project involves other provinces.

The municipality may choose to conduct a project scoping meeting prior to the appointment of the engineer, without the engineer's involvement. If the meeting has taken place, the engineer should request the notes from the meeting.

The municipality may also involve the engineer by conducting the project scoping meeting after the appointment of the engineer. The engineer should confirm with the municipality their role at the meeting.

The engineer and the municipality may, where appropriate, choose to conduct a separate project scoping meeting or conduct it in conjunction with the mandatory on-site meeting as required by Section 9 of the Act. The advantage of combining both meetings is that all participants are brought to the site once, saving time and costs. The disadvantage to this approach is that the municipality and the engineer may not get the desired input from participants, due to the large number of attendees that may be at the on-site meeting.

3.3 Meeting Participants

The participants for a project scoping meeting are usually different than those invited to an on-site meeting. This is often a smaller group to encourage discussion. Meeting participants could include:

- municipal representatives (e.g., drainage superintendent, members of council)
- property owner representative(s) who are involved in the initiation of the petition or improvement request (e.g., contact person on the form)
- agency representation depending on the issue(s)
- utility representatives

In some cases, regulatory or other agencies may need to know the probable scope of the project in advance of their participation in a scoping meeting.

3.4 Running a Project Scoping Meeting

To run an effective project scoping meeting, consider the following:

- Create a general structure for the meeting (e.g., agenda).
- Designate an individual to take minutes.
- Clarify the current issue, intended scope of the meeting and a general overview of the *Drainage Act, 1990* process.
- Establish reasonable goals at the beginning of the meeting for all participants.
- Establish ground rules for the discussion and input.
- Introduce meeting participants.

At the meeting:

- Have participants share all available information (e.g., maps, plans, studies, history) for the area.
- Ask the property owner(s) and/or municipal representative(s) to identify the issues and interests.
- Ask resource agencies and public agencies to identify interests and legislative requirements.
- Scope out potential options for resolving the drainage problem, and for each option identify the agency concerns and legislative requirements.
- Establish the next steps for after the meeting.

3.5 Meeting Outcomes

Based on the discussion and information gathered, the meeting may result in one of the following outcomes:

- The project proceeds with the development of a final report.
- The council instructs the engineer to prepare a Benefit cost statement or an environmental appraisal.
- The council instructs the engineer to prepare a preliminary report to more thoroughly investigate options.
- The council recommends to the property owners or to the road authority that they withdraw their petition (Section 4).
- The council decides to withdraw acceptance of the petition (Section 4) or terminates the drain improvement project (Section 78).

If the project proceeds, the agencies may identify studies that are required to get legislative approvals and develop terms of reference and associated timelines. In consultation with the municipality, determine if the complexity of the project justifies continuing the project scoping meeting as a project steering committee.

DID YOU KNOW? OMAFRA has a series of factsheets on the topic of running effective meetings (ontario.ca/omafra search for "Effective Organizations").

CHAPTER 4

ON-SITE MEETING

4.1 Introduction

The *Drainage Act, 1990* requires that an on-site meeting be held for all construction (Section 4) and/or improvement (Section 78) projects (Section 9) (Figure A4–1). There are two main purposes for the meeting:

- to provide a forum for property owners and agencies to present the goals, objectives and constraints of the drainage project to the engineer
- to confirm the authority
  - of a drainage project initiated by petition (Section 4), the engineer must define the area requiring drainage and evaluate the validity of the petition
  - of a drainage improvement project (Section 78(1.1)), the engineer must verify that the proposed improvement to an existing drain is authorized

Figure A4–1. Conducting an on-site meeting

4.2 Notification of an On-Site Meeting (Section 9(1))

Take the following steps in advance of the on-site meeting, to prepare the meeting notification.

a) Get the municipal assessment roll and parcel map data for:
   - the area requiring drainage identified by the petition and for neighbouring properties, in the case of a drainage project initiated by petition (Section 4)
   - the properties affected by the proposed drain improvement project, in the case of a drainage improvement project (Section 78) (usually all properties in the watershed are shown in a previous drainage report)

b) For each property, compare the names of the owners on the petition to the names of the owners listed on the assessment roll. Verify that property owners' names on the petition accurately represent the property ownership (Section 4).

c) Prepare a list of persons invited to attend the on-site meeting and submit it to the municipal clerk. This should include:
   - owners of properties in the area that requires drainage, as described by the petition (Section 4), or of properties affected by the proposed drain improvement project (Section 78)

- public utilities that may be affected by the proposed project
- agencies that may be affected by the proposed project
- upstream and downstream owners that the engineer believes may be affected by the project
- the drainage superintendent, to assist in liaising with the property owners

Consider inviting members of the council and the road superintendent to attend the meeting.

d) In consultation with the municipality, select a date and time for the on-site meeting, ensuring that the date allows for a minimum of seven (7) days' advance notice.

e) Select a location for the site meeting that is in the vicinity of the proposed drainage project and that can safely host a group and their vehicles.

f) Confirm the clerk has prepared and sent out the on-site meeting notice, in the form prescribed in O. Reg. 381(3). Go to the Central Forms Repository (www.forms.ssb.gov.on.ca) and search for "notice of on-site meeting for construction."

4.3 Preparing for the On-Site Meeting (Section 9(2))

The following is a list of activities to consider prior to conducting a productive on-site meeting.

- Obtain and review the following information:
  - the most recent aerial photography
  - topographical mapping
  - the municipality's drainage map
  - area soils data and geotechnical studies
  - other drainage reports, land use planning documents and/or transportation studies
  - existing drain reports and/or by-laws in the area
  - information from an earlier project scoping meeting
- Conduct a windshield inspection to look at physical features in the watershed (Figure A4–2).

Figure A4–2. A windshield survey with a map on the dashboard.

Source: Owen Brook, Guelph, Ontario.

- Prepare a sketch or use an aerial map to show:
  - the potential areas to be drained, as identified on the petition, or the area requiring improvement, as identified on the improvement request
  - total watershed area and affected adjacent lands
  - property parcels with names of affected owners
  - existing drains (e.g., municipal, private, award, mutual agreement) in the area
  - wetlands and other sensitive features
  - public utilities
- Get local background information from the municipality's drainage superintendent about the watershed.
- Consult with regulatory agencies on potential requirements from other legislation (Part C), especially if it pertains to wetlands (Part B, Chapter 8 Wetlands and Water Retention).
- Consult with the road authorities and/or public utilities.

DID YOU KNOW?
The Agricultural Information Atlas (AgMaps) can be used to develop a preliminary plan or sketch of the area that includes property boundaries, the location of existing drains, topography, soil types, etc. (go to ontario.ca/drainage and select the link for AgMaps).

4.4 Conducting the On-Site Meeting

This section applies to on-site meetings for both the construction (Section 4) and the improvement (Section 78) of a drain.

Arrive early at the selected on-site meeting location. Decide whether the site conditions are appropriate for conducting the meeting or whether it is necessary to move to a backup site. If relocation occurs, ensure notices are left at the selected site to direct late arrivals to the new location.

Start the meeting by:

- introducing all participants and determining their connection to the project
- circulating a sign-in sheet
- providing or describing the agenda
- providing a sketch or map of the area
- informing everyone that all comments and questions should be directed to the engineer
- advising that notes will be taken

DID YOU KNOW? It is important to take notes to capture the wide variety of information and opinions conveyed at the meeting. It also provides assurance to all participants that their contributions have been heard and recorded.

The participants may have various levels of understanding of the *Drainage Act, 1990.* It is important to provide:

- information on how the project was initiated
- an overview of the Drainage Act,1990 procedures
- a description of the engineer's legal obligations and authority
- the purpose of the on-site meeting
- a description of the steps that will occur after the meeting
- information on available grants for the project, provided their property is assessed at the Farm Property Class Tax Rate (ontario.ca/omafra search for "Farm Property Class Tax Rate Program")

Provide a forum for property owners and agencies to discuss the goals and objectives of the project. Encourage each participant to describe and identify:

- existing drainage systems, including outlets from inside and outside the watershed
- area flooding, drainage and erosion problems
- soil conditions
- proposed drainage needs, including any planned agricultural tile drainage systems
- existing culverts/bridges, including any deficiencies
- options for drain location and type
- any private or municipal drainage systems to be abandoned/removed
- private land activities that have benefit to the drainage system (e.g., WASCoB, outlet controls, low-impact development, wind breaks, cover crops, buffers, grassed waterways)
- construction timing considerations (e.g., crops, fisheries, endangered species, etc.)
- construction techniques, including possible access routes, staging areas, clearing methods, brush disposal, management of the excavated materials
- agencies' concerns, including roads, utilities and environmental attributes
- drainage superintendent needs for future management of the drain

Encourage owners of property in the area requiring drainage that have not signed the petition to provide input. If they wish to extend the drainage system to their property, advise them that they are required to sign the petition. The engineer may be required to establish the requirements for a petition to comply with Section 4 (Section 9(2)).

Encourage owners of property located outside of the area requiring drainage to provide input. If they wish to extend the drainage system to their property, advise them to sign a new petition. The municipality is able to instruct the engineer to prepare one report for two or more petitions (Section 8(4)).

The engineer may be asked for a cost estimate of the proposed drain. Since no design and cost estimation has been performed at this point, do not provide an estimate. If the costs of comparable past projects are available, consider describing them.

The outcome of the on-site meeting should provide the engineer with the information to:

- determine if there is authority to proceed with the project (i.e., there is a valid petition under Section 4 or the project is within the scope of work listed in Section 78(1.1))
- identify if there is a need to have a project scoping meeting due to unforeseen complexities
- decide whether a preliminary report to examine different options for a drainage system should be recommended to council (Section 10(1))
- facilitate the survey and design of the project
- identify required approvals

If additional work is required to determine if there is authority for the project to proceed, the engineer may wish to adjourn and reconvene the meeting once further reviews are completed.

DID YOU KNOW? Differing opinions about the benefits of the project and assessment of costs may lead to the meeting becoming contentious. It may be more beneficial to adjourn and reconvene the meeting at a later date if the gathering becomes confrontational.

The engineer should always consider if the cost of the work requested is justified. Where the engineer has concerns that the work requested may have costs greater than the possible benefits, record that in the notes for follow-up after the meeting.

At the end of the meeting, consider touring the anticipated project site and inviting those interested to participate (Figure A4–3). The purpose is to observe or verify the information obtained during the on-site meeting and to allow the engineer to become familiar with the watershed.

Figure A4–3. Engineer touring meeting participants at the site.

After the meeting, it is a good practice to contact any owners or agencies that did not attend the on-site meeting.

4.5 Authority for Drain Improvements (Section 78)

There are a variety of improvements that may be proposed for an existing drain, but not all of these are authorized. The engineer must verify that the authority to undertake the proposed improvement to the drain exists under Section 78(1.1). Some examples of common authorized improvements include:

- addition of a crossing
- increasing the capacity of an existing drain
- relocating an existing drain
- enclosing an existing drain
- wetland restoration

Works that are considered to be more than improvements to an existing drain and are not authorized include:

- the extension of an existing drain upstream
- the addition of a new branch to an existing drain

In these situations, the engineer will have to consider if the project should have been initiated by a petition (Section 4).

4.6 Area Requiring Drainage and the Validity of the Petition (Section 4)

The petition is the legal document that initiates the *Drainage Act, 1990* process to design, construct and finance a drain across multiple properties. Property owners can challenge the validity of a petition to the referee (Section 47(1)). The validity of the petition is the most significant determination that an engineer makes for a drainage works initiated by petition.

Section 4(1) establishes four criteria for the engineer to evaluate the validity of the petition. In order for a petition to be valid, it must contain signatures from one of the following:

- the majority in number of owners in the area requiring drainage
- the owners representing at least 60% of the area requiring drainage
- the road authority, where a road requires drainage
- the Director, where drainage is required for agricultural land

A petition must be submitted on one of the three forms referenced in O. Reg. 381/12 of the *Drainage Act, 1990:*

- Petition for Drainage Works by Owners — Form 1
- Petition for Drainage Works by Road Authority — Form 2
- Petition for Drainage Works by Director — Form 3

DID YOU KNOW?
The determination of the validity of the petition has been a major cause of appeals to the referee. Guidance in making this determination is found by reviewing referee and appeal court decisions that relate to the validity of the petition.

The engineer should create a map showing all property boundaries and roads within the area requiring drainage and keep it on file. The map should identify:

- property boundaries, area and ownership
- for a Form 1 petition, properties (including roads) that are legally bound by the signatures
- for a Form 2 petition, properties for the signing road authority

4.6.1 Petition for Drainage Works by Owners

The petition by owners is submitted under Section 4(1)(a) or (b). To evaluate the validity of the petition, the engineer must conduct three steps.

1. The *Drainage Act, 1990* does not provide a definition of the area requiring drainage or a defined process for determining that area. The engineer must be satisfied there is an area that requires drainage. Rely on the following items to establish the boundaries of the area requiring drainage:
    - area requiring drainage as described on the petition
    - input received by the petitioners and other participants at the on-site meeting
    - visual observations of the area including topography, land use, physical features and drainage features
    - topographical mapping and other maps gathered in advance of the on-site meeting
    - guidance provided by referee or appeal court decisions
2. Once the engineer has determined the area requiring drainage, the next step is to **verify the signatures of the petitioners.**

Confirm that:

- the required form of petition was used
- municipal staff have verified the owners of the petitioning properties against the assessment roll and the Land Registry Office (Section 4(4))
- each property listed has the proper signatures

Consider the definition of "owner" (Section 1). To legally bind a property to a petition:

- All joint owners of any property must sign for the property (Section 4(5)).
- In the case of property owned by a corporation, an individual who has signing authority for the corporation must sign for the property. The form of petition (Regulation 381/12) allows an individual with signing authority to identify this designation below the area for the signature.
- In the case of land owned by a partnership, all partners must sign.
- An estate is one owner, regardless of the number of executors, and the estate's signing authority has signed the petition.
- A power of attorney is required for one person to sign for another.

DID YOU KNOW? If a petitioner sells their property to another owner, the original owner's signature continues to bind the property (and the new owners) for the purposes of the petition.

3. There are two ways to **determine the validity of the petition:**

   a) Evaluate the percentage of owners (Section 4(1)(a)) (Figure A4–4), as follows:

      - Count the total number of properties and road jurisdictions within the area requiring drainage (A).
      - Count the number of properties and road jurisdictions within the area requiring drainage who have properly signed the petition (B).
      - Calculate the percentage of owners and road jurisdictions who have properly signed the petition (C = B/A x 100%).

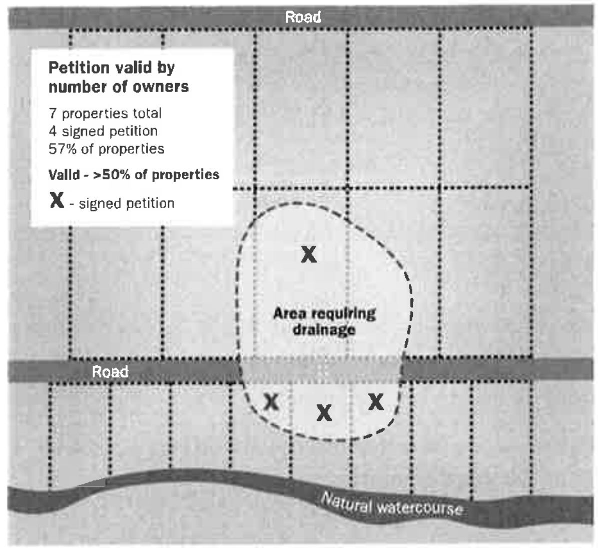


Figure A4–4. Determining the validity of a petition by percentage of owners.

A petition is valid when the percentage (C) is greater than 50%.

Determining the number of legally bound properties in an area requiring drainage can be complicated. Some common situations may include:

- multiple properties owned by one owner
- a property owned by one owner and another property owned by the same owner in a partnership
- more than one road owned by a single municipality

   b) Evaluate the percentage of area (Section 4(1)(b)) (Figure A4–5), as follows:

      - Calculate the total area in acres or hectares of the area requiring drainage (A).
      - Calculate the total affected area of the properties with owners that have properly signed the petition (B).
      - Determine the percentage of area requiring drainage represented by the owners who have properly signed the petition (C = B/A x 100%).

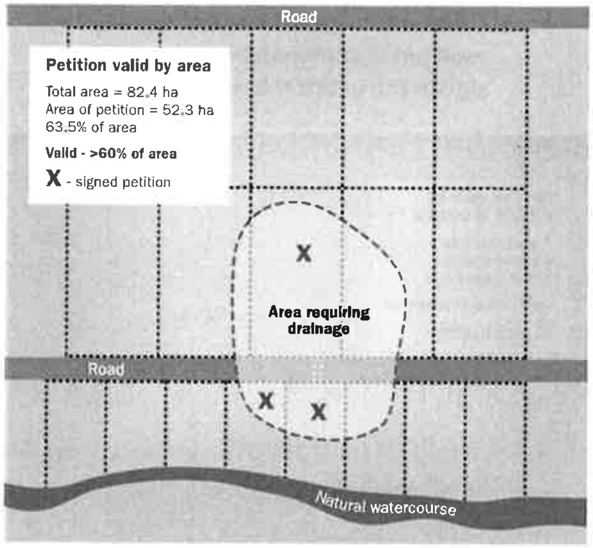


Figure A4–5. Determining the validity of a petition by percentage of area.

A petition is valid when the percentage (C) is greater than 60%.

4.6.2 Petition for Drainage Works by Road Authority

There is no need to define the area requiring drainage to determine the validity of a petition submitted by a road authority (Figure A4–6). The petition is valid under Section 4(1)(c) provided the engineer is satisfied that:

- the petition is signed by the person who has the authority to represent the road
- the drainage works is required to provide drainage for the road described in the petition

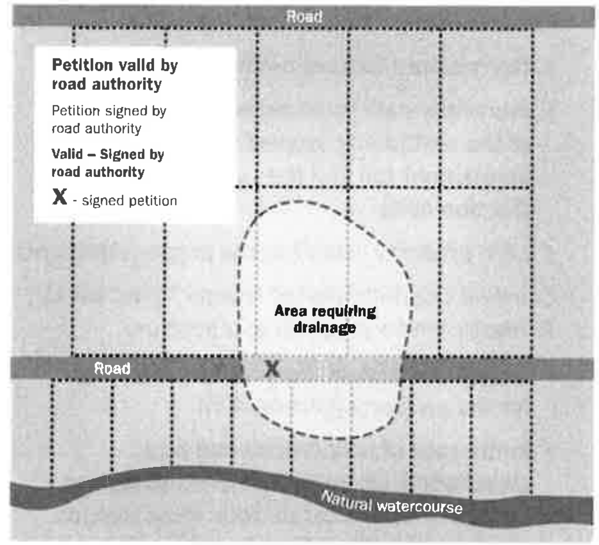


Figure A4–6. Determining the validity of a petition by road authority.

Examples of when a road authority petition is valid are when a road is experiencing flooding or when there is a need for an improved downstream outlet.

4.6.3 Petition for Drainage Works by Director

The Minister of Agriculture, Food and Rural Affairs appoints a Director for the purposes of the *Drainage Act, 1990* (Section 91). When a petition is submitted by the Director, there is no need to define the area requiring drainage to determine the validity of a petition. The petition is valid under Section 4(1)(d) provided the engineer is satisfied that:

- the petition is signed by the person designated as the Director (Section 91) of the Drainage Act, 1990
- the drainage works is required to provide drainage for the agricultural land described in the petition

4.6.4 Petition Is Valid

The engineer should state that the petition is valid at the on-site meeting (Section 9(2)) and also notify the council. Proceed with the preparation of the preliminary or final report as instructed by the council.

4.6.5 Petition Is Not Valid

The engineer should state that the petition is not valid at the on-site meeting (Section 9(2)) and establish the requirements for a petition that will comply (Section 9(2)(c)).

After the on-site meeting, the engineer must report to the council (Section 9(4)) stating:

- the petition is not valid
- how the petition is deficient
- the requirements for the petition to comply
- the amount of engineering fees incurred to date and how the fees are to be paid

In stating that the petition is deficient, the engineer can advise whether a new petition is required or whether additional names are required on the existing petition.

The council should send a copy of the engineer's Section 9(4) report to each petitioner. The petitioners can:

- decide not to modify the petition, thereby terminating the project; or
- challenge the engineer's decision about the validity of the petition through an appeal to the referee (Section 106(1)(b)); or
- submit a new or updated petition within 60 days of the engineer's report to the council (Section 9(5)).

If a new or updated petition is submitted, the engineer will verify that any new or updated petition complies with Section 4. If it complies, proceed with the preparation of the preliminary or final report as instructed by the council, with the engineering fees incurred to date included as part of the project costs.

4.7 Case Law Related to the Validity of the Petition

Guidance for determining the area requiring drainage and the validity of the petition is provided through case law. These decisions are found on the website of the Canadian Legal Information Institute (www.canlii.org/en/on/ondr).

There are various considerations to think through when determining the area requiring drainage and the validity of the petition. The following quotes taken from various referee and appeal court decisions can provide guidance to the engineer. They are listed from the oldest to the most recent decision.

Note that before 1975, the municipality determined the validity of the petition. With the amendments made to the *Drainage Act* in 1975, this responsibility was assigned to the engineer.

1. **Duane vs. Township of Finch, Referee G. Henderson, 1908**

   "Since that amendment it is no longer necessary that the petition should be signed by a majority of the owners whose lands are found to be benefited by the engineer who makes the report, but it is still necessary, as it always was necessary, that the petition should describe a real drainage area, which should bear some reasonable proportion to the size and extent of the drainage scheme ..."

   "It is the intention of the Act that the township council should pass judgment upon the sufficiency of the area described in the petition, and should see to it that the area is therein fairly described. When a township council does really and fairly exercise judgment upon such a matter, I think I should be loath to review their exercise of judgment ... What I wish to point out very plainly is that it is not proper to pick out any portion or portions of what is in fact a distinct basin requiring drainage. Subject to the discretion of the township council, the majority are to rule, but they must constitute a real majority, and in no case should the council permit the provisions of the Act to be abused by allowing a real minority to impose upon an actual majority."

2. **Township of South Easthope vs. Township of East Zorra, 1944**

   "The engineer in the course of doing his work thought the drainage area should be enlarged, and properly reported that fact to the council; the council thereupon instructed the clerk to add to the petition that had already been signed certain lands that were not in the drainage area as described in the petition when it was signed, and having made this unauthorized alteration in the petition they proceeded to again instruct the engineer to report on the enlarged scheme. That was all absolutely unwarranted. They had spoiled the only petition they had, and the engineer was proceeding really without any authority, just as the council was. This is a matter that goes to the basis of the whole proceeding, and the whole proceeding falls to pieces."

3. **McDougal vs. Township of Harwich, Ontario Appeal Court, 1945**

"I think the township council were justified in approving the sufficiency of the petition as presented. It was reasonable for them to conclude that the lands described in the petition presented might fairly be said to constitute a real drainage area. The fact that the engineer subsequently thought that the proposed drain should be taken to an outlet different from that apparently contemplated by the petitioners, and that he assessed for benefit some lands in addition to those described in the petition, was not fatal to the sufficiency of the petition."

4. **McKeen vs. Township of East Williams, Referee S. Clunis, 1966**

"The Drainage Act contemplates the work of improving natural watercourses, the construction of dykes, the removal of water by pumps and the protection of shorelines by seawalls and jetties. If, therefore, one keeps in mind this variety of artificial works which may be undertaken within the scope of the Act, I think it is possible to define the term 'drainage area' as it is used in the Act. I believe it may be said that a drainage area is a compact tract of land bounded by a ridge or surface barrier which tract could secure some relief from flooding or some lowering of its natural water table if an artificial drainage work were constructed in or near it."

"As a general proposition of law, it cannot be said that under no circumstance may a petition be valid if it describes more than one drainage area as the land requiring to be drained. But, it would be unusual; indeed, if a petition describing two areas were permitted to stand if it did not contain the signatures of the majority of the eligible petitioners in each of the drainage areas described."

"...the Act does not authorize a municipality to pass a by-law for the construction of a drainage system which differs substantially in size and cost from the drain petitioned for because such a by-law is in effect based upon no petition at all..."

"In this connection, it seems to me to be a necessary corollary of this principle that if a sufficiently signed petition which describes a drainage area is filed, it is not to be taken as authority to proceed with any drainage work that may seem desirable in the general area of which the petitioning area is only a part."

"It must be kept in mind ... that the Act does not contemplate that every landowner in a drainage scheme is entitled to expect perfect drainage. It does contemplate that every landowner who is assessed will secure improved drainage."

5. **Ingersoll Golf Course vs. Township of South-West Oxford, Referee J. McMahon, 1977**

"In defining an area to be drained in a petition, absolute certainty is in most instances impossible. An adequate definition of a drainage area in most instances is not possible until the report of the engineer is prepared since it is dependent upon the topography and the variation of ground levels. In essence, the initial area set forth on the petition may increase or decrease, dependent upon the professional determination of the engineer."

"The last submission ... was that the area was 'artificially' created. Whether or not any specific area is a drainage area within the meaning of the Act is a question of both fact and law. One must distinguish between a drainage area and a drainage problem. In most recent drainage cases one could say that the problem was 'artificially' created in the sense that the natural flow was increased, impeded, or diverted by human projects such as subdivisions, road, shopping centres or indeed golf courses. This does not, however, necessarily mean that a drainage area has been 'artificially' created. The initial responsibility of defining the drainage area is imposed upon the engineer by statute, who is required to act with professional competence in accordance with his oath. Any artificial increase to the drainage problem should be compensated for by an assessment for benefit or outlet liability."

6. **Crumb & Leitch vs. Township of Mariposa, Referee J. McMahon, 1978**

"In many instances therefore, the exact limits of the drainage area as set forth in the petition, will not coincide with the description contained in the subsequent report. The owners of the land described in the petition may therefore be greater or less than the owners of the land assessed for benefit as later determined by the engineer."

7. **Eves et al. vs. Township of Amherst Island, Referee W. Turville, 1983**

"As I read Section 4(1)(a) must be complied with, 'or' 4(1)(b). The legislation failed to include the 'or' but a common sense view would see that it should have been inserted."

"[The appellant] urged that at the 'on-site meeting' as required by Section 9(1), the Engineer was obliged to determine the area requiring drainage at that meeting. In addition, he put forth the view that the on-site meeting must take place on the site as prescribed by the required Form. On the evidence, the area required to be drained was determined approximately one week after the on-site meeting which was held just outside of the watershed at the Amherst Island Public School on December 20, 1978 at 8:00 p.m. Apparently, the weather that night was described as 'inclement'. It is to be noted no one complained of not receiving notice and it would be highly impractical and absurd to suggest that the legislators intended that this Section of the Act be given such a narrow and strict interpretation. Because of the engineering input required, it is as well an absurdity to suggest that the Engineer must define properly the area requiring drainage on the evening of December 20, 1978."

8. **Westerdorp et al. vs. Township of Elizabethtown, Referee W. Turville, 1986**

"The best definition of the area requiring drainage that I was able to research appeared in a letter dated November 29, 1929, to the Clerk of the Township of West Williams from Drainage Referee George F. Henderson:

'It is not necessary that there should be a majority of the petition of all those whom the engineer finds to be eventually interested in the drainage work. What you need is in first place a reasonably well defined drainage area, that is, a section of land requiring drainage, and it is this territory which should be described in the area. It is of course not proper to pick out just enough lots to enable a majority, but there should be what I generally speak of as an irregularly shaped saucer with reasonably well defined banks around it. This might be all on one lot, although that is of course a rare case, but the point is that once you have that low lying section of land requiring drainage, it is a majority of the owners in that section that you need for a petition, no matter how many others the Engineer may bring in...' "

"The present Act requires that the engineer shall make the determination of the area requiring drainage and that it complies with Sec. 4. He is not required to communicate his findings to anyone should it comply but only that 'he shall proceed to prepare his report or a preliminary report, as the case may be.' in accordance with (see Sec. 9(3)). It is irrelevant and at times impractical that he should make this determination at the on-site meeting. He is however, required in the interest of saving costs to make this determination early as to whether it complies with Sec. 4. His position is quasi-judicial. He need not give evidence as to how he established the area requiring drainage, but only to satisfy this Court of his definition of the area requiring drainage and those owners and their lands that fall within that area."

"There is nothing in the present legislation ... that requires the engineer, as had been the case in some previous legislation that those who are assessed for benefit must be within the area requiring drainage."

9. **Jones vs. Township of Derby, Referee W. Turville, 1986**

"[The engineer] was of the view that those owners who signed the first Petition did so without the written consent of their joint owner, causing concern that there had been no majority in compliance with the prerequisite of Sec. 4."

"... a second Petition was accordingly filed at the engineer's request, however no on-site meeting was held as required by Sec. 9(1)..."

"I view the failure to hold this on-site meeting following council's acceptance by resolution of the second petition on September 22, 1983, as more than a mere technicality. The added names to the second Petition increase the possibility that at the second on-site meeting more information and discussion could be exchanged."

"You cannot adjust the irregular 'shaped saucer with reasonably well defined banks around it' just because a landowner indicates his desire for drainage, without first ascertaining where those well-defined banks are located on the ground. In his zeal to accept the Petitioner's version of the area requiring drainage [the engineer] has not formed the proper independent judgment when making his assessment."

"I am of the view that it is the intention of the present Drainage Act that lands not described in the petition as requiring drainage that are subsequently found to require drainage by the engineer in his report to have similar physical features so as to form one area requiring drainage within those lines described in the petition as requiring drainage, are as well, to be included when the requirements of Sec. 4(a) or (b) are being considered, otherwise the lands described in the report by the engineer in accordance with Sec, 8-1(a) would not be fairly described. Failure to do so would not afford the intended protection for those who did not sign the petition."

"...it is my view that once [the engineer] observed water moving in a westerly direction at different locations under Concession Road 6-7, he was duty-bound to address the question that prior to his determination of the area requiring drainage there was a likelihood of a larger area requiring drainage, and not one that was separated by a man-made road under which water was intended to pass. This omission creates a significant risk in the face of engineering evidence to the contrary that the area was not fairly described in his report."

10. Belzner et al. vs. Town of Dunnville, Referee R. Johnston, 1992

"I am of the opinion myself that wherever possible, procedural errors, whether by a landowner or the Township, should be forgiven if everyone has had an opportunity to make representations and no one has been harmed or injured.... However, I am not at all certain that I have the power under the Act to validate the otherwise invalid Petition in this matter. In any case, I am not prepared to relieve the irregularity in this case. The Petition is the cornerstone of the procedure for owners to obtain a sufficient outlet for their water. It must be properly completed and signed."

"Several points were raised ... which bear on the sufficiency of a Petition...

The first matter is whether all the signatures of joint owners, co-owners and partners are necessary on a Petition. The answer is that they are. If land is held by a husband and wife, whether jointly or as co-owners, both have to sign the Petition. The same applies to unrelated joint or co-owners, regardless of how many there are. If there are three (3) joint or co-owners they all have to sign. All partners of a partnership or land that is held as partnership property have to sign. ... In the case of a Corporation, an authorized signing officer of the Corporation may sign the Petition. But, the proper name of the Corporation must be clearly printed on the Petition and the office held by the signing officer must be printed under his or her signature and the Corporate seal must be affixed to the Petition or a statement be included underneath the signing officers signature stating that he or she has authority to bind the Corporation.

...Section 4(5) states as follows: 'Where two or more persons are jointly assessed for a property, in determining the sufficiency of a petition they shall be deemed to be one owner. R.S.O. 1980, c. 126, s.4.' This section means that where there is joint or co-tenants or partners, regardless of how many there are, they are only treated as one person for purposes of calculating a majority under Section 4(1)(a) of the Act... Similarly, all owners of the same property must sign the Petition for their property to be counted in support of the Petition in the calculation under Section 4(1)(b)."

11. Hodgson et al vs. Township of Mariposa, Referee R. Johnston, 1993

"I would add that in determining the area requiring drainage there should be some physical characteristic which is different where the proposed drain ends from that of the surrounding territory. This could be the extent of the grade; the kind of cropping that is taking place in the area, or other physical characteristics."

12. Landmark Ltd. vs. Township of Hay, Referee D. O'Brien, 1998

"Accordingly I conclude:

That the general description in the petition of the proposed drainage area does not require precision and minor errors contained in the general description do not invalidate a petition.

Errors in the identification of the various owners' properties, although they should be reviewed and corrected, likewise do not invalidate a petition providing that the signatories are in fact owners within the area requiring drainage."

"The identification of 'the area requiring drainage' is the function of the drainage engineer, and requires professional expertise. The engineer has a duty to review the names on the petition and satisfy himself that they are in fact the owners of the land. This function is often done in consultation with the Municipal Clerk, as they together review the assessment roll. It should be noted that Section 4(4) of the Drainage Act provides for the Clerk to be the final arbitrator of the ownership in circumstances where the assessment roll does not identify the true owner."

"Having found, following the Belzner Case, that it is necessary to have both spouses sign when they are joint owners, it is even more necessary to have clear proof of authorization if the petition is signed by someone other than the owner. The onus falls upon the drainage engineer to provide proof that the signatures are duly authorized, here the evidence was insufficient. If a party signs on the behalf of two owners, there must be clear, legal written authorization to do so and the engineer must be satisfied that the authorization exists."

13. Pannabecker & Leddy vs Township of West Wawanosh, Referee D. O'Brien, 2000

"The purpose of the Drainage Act was to remedy the deficiencies of the Common Law and to provide the downstream owner inundated with sheet flows from upstream lands with an instrument to obtain relief. That, put in simplest terms, is the role of the Drainage Act which has served this Province well for over a century."

"This case illustrates clearly how the Drainage Act can be utilized to give relief to a single owner ... when that landowner is the only owner in the watershed 'requiring drainage'."

"It should be noted that the 'lands requiring drainage' decision must not only evaluate the objective physical condition of the lands in question, but also must examine the land use factors, all of which together must be weighed in determining which lands require drainage."

14. Bluewater vs. South Huron et al., Referee D. O'Brien, 2002

"The issue to be determined is whether the majority in numbers of the signatures on a petition is based on the number of owners or the number of properties. This issue has caused confusion in past years and requires clarification. In my opinion the drafters of the legislation did not foresee that there would be confusion with respect to this matter, having provided for two separate tests for the validity of the petition, both utilizing the historic democratic measure of the 'majority'. The first related to the number of owners (e.g. persons) the second related to quantity of land. In Section 4 (1)(a) the majority of owners regardless of acreage is the determining factor and in Section 4 (1)(b) the number of acres regardless of the number of owners is the determining factor. The tests stand in the legislation in juxtaposition to one another and ought not to be mixed."

"The *Drainage Act* is remedial enabling legislation and accordingly is to be given the most liberal interpretation to ensure the purposes of the Act are carried out in the most equitable and expedient manner."

15. Whalen vs. Town of Mississippi Mills, Referee D. O'Brien, 2003

"I further find Section 4(1)(c) need not be restrictively interpreted as to its application. Road authorities universally have special problems with respect to drainage, and it is common knowledge that excellent drainage is absolutely necessary for the proper maintenance of roads and for public safety. Further, the road authority is responsible for its actions to a Municipal Council which is responsible to the electorate for its actions. The accountability is to the public at large which makes use of the highways and not to the immediate land owners in the water shed, as is the case with the other subsections. Accordingly, I am of the opinion that Section 4(1)(c) requires a liberal rather than a restrictive interpretation as to its use."

16. M. & M. Farms Ltd vs. Town of Kingsville, Referee D. O'Brien, 2004

"If democracy alone were to determine whether a drainage project was to proceed we would have no need for the enabling words 'area requiring drainage' in the Drainage Act, but rather could depend on a majority vote of owners in the watershed. The Drainage Act long ago removed dependence on the will of the majority. The current Drainage Act went further and determined that the decision as to the 'area requiring drainage' should not be made by a municipal council composed of laymen subject to political pressures, but rather it specifically allocated that responsibility to a professional drainage engineer. He is charged with the responsibility without guidelines, but pursuant to the directions of Section 11 of the Drainage Act..."

"The words of the Drainage Act are simple and in plain language: 'The area requiring drainage' and should not be subject to misinterpretation. The Drainage Act is an enabling legislation and we are directed by the Interpretation Act... to interpret it liberally to accomplish the purpose for which it is enacted. Section 10 of that Act states...:

Every Act shall be deemed to be remedial, whether its immediate purport is to direct the doing of anything that the Legislature deems to be for the public good or to prevent or punish the doing of anything that it deems to be contrary to the public good, and shall accordingly receive such fair, large and liberal construction and interpretation as will best ensure the attainment of the object of the Act according to its true intent, meaning and spirit. R.S.O. 1980 c. 219, s. 10."

"...even if the drainage engineer finds the petition to be valid, he must weigh it against his duties and responsibilities defined by Section 40 of the Drainage Act which again imposes an essential responsibility on the appointed drainage engineer and which section is not, in my view, sufficiently utilized by the profession."

"...the drainage engineer when determining the 'area requiring drainage' can take into account the saucer concept, the physical characteristics of the land and the land use considerations including cropping, etc. In every case the final decision is left to the appointed drainage engineer using his judgment and determining in accordance with the plain words of the Act what is the 'area requiring drainage.' He must act professional and honestly when confronted with modern farming methods that completely alter the landscape, creating circumstances that were never contemplated in previous generations and he must adjust to current needs to keep the Drainage Act relevant."

"As more and more urban dwellers move to the country to experience a country lifestyle, as more and more recreational complexes are constructed in the countryside, as more and more emphasis is placed on environmental considerations, and as the investment in high tech agriculture mounts utilizing a selected land base, consideration of land use will become more and more important."

17. Bluewater vs. South Huron et al., Referee R. Waters, 2008

"When the staff of South Huron formed the intention to withdraw from this process through its inherited position as petitioner, by its purchase from the [original petitioning landowner], it should have notified the parties immediately in order to forestall future costs on what has been an unfortunate project."

"I also find it difficult to accept the argument of South Huron that it felt it had to wait for completion of the Preliminary Report or the Final Report before withdrawing when previously the Town of Exeter, had already withdrawn at a stage prior to the Preliminary Report."

18. **Bluewater vs. South Huron et al., Referee R. Waters, 2009**

"Going forward, I would recommend to any Municipality and Drainage Engineer as a best management practice that they review the ownership of parcels, firstly through their assessment rolls which is cost free, but secondly through the electronic registration system to ensure that the problems which exist but become evident only on a delayed basis, are not encountered in future petitions where there is no strong majority in favour."

"...to petition drains, the tests in 4(1)(a) and 4(1)(b), as is often stated, are not to be mixed and are separate from each other in order to provide drainage for an area requiring drainage that is less onerous for purposes which have been found by the Legislature to be for the public good."

"...the test in 4(1)(a), whether it be the number of owners or the number of properties, in my opinion, while still governed by sections 4(4) and 4 (5), should be the one which best facilitates a drain being established but provides that a clear majority exists in favour of the project for the area requiring drainage."

CHAPTER 5

PRELIMINARY REPORT

5.1 Introduction

A preliminary report is used to evaluate alternative solutions to the drainage problem, including cost estimates, without incurring substantial engineering costs. The preliminary report process allows:

- the engineer to evaluate options and provide recommendations
- owners and council to review options and recommendations
- owners and council to determine which option, if any, should proceed to a final report

Without the preliminary report process:

- if petitioners decide to terminate a project, they pay the engineering costs for the full design of the project
- the scope of the drainage project could become more complex and expensive than originally envisioned

When an environmental appraisal is requested (Section 6), the preliminary report process must be implemented. In all other situations, the preliminary report is an optional process that is performed by the engineer only when directed by the municipality.

Not all municipal councils will be aware of the preliminary report option. Some situations that may warrant a preliminary report are when:

- there are various solutions to the drainage problem (e.g., drain form, construction techniques or routes)
- obtaining regulatory approvals may be unattainable or difficult
- addressing technical, environmental or archaeological issues is complex
- a drainage project may not be feasible (e.g., land values or improved crop yields are marginal)
- a complex project is considered (e.g., urban development, new or altered road construction, natural channel design)

The *Drainage Act, 1990* (Section 10(1)) requires that a preliminary report contain:

- a sketched plan of the drainage works
- an estimate of the cost
- an environmental appraisal, if requested (Section 6)
- a Benefit cost statement, if requested (Section 7)

5.2 Preparing the Preliminary Report (Section 10)

When the engineer is instructed to prepare a preliminary report, the steps are as follows:

1. Preliminary consultation
2. Preliminary survey and design
3. Cost impacts on individual properties

5.2.1 Preliminary Consultation

At the on-site meeting, at the project scoping meeting or during subsequent discussions with property owners, agencies or the municipality, the engineer should identify the issues to be addressed in the preliminary report. The engineer should advise that there are increased costs for gathering more information. Regardless of the consultation results, the final decision of the content of the preliminary report rests with the engineer.

5.2.2 Preliminary Survey and Design

A useful preliminary report will provide a high-level cost estimate of the various options explored. In order to accomplish this, an appropriate level of survey and design work is required. The engineer will have to use judgment as to the extent of any survey and design work necessary.

The survey and site examination work needs to be extensive enough to establish sufficient elevation data and cross-sections that a general knowledge of gradients, capacities and outlets can be judged. A site investigation should be performed to obtain preliminary information on the watershed such as environmental features, utilities, road crossings, soils and other physical constraints.

For the design of each option, consider preliminary hydrology and hydraulics calculations, outlet considerations and environmental features, et cetera. The cost estimate of each option should consider the construction, engineering, allowance calculations, permits and other costs.

5.2.3 Cost Impacts on Individual Properties

Although the Act does not allow the inclusion of an assessment schedule in a preliminary report, it may be useful to include broad principles of assessments in the preliminary report.

If the engineer is asked by property owners to develop preliminary cost assessments, the engineer should take the following steps:

- Ask the municipality for authorization to complete the additional work.
- If directed by the municipality, produce a preliminary cost assessment. This should not be included in the preliminary report.
- Separate the fees to produce a preliminary cost assessment from the rest of the preliminary report cost.

DID YOU KNOW? If a preliminary report is terminated, the cost of preparing the report may, with conditions, be eligible for grants through the Agricultural Drainage Infrastructure Program (ADIP).

5.3 Suggested Components to Include in a Preliminary Report

The following are the suggested components to address in a preliminary report:

- background
- the applicable *Drainage Act, 1990* sections
- the appointment of the engineer
- the outcomes of the on-site meeting and requested work
- the validity of the petition or project authority under Section 78(1.1)
- the limitations of the preliminary report
- constraints (e.g., outlet, environmental, societal, utilities, roadways, soils)
- assumptions used and any variables that could alter the project cost in the final report
- design basis, hydrology and hydraulics
- any municipal or provincial standards applicable
- options considered
- cost estimates, including allowances, construction, engineering, eligible administration for all options
- the broad basis of cost sharing and/or principles of assessment that may become involved
- regulatory approvals
- a plan to show approximate watershed area, lots and concessions, owners' names and the location of any existing or proposed drains
- an environmental appraisal (Section 6)
- a Benefit cost statement (Section 7)
- a summary
- next steps

A preliminary report does not include drawings containing profiles or construction specifications.

5.4 Environmental Appraisals

If an environmental appraisal is requested, a preliminary report is mandatory and must include this appraisal (Section 10(1)).

Four parties may request an environmental appraisal (Section 6):

- the municipality undertaking the project
- any other municipality involved in the project
- a conservation authority
- the Ministry of Natural Resources and Forestry

Environmental appraisals are rarely requested because the requesting party must pay the cost (Sections 6(1) and 6(2)).

The Act does not define the involvement of the appointed engineer in the development of the environmental appraisal. The engineer could be required to:

- consider an appraisal prepared by external expertise
- oversee the development of an appraisal using external expertise
- prepare an appraisal using internal expertise

When the engineer is assigned responsibility to complete the environmental appraisal, seek technical advice and expertise of other specialists such as biologists, hydrogeologists, etc. The engineer should always consider their own personal knowledge limitations and the need for specialists who may fulfill the task.

DID YOU KNOW? For more information regarding environmental appraisals, refer to the document *Guidelines for Environmental Appraisal under the Drainage Act, 1975* (www.landdrainageengineers.com).

5.5 Benefit Cost Statements

A Benefit cost statement is the anticipated benefits expressed in dollars compared to the total estimated cost of the drainage works.

There are three parties who may request a Benefit cost statement (Section 7):

1. the municipality undertaking the project
2. any other municipality involved in the project
3. the Ontario Ministry of Agriculture, Food and Rural Affairs

Benefit cost statements are rarely requested because the requesting party must pay the cost of preparing the statement (Sections 7(1) and 7(2)).

A Benefit cost statement can be prepared independent from a preliminary report. If a Benefit cost statement has been prepared and the municipal council has instructed the engineer to prepare a preliminary report, the engineer is required to include the Benefit cost statement in the preliminary report.

The Act does not define the involvement of the engineer in the development of the Benefit cost statement. The engineer could be required to:

- consider a statement prepared by external expertise
- oversee the development of a statement using external expertise
- prepare a statement using internal expertise

If instructed to complete the Benefit cost statement, the engineer is advised to seek the technical advice and expertise of other specialists (e.g., real estate appraisers, soil specialists, crop consultants).

Items that could be considered in a Benefit cost statement include, but are not limited to:

- why the Benefit cost statement was requested
- a general description of the watershed and its drainage requirements
- the proposed drainage works, options and costs
- the lands and roads expected to receive benefit
- outcomes from the on-site meeting
- other private work that may be necessary to achieve a benefit from the proposed drain

- calculation of annual benefits per property such as the benefit of:
  - maintaining lands in production
  - increased yields
  - increased land values
  - preservation of drainage systems
  - improved road drainage
- calculation of annual costs per property including:
  - drainage assessments
  - future maintenance costs
  - additional private drainage costs, etc.
- cumulative present day values
- summary of the benefit cost analysis

Even if a Benefit cost statement is not requested, the engineer should prepare and maintain calculations to demonstrate that the project benefits exceed the costs should an appeal arise (Section 48(1)(a)).

DID YOU KNOW? During the development of a preliminary report, an engineer may use Section 40 of the Act to terminate a project if it is determined that the drainage works is not required, impractical or not possible to construct. See Part A, Chapter 13 for more information on Section 40 reports.

5.6 Processing a Preliminary Report

After the preliminary report has been completed and submitted to the municipality, the municipality is required to hold a meeting to consider the preliminary report. This is a council meeting where property owners within the area requiring drainage and involved utilities, road authorities and agencies are invited to attend (Section 10(2) to Section 10(5)).

It is mandatory to invite:

- every owner in the area requiring drainage (as determined by the engineer or as described in a petition)
- any public utility or road authority that may be affected
- any other local municipality that may be affected
- the local conservation authority or the Ministry of Natural Resources and Forestry (if no conservation authority exists)
- the Director appointed under the *Drainage Act, 1990*

The municipality may request the assistance of the engineer in identifying other parties (e.g., additional agencies, upstream and downstream property owners) to invite to the meeting to consider the preliminary report.

If it is a drain improvement project (Section 78), it is recommended that all property owners within the defined watershed be invited to the meeting.

The municipality may also request the assistance of the engineer at the meeting to:

- present the findings of the preliminary report
- identify the range of possible assessments
- advise the municipality of the sufficiency of the petition
- advise the municipality and property owners of the implications and cost allocations if a preliminary report is terminated

There are several possible outcomes from the meeting to consider the preliminary report.

The report is accepted. It is the engineer's responsibility to select the appropriate design option from the preliminary report (Section 10(5)). The costs of producing the preliminary report are included in the final report costs for both Section 4 and Section 78 projects.

Petition is no longer valid. Where property owners modify the petition (Section 4 project) by adding or withdrawing their names, the engineer re-evaluates the validity of the petition. If it is no longer a valid petition, the process stops and the costs are divided equally between the original petitioners. However, any costs of an environmental appraisal and/or a cost benefit statement are to be paid by the parties that requested them (Section 10(4)).

DID YOU KNOW? When a project is terminated at the meeting to consider the preliminary report, the ADIP policies provide direction on claiming a grant.

The council stops the proceeding. The council may decide to terminate the project by instructing the engineer not to prepare a final report. The council needs to be aware that this decision can be appealed to the Agriculture, Food and Rural Affairs Appeal Tribunal (Tribunal) (Section 10(6)).

- For a drainage project initiated by petition (Section 4), the municipality has no ability to assess the costs of the terminated preliminary report and must absorb these costs.
- For a drain improvement project (Section 78), the *Drainage Act, 1990* provides no direction on the recovery of costs. For considerations on recovery of cost, see Part A, Chapter 10.2.1.

For information on the Tribunal, see Part A, Chapter 11.2.

5.7 Appeal of Preliminary Reports

If the council does not direct the engineer to prepare a final report (Section 10(6)), an appeal can be filed to the Tribunal by:

- any petitioner
- the Minister of Agriculture, Food and Rural Affairs, where agricultural lands are involved

The only allowable appeals to the Tribunal regarding the content of the preliminary report are those based on environmental appraisals.

If dissatisfied with an environmental appraisal, the following parties may appeal to the Tribunal (Section 10(7)):

- any owner of land in the area requiring drainage
- any public utility, road authority or local municipality affected by the drain
- any conservation authority having jurisdiction over the area (or if no conservation authority exists, then the Minister of Natural Resources and Forestry)

An environmental appraisal may be referred to the Tribunal (Section 10(8)) by:

- the Minister of Agriculture, Food and Rural Affairs, where lands used for agricultural purposes are in the area requiring drainage or
- the Minister of Natural Resources and Forestry, where any conservation authority or regional office of MNRF reports that an environmental appraisal is unsatisfactory

Any party requesting an environmental appraisal may appeal the costs of an environmental appraisal to the Tribunal (Section 6(3)).

CHAPTER 6

SURVEY AND SITE EXAMINATION WORK

6.1 Introduction

A survey and site examination is an essential part of the preparation of an engineer's report for a drain construction (Section 4) or improvement project (Section 78). A professional design requires a site visit and the collection of detailed field information from a survey.

The engineer has the authority to:

- enter on the land of any person (Section 12)
- measure, survey and plant stakes on the land (Section 12)
- establish benchmarks and record the data in the report (Section 13)

The extent of the survey should include all reasonable drain routes in consultation with the affected property owners and the drainage superintendent. Select drain routes based on land topography, land use, soil type, presence of bedrock, proposed drain connections, outfall location, roads and utilities.

6.2 Entry on the Land

The engineer has the legal authority to enter onto any land in order to perform the work (Section 12). In most cases, the property owner will not object to accessing the site. If the property owner objects, the engineer should leave the property immediately and take the following steps to remedy the situation:

1. Negotiate with the property owner to get permission.
2. If that negotiation is unsuccessful ask the local police for assistance.
3. If the police are unwilling to intervene, initiate legal action to obtain an order from the drainage referee to allow entry for continuation of the drainage project.

DID YOU KNOW? In 1972, Referee Clunis confirmed in two separate decisions that it is an offence to interfere with the engineer or obstruct the engineer as the work is carried out (Section 12). In both cases, the referee ordered the engineer be allowed to enter and levied costs against the owners who obstructed the engineer. Read the case summaries of Township of Woodhouse vs. De Coutere Farms (search "1972 ONDR 2") and Township of Woodhouse vs. Tchorek (search "1972 ONDR 3") at www.canlii.org/en/on/ondr.

6.3 Surveying

The purpose of the survey and field component of the engineer's work is to collect information that can be used for:

- determination of the location and extent of utilities
- determination of the location and extent of environmental concerns
- evaluation of the sufficiency of the outlet
- design
- drawings
- specifications
- assessments

The engineer should consider the following when selecting a survey method (Figures A6–1 and A6–2):

- the limitations and benefits of a method
- time available to conduct the survey
- availability of any existing surveys and drawings
- data that is available (e.g., Light Detection and Ranging (LiDAR))
- the level of accuracy needed for the report
- the size and the required resolution of the project
- weather conditions
- seasonal factors (e.g., vegetation, ice cover)
- accessibility of the property
- satellite coverage
- land cover
- ease of recording and plotting data
- complexity of project

Figure A6–1. A GPS base station.

Figure A6–2. Laser survey equipment.

Regardless of the survey method, field markers (Figure A6–3) are recommended for site visits and reviews by property owners, engineering staff, agencies and contractors.

Figure A6–3. Field markers.

Source: N.J. Peralta Engineering Ltd., Kingsville, Ontario.

6.3.1 Establishing Benchmarks

Establish sufficient benchmarks or permanent levels along a drainage works and record them in the report (Section 13). Select benchmarks that are permanent, easily located, will not physically change over time (e.g., location or elevation) and ideally meet Geodetic Datum (Figure A6–4). This ensures that the elevation data in the report can be re-established at any time and by anyone from the time of construction through to future maintenance.

Select locations of benchmarks in consultation with the drainage superintendent or other municipal representatives.

Figure A6–4. A geodetic survey benchmark.

6.3.2 Instructions to the Survey Crew

The survey is most often conducted on private property. The engineer should inform the drainage superintendent of the survey dates and determine their involvement. It is good practice to:

- notify each property owner about the project and when the survey will take place
- ask the property owner to identify any drainage concerns and needs
- ask the property owner to locate features that should be surveyed and recorded
- respect the property (e.g., crops and fences)

Ensure that the field crew is aware of the project requirements and instruct them to record specific data such as:

- benchmarks and control points
- cross-sections of the drain at specific intervals
- a note on what is being surveyed (the main drain, a branch, access culverts or road crossing)
- location and elevation of tile outlets, trees and other features important to the design
- a detailed sketch showing locations, elevation and coordinates of benchmarks and control points used for the survey

This information will assist the processing of the survey data by identifying where the project is geographically located and confirming control points, coordinates and elevations. The field notes will help relate the survey data to the actual site.

6.3.3 Recommended Practices

The following recommended practices will ensure a thorough record of existing conditions, making it possible to accurately design the construction or improvements of drains.

General steps for all projects:

- Conduct a review of watershed boundaries and land uses for hydrology and assessment purposes.
- Ensure all surveys are checked by either surveying from one geodetic benchmark to another or running a double survey through the benchmark system.
- If possible, tie into the benchmark system of a previous survey for an existing drain.
- Locate benchmarks every 300–500 m and/or at a location where specific work is intended to be completed. Note if the elevations are assumed or geodetic.
- Record elevations along the course of the existing and/or new drainage works as required (a frequency of every 25–50 m is suggested).
- Place stakes along the drainage works for reference and illustration purposes at a frequency proportional to the complexity of the project work.
- Ensure the survey is comprehensive enough to include all potential drain routes.
- Coordinate with utility companies to identify buried utilities (e.g., location, elevation and type of materials).
- Identify any low areas of land that the property owner wishes to drain and outlet to the new drainage works.
- Where a well exists near a drainage works, record the elevation of the top of well, ground surface and the water level in the well.
- Where an off-line pond exists near a drainage works, record the elevation of the adjacent ground surface and water level.

- Probe the proposed route of the drain to identify the extent of rock or hardpan.
- Identify stone piles and rock outcrops.
- Note spongy ground and leaning posts to identify any potential areas of underlying soft, unstable soil or sink holes.
- Test holes may be useful to identify poor soil conditions and high water table.
- Record all significant features that may affect design and construction such as:
  - landscaping — vegetation (health, size, type), fences, soil types
  - woodlots and orchards
  - wetlands
  - utility features — pole lines, buried utility markers
  - roadway and laneway crossing details (widths, depths and types of material, condition)
  - adjacent buildings — building openings and floor elevations
  - drainage features — existing private tile drainage, spring or seepage areas
  - potential and existing access routes
  - locations for material disposal
- Take photos and/or video of the drainage route and features that may be impacted.

DID YOU KNOW? Information on well construction records can be found at ontario.ca/data/water-wells.

Surveying Channels

- Survey cross-sections of existing watercourses at intervals of 100–200 m (Figure A6–5). Depending on the type of project and topography, cross-sections may be required more frequently or at specific locations.
- Identify and document:
  - water elevations and known high-water marks
  - the condition of existing slopes along a channel to evaluate slope stability
  - existing crossings — lane profiles, soffits, spans, heights, diameters, type of material, structural condition, footing elevations, lengths, scour, skews, adjacent channel cross-sections, inverts
  - any tile outlets in the channel — size, elevation, condition, side, rodent gates
  - tributary channels
  - surface water entry locations — size, conditions, existing protection
  - area of bank erosion — extent and cause
  - beaver dams — width, age, effectiveness, activity
  - any low-flow or at-grade crossings — description, elevations, condition
  - fish habitat — pools, gravel substrates
  - other environmental features — species, habitat, enhancements

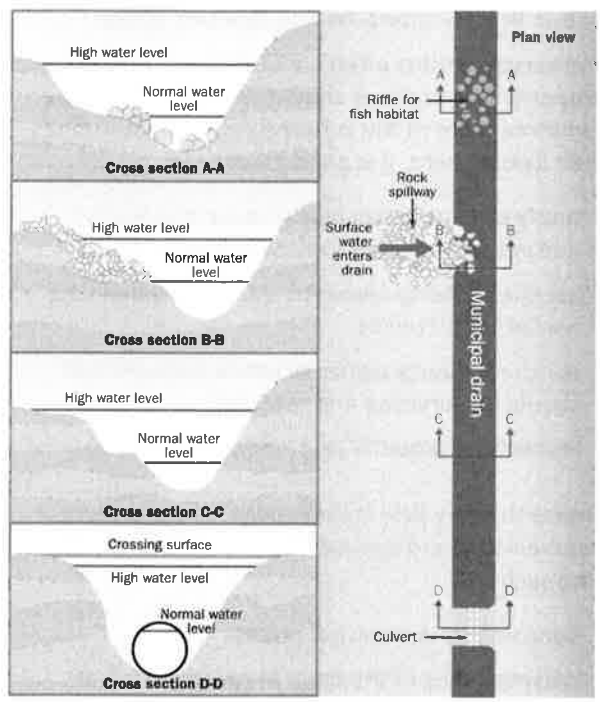


Figure A6–5. Plan view and four cross-sections of a surveyed watercourse.

Surveying Piped Drains

- Identify and document:
  - the soil type along the anticipated route to determine if envelope material is needed
  - grassed waterways — geometries, conditions, materials
  - water retention areas — terrain, rock berms (e.g., size, materials condition)
  - private drainage features — as identified in the field and recorded from property owners (include information on blowouts, tile failure and repair)
  - surface flow paths and where additional surface inlets may be warranted
  - existing surface inlet details — materials, sizes, connections, condition, elevations
  - elevation of road ditches along route of road crossings

Surveying in Urban Areas

- Identify and document:
  - road cross-sections at 25–50 m intervals extending from building to building
  - lot drainage details — swales, stormwater management structures
  - driveway information — locations, materials, geometrics, elevations, condition
  - road signs
  - tree details — location, type, size, condition
  - private land use features
  - location of sanitary and storm features, pipe invert elevations and pipe diameter
  - water mains, valves, hydrants and individual water shut-off
  - intersecting street information — profile, geometrics, materials
  - buildings — location, basement floor elevations
  - sidewalks

CHAPTER 7

FINAL REPORT

7.1 Introduction

This chapter provides guidance on the content of reports prepared for the construction (Section 4) and improvements (Section 78) of drainage systems. The *Drainage Act, 1990* requires the engineer to prepare a final report that specifies the proposed solution to the drainage problem. The report combines information that complies with the *Drainage Act, 1990* (Part A), technical design (Part B) and other applicable legislation (Part C).

The final report summarizes the engineer's work performed to date. It becomes the focal point for all parties involved in the project, including property owners, municipal staff and council, contractors, environmental and approval agencies, etc. A professional report clearly presents the information while recognizing the different levels of knowledge of engineering or *Drainage Act, 1990* terminology.

DID YOU KNOW? The engineer may be required to write other reports under the *Drainage Act, 1990*? These reports are addressed in Part A, Chapter 13.

7.2 Required Components of a Final Report

The *Drainage Act, 1990* sets out the required components of a final report (Section 8) including:

- plans, profiles, and specifications of a drainage system
- a description of the area requiring drainage (Section 4)
- a detailed estimate of total costs
- the allowances paid to property owners
- an assessment of costs

The Act also requires the engineer to consider the following:

- the need to be fair, impartial and file a true report (Section 11)
- capacity in piped drainage systems (Section 14)
- sufficiency of outlet (Section 15)
- disposal of materials (Section 16)
- road crossings (Section 17)
- other crossings and structures (Section 18)
- for drain improvements, abandonment of an existing drain (Section 19)
- the working space (Sections 29, 30, 63)
- future maintenance of the drain (Sections 38, 74)
- time for filing the report (Section 39)
- the need to report where the drain is not required, is impractical or cannot be constructed under the Act (Section 40)
- an account of engineering fees (Sections 70, 71)

7.3 Developing the Final Report

In developing the final report, the engineer integrates the drain design, the allowances to property owners and the assessment schedule. These topics are covered in the chapters on

Allowances and Assessments (Part A, Chapters 8 and 9).

After the on-site meeting, design the drain and develop the final report. This process includes:

- developing plans, profiles and cross-sections of existing conditions (Part A, Chapter 7.4.20)
- completing the hydrologic analysis (Part B, Chapter 2)
- completing the hydraulic analysis (Part B, Chapter 3)
- establishing the hydraulic grade controls and the gradient for the drainage system (Part B, Chapter 3)
- identifying and evaluating options for the drainage system
- selecting the preferred design option
- determining allowances (Part A, Chapter 8)
- estimating other costs (e.g., construction, engineering, administration and contingencies) (Part A, Chapter 9).
- developing estimates of assessments (Part A, Chapter 9)
- developing detailed specifications for construction (Part A, Chapter 7.4.20)
- coordinating the review of the draft report by agencies and the drainage superintendent(s)
- considering holding an additional meeting with property owners to discuss the draft report, prior to the submission of the report to the council
- finalizing the report and submitting it to the council

The engineer is required to file the final report as soon as it is completed or within one year after the appointment. If the report cannot be completed within one year, request an extension from the council (Section 39(1)). Failure to meet the timeline may result in a financial penalty (Section 39(2)).

> **DID YOU KNOW?** The OMAFRA ADIP policies identify various requirements for engineering reports. To ensure provincial grant eligibility, review these policies during the preparation of the report.

7.4 Suggested Table of Contents

A suggested table of contents for a final report includes the following:

Executive Summary

Objective

Drainage Act, 1990 Process

Description of the Watershed

Drain History

Authorization for the Final Report

- Validity of Petition (for Section 4 Reports)
- Compliance with Section 78(1.1) (for Section 78 Reports)

Meetings

Design Considerations

Recommendations

- Design Criteria
- Description of the Drain
- Construction Considerations

Cost Estimate Principles

Cost Assessment Principles

Future Maintenance and Repair Provisions

General Instructions to Property Owners, Road Authorities and Public Utilities

Grants

Seal and Signature of the Engineer

Allowance Schedule

Cost Estimate

Assessment Schedule

Assessment Schedule for Future Maintenance

Plans, Profiles and Specifications

7.4.1 Executive Summary

A concise summary of the engineer's report may be useful for the reader. Suggested content could include:

- location and name of the drainage works
- the purpose of the drainage project
- authorization for the project
- proposed drainage work:
  - length and type of drain
- the estimated total costs, distributed by allowances, construction, engineering, bridges and culverts, interest charges and other costs, to assist municipal staff in completing the ADIP grant application
- reference to the assessment schedule
- other information needed to complete the grant application:
  - watershed area
  - assessments based on property ownership types (i.e., federal, provincial, municipal, non-agricultural and agricultural)

7.4.2 Objective

Describe the purpose(s) of the drainage project and the properties directly impacted, including:

- creating a solution for the specific area requiring drainage, which may include various land uses such as agriculture, residential, roads, etc.
- adding/replacing a crossing
- relocating or enclosing an existing drain
- creating/enhancing a wetland
- naturalizing a drain
- addressing erosion problems
- establishing buffers

7.4.3 *Drainage Act, 1990* Process

Provide a summary of the *Drainage Act, 1990* process:

- steps completed to date:
  - authorization
  - project scoping meeting (if any)
  - on-site meeting
  - preliminary report (if any)
  - survey work
  - meetings and agency consultation
  - engineering design
  - final report
- next steps:
  - meeting to consider the report
  - appeal rights (court of revision; Agriculture, Food and Rural Affairs Appeal Tribunal; drainage referee)
  - authorizing the work under a by-law
  - tendering
  - construction
  - project finalization
  - applying for grants and assessing cost
  - appeal rights on quality of construction

7.4.4 Description of the Watershed

Describe the watershed and include:

- the geographic location
- watershed features such as drainage area, soil types, topography, hydrology, land uses, etc.
- drainage features such as existing municipal drains, private drainage systems and natural drainage features

7.4.5 Drain History

Provide a history of the municipal drains in the watershed that may include:

- original drainage issues
- the initial establishment of drainage works
- subsequent improvements
- maintenance and repair activities

7.4.6 Authorization for the Final Report

State the authorization for the development of an engineer's report under:

- Section 4, initiated by petition of property owners or road authority, for the construction of a drainage system

- Section 78, initiated by municipal council, for the improvement of an existing municipal drain
- a combination of Sections 4 and 78 for a project that includes the construction and improvement of a drain system

It is important for the reader to understand how the project to construct a drain was initiated. In the report, the engineer should summarize the information developed in Part A, Chapter 4.

- for projects initiated under Section 4:
    - indicate the properties that petitioned for the drain
    - provide a written description of the area requiring drainage
    - determine how the petition complies with the criteria in Section 4(1)
- for projects initiated under Section 78, indicate how the report implements one or more of the requirements of Section 78(1.1).

7.4.7 Meetings

Provide a high-level summary of any project scoping meetings and on-site meetings. In the summary, identify key information gathered to establish the scope of the overall report and provide a summary of discussions or information.

7.4.8 Design Considerations

The engineer should provide descriptions of the:

- drainage problem
- options considered during the design (e.g., property owner's needs)
- design criteria used for the drainage system
- sufficient outlet for the drainage system (Section 15)
- work required to comply with environmental and other legislation
- other design factors, including soil types, erosion control, working space, future maintenance, access corridors, utilities, construction equipment and methods, drain abandonment, etc.

7.4.9 Recommendations

The engineer should describe the design criteria:

- hydrologic design basis used for the overall system
- details of any hydraulic grade line controls in the system
- probable life expectancy for the drainage system, including any existing drains being retained or incorporated into the project

While exact details of the project are found in the plans and specifications, provide readers with a clear understanding of the work to be performed on each property. The description of the drain can include:

- location, dimensions and type of drain, crossings, inlets and outlets
- working space to be used for construction and future maintenance
- access corridors and staging areas
- locations for future private drainage connections
- management of existing private drainage connections
- portions of existing municipal drains to be abandoned
- sediment control during construction
- erosion protection and site restoration measures
- manner of disposal of material
- incorporation of any private drains into the municipal drainage system
- pumping stations on private lands
- environmental features

When a portion of an existing municipal drain is being replaced or relocated, the engineer should describe the part of the drain that is to be abandoned (Section 19). Under the *Drainage Act, 1990,* an abandoned portion of a municipal drain no longer has legal status and the municipality is no longer responsible for managing it. Examples include:

- an existing pipe municipal drain being replaced by a new pipe
- an existing ditch municipal drain being filled in and replaced with a pipe

- an existing ditch municipal drain being partially filled in and replaced with a combination pipe and swale

The engineer should identify any construction considerations for the project once the report has been adopted by by-law. Include the following milestones:

- tendering
- conditions imposed by any regulatory approvals, such as timing restrictions
- expected working days
- pre- and post-construction meetings
- restoration work
- maintenance period

7.4.10 Cost Estimate Principles

Provide a summary of the project cost estimates covered in Part A, Chapter 9.2, including:

- the five cost components (i.e., allowances, construction, engineering, eligible municipal administration and contingencies)
- costs for each branch or section of the drainage system
- costs of the drainage system within each municipality (Section 27)
- separate costs for work performed on road crossings and public utilities (Section 26)
- a reference to the location of the detailed cost information in the report, if not provided here
- the assumptions used during the development of the cost estimate

Include a general statement that:

- if tender prices are 33% higher than the engineer's estimate of the contract price, then another meeting must be held before the work can proceed (Section 59)
- allowances are fixed amounts
- assessments are based on the estimated costs, and the actual assessments will be pro-rated based on final project costs

7.4.11 Cost Assessment Principles

Provide a summary to assist property owners, road authorities and public utilities in understanding the user pay system and why their specific property is being assessed costs for the drain. Define the various types of assessments and how the general principles are applied to the properties and utilities.

In order to direct the reader to a specific assessment, provide a reference to the detailed Assessment Schedule.

7.4.12 Future Maintenance and Repair Provisions

Once constructed, municipalities are responsible for maintenance and repair of municipal drains (Section 74). Therefore, the engineer should review a draft of the report with the drainage superintendent on some aspects of the project that may impact future management, including:

- working space
- maintenance assessment schedule
- benchmarks
- disposal of materials
- abandonment
- plans, profiles and specifications
- riparian buffers (Part B, Chapter 9)
- other structures (e.g., permanent sediment control)
- other instructions

The engineer is required to take a drain to a sufficient outlet. The continued sufficiency of the outlet is dependent on the management of the drainage system. Consider providing a statement that existing drains may require repair, maintenance or improvement in the future to maintain the sufficient outlet.

The report should identify the components of construction that are not part of the drainage system and will not be maintained by the municipality. Examples include restoration of private features such as fencing, surface water routes, crossing surfaces (e.g., asphalt) and tile outlets.

Include instructions on how the cost of future maintenance and repair is to be assessed (see Part A, Chapter 9.5.5).

7.4.13 General Instructions to Property Owners, Road Authorities and Public Utilities

Once the drainage system is constructed, it is the municipality's responsibility to manage it. Other regulatory agencies have jurisdiction over the use and management of the natural resources within the drainage system. The engineer's report is an opportunity to educate property owners about their responsibilities related to the drain by including statements that explain concepts such as the following:

- The drainage system becomes part of the municipal infrastructure and is to be repaired and maintained by the municipality, not by the property owners.
- The drainage system must not be obstructed (Section 80). Examples include filling in a ditch municipal drain, installing an undersized crossing, dumping materials in the drain, constructing a dam or planting trees over a pipe municipal drain or in the working space along a drain.
- The drainage system must not be damaged (Section 82). Examples include a property owner relocating a ditch municipal drain, vandalism at a pump station, heavy equipment breaking a pipe municipal drain, improper tile outlet connections causing erosion and bank slumping, etc.
- Future connections to a municipal drainage system require permission from the municipality (Section 65(5)).
- The drain is designed based on land use and management. Municipal approval is required if land use is changed such that the drain is impacted (Section 65(3)).
- No material that can impair water quality should be discharged into the drainage system. (Section 30, *Ontario Water Resources Act, 1990*).
- A Permit to Take Water is required if more than 50,000 L/day of water is taken from the drain (Section 34, *Ontario Water Resources Act*, 1990).
- The use of environmental enhancements on private property that can benefit the drain (e.g., erosion control, vegetated buffers).

7.4.14 Grants

Provide a summary of grants available under the *Drainage Act, 1990,* and describe the property owner requirements for grant eligibility.

Provide a summary of any other grants or funding that may be available for the project.

7.4.15 Seal and Signature of the Engineer

Before it is issued, the report must be signed, dated and sealed by the engineer appointed under the *Drainage Act, 1990.* Every final drawing, specification and plan within the report must also be signed, dated and sealed by an engineer (*Professional Engineers Act, 1990,* Reg. 941, s. 53). Each of these documents should reference the name of the drain and show a consistent date.

For more information on the use of the engineer's seal, refer to the Professional Engineers Ontario website (www.peo.on.ca).

7.4.16 Allowance Schedule

The Allowance Schedule is a required part of the report (Section 8(1)). Present a summary of the allowances as described in Part A, Chapter 8 Allowances and Part A, Chapter 15 Case Study.

7.4.17 Cost Estimate

The Cost Estimate is a required part of the report (Section 8(1)). Present a summary of the cost estimates as described in Part A, Chapter 9 Cost Estimates and Assessments and Part A, Chapter 15 Case Study. Remember to separate out the cost estimates for each part of the drain, as well as work performed on road crossings and public utilities (Sections 26 and 69). List the assumptions used or limitations of the cost estimate in the report.

7.4.18 Assessment Schedule

The Assessment Schedule is a required part of the final report (Sections 8(1) and 21). Present a summary of the assessment schedule, but do not include grants and allowances. Part A, Chapter 9 outlines an approach to calculating the assessment, suggests how to develop the schedules (with examples) and provides a suggested format. The Case Study (Part A, Chapter 15) shows how the assessments may be calculated, and an Assessment Schedule is included.

7.4.19 Assessment Schedule for Future Maintenance

The engineer is required to consider how the costs of future maintenance and repair will be addressed (Section 38). Part A, Chapter 9 describes different ways to develop the schedule, and the Case Study (Part A, Chapter 15) provides an example.

7.4.20 Plans, Profiles and Specifications

Plans, profiles, and specifications are mandatory components of all engineers' reports under the *Drainage Act, 1990.* They are used by contractors to bid on and construct the project. The engineer needs to ensure that the project can be constructed as designed in the plans, profiles and specifications. The plans and profiles also provide a visual overview of the project. Use common terms to help property owners and agencies understand the technical design concepts.

Plans and Profiles

The engineer should use standard engineering practices for the development of plan and profile drawings. The following is a list of items that are of importance to *Drainage Act, 1990* projects and should be included on all drawings:

- north arrow, scales (bar scales), dates, legends
- lots, concessions, geographic townships and municipalities
- the watershed boundary for the full drain, and sub-watershed boundaries for all branches and drain intervals
- property information including parcel boundaries, roll numbers and names of property owners — this information should match the information on the assessment schedule
- prominent geographic features such as roadways, railways, pipelines, natural watercourses, other existing drainage systems
- known environmental features including wetlands and wooded areas
- elevations of underground utilities (e.g., fibre optic lines, gas lines, oil pipelines, water lines, sanitary sewer lines)
- overhead utilities within the work area
- locations and elevations of known hardpan and rock outcrop areas requiring special excavation techniques and offsite disposal
- features of the proposed drainage system:
    - location of the drain, including any branches
    - direction of flow of the drains
    - description of the drain (e.g., pipe, ditch) and dimensions
    - special features such as catch basins, junction boxes, inlets, pumping stations
    - survey stations at property boundaries and other significant locations
    - location and elevation of benchmarks
    - location and elevation of public and private crossings
    - locations and names of roadways
    - present and proposed ground elevations
    - present and proposed drain elevations
    - existing water levels
    - cross-sections of channels, road crossings, culvert bedding, pipe bedding
    - cuts from ground to drain bottom
    - design gradients
    - culverts (i.e., materials, size, length, elevation, back filling, rip-rap, restoration)
- additional features associated with urban/built up areas such as:
    - frequent cross-sections to show roads, boulevards, adjacent private lands
    - intersecting streets
    - sewer and water servicing details (e.g., manholes, valves, inverts, grades)
    - landscaping/tree details
    - fences
    - basement floor elevations

The following is a list of items that may be included on drawings:

- the area requiring drainage (Section 4 only)
- regulatory flood lines, locations of any known species at risk, designated heritage sites, mapped groundwater recharge areas, wells, etc.
- fences and fence lines

- elevation of features such as building openings, wells, permissible flood elevations at roadways, etc. as compared to the hydraulic grade line
- known or expected areas of excessive stoniness and soft unstable soils

DID YOU KNOW? Including an aerial photograph as the background on the plan can assist with better comprehension of the project.

Specifications

The specifications should detail all of the work required to complete the project and convey to the contractor the project to be built. They may also be of value to interested property owners, municipal staff, agencies and appeal bodies to understand the details of the project.

A standard specification for the construction of drainage systems under the *Drainage Act, 1990* has never been produced, so it is recommended to:

- use standard specifications developed by the Province or municipality, where applicable
- create a specific or special provision specification, where there is not an appropriate standard specification
- reference the source of the specifications used

In developing specifications, the engineer is encouraged to learn from similar projects.

The specifications should:

- be detailed, specific to the work and complete
- use terminology and units of measurement that are consistent with the drawings
- include a table of contents
- include a statement describing the general scope of work
- include a description of the various classes of work
- for easy reference, segregate the work by trade under the proper specification sections and headings
- define the quality of materials and workmanship required
- include both general (standard) and specific (special provisions) specifications
- include separate specifications for drainage work in urban area

The specifications may include technical information such as:

- references to technical standards (i.e., *Drainage Guide for Ontario,* Ontario Provincial Standard Specifications, Ontario Provincial Standard Drawings)
- safety requirements
- traffic control
- livestock management
- working area/limits, access routes
- material standards and procedure for testing
- brush removal and disposal
- fence removal and replacement
- erosion control measures
- excavation
- pipe installation, including inlets and outlets
- connection of existing drainage systems
- disposal of materials
- backfilling of drains
- provisions for crossing utilities and roads
- provisions for culverts and other crossings
- catch basin standards
- seeding specifications, including timing, seed and fertilizer rates, application methods
- cleanup after construction
- contingency work such as additional/missed drain connections, unstable soils, rock, hard pan, beaver dams

Standard specifications and special provisions should address non-construction items (also known as general conditions) such as security requirements, holdbacks, payments, warranties, maintenance periods, working days or equivalent, working hours, time of commencement and completion, construction meetings and reviews with property owners.

CHAPTER 8

ALLOWANCES

8.1 Introduction

An allowance is compensation that an engineer must provide to a property owner affected by the drainage works (Section 8(1)(d)). The allowances are paid for the following:

- loss of land and use of land for rights-of-way (Section 29)
- damages to crops, lands, fences, etc. (Section 30)
- incorporating a previously constructed private drain (Section 31)
- a drainage system, by design, that is not carried to a sufficient outlet (Section 32)
- loss of access if the drainage system cuts off access to part of the owner's property and does not provide the owner with a new crossing (Section 33)

This chapter is based on the content in the following two papers:

- *Allowances and Compensation under the Drainage Act* by E. P. Dries, P. Eng., and D. R. McCready, P. Eng. (1998 Drainage Engineers Conference).
- *Easements in Drainage* by D. O'Brien, LLB QC (2010 Drainage Engineers Conference).

These papers are found on the Ontario Society of Professional Engineers Land Drainage Committee website (www.landdrainageengineers.com).

DID YOU KNOW? The Agricultural Drainage Infrastructure Program (ADIP) policies provide direction on the provision of allowances that are acceptable or eligible for grant payment.

8.2 Direction to the Engineer

Almost every drainage works completed under Section 4 or Section 78 will result in impacts to some properties. The engineer should provide proper compensation while being fair to the other property owners in the watershed that are paying for the allowances. Some property owners may disagree with the allowances identified in the engineer's final report. Arguments and appeals may be avoided if in the report the engineer clearly explains how the allowances were calculated and provides a credible rationale for the development of each value.

DID YOU KNOW? Property owner appeals on allowances are addressed by the Ontario Agriculture, Food and Rural Affairs Appeal Tribunal; the court of revision has no authority to adjust the allowances identified in a report.

The following are recommended practices in providing allowances:

- The report should define each type of allowance that is identified in the *Drainage Act, 1990* (Sections 29–33).
- Identify each property that should be paid allowances and the amount of land affected.
- Determine the rate per hectare allowed for land and crop damages, and provide the supporting information for these rates.
- Develop a rationale for the calculation of an allowance value for each property.
- For each property receiving allowances, provide a breakdown of any of the five types of allowances. The allowance schedule should only include columns for the types of allowances applicable to the project. Table A8–1 is an example of an Allowance Schedule.
- The value of all allowances applied must be realistic. The allowances must be fair to the property owners that receive them but also fair to the other property owners in the watershed that are contributing to the payment of the allowances. Maintain good records of the allowance calculations. They are useful to explain the allowance amounts to property owners, municipal council and appeal bodies. These detailed calculations do not need to be included in the report.
- The allowances are paid to the owners of each property and not to the tenants.
- The allowances should be shown separately for different sections of the drain (e.g., branch drains and drain intervals).
- If a drainage system crosses a municipal boundary, the allowances in each municipality should be shown separately.
- The total project cost identified in the engineer's final report must include the allowances.
- In past practice, allowances have not been provided to public rights-of-way and roads.

8.2.1 Determining Crop Values

To assist with calculating allowances, the engineer can determine:

- The values of standard crops used in rotation (e.g., corn-soy-wheat) for the land in the drainage watershed. The engineer can use the predominant crops or a composite average of all the county crops grown.
- The values for high-value crops (e.g., ginseng, vegetables). The engineer can apply the allowance for specific properties growing each high-value crop.

To account for fluctuations in weather and crop prices, the average crop value can be calculated over a 3–5 year period.

DID YOU KNOW? The Ontario Ministry of Agriculture, Food and Rural Affairs website – Crop Statistics (ontario.ca/omafra search for "crop statistics") is updated annually to provide current information on the values of each type of crop grown in each county. Use the data to calculate the maximum amount of crop loss a property owner may have in a construction year.

Table A8–2 is an example that was developed for Oxford County. The calculation of this value is based on the 3-year composite annual average of all crop types (not including high-value crops) and was determined to be $1,703.50/ha (rounded to $1,704/ha). This value is used in the allowance examples throughout this chapter.

Table A8-1. Example of an Allowance Schedule

Allowances

The allowances payable ($) to property owners are as follows (Sections 29–33):

				Land and Right-of-Way (Section 29)		Damages (Section 30)					Existing Drain (Section 31)	Insufficient Outlet (Section 32)	Loss of Access (Section 33)	Total
Lot or Part	**Con**	**Owner**	**Roll No.**	**Land Taken**	**Access and Maintenance Corridor**	**Lawn**	**Trees**	**Fence**	**Lands and Crops Along Drain Route**	**Lands and Crops Along Access**				
Branch 1 — ditch drain														
33	7	T. Brook	(7-071)	5,560	1,250	–	–	–	2,235	–	–	–	–	9,045
Property A	7	A. Kester	(7-070)	7,560	1,343	–	–	–	2,684	150	–	–	–	11,737
35	7	A. Robertson	(7-069)	6,200	1,426	–	–	–	2,405	–	–	–	–	10,031
Total Allowances, Branch 1				19,320	4,019	0	0	0	7,324	150	0	0	0	30,813
Branch 2 — pipe drain														
32	6	D. Smith	(6-072)	–	225	–	–	–	300	50	–	–	–	575
33	6	J. Laporte	(6-071)	–	250	–	–	–	450	125	–	–	–	825
Property B	7	S. Vander Veen	(6-070)	–	275	–	–	–	681	205	–	–	–	1,161
Total Allowances, Branch 2				0	750	0	0	0	1,431	380	0	0	0	2,561
Total Allowances				19,320	4,769	0	0	0	8,755	530	0	0	0	33,374

Notes:

1. The allowances shown for Branch 1, Property A and Branch 2, Property B are based on the examples in this chapter.
2. For demonstration purposes, this schedule shows columns for all 5 types of allowances. The schedule included in the engineer's report would normally only include allowances that are being provided.

Table A8–2. Crop Values in Oxford County

Crop	2010 Ontario Agricultural Statistics					2011 Ontario Agricultural Statistics					2012 Ontario Agricultural Statistics				
	Area Harvest (Acre)	Yield (Bu/Acre)*	Price ($/Bu)*	Value ($1000)	Unit Value ($/Acre)	Area Harvest (Acre)	Yield (Bu/Acre)*	Price ($/Bu)*	Value ($1000)	Unit Value ($/Acre)	Area Harvest (Acre)	Yield (Bu/Acre)*	Price ($/Bu)*	Value ($1000)	Unit Value ($/Acre)
Soybeans	86,900	49	19.3	82,180	945.7	169,800	44	19.59	146,360	862	70,000	54	11.1	41,960	599.4
Grain Corn	173,600	153	5.71	151,660	873.6	161,700	151	5.14	125,500	776.1	149,600	176	5.25	138,230	924
Hay	71,700	3.7	116.4	30,880	430.7	75,900	3.4	117.1	30,220	398.2	75,200	3.7	115.1	32,030	425.9
Winter Wheat	52,000	92	4.69	22,440	431.5	50,000	81	4.31	17,460	349.2	41,000	86	5.25	18,510	451.5
Fodder Corn	20,600	21.5	20.4	9,040	438.8	25,800	18.9	20.9	10,190	395	23,700	18.2	27.8	11,990	505.9
Barley	1,300	73	4.28	410	315.4	1,800	73	3.31	430	238.9	1,100	82	4.16	380	345.5
White Beans	2,000	22.5	50.51	2,270	1135	1,200	17	50.14	1,020	850	2,400	22	30.34	1,600	666.7
Spring Wheat	600	48	5.34	150	250	400	44	4.93	90	225	500	58	5.8	170	340
Mixed Grain	1,700	81	3	410	241.2	2,700	67	2.65	480	177.8	3,600	87	3.41	1,070	297.2
Oats	2,900	72	3.81	800	275.9	2,100	57	2.83	340	161.9	700	57	2.92	120	171.4
Canola	0	0	10.81	0	0	0	0	9.26	0	0	0	0	10.32	0	0
Coloured Beans	10,600	26.5	25.42	7,140	673.63	8,200	20	24.08	3,950	481.7	8,100	22.5	33.97	6,190	764.2
TOTALS	423,900	–	–	307,380	**725.12**	499,600	–	–	336,040	**672.6**	375,900	–	–	252,250	**671.06**
3-YEAR COMPOSITE ANNUAL AVERAGE:				**689.6**	$/acre	**1704**	$/ha	–	–	–	–	–	–	–	–

Notes:

1. Annual average crop values are a blended average of 11 field crops with available county statistics as compiled by OMAFRA. Although tobacco falls into this category, it is a high-value specialized crop that has been purposely omitted so as to avoid skew.
2. *Units are bushels in 75% of cases; exceptions are white beans (hundred weight (cwt)) and hay, fodder and corn (tons).

8.3 Allowances for Land and Right-of-Way (Section 29)

Allowances provided under this section are generally provided only once at the time the land is taken for the required purpose. Provide an allowance for right-of-way on all access routes and rights-of-way for both channel and pipe drains.

An allowance is provided for land taken out of production permanently as a result of the construction or improvement of a drain (Section 29(a)). This could be a new channel drain, significant widening of an existing channel drain, or lands designated as a permanent buffer, vegetated berm or grassed waterway.

This section also provides for allowances to land used as rights-of-ways for:

- access to a drainage system where required
- a maintenance corridor along the channel drainage system
- a maintenance corridor over the piped drainage system

This allowance recognizes the right-of-way for both construction and future maintenance activities. These rights-of-way are not required to be taken out of production but are to always be available for maintenance.

An allowance is provided for land taken out of production permanently as a result of the disposal of material (Section 29(b)). This could be a situation where it is not possible to restore the lands on which material is disposed of or where the lands are identified as a dyke or earth berm.

An allowance is provided for land on which a pump station is constructed (Section 29(c)).

An allowance is provided for land required to access a pump station (Section 29(d)). This assumes that the access will be used on a frequent basis such that the access will not be productive for any other purpose.

DID YOU KNOW? The allowances provided under this section do not give ownership of the land to the municipality. However, the municipality acquires a form of easement on the lands (see *Easements in Drainage* by D. O'Brien, LLB QC, 2010 Drainage Engineers Conference) (www.landdrainageengineers.com).

Where a pipe drain is constructed, the property owner maintains use of the land above the drain. An allowance:

- is not provided for the permanent use of land above the pipe drain where agricultural use is not restricted except during repair and maintenance activities
- may be provided on non-agricultural lands if it restricts the future use of the land
- is provided for access and right-of-way for repair and maintenance

When completing improvements to an existing channel drain:

- do not provide a land allowance when minor trimming or stabilization is carried out on the banks of a drain
- provide a land allowance for the additional land required if the existing channel will be widened
- do not provide a new allowance for a drain relocated on the same property, unless the new drain route results in additional land taken
- provide an allowance if the property has not previously received an allowance for access and/or right-of-way along an existing open drain

8.3.1 Allowances for Land Taken Permanently Out of Production

When calculating allowances for land or rights-of-way where the land is taken permanently out of production, consider the following sources of information:

- compensation rates that are set by local road authorities for purchasing land for road widening
- the market value of similar lands in the area
- Municipal Property Assessment Corporation (MPAC) property assessment values
- land values published by Farm Credit Canada
- in the case of unusual or difficult circumstances, the opinion of a land appraiser retained to determine land values

When constructing a new channel, an allowance for land taken should be based upon the area of land being used permanently by the drainage system and the current use of that land. This includes not only the area of the channel but also any permanent buffer or riparian area along one or both sides of the channel.

8.3.2 Allowances for Land Used Periodically

Allowances can be provided for the periodic use of land (e.g., access for construction equipment, spreading of excavated material, temporary storage of excavated and vegetative material).

For a right-of-way that is used periodically, do not give an allowance equal to the full value of the land. The allowance is based on the investment necessary today (present value) to generate a payment for crop loss for every estimated use, over the expected life of the drain, at an assumed interest rate.

The engineer should specify a **right-of-way for future maintenance** along a channel or pipe drain. The engineer should determine an allowance for the right-of-way based on:

- the width of the right-of-way — a 10 m right-of-way is sufficient to allow for most cleanouts and pipe repairs, although certain projects may require a different width
- the estimated frequency of use — e.g., the right-of-way for a ditch may be used once every 10 years and for a pipe may be used once every 25 years
- the full or partial crop value lost on each occasion the access or right-of-way is used
- the recommendation of the drainage superintendent
- the estimated life expectancy of the drain

In a right-of-way where spoil has previously been levelled, crop production may be reduced. This should be taken into consideration when determining whether the allowance is based on full or partial crop values lost.

The engineer should specify a **right-of-way for equipment access for construction** to the drain. The engineer determines the location, length and width of the access and the type of lands/crops crossed. The engineer can allow the property owner to guide the contractor to a different access route to minimize disruption to farming practices, provided it has minimal impact on the project. In some cases, the access is an existing laneway that is not cultivated, so the value of the allowance is significantly less. Where cropped lands are used for equipment access, use the same process of allowance calculation for maintenance right-of-way.

Record the calculated allowances for each property in a schedule in the report (see Table A8–1 for an example allowance schedule).

8.3.3 Example — Allowances for Land and Right-of-Way (Section 29)

In 2013, an engineer is retained to design a drain in Oxford County where the land values are $36,000/hectare. What land and right-of-way allowances (Section 29) should be provided for the following proposed construction (Figure A8–1)?

- **Property A:** A channel drain will be dug for 350 m where no channel now exists. The new channel top width will be 6 m. The working space along the drain is 10 m. The access to this work site, also located on this property, will use a dirt lane that is 300 m long. Assume the access is used once every 10 years and the contractor will leave the access in reasonable condition after the work is completed.
- **Property B:** A 300 mm diameter pipe is installed over a 250 m length with a 10 m working space. The access is 100 m long, 6 m wide and located on cropped lands. Assume the access is used once every 25 years.

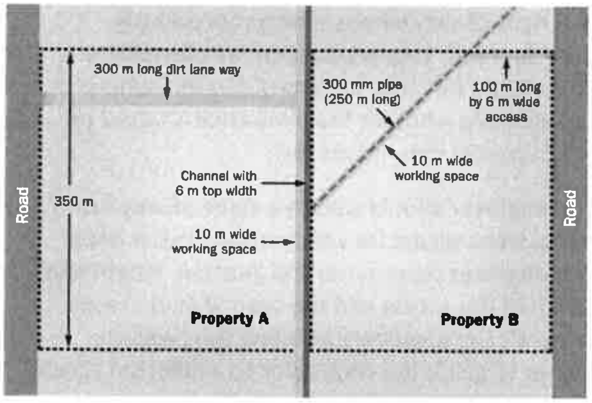


Figure A8–1. Land and right-of-way allowances.

Solution for Property A

Property A is entitled to:

a) an allowance for land permanently taken

b) an allowance for land used periodically for an access right-of-way

c) an allowance for land used periodically as a working space

Explanation:

a) Section 29 allowance for land taken permanently

The value of land taken for the 6 m wide, open channel is:

350 m x 6 m x \$36,000/ha /10,000 m^2/ha = \$7,560

b) Section 29 allowance for land used periodically for a maintenance access right-of-way

The engineer estimates an allowance of \$0.50/m each time the access is used, to compensate the property owner for the work to restore the access once the construction is complete (e.g., further levelling, gate repair, etc.).

The design life of the drain is estimated at 50 years. The number of times that the drain is estimated to be maintained is 5 times over the life of the drain.

50 years/maintenance of drain every 10 years = 5 times

Every time there is drain maintenance (in years 10, 20, 30, 40 and 50), the owner should be compensated the following amount:

Future Value (FV) = \$0.5/m x 300 m = \$150

The allowance paid today (present value) to compensate the owner \$150 (future value) in years n = 10, 20, 30, 40 and 50 using a reasonable interest rate (assumed i = 4%) is calculated as follows:

$$Allowance\ (present\ value) = \sum \frac{1}{(1+i)^n} \text{x} FV$$

$$Allowance = \left(\frac{1}{(1+0.04)^{10}} + \frac{1}{(1+0.04)^{20}} + \frac{1}{(1+0.04)^{30}} + \frac{1}{(1+0.04)^{40}} + \frac{1}{(1+0.04)^{50}}\right) \text{x } \$150$$

$$Allowance = (0.68 + 0.46 + 0.31 + 0.21 + 0.14) \text{ x } \$150$$

$$Allowance = (1.80) \text{ x } \$150$$

$$Allowance = \$270$$

The allowance paid today to compensate for future maintenance is \$270.

c) Section 29 Allowance for land used periodically as a working space

No allowance for land used periodically as working space is provided during construction (year 0), since crop damage allowance (Part A, Chapter 9.4) will be provided.

The allowance to use land periodically as a working space is paid to compensate for future crop damages in years 10, 20, 30, 40 and 50. It is also based on the rate of \$1,704/ha (Part A, Chapter 9.2.1).

The allowance is calculated as follows:

Every time there is drain maintenance, the owner should be compensated the following amount.

350 m x 10 m x \$1,704/ha / 10,000m^2/ha

= \$596 is considered the future value (FV) paid to the property owner

Using the same formula in b) the allowance is calculated by multiplying the future value by 1.8.

Allowance = 1.8 x \$596
= \$1,073

The allowance paid today to compensate for the future use of the working space is \$1,073.

Solution for Property B

Since a pipe drain is being constructed, no land is being taken out of production permanently.

Property B is entitled to:

a) an allowance for land used periodically for an access right-of-way

b) an allowance for land used periodically as a working space

Explanation:

a) Section 29 allowance for land used periodically for an access right-of-way

The design life of the drain is estimated at 50 years. The number of times that the drain is estimated to be maintained is 2 times over the life of the drain.

50 years/maintenance of drain every 25 years = 2 times

Every time there is drain maintenance (in years 25 and 50), the owner should be compensated the following amount:

FV = \$1,704/ha x 100 m x 6 m /10,000 m^2/ha = \$102

The allowance paid today (present value) to compensate the owner \$102 (future value) in years n = 25 and 50 using a reasonable interest rate (assumed i = 4%) is calculated as follows:

$$Allowance\ (present\ value) = \sum \frac{1}{(1+i)^n} \text{x} FV$$

$$Allowance = \left(\frac{1}{(1+0.04)^{25}} + \frac{1}{(1+0.04)^{50}}\right) \text{ x } \$102$$

$$Allowance = (0.38 + 0.14) \text{ x } \$102$$

$$Allowance = (0.52) \text{ x } \$102$$

$$Allowance = \$53$$

The allowance paid today to compensate for access to the drain is \$53.

b) Section 29 allowance for land used periodically as a working space

This allowance is paid to compensate for future crop damages in years 25 and 50.

The allowance is calculated as follows:

Every time there is drain maintenance, the owner should be compensated the following amount.

250 m x 10 m x $1,704/ha /10,000m²/ha

= $426 is considered the future value paid to the property owner

Using the same formula in a) the allowance is calculated by multiplying the future value by 0.52.

Allowance = 0.52 x $426
= $222

The allowance paid today to compensate for the future use of the working space is $222.

Table A8–3 summarizes the allowances provided in the example for Properties A and B.

Table A8–3. Summary of Section 29 Allowances for Properties A and B (example)

Property	Land Permanently Taken	Land Used Periodically for Right-of-way	Land Used Periodically for Working Space	Total Right-of-way Allowance
A (ditch drain)	$7,560	$270	$1,073	$8,903
B (pipe drain)	$0	$53	$222	$275

8.4 Allowances for Damages (Section 30)

Section 30 provides for allowances for damages to ornamental trees, lawns, fences, lands and crops caused by the disposal of material removed from the drainage system (Figure A8–2). These are the most common types of allowances that an engineer will encounter in a drainage project.

Figure A8–2. Damage to a soybean field resulting from drain construction.

Define a working area needed to construct the drainage project:

- On a channel, the working area is normally the channel and the adjacent lands to be used for levelling of material.
- On a pipe drain, the working area is the area expected to be damaged by equipment used for stringing out the tile, stripping soils in advance, trenching, backfilling and rough grading of the ground upon completion.

It is this working area that is entitled to allowances for damages to lands and crops (Section 30). Additional allowances for damages may be necessary on any project for access routes, clearing operations and new or reworked connections if the damage occurs outside the working area.

Record the calculated allowances for each property in a schedule in the report (see Table A8–1 for an example allowance schedule). Section 30 allowances should be separated under the applicable subheadings (e.g., ornamental trees, lawns, fences, lands and crops).

8.4.1 Ornamental Trees

The term "ornamental trees" is not defined in the *Drainage Act, 1990*. In practice, it has been used to provide allowances for all trees including those on residential properties, windbreaks, and woodlots.

Construction of a drain may damage or require the removal of some ornamental trees. The engineer's report must clearly identify which trees are to be removed, as the allowance is calculated on the value of the trees removed. Also consider an allowance for those trees that are not removed but are adversely affected by the construction. The value of trees is established with the help of local nurseries, conservation authorities and the Ministry of Natural Resources and Forestry.

Consider fruit trees in producing orchards, Christmas trees and woodlots managed for commercial production as crops. Advice on the valuation of these trees can be obtained from the Ministry of Natural Resources and Forestry, the Ministry of Agriculture, Food and Rural Affairs or private woodlot appraisers.

When a drain is constructed, the municipality acquires a right-of-way or easement along the drain. If property owners plant trees within this right-of-way without permission, allowances are typically not provided for Section 78 reports.

8.4.2 Lawns

If lawn areas are disturbed by the construction of a drainage system, the project typically provides for restoration of the lawn. Alternatively, an allowance is paid to the property owner that is sufficient to have the lawn restored by sodding. The report should clearly identify that this is an allowance for lawn damages and should define the dimensions of the area that the allowance is based upon.

8.4.3 Fences

Fences are often encountered during drainage projects. Fences are frequently restored as part of the project; however, allowances for the value of existing fences may be provided instead. Base the fence allowance on:

- The type of fence found at the time of the report and not the type of fence that the owner may want to replace it with.
- The age and condition of the fence that will be removed. When good fences may be damaged by the drain, provide an allowance sufficient to permit the property owner to reconstruct a fence of similar type.
- The property owner should receive a depreciated allowance for damage to fences that are in fair or poor condition depending on the age, condition and remaining useful life of the fence. An allowance is not given for fences that are not capable of restraining livestock.

When a drain is constructed, the municipality acquires a right-of-way or easement along the drain. Property owners occasionally erect fences within this right-of-way without permission. When calculating an allowance for the fence for Section 78 reports, the engineer needs to balance the encroachment within the easement against the environmental benefits of livestock fencing along a drain.

The report should identify the exact location of fences to be removed so that the property owner will know what the allowance applies to.

8.4.4 Lands and Crops

Allowances for damages to lands and crops caused by the disposal of excavated material provides for the temporary disruption in the productivity or use of the affected lands.

When determining allowances for damages to crops, the required working areas, access corridors and disposal areas are detailed in the report. The crop allowances are based upon these areas. There are two factors to consider when estimating the rate per hectare for damages to lands and crops:

- first-year damage, based on the type of crop planted, the value per hectare and the estimated crop loss
- the long-term damage to the land and the effects it will have on crop production over the next few years

During the first year, the actual crop loss will depend on the time of year that the construction work is carried out and the area impacted. It is difficult to estimate the actual crop loss because of unpredictable delays caused by weather conditions, approvals and appeals. When calculating the allowance, it is best to assume a total loss of crop in the working corridor. Communicate project timelines to the property owners in order to minimize crop losses.

The damage allowance should also compensate for any long-term effects on the land that would reduce crop production over the next few years. Estimate the period of time that the reduced crop production will occur and provide allowances for crop loss over that period following the initial construction year, on a declining basis.

The damage allowance for the spreading of excavated material is not only related to the area of land affected but also by the depth of material placed on the land and the quality of the material. The specifications must clearly define the area affected by the spreading and levelling work in addition to the depth to which the material will be placed. Allow for a declining percentage of crop loss in subsequent years for different depths and qualities of material.

Calculate the crop damage allowance using the following equation:

crop damage ($) = crop value ($/ha) x area affected (ha) x thickness factor x duration factor x quality factor

Where:

- crop value is determined from Part A, Chapter 8.2
- area affected is determined from the design of the drain
- thickness factor is selected based on the depth of soil to be spread on the property, as shown in Table A8–4

Table A8–4. Thickness Factor

Soil Depth	Thickness Factor
150 mm or less	1.0
300 mm	1.5
600 mm	1.75

Use a default factor of 1.0 for pipe drainage projects where no excavated material is spread or channel projects where excavated material is buried or hauled away.

Generally engineers avoid spreading excavated materials greater than 300 mm. Where a high volume of material is encountered, consider widening the working space to accommodate a 300 mm thickness.

- duration factor is calculated based on the length of time crop damage is expected to occur, as shown in Table A8–5

For pipe drains installed by a trenching machine, or channel projects where excavated material is buried or hauled away, the damages to the land and crops are generally limited to the construction year (duration factor = 1.0).

Where the trench excavation will be wide (unstable soils or deep cut conditions), some additional allowance for long-term damage (e.g., damage over a 5-year period) is reasonable for the trench area (duration factor = 3.0). The report should specify the width of the working corridor and estimate the trench width to calculate the allowance.

The quality factor is an indicator of the agronomic value of the spread material. Use Table A8–6, along with discretion, to select this factor.

Table A8–5. Duration Factor

Duration of Crop Damage	Duration Factor	Rationale
1 year	1.0	full crop loss in the first cropping year
3 years	2.0	full crop loss in the first cropping year, 67% in the 2nd and 33% in the 3rd
5 years	3.0	full crop loss in the first cropping year, 80% in the 2nd, 60% in the 3rd, 40% in the 4th and 20% in the 5th year

Table A8–6. Quality Factor

Quality of Materials	Quality Factor
Poor	1.0
Fair	0.75
Good	0.5

Note: If no soil is spread, use a factor of 1.0 because the reduced crop damages will be recognized through the thickness factor and the duration factor.

Use this method as guidance in determining allowances for crop damages. The engineer must be able to defend the calculations to the property owner receiving the allowance, the property owners contributing to the allowances and any appeal body.

Example — Crop Damage Allowances (Section 30)

In 2013, an engineer is retained to design a drain in Oxford County where the land uses are typical within the county. What crop damage allowances (Section 30) should be provided for the following proposed construction (Figure A8–3)?

- **Property A:** A channel drain will be dug for 350 m where no channel now exists. The new channel top width will be 6 m. The excavated material is primarily subsoil and is spread to a depth not exceeding 300 mm across a 10 m working area on one side of the channel. The access to the ditch will be across a dirt lane 300 m long. The 6 m width to be used for the ditch is presently so wet that in most years, no crops can be grown.
- **Property B:** A 300 mm diameter pipe is installed for 250 m length with a 10 m working space. The pipe must be installed deep, so the top width of the excavated trench will be 3 m. The access is 100 m long, 6 m wide and is on cropped lands.

Solution for Property A

Allowances for Land Damages in Working Corridor beside the Ditch ($)

Allowances for crop damage ($) = crop value ($/ha) x area affected (ha) x thickness factor x duration factor x quality factor

= $1,704/ha x (350 m x 10 m)/10,000 m^2/ha x 1.5 x 3 x 1.0

= $2,684

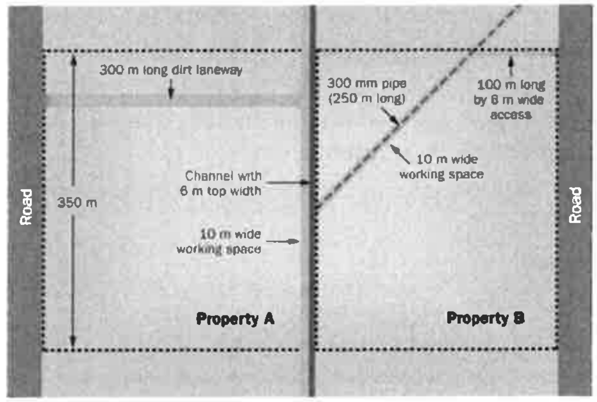


Figure A8–3. Crop damage allowances.

Note: The thickness factor used is 1.5 because the soil is spread to a 300 mm depth.

The duration factor used is 3.0 because the crop loss is assumed to occur over 5-year period.

The quality factor used is 1.0 for poor-quality material.

Allowances for Land Damages over the Access Corridor ($)

The engineer estimates an allowance of $0.50/m each time the access is used, to compensate the property owner for the work to restore the access once the construction is complete (e.g., further levelling, gate repair, etc.).

Allowances for crop damage ($) = $0.50/m x 300 m = $150

Solution for Property B

Allowances for Land Damages in Working Corridor over the Trench ($)

Allowances for crop damage ($) = crop value ($/ha) x area affected (ha) x thickness factor x duration factor x quality factor

= $1,704/ha x (250 m x 3 m)/10,000 m^2/ha x 1.0 x 3.0 x 1.0

= $383

Note: The thickness factor used is 1.0 because the soil is spread to a 150 mm depth.

The duration factor used is 3.0 because the crop loss is assumed to occur over 5-year period.

The quality factor used is 1.0 for poor-quality material.

Allowances for Land Damages in Working Corridor Adjacent to the Trench ($)

Allowances for crop damage ($) = crop value ($/ha) x area affected (ha) x thickness factor x duration factor x quality factor:

= $1,704/ha x (250 m x 7 m)/10,000 m²/ha x 1.0 x 1.0 x 1.0

= $298

Note: The duration factor used is 1.0 because the crop loss is assumed to occur in one year only. Use 1.0 for the thickness and quality factors since no soil is spread.

Allowances for Land Damages over the Access Corridor ($)

Allowances for crop damage ($) = crop value ($/ha) x area affected (ha) x thickness factor x duration factor x quality factor:

= $1,704/ha x (100 m x 6 m)/10,000 m²/ha x 1.0 x 2.0 x 1.0

= $204

Note: The duration factor used is 2.0 because the crop loss is assumed to occur over 3 year period. Use 1.0 for the thickness and quality factors since no soil is spread.

Table A8–7 provides a summary of the Section 30 allowances for properties A and B.

Table A8–7. Summary of Section 30 Allowances for Properties A and B

Property	Working Corridor	Access Corridor	Total Allowance
A (ditch drain)	$2,684	$150	$2,834
B (pipe drain)	$681	$204	$885

8.5 Allowances for Existing Drain (Section 31)

Section 31 authorizes the engineer to incorporate a private drain into the municipal drainage system and to compensate the owner for its value. The challenge is to provide an allowance that is both fair not only to the owner(s) of the private drain who paid the original capital costs but also to the other property owners in the watershed who will make use of the drain and will contribute towards the cost.

The valuation of a private drainage system is dependent on its condition and its value to the municipal drainage system. The calculation of this allowance may require the engineer to estimate the cost of constructing the drain two different ways:

- assuming the existing private drain is not present
- assuming the existing private drain is incorporated into the new drain

The allowance provided to the owner of the private drainage system is the difference between these two cost estimates (the cost savings).

In calculating the estimates of the cost to incorporate the existing drain, consider the following:

For a ditch:

- Assess the value of the past ditch construction if the ditch is of suitable depth, capacity and location.
- Assess the condition of the existing ditch (e.g., brush and tree cover, soil suitability, bank stability, sediment deposition) and the cost for repair, maintenance or improvement needed to provide the required depth and capacity.

For a pipe:

- Estimate the capacity of existing pipe. Determine if the added capacity provided by the private drain is of value to the proposed municipal system.
- An existing private pipe provides some drainage capacity, but if it is old, it may have very limited value to the municipal system.
- An existing pipe that is full of sediment or shows signs of deterioration may have limited value to the municipal system.
- Calculate the actual cost of the existing pipe installation if the pipe is adequate in all respects for incorporation into the municipal drainage system.

If the engineer intends to incorporate a private drain that has very little value into a municipal drainage system, the report should include a nominal allowance under this section.

8.6 Allowances for Insufficient Outlet (Section 32)

Drainage systems must be taken to a sufficient outlet (Section 15), with one exception. A sufficient outlet is defined as a point at which water can be discharged safely so that it will do no damage to lands or roads. The exception to this requirement is to provide compensation to the affected property owners instead of taking the drain to a sufficient outlet (Section 32).

It may be less expensive to provide an allowance to compensate property owners rather than to construct a drain to a sufficient outlet for situations such as:

- a drain that would continue through a wetland or woodlot
- a drain that would require addressing conditions imposed by regulatory agencies
- land periodically used for water storage by design or agreement

Allowances for insufficient outlet are provided only once to affected properties unless further improvements on the upstream drainage works are undertaken. When drain improvements are considered, only the incremental increase in potential damages should be compensated.

Compensation paid for insufficient outlet is normally not more than the market value of the land that would be subject to increased flooding. Provide an allowance for the incremental increase in damages caused by the drainage system as determined through a hydrologic and hydraulic analysis. The frequency and extent of incremental flooding, land use and crop loss values are important considerations in determining compensation.

Allowances for an insufficient outlet can address:

- an insufficient outlet related to an existing drainage works or
- an anticipated insufficient outlet resulting from a new upstream project

Part A, Chapter 9 presents how the difference between these two situations of insufficient allowances is assessed.

8.7 Allowances for Loss of Access (Section 33)

The *Drainage Act, 1990* requires the engineer to provide property owners with access to their land through the construction of bridges and culverts (Section 18). As an exception, an allowance may be provided to a property owner for the loss of access to their land caused by the drain (Section 33).

Usually, an allowance for loss of access is provided only once. When determining this allowance, estimate the value for the following:

- cost of constructing a suitable bridge or crossing in the drain
- the value of the land cut off from the rest of the property by the new drain
- the reduction in the market value of the entire property once the new drain is constructed

The allowance for the loss of access should be the lesser of these values to appropriately compensate the property owner while also being fair to the remainder of the assessed watershed.

The following are two examples where loss of access allowances may be used (Figure A8–4).

Loss of Access — Example 1

The construction of a channel municipal drain will cut off a 1 ha section of farmland and 6 ha of woodlot from the rest of Property A. The cleared land is worth $5,000/ha, the woodlot is $1,000/ha, and a crossing to access this land will cost $15,000. If the engineer decides not to provide a crossing, the allowance (Section 33) provided to the property owner is the lesser of:

- 1 ha of farmland @ $5,000/ha + 6 ha of woodlot @ $1,000/ha = $11,000
- cost of crossing = $15,000

The loss of access allowance for Property A would be $11,000.

Loss of Access — Example 2

The construction of the same channel municipal drain will cut off a 5 ha section of farmland and 2 ha of woodlot from the rest of property B. The cleared land is worth $5,000/ha, the woodlot is $1,000/ha, and a crossing to access this land will cost $15,000.If the engineer decides not to provide the owner with a crossing, the allowance (Section 33) provided to the property owner is the lesser of:

- 5 ha of farmland @ $5,000/ha + 2 ha of woodlot @ $1,000/ha = $27,000
- cost of crossing = $15,000

The loss of access allowance for Property B would be $15,000.

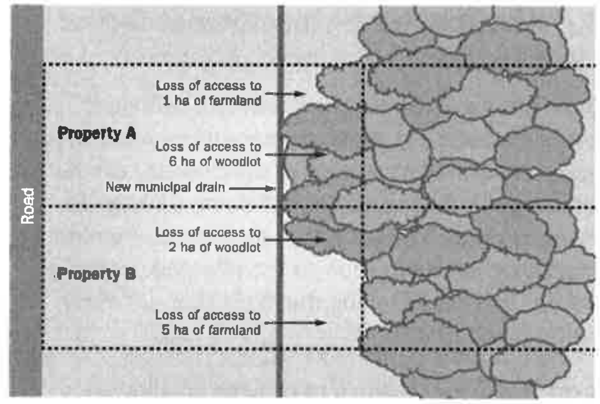


Figure A8–4. Loss of access allowance.

DID YOU KNOW? When allowances are provided under Sections 32 or 33, the municipality must register a copy of the by-law adopting the report in the local land registry office (Section 68). It must include a statement of the amount paid and the description of the land to which it was applied. This is to ensure future owners are aware that their land has received compensation.

CHAPTER 9

COST ESTIMATES AND ASSESSMENTS

9.1 Introduction

All reports are required to contain an assessment schedule to distribute the costs of the project over the lands and roads within the drainage area (Section 8(1)(c)).

The *Drainage Act, 1990* allows for the following types of assessments:

- benefit (Section 22)
- outlet and injuring liability (Section 23)
- special benefit (Section 24)
- increased costs to public utilities and road authorities (usually called special assessments) (Section 26)

The assessment principles used in this guide are based on the methodology outlined in the following two papers:

- *Drainage Assessment Revisited* by E. Dries, P.Eng. and H. Todgham, P. Eng., (1988 Drainage Engineers Conference)
- *Increased Costs due to Roads and Public Utilities — Section 26 of the Drainage Act* by J. Andrew McBride, P. Eng. and Jeffrey R. Dickson, P.Eng. (1999 Drainage Engineers Conference)

These papers are found on the OSPE Land Drainage Committee website (www.landdrainageengineers.com).

9.2 Cost Estimates

The cost of the proposed drainage system must be estimated before the assessments to individual properties are determined.

9.2.1 Cost Components

The cost estimate for a drainage system usually has five broad components: allowances, construction, engineering (Section 70), eligible municipal administration and contingencies. All of these costs, with the exception of allowances, are estimates.

Allowances

For more information on how to calculate allowances, see Part A, Chapter 8 Allowances.

Construction

Based upon the design, estimate how much the drainage system will cost to construct. In developing the estimate, consider:

- construction costs on similar projects in the area
- price lists from suppliers
- costs of non-standard construction items and methods
- physical landscape
- time of year of construction
- availability of contractors and equipment

Engineering

Engineering fees and expenses include meetings, drain survey, design, report preparation, contract administration and construction supervision (Section 70). The costs contained in the report should be a combination of the actual known costs incurred up to the submission of the report and the estimated costs to be incurred after the submission of the report.

The costs for the engineer to appear before appeal bodies to defend the report are not normally included in the engineering cost estimate since appeals cannot be anticipated. This assumption should be clearly stated in the report. However, these costs are eligible as part of the project and can be recovered by the municipality (Section 73).

Eligible Municipal Administration

Administration costs include items such as financing, legal and permitting fees, applicable taxes, office expenses and costs of non-council court of revision members, etc. Administrative costs should not include municipal council or staff time (Section 73(2) and (3)).

Contingency

Include a contingency allowance for unforeseen items that could be encountered during the project. If a contingency allowance is included, outline the purpose and application of this portion of the cost estimate.

9.2.2 Developing the Cost Estimate

List the assumptions used or the limitations of the cost estimate in the report. While accurate cost estimates are important, it is wise to estimate conservatively for the following reasons:

- Assessed property owners are more receptive to a final cost that is at or below the estimated price.
- A tender price that is 33% higher than the engineer's construction cost estimate requires an additional meeting where petitioners can terminate the project (Section 59).

The report must contain a separate cost estimate of:

- the work impacted by road authorities and/or public utilities (Section 26)
- the work in each municipality affected (Section 27)
- the work within boundary road allowances (Section 27)
- lateral drains (Section 37)

DID YOU KNOW? Lateral drains are defined in Section 1 of the *Drainage Act, 1990* as a drain that is designed for the drainage of one property and begins and ends on the same property.

9.2.3 Cost Estimates by Interval

The cost estimate can be developed on an interval-by-interval basis. Intervals are defined as:

- recognizable man-made features such as roadways, railways or property lines
- recognizable watershed features such as branch drains, private drains or other locations where sub-watersheds enter the drainage system
- the point where private drainage systems have been incorporated into the drain

Developing cost estimates by interval is also important for assessing these costs (Part A, Chapter 9.5.3). Samples of cost estimates developed by interval are included in the Case Study (Part A, Chapter 15).

9.3 Assessment Types

The *Drainage Act, 1990* gives authority to assess lands, roads and public utilities for benefit, outlet and injuring liability, special benefit and special assessments.

9.3.1 Assessments for Benefit (Section 22)

General Principles of Benefit

Benefit, as defined by the Act, means the advantages to any lands, roads, buildings, utilities or other structures from the construction, improvement, repair or maintenance of a drainage system that result in:

- a higher market value
- increased crop production
- improved appearance
- better control of surface and subsurface water
- easier and reduced maintenance
- other advantages

The assessment for benefit is made based upon the improvement to the lands, roads, buildings, utilities or other structures that result from the drainage system. The benefit assessment should not be influenced by the current owner.

Examples of benefits to lands, roads, buildings, utilities or other structures resulting from a drainage system include:

- draining water more efficiently by constructing new drainage systems, deepening existing channels, installing pumps or increasing downstream capacity
- reducing flooding
- cutting off the natural flow of surface water from adjoining lands (cut-off benefit)
- reducing peak flow across downstream lands with the use of stormwater management facilities
- managing channel vegetation and obstructions to improve appearance and hydraulic efficiency
- reducing drain bank erosion
- replacing a channel with a pipe
- constructing a piped drain with more capacity
- providing drainage for the granular bases, embankments and/or boulevards of roads
- providing a crossing over a channel

The *Drainage Act, 1990* can also be used to create or enhance natural areas. In these situations, examples of benefits to lands, roads, buildings, utilities or other structures include:

- managing water to provide specific property benefits for natural habitat, wetland restoration or enhancement
- replacing a pipe with a channel (called daylighting)

The engineer should be able to support the benefits assigned to each property.

Benefit Assessment Principles

"Benefit value" is the estimated value the drain provides to a property, and "benefit assessment" refers to the share of the cost of the drain assessed as benefit to a property. Benefit assessments are based on the benefit value to each property and are not proportional to watershed areas. However, when the benefit value to a property is for increased market value, the property size may be a factor.

Properties alongside or immediately upstream of the proposed drain are typically assessed benefit, with the majority being assigned to the properties in the vicinity of the drain. The exceptions to this are the following:

- Downstream properties can be assessed for cut-off benefit for stormwater management measures constructed to reduce peak flow.
- Specific upstream properties or tributary sub-watersheds can be assessed for benefit if they receive a drainage improvement beyond that received by other properties.

Protected wetlands that discharge into a drain should not be assessed for benefit. When projects protect or enhance a wetland, the wetland property may be considered for benefit assessment.

When assigning benefit value to lands covered with trees and brush, consider the future use of the land. If the property owner will be able to clear and cultivate the land, then the benefit value assigned to the property should be the same as land already under cultivation. However, if there are regulatory restrictions on clearing land, then assign benefit value to the land as trees and brush.

Example #1 of Benefit Value Calculations

A piped municipal drain is proposed in a watershed that consists primarily of agricultural lands that will reach their maximum yield potential with systematic drainage (Figure A9–1).

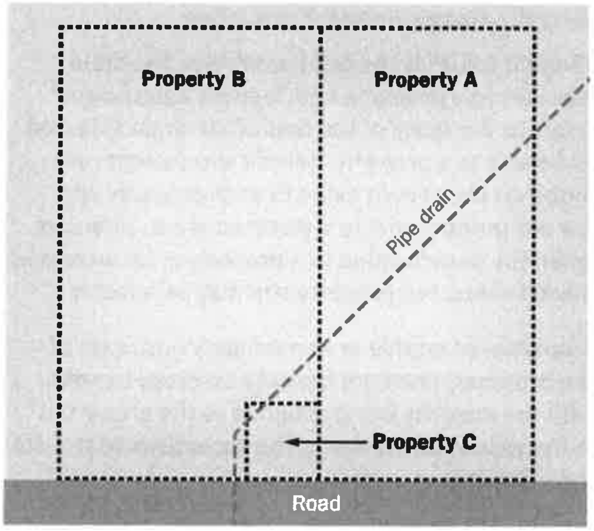


Figure A9–1. Benefit value calculations.

The engineer has determined that:

- Average crop values are \$2,500/ha.
- 50% of average crop value is the net income after input costs (e.g., planting, harvesting, cultivation, insurance, depreciation).
- Subsurface drainage systems are being installed at a spacing of 10 m.
- Without the municipal pipe drain, a strip of land varying from 20-40 m in width (minimum) along the drain route is currently unavailable for cropping due to seasonal wetness. The benefit value is the ability to crop that strip of land to achieve a full net income of \$1,250/ha/year.
- Properties in which the proposed drain is situated may experience the following benefits:
  - The new drain may replace at least one lateral drain on each traversed property.
  - The header tile size for private systems could be reduced since it can be joined periodically to the municipal drain at controlled locations or structures.
  - The new drain allows the owner to connect any systematic drainage scheme to a municipal outlet without having to traverse other properties.
  - The new drain provides some subsurface and surface drainage benefits to that property.
- The market value of drained farmland in the area is \$37,000/ha.
- The market value of undrained farmland in the area is \$31,000/ha.

Example #2 of Benefit Value Calculations

Using the information in this example, what are the benefit values for a 15 ha agricultural property (Property A) in the watershed that is traversed by 200 m of drain?

Benefit Value for Better Surface Water Drainage

Due to a lack of drainage, Property A has a 40 m strip of land that experiences:

- total crop failure once every 10 years
- 50% crop failure three times every 10 years
- full crops in the remaining years

With the construction of the drain, the property will be able to crop the 40 m strip of land every year.

For this example, the engineer estimates the total crop loss as:

(40 m wide x 200 m long)/10,000 m^2/ha x \$1,250/ha (net income) = \$1,000/year

Since total crop loss does not occur every year, the engineer estimates the average annual benefit value as:

$$= \frac{(\$1{,}000/yr \times 1\ yr) + (0.5 \times \$1{,}000/yr \times 3\ yrs) + (0 \times \$1{,}000/yr \times 6\ yrs)}{10\ yrs}$$

Average Annual Benefit Value = \$250/yr

The benefit value for the construction of the drain (present value) to account for the annual increase in crop production of \$250/yr over the life of the drain (n = 50 years), using a reasonable interest rate (assumed i = 4%), is calculated as follows:

$$Benefit\ Value\ (present\ value) = \frac{(1+i)^n - 1}{i(1+i)^n} * Annual\ Increase$$

$$Benefit\ Value\ = \left(\frac{(1+0.04)^{50} - 1}{0.04(1+0.04)^{50}}\right) \times \$250$$

$$Benefit\ Value\ = (21.5) \times \$250$$

$$Benefit\ Value = \$5{,}375$$

The benefit value for the construction of the drain (present value) to account for the annual increase in crop production is $5,375.

Benefit Value for Subsurface Water Drainage

For this example, the engineer judged the benefit value to this property was equivalent to the cost savings of not having to install a 100 mm diameter pipe drain along the route of the new municipal tile. This means that one less lateral drain is required. The cost for a 100 mm pipe was estimated to be $10/m. The engineer estimates the subsurface water drainage benefit value as $10/m x 200 m = $2,000.

Benefit Value for Direct Connection

Without a municipal drain, very few properties have the ability to directly connect to an outlet. The municipal drain traversing a property provides a direct connection benefit value. The benefit value for this property is calculated as the average cost for other properties to construct a private drain to reach an outlet.

For this example, it is assumed that the cost to connect a typical private drain (in this watershed) to a sufficient outlet would involve 300 m of 150 mm pipe at a cost of $4,500 (300 m x $15/m).

Benefit Value for Increased Market Value

A municipal drain can increase the market value of a property. For this example, the engineer estimated:

- the value of drained farmland in the area (excluding buildings) was $37,000/ha
- the value of undrained farmland in the area was $31,000/ha
- the net difference is an increased market value of $6,000/ha
- the cost to install a private subsurface drainage system is estimated $3,000/ha

The benefit value is calculated by subtracting the private drainage costs from the increased market value ($6,000/ha – $3,000/ha = $3,000/ha).

The benefit value for the property is $3,000/ha x 15 ha = $45,000.

Solution

The following benefit values are attributed to the 15 ha agricultural property, traversed by 200 m of drain:

- benefit value for better surface water drainage = $5,375
- benefit value for subsurface water drainage = $2,000
- benefit value for direct connection = $4,500
- benefit value for increased market value = $45,000
- Total benefit value = $56,875

This benefit value ($56,875) is used to determine benefit assessment in Part A, Chapter 9.5.3.

9.3.2 Outlet and Injuring Liability Assessments (Section 23)

General Principles of Outlet and Injuring Liability

Under common law, surface water has no right of drainage. If surface water is collected and discharged on to a lower property, it can be a liability. Lower property owners may protect their property from surface water discharge by building berms, dykes or other protective measures. The drainage of surface water is not an inherent right for all properties, but can be acquired through the use of the *Drainage Act, 1990.*

Under the *Drainage Act, 1990,* this right is acquired through the outlet and injuring liability assessments. Outlet liability assessments may be levied for construction completed to avoid the downstream damages. Injuring liability assessments are levied for construction completed to address situations where damages are occurring.

Outlet liability assessments (Section 23(1))

Outlet liability assessments are made to lands and roads to allow them the right of drainage into a drainage system either directly or indirectly through the medium of any other drainage works or of a swale, ravine, creek or watercourse. To assess for outlet liability, the engineer must be able to show that either

- the lands can be more effectively drained after completion of the work than before because they will have a new or improved outlet that they did not have before; or
- the work is necessary in order to carry the drain to a "sufficient outlet" so that the water can be discharged safely and will do no injury to lands or roads.

Injuring liability (Section 23(2))

When an upstream property owner collects surface water and causes it to flow upon and injure any other land or road, the property owner may be liable for damages under common law. When a drainage system is constructed under the *Drainage Act, 1990,* this upstream property owner may be assessed for **injuring liability.**

To assess for injuring liability, the engineer must be able to show that either

- the construction of the drainage system will remove existing injury to downstream lands; or
- an allowance under Section 32 has been provided to the injured lands rather than constructing a drainage system to address the existing injury.

DID YOU KNOW? Most engineers today combine both outlet and injuring liability assessments. Engineers increasingly avoid distinguishing injuring liability assessments because it is difficult to show clearly that downstream lands were previously being injured by water being drained by artificial means.

Assessments for both outlet liability and injuring liability are based on the **volume** and **rate of flow** of the water **artificially caused to flow** into the drainage system from the lands and roads liable for such assessments (Section 23(3)).

The engineer must consider if there have been any activities on the land that have caused water to artificially flow onto other lands and/or roads. If any activities have occurred that actually caused the volume or rate of flow of water to increase, then assess the lands or roads for outlet or injuring liability. Examples include:

- land clearing
- cultivation of lands
- private subsurface drainage systems
- improved surface drainage systems
- roads
- subdivisions
- commercial, industrial or institutional activities and structures

A component of the basis for outlet and injuring liability assessments is the term "artificially caused to flow." This introduces an uncertainty whether properties that have natural drainage (e.g., wetlands, forested areas) should be assessed for outlet liability. Some engineers will assess these properties a small amount because the lands are marginally connected to the drain (Section 23(1)). Others will not assess these properties because the land does not artificially cause water to flow (Section 23(3)). In deciding to assess outlet liability, the engineer should consider whether there has ever been a land use change or a ditch on an adjacent property that has altered runoff.

Do not assess lands that generate no flow into the drainage system. Examples may include extraction pits (not discharging into the drain) and sinkholes.

Consider riparian properties that have the right to drain into a natural watercourse. The decision to assess or not assess riparian owners is controversial. A referee decision indicates that riparian owners can be assessed (O'Brien Referee Decision, 2002, Town of Bradford-West Gwillimbury and Township of King et. al. (www.canlii.org)). If a decision is made to assess riparian property owners, provide a rationale for this decision in the report.

It is impossible to accurately determine the volume and rate of flow from a property. Therefore, most engineers use an equivalent areas method of calculating the outlet or injuring liability assessments.

The Equivalent Areas Method to Distinguish Volumes and Rate of Flow

The equivalent areas method is a technique used to simplify the process of calculating the outlet or injuring liability assessment. The liability assessment on a parcel of land is based on the "volume and rate of flow of water artificially caused to flow," which varies with factors related to land use, soil type and surface conditions (e.g., depressions, gradient and land cover).

Using the predominant land use in the watershed as the benchmark, determine an appropriate factor based on coefficients of runoff (runoff factor C) to recognize different land uses, soil types and surface conditions that exist in the watershed. An example for developing the factors is provided in Table A9–1.

For the purpose of the table, cropped clay loam soils with 1% gradients is the predominant land use, soil and gradient in the particular watershed. This was selected as the benchmark and assigned an equivalent area value of 1. The equivalent area adjustment factor for the other land use, soil and gradients are calculated by proportioning the C value.

The equivalent area adjustment factor = runoff factor C/benchmark C

There are situations where a portion of a property contributes surface water to the drain, but subsurface water is directed out of the watershed. There may also be situations where a property is not within the watershed of a drain, but its subsurface drainage system is connected to the drain (this situation is called split drainage). An equivalent area adjustment factor ranging from 0.33 to 0.67 can be used to acknowledge the reduction in the volume and rate of water artificially caused to flow to the drain.

DID YOU KNOW? A study conducted by MTO, *Municipal Drains — Outlet Liability Assessment Factors for MTO Highway Rights of Way*, showed that the equivalent area adjustment factor for provincial highways is calculated by determining the average C factor for the roadway by factoring the overall width, the width paved, the width with gravel and the width in grass. The study results are found on the MTO website (ontario.ca/mto).

Table A9–1. Examples of Adjustment Factors in the Equivalent Area Method

Soil Type	Gradient	Land Use	Runoff Factor C*	Calculation	Equivalent Area Adjustment Factor
Clay Loam	**1%**	**Cropped Agricultural**	**0.3**	**0.3/0.3**	**1**
Clay Loam	1%	Permanent Pasture	0.2	0.2/0.3	0.67
Clay Loam	5%	Cropped	0.4	0.4/0.3	1.33
Clay Loam	1%	Forest	0.15	0.15/0.3	0.5
Sands	1%	Cropped Agricultural	0.25	0.25/0.3	0.83
Clay	1%	Residential	0.4	0.4/0.3	1.33
Paved Road	–	Paved Local Road	0.6	0.6/0.3	2.0
Gravel Road	–	Gravel Local Road	0.4	0.4/0.3	1.33
Muck/Organic	0.2%	Cropped	0.15	0.15/0.3	0.5
Muck/Organic	Depressional	Previously Cleared/Some Overflow	0.06	0.06/0.3	0.2
Gravel Pit (no artificial discharge)	Depressional	No Overflow, No Subsurface Connection	0.0	0.0/0.3	0

*Consult hydrology tables for a comprehensive listing of runoff factor C (Part B, Chapter 2).

Example

J. Smith owns a property that is 15.6 ha in total that drains into a drainage system. The land consists of 13.2 ha agricultural and 2.4 ha forest (Figure A9–2). Of the agricultural land, subsurface drainage on 0.8 ha is directed out of the watershed.

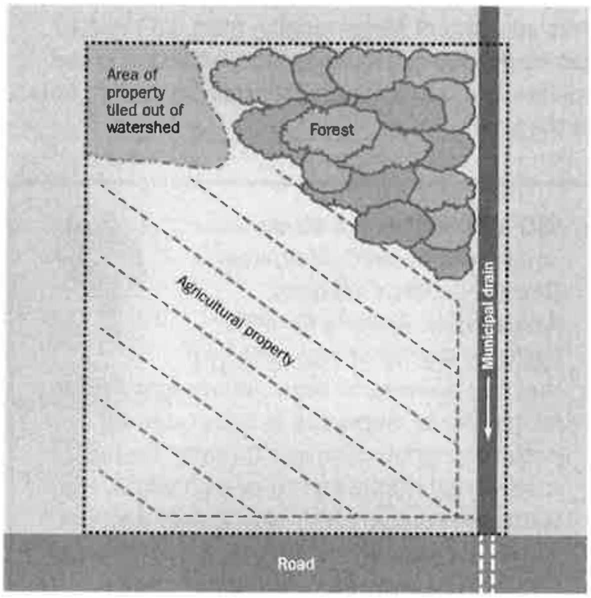


Figure A9–2. Equivalent area calculation.

Perimeter Factor

Some properties with smaller acreages and good natural drainage near the perimeter of the watershed may be assessed for multiple drain intervals and their overall assessment may become unreasonably high. To address this, a perimeter factor is applied to a property for a fairer distribution of costs. This value could typically range between 0.2 and 1.0, based upon the engineer's opinion.

Some engineers do not apply this factor. In this case, eliminate the factor when calculating the total adjusted area.

Equivalent Length Factor

An equivalent length factor is used to account for a property's use of a drain interval:

- If a property is upstream of a drain interval (uses the entire interval), assign an equivalent length factor of 1.
- If a property is downstream of a drain interval (does not use the interval), assign an equivalent length factor of 0.
- If a property is located within an interval, it does not make full use of the drain interval and should not be assessed the full outlet/injuring liability assessment. An equivalent length factor is calculated and applied to the property.

Table A9–2 calculates the equivalent area for this property.

Table A9–2. The Calculated Equivalent Area (example)

Land Use	Equivalent Area Adjustment Factor	Actual Area (ha)	Equivalent Area Calculation	Equivalent Area (ha)
Agricultural	1.0	12.4	12.4 x 1	12.4
Split drainage	0.5	0.8	0.8 x 0.5	0.4
Forest	0.5	2.4	2.4 x 0.5	1.2
TOTAL	–	**15.6**	–	**14.0**

Example

A 30 ha property is at the downstream end of the drain interval. It should not be assessed at the same rate as a property at the upstream end of the interval for the liability assessment. This is because it does not make use of the full length of the interval. It is determined that 10 ha of the property outlets to the lower one-third of the drain, 5 ha outlets to the middle third (therefore uses two-thirds of the interval), and the balance of 15 ha drains through the full interval (Figure A9–3).

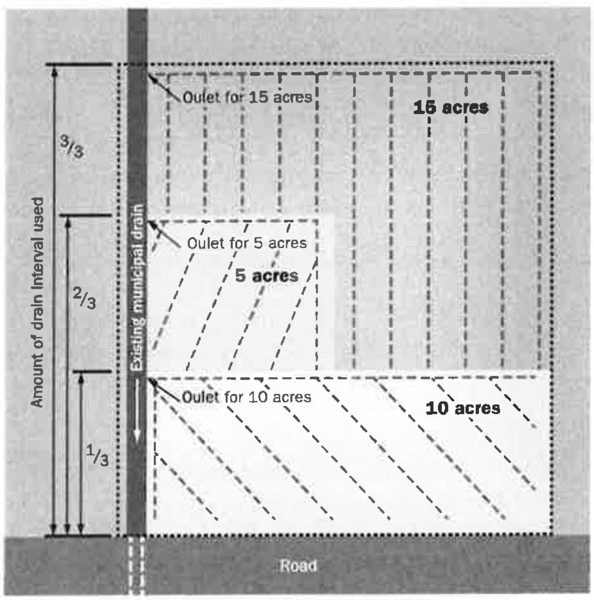


Figure A9–3. Equivalent length calculation.

Table A9–3 calculates the equivalent length for this property.

Table A9–3. The Factor for Equivalent Length (example)

Area (ha)	Proportion of Interval Used	Calculation
15	1.0	15 ha x 1.0 = 15.0
5	0.67	5 ha x 0.67 = 3.33
10	0.33	10 ha x 0.33 = 3.33
Total = 30	–	Total = 21.66

The equivalent length factor is 21.66/30 ha = 0.72.

Total Adjusted Area

The total adjusted area for each property in an interval is calculated using the equivalent area calculated in Part A, Chapter 9.3.2 multiplied by the perimeter factor (if applied) and equivalent length factor.

9.3.3 Assessments for Special Benefit (Section 24)

General Principles of Special Benefit Assessments

Special benefits as defined by the Act are any additional works or features included in the construction, repair or improvement of the drainage system that have no effect on the functioning of the drainage system. The engineer may assess a property for a special benefit where a feature provides value only to the individual owner and not the entire watershed and/or where it is not required for normal use of the property (Figures A9–4 to A9–6).

Some examples may be:

- an extra-long crossing
- special surface treatment over a crossing
- aesthetic features (e.g., decorative crossing end walls, coloured stone, plantings)
- lawn piping (enclosing an existing drain through a lawn)
- stripping of top soil, applying excavated material and replacing the top soil
- relocation or realignment of the drain for the benefit of one specific property
- additional private connections (e.g., surface water inlets, rock chutes, tile outlet pipes)
- extra structures to allow for future private connections to a piped drain
- private utilities

Figure A9–4. A crossing with decorative end walls.

Source: Municipality of Chatham-Kent, Ontario.

Figure A9–5. A private crossing with an asphalt surface (side view).

Source: Municipality of Chatham-Kent, Ontario.

Figure A9–6. A private crossing with an asphalt surface.

Source: Municipality of Chatham-Kent, Ontario.

DID YOU KNOW? ADIP policies identify some cost items (e.g., second crossing) that are not eligible for the provincial grant. Indicate these items in the report.

There are situations where, in the engineer's opinion, the cost of a single drain feature could be assessed using any combination of benefit and special benefit to the property owner or outlet liability to the upstream owners. The engineer should document these decisions in the report.

Normally costs on a drainage project are pro-rated, but the engineer may decide, based on the value and uniqueness of the feature, to make an exception for the cost of special benefit features. If the cost of the special benefit feature is not to be pro-rated, keep the costs of the special benefit feature separate and assess the actual cost to the property owner. If a portion is not to be pro-rated, provide rationale in the report to calculate the cost of the benefit and the special benefit assessed to the property owner and the remaining costs assessed to the watershed.

DID YOU KNOW? The actual cost of a drainage works will differ from the cost estimated by the engineer. This difference in cost is applied proportionately to all assessed properties based on the assessments in the engineer's report. This practice is known as pro-rating the cost.

Example

The owner of a property requested that an existing 9 m crossing be replaced with a culvert 13 m long due their equipment requirements. The engineer determined that it was reasonable to provide the owner with a crossing, but that the culvert only needed to be 9 m long. The engineer was of the following opinion:

- The cost of the 4 m additional length should be assessed as a special benefit.
- The cost of the 9 m length should be assessed as benefit and outlet liability. The engineer decided that 40% of this cost is assessed as benefit and the remainder (60%) as outlet liability.
- All assessments are pro-ratable.

Proposed work cost estimate:
13 m pipe culvert with cost of $12,000

Special benefit assessment to property
(4 m/13 m = 0.3 of total cost):
$3,600

Remaining cost to drain:
$8,400

Benefit assessment to property (40% of $8,400)
$3,360

Outlet liability assessment to the upstream watershed (60% of $8,400) $5,040

9.3.4 Increase in Cost Due to Public Utilities and Roads (Section 26)

General Principles of Section 26 Assessments

If they own land, road authorities and public utilities are assessed similar to other property owners.

Regardless of whether they own land, the road authority and public utilities are assessed all the increase of **the actual cost** of the drainage system caused by the existence of the road or public utility. This is often called a special assessment (Section 26).

There may be debate over who pays these additional costs because of:

- the application of the provincial *Drainage Act, 1990* to federally chartered bodies
- Franchise Agreements (Part C, Chapter 8)
- the provisions of the *Public Service Works on Highways Act, 1990*
- Municipal Access Agreements under the federal *Telecommunications Act, 1996*

It is the duty of the municipality, in consultation with the road authority or public utility, to determine how the assessment will be paid. These details are not included in the engineer's report.

DID YOU KNOW? Advise the municipality that they should tender separately or provide a specific line item in the tender for works involving a public utility or road authority to facilitate the calculation of actual costs. The separate tender can be cancelled or the construction line item removed, should the utility or road authority decide to complete the work themselves (Section 69). The municipality should also ensure the tender allows for calculation of unit costs of works adjacent to the road or public utility to allow for actual equivalent drain costing.

Section 26 normally applies where a drain crosses or proposes to cross a road or public utility. However, there may also be increased costs from a drain running adjacent to a road or public utility or by following a different route to avoid a crossing of the road or public utility.

DID YOU KNOW? Road authority is defined in Section 1 of the *Drainage Act, 1990* and includes all public roads such as municipal, county, regional and provincial roads. It does not include private roads.

DID YOU KNOW? Public utility is defined in Section 1 of the *Drainage Act, 1990* and includes services such as railways, telephone, natural gas, electricity, water, sewers or any other works that supply the general public with necessities or conveniences (e.g., cable TV). It does not include private utilities.

Estimating the Total Cost and the Increase in Cost

The following is a suggested four-step process to apply Section 26 when preparing the assessment schedules.

1. Estimate the construction cost for the section (or interval) of the drain that includes the road or public utility.
2. Estimate the construction cost of the same section of drain, assuming that the road or public utility was not present (equivalent drain cost). Provide a rationale for the equivalent drain cost to be used.
3. Estimate the engineering and eligible municipal administration cost:
   a) associated with the construction of a road or public utility crossing
   b) assuming that the road or public utility was not present

Determine the increased costs due to the presence of the road or public utility by subtracting b) from a). Maintain record of the actual engineering and eligible municipal administration costs for final cost calculations.

4. Calculate the Section 26 assessment by taking the estimated cost from Step 1, subtracting the equivalent drain cost from Step 2 and adding the additional engineering and administrative costs from Step 3.

Presenting the Estimated Special Assessments in the Report

The engineer should include the following in the report:

- A summary of the authority of Section 26 of the *Drainage Act, 1990* that indicates that the increase in cost caused by road or public utility is to be assessed to them. Lands exempt from taxation are still assessed and must pay their Section 26 assessment.
- A summary of Section 69 of the *Drainage Act, 1990* that provides the option for a public utility or road authority to perform the work on their right-of-way themselves. This may not eliminate a special assessment, since increased engineering and eligible municipal administration costs may still apply.
- Include a table that shows the calculations of the estimated increase in costs.

Calculating the Actual Increase

After construction, it is the actual increase in cost that is charged to the road authority or public utility. While determining the actual costs is a municipal responsibility, the engineer may be asked to assist. The same four-step process to calculate the Section 26 assessment should be repeated with actual costs. This can conveniently be done as shown in Table A9–2. The engineer must separately identify and document:

- the actual construction cost for the section of the drain that includes the road or public utility
- an updated equivalent drain cost based on the tendering for the work completed in the adjacent land use
- the actual increased engineering and administration fees as tracked through report processing and construction

Example of a Special Assessment Calculation

Existing conditions

At a road crossing, the land on each side of the road is agricultural and is serviced by a 450 mm pipe that flows towards and crosses the road. There is an existing catch basin (A) upstream of the road to catch roadside drainage. At the downstream side of the road, a 300 mm pipe drain, servicing agricultural land, is connected with an existing catch basin (B). Downstream of the connection is a 525 mm pipe drain. The road right-of-way (ROW) is 20 m wide, but the pipe crosses the road diagonally and is 29 m in length (Figure A9–7).

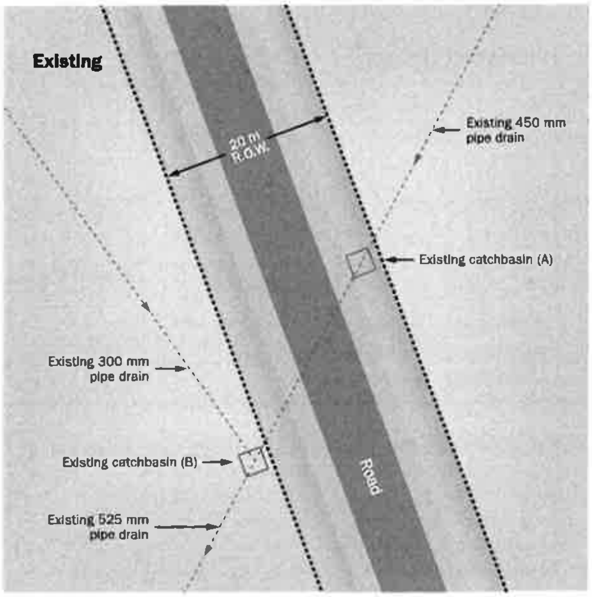


Figure A9–7. Existing conditions.

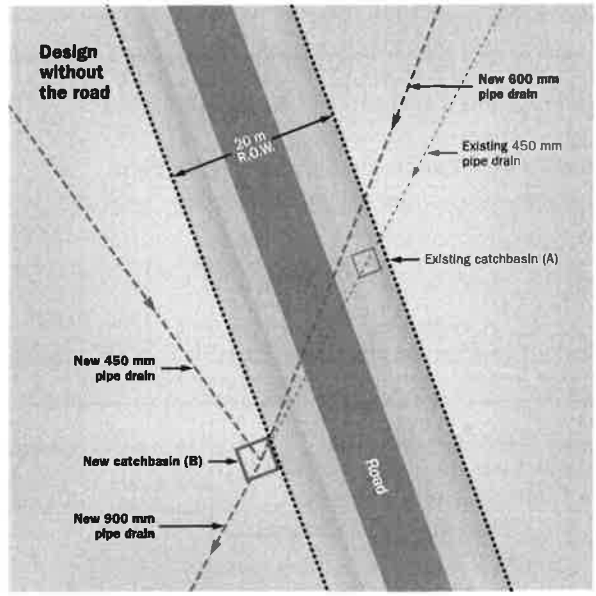


Figure A9–8. Design without the road.

Design without the road

With or without the road, there is a need to replace the existing:

- catch basin (B)
- 300 mm pipe with a 450 mm pipe
- 525 mm pipe with a 900 mm pipe

If the road did not exist, the engineer has determined drainage could be provided by twinning the existing 450 mm pipe drain with a new 600 mm diameter concrete tile drain (Figure A9–8).

Design with the road

Rather than having two pipe crossings, the township requested a single 900 mm high-density polyethylene pipe to replace the existing 450 mm pipe and the proposed 600 mm pipe. Catch basin (A) must be replaced with a larger catch basin due to this request (Figure A9–9).

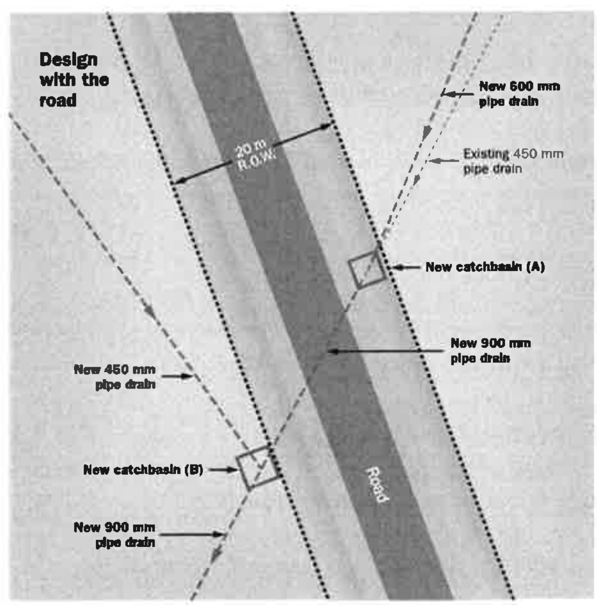


Figure A9–9. Design with the road.

Question

a) What is the estimated Section 26 special assessment against the road authority?

The estimated costs are shown in Table A9–4

Table A9–4. Estimated Special Assessment

Estimated Costs			
Step 1: Construction with Road	**Step 2: Construction without Road (Equivalent Drain Cost)**	**Step 3: Additional Engineering and Eligible Municipal Administrative Costs**	**Step 4: Estimated Special Assessment**
29 m x 900 mm high-density polyethylene pipe (open-cut method) with granular backfill & surface 29 m @ \$300/m + \$1,300 for granular = \$10,000 Add one additional 900 x 1800 mm ditch inlet catch basin = \$4,000	29 m x 600 mm concrete tile 29 @ \$62/m = \$1,798 Rounded to \$1,800	Design, estimating, inspections and administrative, etc. costs above and beyond what would be required for the equivalent drain in a field setting \$4,000 was incurred up to report submission, and \$3,000 is expected to be incurred at construction.	Step 1 – Step 2 + Step 3 = Step 4 = \$14,000 – \$1,800 + \$7,000
\$14,000	\$1,800	\$7,000	\$19,200 (+ net HST)

Solution

The estimated Section 26 special assessment against the road authority is \$19,200 (+ net HST).

After the report was presented and adopted by municipal council, the project was tendered. The selected contractor provided the costs as shown in Table A9–5.

Table A9–5. Comparison of Estimated and Actual Costs

Cost Comparison		
Item	**Actual Cost (from Tender)**	**Estimated Costs**
900 mm high-density polyethylene pipe complete with granular	\$11,500	\$10,000
900 x 1800 mm catch basin	\$2,750	\$4,000
600 mm concrete tile as tendered for 29 m	\$1,885	\$1,800
Additional engineering and eligible municipal administration costs at construction	\$3,250	\$3,000
Engineering and eligible municipal administration costs up to report submission	\$4,000	\$4,000

Question

b) What is the actual Section 26 special assessment levied to the road authority?

After construction of the drain, the actual special assessment calculations are made with the actual construction, engineering and eligible municipal administration costs as shown in Table A9–6.

Table A9–6. Actual Special Assessment

Actual Costs (from Tender)			
Step 1: **Construction with Road**	**Step 2:** **Construction without Road (Equivalent Drain Cost)**	**Step 3:** **Additional Engineering and Eligible Municipal Administrative Costs**	**Step 4:** **Actual Special Assessment**
29 m x 900 mm high-density polyethylene pipe (open-cut method) with granular backfill and surface Lump sum = $11,500 + 900 x 1800 mm catch basin $2,750	29 m x 600 mm concrete pipe 29 m @ $65/m = $1,885	Actual additional design, estimating, inspections and administrative costs, etc. Report Phase $4,000 Construction Phase $3,250	Step 1 - Step 2 + Step 3 = Step 4 = $14,250 – $1,885 + $7,250
$14,250	$1,885	$7,250	$19,615 (+ net HST)

Solution

The actual Section 26 special assessment levied to the road authority is $19,615 (+ net HST).

9.4 Instructions for Specific Situations

9.4.1 Block Assessments (Section 25)

The *Drainage Act, 1990* requires that each property be assessed individually. Section 25 provides an exception to this principle by allowing a built-up area to be assessed as one block. This exception is only implemented if municipal council passes a resolution directing the engineer to assess as a block.

> **DID YOU KNOW?**
> Built-up area is defined in Section 1 of the *Drainage Act, 1990.*

Block assessments are used when it is impractical to assess each property individually. For example, if there is a hamlet in the watershed of a municipal drain, each residential property must be assessed. The engineering cost to assess each of these properties individually may be greater than the assessment that would be levied. The application of Section 25 allows the engineer to assess the group of properties as a single block (Figure A9–10).

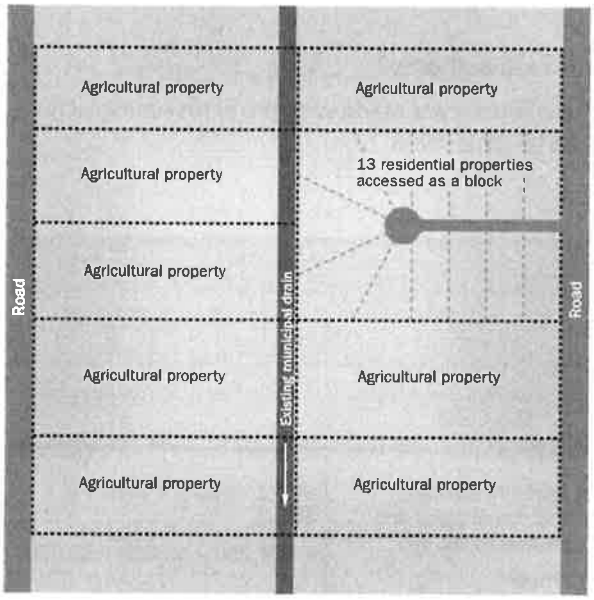


Figure A9–10. A plan showing a block or built-up area.

The municipality recovers the block assessment by levying each property within the built-up area proportionally on assessed value (i.e., the individual property assessed value divided by the block's total assessed value after the public road proportion is deducted).

The suggested procedure in making a block assessment is as follows:

- Identify area(s) that could be assessed as a block.
- Recommend that municipal council pass a resolution directing the engineer to assess the built-up area as a block.
- Once authorized by the council:
    - calculate an assessment for the block
    - assign the proportion of the block assessment to be charged against the public roads
    - show the outline of the block(s) on the plan; consider including the lot and road fabric and a listing of properties (by roll numbers) within the block

9.4.2 Assessing Land in Another Municipality (Sections 27 and 28)

A drain must be continued downstream to a sufficient outlet (Section 15), even if it is required to extend beyond the limits of the initiating municipality (Section 20). The engineer is allowed to assess those lands in any downstream municipality (Section 27).

For situations where lands in an upstream municipality are in the watershed of a proposed drainage system, the engineer may assess those lands in the upstream municipality (Section 28).

The engineer is required to list separately:

- the estimated cost of the drainage system in each municipality
- the estimated cost of the drainage system to roads and lands that form municipal boundaries
- the total of assessments in each municipality (Section 37)

Listing the assessments within each municipality is needed for the municipality to recover the costs of the drain. However, the engineer should assess the drain as one watershed, regardless of municipal boundaries. As a result, there is no requirement that the total assessments in a municipality equal the total cost of the work in that municipality.

9.5 Distributing the Costs

9.5.1 General

Once the total estimated cost of the project is known, the engineer should confirm the benefits of the project are greater than the cost. If they are not, the engineer should write a Section 40 report to stop proceedings under the Act (Part A, Chapter 13). If the benefits exceed the cost, then assign a share of the cost to individual properties, roads and public utilities. The assessment of the cost is important because it allows the municipality the ability to recover their expenditures for the project. In assigning these costs, the engineer is required to follow the assessment principles provided in the *Drainage Act, 1990* and summarized in Section 9.3.

Interested parties may pressure the engineer when the engineer is assigning project costs to individual property owners. The engineer must exercise independent judgement and not be influenced by:

- the allowances provided to a property
- the ability of a property owner to pay the assessment
- contractual arrangements made between property owners and other parties
- any additional sources of funding that may be available for the project (e.g., Ducks Unlimited, conservation authority, government agencies)
- the property tax status (i.e., property tax exempt properties should still be assessed)
- grant eligibility for agricultural properties (ADIP)

9.5.2 Crossings on Private Property

The cost of crossings on private properties is assessed by engineers in a variety of combinations of benefit, special benefit or outlet liability. The assessment of costs for private crossings can be contentious. The methodology used is dependent upon the specific circumstances but should be consistent throughout the entire length of the drain. The engineer should consider the following factors that influence whether to assess a particular crossing under:

a) Benefit assessments:

- number of crossings on the property
- the need for a crossing (resulting from a severance)

b) Special benefit assessments:

- additional length of crossing beyond the standard length
- surface type (e.g., gravel, pavement)
- high-strength pipe to accommodate a property's crossing needs
- decorative features

c) Outlet liability assessments:

- upstream watershed area that contributes to the size of crossing
- total number of crossings on the drain

When assessing the cost of crossings on private property, it is recommended that the engineer consult with other experienced engineers, standard practices of the engineering firm, and municipal staff. For projects involving multiple crossings, consult the presentation *Drain Crossing Assessments,* Antonio Peralta, P. Eng., N. J. Peralta Engineering Ltd., 2014 (www.landdrainageengineers.com).

9.5.3 Assessment Schedules for Drain Construction Projects

The engineer is required to assess properties, roads and utilities for the applicable benefit, outlet and injuring liability, special benefit and special assessments. The rational for the assessment must be defendable to those assessed and appeal bodies.

In establishing an assessment for the construction of a drain, it is recommended that the engineer consider the following procedure.

Step 1. Divide the project into intervals

Divide the total length of the proposed drain into intervals. These intervals can be determined by:

- recognizable features such as roadways, railways and property lines (in most cases, separate intervals for roads could be created to assist special assessment calculations)
- recognizable watershed features such as branch drains, private drains or other locations where sub-watersheds enter the drainage system
- locations where private drainage systems are incorporated into the municipal drainage system

Suggested intervals lengths are between 300 m and 1,000 m.

Step 2. Determine the cost of each interval

Create an equivalent area and lengths table, and then complete the hydrology, hydraulics and drain design by:

- calculating allowances
- estimating other costs (construction, engineering, eligible municipal administration and contingency):

- Determine the construction cost of each of these intervals. The costs for allowances, engineering, eligible municipal administration and contingency for each interval are generally proportioned consistent with the construction costs, unless increased costs were incurred in specific intervals.

Step 3. Calculate special benefits and special assessments

Calculate any special benefits and special assessments, and deduct these assessments from the total cost. This is the net interval cost.

Step 4. Select the split between benefit assessment and outlet liability for each interval

Determine the approximate and fair proportions of the net interval cost that should be assessed as benefit and as outlet liability. This is the most difficult decision to make in an assessment procedure. This is a judgement call that should take the following points into consideration:

- the proportions of costs assigned as benefit should be real and justifiable
- all assessments should be fair when compared to each other
- the proportion to be assigned as benefit may vary from 10%–20% at the downstream interval to up to 80%–90% at the upper interval

Calculate the interval benefit (IB) and interval outlet liability, where interval benefit is the cost to be assessed as benefit to the properties in the interval.

Step 5. Determine benefit value for individual properties

Estimate a benefit value (in dollars) that the drain interval will provide to each property (Part A, Chapter 9.3.1). Compare the benefit values to test for fairness.

Step 6. Calculate the benefit assessments to each property

$$Benefit\ Assessment = \frac{BV}{\sum BV} xIB$$

Where

Interval Benefit (IB) is the cost to be assessed as benefit to the properties.

Benefit Value (BV) is the actual value the drain interval provides to a property.

$\frac{\boldsymbol{BV}}{\sum \boldsymbol{BV}}$ is the proportion of benefit value for each property.

Benefit Assessment refers to the share of the cost for the drain interval assessed as benefit to a property.

Step 7. Divide the interval outlet liability

Using the method described in Section 9.3.2, divide the interval outlet liability between all the properties that contribute water into this interval of the drain.

Example of proportioning benefit

A drain interval traverses three properties: A, B and C (Figure A9–11). After deducting the special benefits and special assessments, the net interval cost is \$50,000 (Steps 1–3).

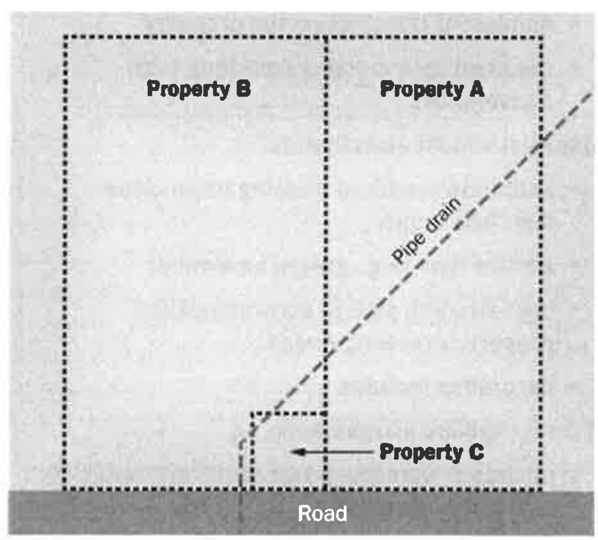


Figure A9–11. Proportioning benefit.

Calculate the benefit assessments to each property using Steps 4–6:

Step 4

- the split between benefit assessment and outlet liability is 20:80
- the interval benefit (IB) is 20% x $50,000 = $10,000
- the interval outlet liability is 80% x $50,000 = $40,000

Step 5

- Property A receives a $56,875 benefit value (see example from Part A, Chapter 9.3.1)
- Property B receives a $64,532 benefit value
- Property C receives an $11,287 benefit value

Step 6

- based on the estimated benefit value to the three properties, the total benefit value of the interval is $132,694 (∑BV))

Property A

- Estimated Benefit Value= $56,875

$$Benefit\ Assessment = \frac{BV}{\sum BV} xIB$$

- Benefit Assessment = $56,875/$132,694 x $10,000

= 0.429 x $10,000
= $4,290

Property B

- Estimated Benefit Value = $64,532

$$Benefit\ Assessment = \frac{BV}{\sum BV} xIB$$

Benefit Assessment = $64,532/$132,694 x $10,000
= 0.486 x $10,000
= $4,860

Property C

- Estimated benefit value = $11,287

$$Benefit\ Assessment = \frac{BV}{\sum BV} xIB$$

Benefit assessment = $11,287/$132,694 x $10,000
= 0.085 x $10,000
= $850

DID YOU KNOW? There is an alternative approach to calculating benefit assessment (Step 6). After the benefit values are calculated (Step 5), they are reduced proportionally to arrive at a preliminary benefit assessment for each property. The benefit assessments for the properties in the interval are totalled, and the percentage of benefit assessment to total cost of the interval is compared to the original target in Step 4:

- If the percentage is close to the target, then the preliminary benefit assessments are accepted.
- If not, then further adjustments to the benefit assessments against individual properties are necessary. The final adjustments to the benefit assessment are to ensure a fair distribution of cost to all properties.

Step 7
Divide the interval outlet liability:

- Using the method described in Section 9.3.2, divide the interval outlet liability between all the properties that contribute water into this interval of the drain.

9.5.4 Assessment Schedules for Drain Improvement Projects

When appointed to make improvements to an existing drain, the engineer should review the assessments and allowances in the previous engineer's reports (Section 34). Based on the review, the engineer may:

- use the existing assessment to pro-rate costs
- adjust the existing assessment
- develop a new assessment (Part A, Chapter 9.5.3)

Pro-Rated Assessment

A pro-rated assessment uses the assessment schedule from the current report adopted by by-law to pro-rate the cost to all the properties in exactly the same proportion. Use this method only if the following five conditions exist.

1. The work is strictly the repair, maintenance or improvement of the entire existing municipal drain.
2. The work covers the same section of the drain as the current report.
3. The work to be done is similar in all respects to the work under the current report; no new features are being added (e.g., new bridges, culverts, erosion control or surface water inlets).
4. The conditions and land use in the watershed have not substantially changed.
5. The assessment in the current report is fair and usable under the present circumstances.

When using the pro-rated method, the engineer's report for the improvement should show:

- The benefit, outlet liability and injuring liability assessments from the current report
- The new amounts assessed to the properties

Adjust the Existing Assessment (Section 34)

If an existing assessment cannot be used in its original form, it may be practical to adjust it where minor changes have occurred within the watershed. The minor changes can include severances, land use changes and property additions to a drain, where the changes do not significantly impact the design of the drain.

State how the existing assessment was adjusted to accommodate the minor changes in the watershed.

Develop a New Assessment

If the existing assessment cannot be used even with adjustments, develop a new assessment schedule similar to a drain construction project (Part A, Chapter 9.5.3).

9.5.5 Assessment Schedules for Future Maintenance and Repair

The cost of future maintenance and repair (Section 74) and minor improvements to a drain (Section 77(1)) (referred to as "maintenance") may be assessed to properties in the same proportions as the assessments for construction or improvement of the drain. However, in developing a report for the construction or improvement of a drain, the engineer may determine that these future costs be proportioned on a basis different than the original assessment schedule (Section 38).

Maintenance is a municipal responsibility carried out by the drainage superintendent. The engineer should consult with the drainage superintendent during the preparation of the maintenance assessment schedules to determine and consider the local practices and preferences for billing out costs.

The engineer should clearly identify in the report how maintenance costs are to be assessed. Options include:

- basing maintenance costs on the construction or improvement assessment schedule without modifications
- basing maintenance costs on the construction or improvement assessment schedule with modifications that are detailed in the report
- developing a new assessment schedule specifically for maintenance costs (Section 35)

When developing a new assessment schedule specifically for maintenance costs, the engineer could complete the following steps for each interval.

1. Estimate a hypothetical maintenance cost for future work.

2. Review the previously determined proportions for benefit and outlet liability used for construction. Adjust the proportion of benefit and outlet liability for maintenance based on the engineer's opinion.
3. Allocate the benefit portion to the benefitting properties (Part A, Chapter 9.5.3).
4. The remaining cost is allocated as outlet liability to all properties:
   a) calculate the outlet liability rate in $/ha
   b) allocate the outlet liability to all properties based on the total adjusted area (Part A, Chapter 9.3.2)
5. Determine the total maintenance assessment for each property by adding together the benefit assessments and outlet liability assessments of each interval.

Provide instructions for using the future, maintenance and repair assessment schedules. If applicable, provide instructions on assessing maintenance costs of other features such as:

- special benefit items
- private crossings
- road, railway and utility crossings

It is important to differentiate between repair and replacement of the crossing structure and flushing of a crossing. It is recommended that the engineer:

- assess the full cost of repairs of the crossing structure to the road, railway or public utility (Section 26)
- distribute the cost for flushing or crossing cleanout between the road, railway or public utility and the upstream property owners

9.5.6 Fairness Test

The engineer must be prepared to confidently defend the assessment to any property. After any assessments have been developed for the entire drain, the engineer should ensure that the assessment schedules (drain construction, drain improvement and drain maintenance and repair) are fair to all concerned. Conduct a fairness test to compare relative assessments on all properties throughout the watershed by:

- comparing benefit assessments per benefiting area on adjacent properties
- comparing outlet liability assessments on adjacent properties
- comparing the assessment per hectare on adjacent properties
- performing a broader review of assessments on all properties

When performing the fairness test, the engineer should identify why the assessments may be different on adjacent properties (e.g., different land uses or types of drains). Situations where the overall assessment per hectare should be less include:

- properties where an open drain is constructed
- properties not cultivated or requiring drainage, such as a depressional area, wetland or woodlot

For properties where a piped drain is constructed, the overall assessment per hectare could be:

- similar when property values, crop values and tiling costs are consistent throughout the watershed
- greater at the downstream end of a project, since lands that would otherwise be flooded are workable
- greater at the upstream end of a project, since the water generated from the property uses the entire length of the drain

Once the draft assessments are reviewed, the engineer may adjust factors such as the proportions between benefit and outlet for each drain interval and the perimeter factor for specific properties. This iterative process will generate a final assessment schedule that is fair to all properties.

A case study is provided in Part A, Chapter 15 to demonstrate these principles of creating an assessment schedule.

DID YOU KNOW? The assessment information generated in this section is useful to determine the cost-effectiveness of the project. This analysis is useful for any cost benefit appeal to the Tribunal under Section 48(1)(a).

9.6 The Assessment Schedule

9.6.1 Requirements of the *Drainage Act, 1990*

After the engineer has performed all the detailed calculations to assess properties, the *Drainage Act, 1990* provides specific instructions on the reporting of assessments. The engineer is required to develop a table called an assessment schedule that includes a column for each assessment type and a row for each assessed property (Sections 21 and 35).

In creating the schedule, the engineer must do the following:

- Show the assessments as dollar values. The engineer has the option to also include the percentage of the total cost that each property is assessed (Section 35).
- Include the number of hectares affected (the area of property within the watershed) for each parcel of land assessed (Section 36). Consider showing the hectares affected in a separate column in the assessment schedule.
- Group all properties within each municipality together within the schedule (Section 37).
- Indicate the properties that are not agricultural lands (Section 37). Many engineers indicate the non-agricultural use with an asterisk in the row opposite the property.
- List as a separate row the cost of any lateral drain, which is a drain located on one property only and designed for the drainage of that one property (Section 37).

DID YOU KNOW? The following are not eligible for grants under the *Drainage Act, 1990*:
- non-agricultural lands (Section 85)
- lateral drains (Section 86)
- agricultural lands owned by any level of government (Section 86)

9.6.2 Suggested Format for an Assessment Schedule

The assessment schedule presents the information required under the Act and provides property owners with an understanding of how the total assessment has been calculated. The following table (Table A9–7) is a suggested format for displaying the assessments to be levied against properties, roads and utilities for a drainage project.

If there are very few properties receiving a special benefit or special assessment, consider presenting this information as a line item rather than in a column.

9.6.3 Other Considerations for Assessment Schedules

The assessment schedule should not include columns for allowance, grant or net assessment for the following reasons:

- Including allowances and grants may lead property owners to incorrectly conclude that the only cost to them on the project is the amount remaining after the allowances are subtracted from the assessment.
- Including net assessments may lead property owners to incorrectly conclude that their assessments are unfair in comparison to their neighbours.

At the meeting to consider the report, property owners may want to know what their net assessments are. The engineer can provide a supplemental table for information purposes only, not included as part of the report.

Some municipalities may request that a minimum assessment be imposed on properties to cover eligible municipal administrative costs.

Table A9–7. Suggested Format for an Assessment Schedule

Initiating Municipality A

Concession	Lot or Part	Roll No.[1]	Owner	Affected Area[2]	Benefit[3]	Outlet Liability[4]	Special Benefit[5]	Special Assessment[6]	Total Assessment[7]
Geographic Municipality A		AABB-CCC							
Property 1		DDD-EEEEE							
Property 2									
Geographic Municipality B									
Property 3									
Property 4									
Total Assessment on Lands									
Road X									
Road Y									
Total Assessment on Roads									
Total Assessment for Municipality A									

Other Municipality B

Concession	Lot or Part	Roll No.[1]	Owner	Affected Area[2]	Benefit[3]	Outlet Liability[4]	Special Benefit[5]	Special Assessment[6]	Total Assessment[7]

Notes:

1 A roll number is made up of 19 digits separated into six different components.
For example, AABB-CCC-DDD-EEEEE-FFFF represents:

- AA - County or Municipal District
- BB - Municipality
- CCC - Ward
- DDD - Area Subcenterision
- EEEEE - Street Subcenterision
- FFFF - Plate number (formerly used in realty/business assessments)

The first three components can be included as a header in the roll number column.

The next two components describe the property and should be listed beside the property being assessed.

The sixth component is generally not used for assessment purposes.

2 This is the area of the property that is in the watershed for the particular drain.

3 See Part A, Chapter 9.3.1 for details on benefit.

4 See Part A, Chapter 9.3.2 for details on outlet liability.

5 See Part A, Chapter 9.3.3 for details on special benefit.

6 See Part A, Chapter 9.3.4 for details on special assessment.

7 Total assessment is the sum of benefit, outlet liability, special benefit and special assessment for a property.

CHAPTER 10

PROCESSING THE REPORT

10.1 Introduction

Processing the report is a term used to describe the activities between when the report is completed and the adoption by by-law.

The municipality will often request the involvement of the engineer to ensure that the project is brought to successful completion and to maintain eligibility for grants under the *Drainage Act, 1990.* The engineer may be requested to:

- attend the meeting of the council where the report is considered (Section 42) to:
  - present a summary of the report
  - provide advice on the validity of the petition
  - advise on cost recovery if the petition fails (Sections 43 and 44)
  - advise on cost recovery for a terminated drain improvement report
  - participate in the court of revision (Section 46)
  - amend the report (Section 57)
  - participate in the appeal hearings (Part A, Chapter 11)

DID YOU KNOW? Some municipal councils have used the authority of the *Municipal Act, 2001* to appoint Drainage Boards to carry out some of the council's responsibilities under the *Drainage Act, 1990.*

10.2 Meeting to Consider the Report

After filing the report, the council hosts a meeting to consider the report (Figures A10–1 and A10–2). Property owners within the drainage watershed and involved agencies are invited to attend and participate. The purpose of the meeting is to present and respond to questions about the report and determine outcomes but not to discuss details of individual assessments. This meeting may be contentious, and it is important to be prepared and maintain a professional manner.

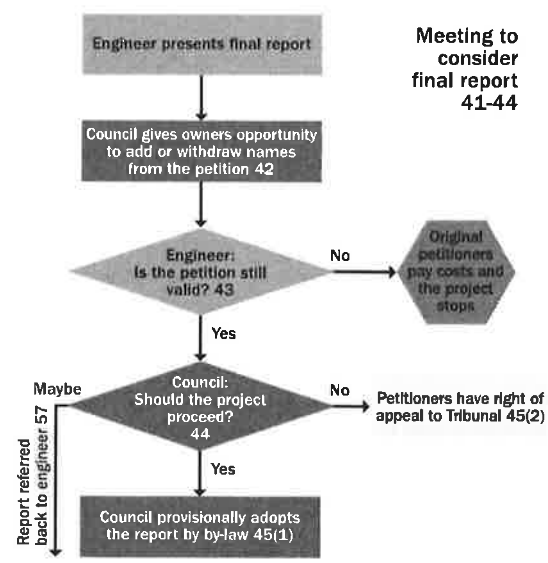


Figure A10–1. Section 4 process for the meeting to consider the report.

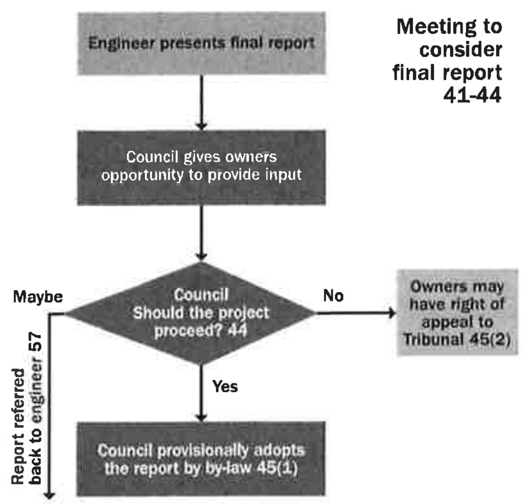


Figure A10–2. Section 78 process for the meeting to consider the report.

Before the Meeting to Consider the Report

The engineer should:

- provide the clerk with a list of individuals and agencies to be notified for the meeting as required by Sections 41(1), 41(2) and 41(3)
- determine the engineer's role at the meeting, in consultation with the municipality
- if requested to give an overview of the project, prepare a presentation that includes drawings to communicate the design features

During the Meeting to Consider the Report

The engineer should:

- If requested, provide an overview of the report
- be prepared to respond to questions
- if new information becomes available, acknowledge that more research or investigation may be necessary to determine its effect on the project

For drainage projects initiated by petition (Section 4), the meeting chair must give property owners within the area requiring drainage the option to add or withdraw their names from the petition.

Next Steps

There are four possible outcomes that the council can decide upon at the meeting. The engineer may be asked to advise the council on these outcomes.

Outcome 1: Petition is no longer valid (Sections 42 and 43)

This outcome is only applicable to drainage projects initiated by petition (Section 4). In the case where property owners modify the petition by adding or withdrawing their names, the engineer:

- may be asked to re-evaluate the sufficiency of the petition using information that the engineer previously gathered
- can advise the council that the meeting may have to be adjourned until the sufficiency of the modified petition is evaluated
- may be asked to assist in determining the sharing of the costs that were incurred to date, if the petition is no longer valid and the project is terminated (Section 43)

If the petition remains valid or the report is for a drain improvement project (Section 78), the council can choose:

- Outcome 2 — stop the proceedings
- Outcome 3 — refer the report back to the engineer
- Outcome 4 — provisionally adopt the report

Outcome 2: The council stops the proceeding (Section 45(2))

If the council decides not to provisionally adopt the report by by-law, the council stops the proceedings and terminates the project. The engineer should advise the council of the following points:

- This decision can be appealed to the Tribunal (Section 45(2)).
- There is no authority to recover the engineering costs for a project initiated by petition. Cost recovery for a drain improvement project initiated by the council (Section 78) is covered in Part A, Chapter 10.2.1.
- There are no *Drainage Act, 1990* grants available for costs incurred.

Outcome 3: The council refers the report back to the engineer (Section 57)

When the council refers the report back, the engineer should:

- ensure that the council's instructions are not interfering with the requirement for the engineer to be fair and impartial and to submit a true report (Section 11)
- decide if another on-site meeting is needed and, if so, identify the property owners, agencies and/or authorities that should attend
- determine what areas of the project should be reviewed in the field
- review the issues of concern, and prepare any needed revisions to the report

Once the report is re-submitted, another meeting to consider the revised report is held.

Outcome 4: The council provisionally adopts the report (Sections 45–46)

If the council decides to accept the report, a by-law adopting the report is given first and second reading (Section 45(1)). This is known as a provisional by-law. The engineer may be requested to assist the clerk with the preparation of the provisional by-law. The by-law must be in a form prescribed by O. Reg. 381/12, under the *Drainage Act, 1990.*

The engineer should advise the municipality that it must send the provisional by-law along with a notice of the court of revision (Sections 46(1–2)). The *Drainage Act, 1990* requires the municipality to schedule the court of revision between 20 to 30 days after the completion of the mailing of the notice and provisional by-law (Section 46(3)).

After the by-law has been provisionally adopted, property owners have the right to appeal the report on cost-sharing, technical and legal matters.

- The court of revision hears appeals on the cost-sharing of the drainage project (Part A, Chapter 10.3).
- The Agriculture, Food and Rural Affairs Appeal Tribunal hears appeals on technical matters and on the decisions of the court of revision (Part A, Chapter 11).
- The referee hears legal or procedural appeals (Part A, Chapter 11).

DID YOU KNOW? Only after appeal periods have expired or have been decided upon can third reading be given to the provisional by-law. The by-law authorizes construction and levying of assessments.

10.2.1 Cost Recovery for a Terminated Drain Improvement Report (Section 78)

When the council stops a project initiated under Section 78, the *Drainage Act, 1990* does not provide any direction on how these costs are recovered. In the absence of clear direction from the legislation, the following guidance has been based on a principle of fairness to the community of property owners on the drain and to the other taxpayers in a municipality.

Scenario 1:

A drain improvement project, initiated to improve the effectiveness of the entire drain, has been terminated.

Rationale: It is not fair to assess these costs to an individual property owner, or a group of property owners, who may have identified that the work was required. It also may not be fair to the municipal taxpayers that the municipality pays the cost out of their general funds. The assessed property owners still have the right to challenge the legality of the assessment to the referee.

Recommendation: There are two possible ways to address costs:

- the costs incurred to date can be assessed to the property owners in the watershed of the drain in accordance with the existing assessment schedule; or
- the council can choose to pay the engineering costs.

Scenario 2:

A drain improvement project, initiated to improve the effectiveness of a single property (e.g., enclosing a portion of a drain, relocating a section of the drain or adding a crossing) has been terminated.

Rationale: It is not fair to assess these costs to all the property owners in the watershed of the drain.

Recommendation: There are three possible ways to address costs if a single property owner requests the council to stop the project:

- a Section 40 report can be prepared indicating that the project is no longer required and identifying how the costs are recovered; or
- the council can decide to terminate the project only after the property owner pays the engineering costs to date; or
- the council can choose to pay the engineering costs.

10.3 Tasks of the Engineer with Respect to the Court of Revision

A court of revision (Figure A10–3) is held for every project initiated under Sections 4, 76 or 78 of the *Drainage Act, 1990.* This is a municipally appointed appeal body that only hears appeals related to assessments.

There are other rights of appeal to the Agriculture, Food and Rural Affairs Appeal Tribunal and the referee, who are addressed in Part A, Chapter 11.

10.3.1 Court of Revision

The *Drainage Act, 1990* specifies the composition of the court of revision (Section 97) and the grounds for appeal that they may hear (Section 52).

The engineer may be asked to assist the municipality in administering the court of revision procedure and by presenting an overview of the report that explains the rationale for the assessments and by responding to specific appeals received in advance of the court of revision.

Before the Court of Revision

The engineer should determine the assistance that the municipality requires in administering the court of revision procedures, which may include:

- confirming that the provisional by-law and notice of the court of revision hearing has been mailed to the assessed property owners (Sections 45–46)
- advising the municipality on the composition of the court of revision (Section 97):
  - 3–5 members, where only the initiating municipality is involved
  - 2 members from the initiating municipality and one from all the other municipalities involved, where multiple municipalities are affected
- being prepared to advise if the appeal is within the jurisdiction of the court of revision (Section 52(1))

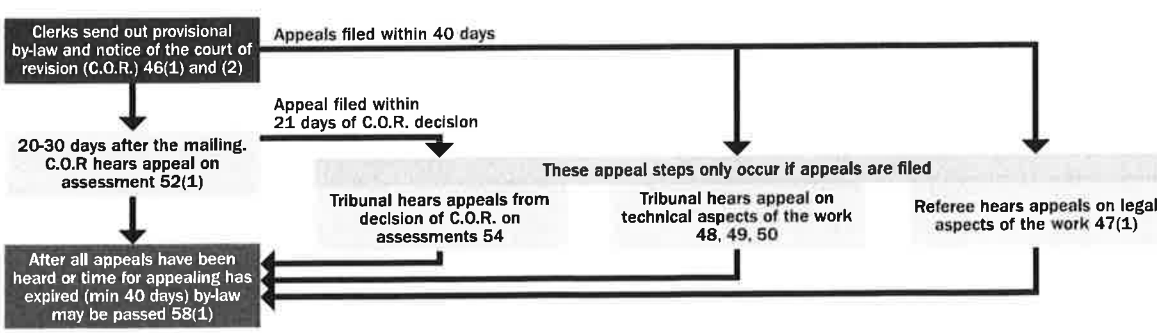


Figure A10–3. Appeals process.

During the Court of Revision

During the court of revision, the engineer should:

- if warranted, remind the court of revision:
  - of their option to hear late appeals (Section 52(4))
  - that the court can only hear appeals on assessments (Section 52(1))
  - that they must adjourn and reconvene if any absent parties may be impacted by a potential decision of the court (Section 53)
- give evidence verbally or in written format prior to the presentation of the appellant(s) (Section 55):
  - on how the project costs were assessed in general
  - responding to the specific appeals
- answer questions from the court of revision and any appellant

After the Court of Revision

Following the decision of the court of revision, the next steps are:

- If the court of revision alters the assessments, revise the assessment schedules. The revised schedule should include a note that it has been updated based upon the court decision(s).
- Submit the revised schedule to the clerk for distribution to the affected owners and inclusion in the provisional by-law (Section 56).
- Advise the municipality that a party to the court of revision has a 21-day period to file an appeal of the decision to the Agriculture, Food and Rural Affairs Appeal Tribunal (Section 54(1)) (Part A, Chapter 11.4).
- Advise the municipality that the by-law cannot be given third reading until all appeals have been decided or the time for appealing has expired (Section 58(1)).

10.4 Amending a Report Initiated under Sections 4 or 78

Before the final passage of the by-law, there is opportunity to amend the report. Once the by-law is passed, the report becomes law and is more difficult to change.

There are three points in the process when the municipality may wish to amend the report:

1. before final passage of the by-law
   - at the meeting to consider the report, before the two readings are given to the by-law, provisionally adopting the report (Part A, Chapter 10.2, Outcome 3)
   - after the by-law is provisionally adopted and before the third and final reading of the by-law
2. after final reading of the by-law but prior to levying of assessments
3. after the levying of assessments

10.4.1 Amending the Report Before Final Passage of the By-law (Section 57)

When the council receives a report, they cannot make changes to it, but they can refer the report back to the engineer for review. This can occur at the meeting to consider the report or after the meeting. It is up to the discretion of the engineer as to what changes, if any, are to be made. If the engineer identifies a need to make changes to the report, they must ask the council to refer the report back in order to make the changes.

10.4.2 Amending the Report After By-law Passage but Prior to Levying of Assessments

Prior to Construction

If an error is found in the report after the by-law has been given third reading, the only way to correct the error is to apply to the Tribunal to correct the error (Section 58(4)). A property owner request for new features (e.g., crossing) is not an error in the report, and the need should have been identified earlier in the process. At this stage, these requests should be considered an improvement to the drain that is addressed through the use of a new Section 78 report.

During Construction

The engineer may find it necessary to modify the drain design. Some changes require the approval of the Tribunal, but others are within the discretion of the engineer. In deciding which category a change falls under, consider the comments of the Tribunal in a 1998 decision on the McLean Drain in the Township of East Zorra-Tavistock (www.canlii.org/en/on/onafraat search "McLean Drain"). In this decision, the Tribunal advised that:

- The engineer must be involved in all changes made during construction.
- The engineer may authorize changes in construction that don't change the purpose, capacity or functionality of the drain. If a change is necessary that will change the purpose, capacity or functionality of the drain, an application must be made to the Tribunal. The engineer is advised to prepare drawings/amendments and submit them to the Tribunal, along with the application.
- The engineer must evaluate the relative costs and impact associated with proceeding with changing the design or halting construction to apply to the Tribunal for a significant change. The engineer should consider all other related factors, such as whether the issue is an emergency or whether the changes are irreversible.
- Where the engineer decides that it is not practical to delay the construction to wait for a Tribunal order, the engineer may be held accountable for costs resulting from the Tribunal's decision. The municipality must follow up this change with an application to the Tribunal that includes the proposed changes to drawings, allowances, assessments and other provisions that may be necessitated to reflect the "as-built" conditions.

The Process

The municipality may ask the engineer to facilitate the application to the Tribunal on their behalf. The suggested procedure would involve:

- temporary suspension or redirection of construction work, if already started
- consultation with the Tribunal to confirm the application procedures
- submission of an application to Tribunal
- complying with the order of the Tribunal, which may include the circulation of proposed amendments
- a hearing, if the Tribunal deems it necessary
- construction of the drain in accordance with the amendment to the by-law ordered by the Tribunal

If the Tribunal refuses to order the proposed changes, the municipality or the engineer could consult legal counsel to investigate options. Please be aware that the Tribunal could find that a party to the application is responsible for any adverse impact or cost resulting from the change.

10.4.3 Amending a Report After Construction Is Complete and Assessments Are Levied

A report cannot be amended after the assessments have been levied.

To incorporate changes or added features that occurred during construction that did not affect the project's purpose, capacity or functionality, the municipality could consider the use of a drain improvement report under Section 78 of the *Drainage Act, 1990.*

CHAPTER 11

RESPONDING TO APPEALS ON THE REPORT

11.1 Introduction

After the by-law is provisionally passed adopting a report and after the court of revision has been held, the report may be appealed to the:

- Agriculture, Food and Rural Affairs Appeal Tribunal (the Tribunal)
  - on technical matters (Section 48)
  - from the court of revision (Section 54)
  - by a conservation authority (Section 49)
  - by other municipalities (Section 50)
- Drainage referee
  - on legal matters (Section 47)

When appeals are filed, the engineer's role is to:

- provide guidance to the municipality on the appeal procedures (however, the engineer must not provide legal advice and must not jeopardize their independence)
- present an overview of the report and provide specific responses to the appeals at the hearing(s)

11.2 The Agriculture, Food and Rural Affairs Appeal Tribunal

The Tribunal is usually made up of a panel of at least three members. On drainage matters, one of the panel members will be a lawyer and a second member is usually an engineer with experience writing reports under the *Drainage Act, 1990.* The third member of the panel is selected based on the specific nature of the appeal. The presence of a lawyer on the panel does not mean that lawyers are needed to represent the case (Figure A11–1).

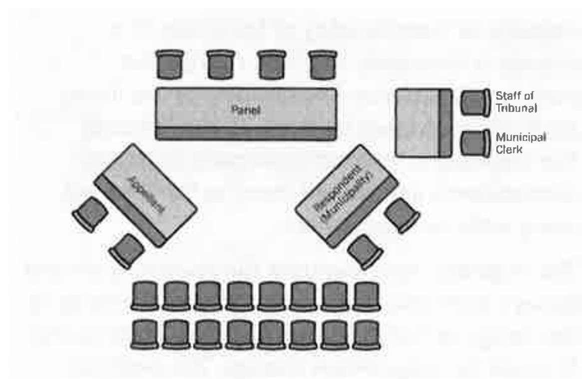


Figure A11–1. Tribunal room layout.

The Tribunal has produced Rules of Procedure that cover all matters of appeals before the Tribunal. In addition, it has also produced a guide entitled *Guidelines for Preparing for a Hearing.* This information can be found on the Tribunal website (ontario.ca/omafra search for "Preparing for a Hearing").

Tribunal decisions do not set precedence for future cases, but they provide good general guidance to engineers in preparing for a hearing.

DID YOU KNOW? Tribunal decisions can be found on the Canadian Legal Information Institute (CanLII) website (www.canlii.org).

The *Drainage Act, 1990* does not set out mandatory requirements of the engineer on appeals or applications to the Tribunal. In all appeals to the Tribunal, the engineer should:

- be familiar with the procedures of the Tribunal and follow their instructions
- obtain and review all documents related to the appeal
- physically review the site conditions that may have changed since report preparation, with emphasis on the lands owned by any appellant
- develop a response to the appeal
- assist the municipality with any required pre-hearing submissions to the Tribunal
- work with the municipality to develop a list of individuals to be called as witnesses during the hearing to present evidence
- prepare the presentation in advance of the hearing
- prepare a large version of the plan (in the report) for use during the hearing
- be prepared to provide a summary of the engineer's training, technical skills and experience, particularly in relation to reports under the *Drainage Act, 1990*
- be prepared to give a brief overview of the report at the start of the hearing
- on an appeal from the decision of the court of revision, present an overview of assessment calculations
- be prepared to respond to the points raised by the appellant

Specific guidance for engineers appearing before the Tribunal is provided in the following resources, found at www.landdrainageengineers.com.

- Brisco, E. C., ODT, *Preparing Material and Presenting Evidence at Hearings,* 1982 Drainage Engineers Conference
- Brisco, E. C., ODT, *Appeals on Quality of Construction,* 1984 Drainage Engineers Conference
- Brisco, E. C., ODT, *Preparing a Case for the Agriculture, Food and Rural Affairs Tribunal,* 1987 Drainage Engineers Conference
- Osyany, Andrew, ODT, *Presentation of Evidence to the Ontario Agriculture, Food and Rural Affairs Tribunal,* 1997 Drainage Engineers Conference

11.3 Appeals to the Tribunal on Technical Matters (Section 48)

Any property owner or public utility affected by the proposed drain may appeal to the Tribunal on these four grounds:

- the benefits from the drain are not proportionate with the estimated cost
- the drain should be modified
- compensation is unfair
- the engineer has determined that the drain is not required or is impractical (i.e., appealing a Section 40 report)

11.3.1 Cost-Effectiveness

The benefits of a drainage project need to be higher than the costs of undertaking the work. If a property owner is of the opinion that this is not the case, they may file an appeal to the Tribunal. On appeal, the cost-effectiveness of a project can be evaluated by:

- reviewing the benefit calculations used in the assessment process
- estimating the advantages from the improved outlet to upstream lands that were not assessed for benefit (the improved outlet should allow for more effective private drainage systems, which should result in increased crop yields)
- estimating the benefits to roads
- considering financing costs and future repair and maintenance costs
- considering the cost and benefits if the project was completed as a private system rather than a municipal drain
- comparing to other options that were considered and the reasons why they were not chosen

The comparison of these benefits to the estimated cost forms the basis for the engineer's response to the Tribunal. The engineer and/or the municipality may retain other professionals to assist in these evaluations.

11.3.2 Request to Modify the Drain

The grounds for this appeal are very open-ended, and the preparation for the hearing is dependent upon the nature of the request. Review the appellant's request and evaluate each proposed modification. Decide if the proposed modifications should be supported at the hearing. Produce drawings and calculations to support the opinion at the hearing.

11.3.3 Compensation Is Unfair

For an appeal claiming that compensation is unfair, review the allowances provided for the property identified in the appeal, including the areas and rates for those allowances. Decide if any changes to the allowances should be supported at the hearing.

11.3.4 Engineer Reports that a Drain Is Not Required or Is Impractical

This appeal is only used after an engineer writes a report under Section 40 recommending the termination of a project on the basis that a project is not required, is impractical or cannot be constructed. Prepare for the hearing by reviewing the Section 40 report, which includes the rationale explaining why the project cannot proceed. For further information on a Section 40 report, see Part A, Chapter 13.5.

11.4 Appeals to the Tribunal from the Court of Revision (Section 54)

A court of revision hears appeals on assessment matters only (Section 52). A party to a hearing of the court of revision may appeal a decision to the Tribunal. They may also appeal the court's omission, neglect or refusal to hear or decide an appeal.

At the Tribunal hearing, the engineer is required to give evidence before the appellant presents the appeal (Section 55). This evidence may include:

- how the project costs were distributed or assessed to all the property owners
- how the appellant's specific assessment was calculated
- why the appellant's assessment is fair when compared to other assessments
- why, for drain improvement projects, the assessments made to a particular property may differ from assessments in a previous report for the same drain

11.5 Other Tribunal Appeals (Sections 49 and 50)

A conservation authority has the right to appeal to the Tribunal on the grounds that the proposed drain will adversely impact a priority of the conservation authority (Section 49). This appeal is used infrequently because authority concerns are usually addressed through the on-site meeting or the project scoping meeting or through a Section 28 permit process of the *Conservation Authority Act, 1990* (Part C, Chapter 5).

Another affected municipality has the right to appeal to the Tribunal (Section 50) on the basis that:

- the drainage project should be abandoned or modified
- the route of the proposed drain should be altered
- the drain does not provide a sufficient outlet
- the drain should be taken to an outlet somewhere other than the appealing municipality
- the proposed project has been impacted by a petition for drainage in the affected municipality
- the work is unnecessary
- the share of the cost assessed to lands in the affected municipality is illegal or unfair

This appeal is used infrequently because concerns of other municipalities are usually addressed through the on-site meeting or the project scoping meeting.

11.6 Decisions of the Tribunal

Most Tribunal decisions are final (Section 101) and are binding on the particular report/drain, but they are not binding on any future reports or drains.

When the Tribunal releases its decision on a particular appeal, it should be reviewed and any orders must be implemented. Orders directed to the municipality may be assigned by the municipality to the engineer to address. Possible outcomes of a tribunal order could include:

- dismissal of appellant's case
- alterations to the assessments or allowances
- modifications to the technical specifications
- a time limit for options or alternatives to be considered
- referral of the report back to the engineer for amendment
- in extreme cases, the setting aside of the engineer's report

Tribunal decisions are found on the Canadian Legal Information Institute (CanLII) website (www.canlii.org).

11.7 Appeals to the Drainage Referee

The drainage referee has the authority to hear all matters of law. The referee's authority is defined in Section 106 of the *Drainage Act, 1990.* It covers:

- appeals on the report of the engineer (Section 47)
- appeals on the validity of the petition or on any resolution or by-law of the council
- applications regarding claims or disputes
- applications for orders directing action
- applications for orders restraining activities
- appeals on any Tribunal decisions that are not final (Section 101)
- any other matters related to the Act

Referee decisions set precedents for future cases and may be appealed to Divisional Court. O. Reg. 232/15 of the *Drainage Act, 1990* sets out the rules of practice and procedures in proceedings before the referee.

Appeals on the Engineer's Report (Section 47)

When some aspect of the engineer's report is appealed to the referee, the engineer should advise the municipality to retain legal counsel experienced in the *Drainage Act, 1990.* In some situations, the engineer should independently consider retaining legal counsel.

The engineer who authored the report can assist legal counsel by:

- explaining all aspects of the report under appeal
- identifying expert witnesses that may be needed to defend the report
- Identifying any applicable referee decisions
- reviewing and commenting on reports submitted by other experts

Referee decisions are found on the Canadian Legal Information Institute (CanLII) website (www.canlii.org).

DID YOU KNOW? If called upon to be an expert witness, refer to the Professional Engineers Ontario (PEO) guideline *The Professional Engineer as an Expert Witness* (www.peo.on.ca).

CHAPTER 12

CONSTRUCTING THE PROJECT

12.1 Introduction

After the report is adopted by by-law, construction or improvement of the project is authorized. In this chapter, the term "construction" refers to both the construction (Section 4) and improvement (Section 78) of a project.

The Act allows for the construction of the drain to be supervised by the engineer or the drainage superintendent (Sections 60, 64, and 88(2)).

12.2 Options for Construction Supervision

The supervision of a drainage construction project can be managed in three different ways:

- by the municipality's drainage superintendent, independent from the engineer
- by the municipality's drainage superintendent, under the direction of the engineer
- by the engineer

12.2.1 Supervised by the Municipality's Drainage Superintendent, Independent of the Engineer

When construction supervision is performed by the drainage superintendent, the cost of the project may be reduced as the drainage superintendents' costs are not charged to the drain. However, there are two risks to the municipality:

- payment of *Drainage Act, 1990* grants for the drain construction work requires the sign-off of the engineer who designed the project and authored the report
- the municipality may incur liability for the construction

For more information on the risks of construction supervision performed by the drainage superintendent, refer to Part A, Chapter 12.6.

12.2.2 Supervised by the Municipality's Drainage Superintendent under the Direction of the Engineer

In order to minimize the cost to the project while maintaining grant eligibility, some municipalities prefer a combined approach. In this approach, the engineer maintains responsibility for the project, but the daily supervision is performed by the drainage superintendent. The engineer should advise the municipality that:

- since the engineer is ultimately responsible for the drain, periodic site inspections will occur during construction
- the drainage superintendent should:
  - possess a minimum level of surveying ability
  - understand engineering drawings and convey this information to the contractor, as required
  - be on the construction site for a specified period of time per day
  - be on-site full-time for certain components of the work
  - take elevations and gradients and record them in a format acceptable to the engineer

- submit for the engineer's review and approval any deviation that is being considered
- communicate regularly with the engineer, property owners and contractor

12.2.3 Supervised by the Engineer

When work is supervised by the engineer, the costs are added to the project and the project maintains its grant eligibility.

12.3 Pre-Construction Procedures

Before the project can proceed to construction, the municipal by-law authorizing the project must be given third reading. Work may only begin (Section 58(1))

- after the time for appealing has expired and there are no appeals; or
- after all appeals have been decided.

After third reading has been given to the by-law, there is an additional 10-day period where notice can be given of intention to make application to quash the by-law. Work should not begin until after this 10-day period has expired.

If the municipality does not readily proceed with construction of the project after a by-law is passed, petitioners have a right of appeal to the Tribunal (Section 58(5)).

Tendering

The engineer needs to understand the tendering and procurement policies specific to each municipality. Confirm with the municipality the extent of involvement, which may include:

- determining the preferred time to perform the work
- advising the municipality to notify OMAFRA about project timing to establish position in the grant queue
- determining the number of contract(s) to be created for the project and identifying that a road authority or a public utility has the option to perform the work on the section of drain that may affect them (Section 69)
- assisting the municipality with preparing the tender documents
- determining the time of advertising, closing and opening of tenders
- determining the method of advertising/ requesting tenders
- in accordance with municipal procurement policies, providing assistance during the tendering process, as required, by:
  - conducting a meeting with interested bidders
  - issuing written answers/explanations and addenda
  - opening and evaluating tenders
  - verifying that the required documents for insurance and security are supplied
  - providing a recommendation for tender selection
- if the tender price for drain construction (Section 4) exceeds the engineer's estimate by more than 33%, advising the municipality of its obligation to call a meeting with all parties to reconsider the project (Section 59(1))
- if the tender price for a drain improvement project initiated by council (Section 78) exceeds the engineer's estimate by more than 33%, recommending that the municipality conduct a meeting with the property owners prior to accepting a tender

Prior to initiating construction, ensure all environmental/agency approvals are in place.

12.4 Construction Procedures

Prior to initiating construction, ensure all environmental/agency approvals are in place. If the engineer is responsible for the management of the construction work, the following is a list of responsibilities to carry out during this phase.

Pre-Construction Meeting

Invite the municipality, selected contractor(s), affected property owners and agencies to an on-site pre-construction meeting to:

- review the project details
- identify the access routes and the working area(s)
- inform the meeting participants that the contractor(s) have the right to enter upon whatever lands are necessary to complete the work within the working space designated in the engineer's report (Section 63)

Contract Administration

A separate on-site project review with the selected contractor could also be held after the pre-construction meeting to:

- review permit conditions with the contractor and ensure the contractor has copies of all environmental approvals/permits at the site
- confirm the contractor has obtained the locates for buried utilities
- confirm the contractor's construction schedule
- review the contract document requirements with the contractor (e.g., clearing, levelling, location of existing drains, structure locations)
- confirm that the contractor has developed and implemented a traffic plan where necessary and that school boards, fire departments, etc. are notified of any road closures
- confirm the contractor will address livestock fencing/control
- discuss potential adverse weather conditions and implications for the construction site

Discuss potential property owner conflict issues. If the property owner refuses entry on the land, advise the contractor to work with the property owner to get permission. If the contractor's efforts are unsuccessful, the engineer should:

1. attempt to get permission by explaining the authority for the project and the right of entry onto land to perform the work
2. ask the local police for assistance
3. initiate legal action to obtain an order from the drainage referee to allow entry for construction of the drainage project

Site Supervision

To ensure a well-managed site, an engineer should:

- ensure benchmarks are clearly identified at the construction site
- provide any field layout as required by the contract documents
- review shop drawings as necessary
- arrange for inspection and testing by others as required
- be prepared to review and comment on requested options by the contractor
- provide on-site inspection services as necessary to confirm compliance with contract drawings and documents
- prepare regular written inspection reports
- liaise with property owners to avoid surprises or issues later in the project
- be aware of unforeseen conditions that may impact the drain (e.g., adverse soil conditions, erosion, sediment deposition, utilities) and may require design changes
- evaluate contractor-requested change orders or extra work items promptly, should unforeseen conditions occur during construction
- liaise with agencies as necessary to ensure compliance with environmental approvals
- respond to other potential environmental issues (e.g., spills)
- maintain regular contact with the contractor — where warranted, conduct additional on-site meetings with the contractor and affected property owners, regulatory agencies, etc.
- verify materials supplied are as required by contract documents
- ensure WSIB clearances are provided and prepare payment certificates
- if the utility or road authority has chosen to perform work themselves, ensure the work is completed (Section 69)
- complete construction surveys and prepare as-built drawings

Design Changes

If drain design changes are requested or become necessary prior to or during construction, be aware that changes and associated costs (made without an authorizing by-law):

- cannot be assessed to the drain
- are not eligible for the provincial grant to agricultural assessments
- may result in liability to the municipality (and to the engineer, if the engineer is involved)
- cannot legally be repaired and/or maintained

If changes in design or added features are necessary, follow the procedures outlined in Part A, Chapter 10.4.2.

12.5 Post-Construction Procedures

Contract Administration

- Develop a list of contract items that have not been completed (deficiencies) and ensure they are addressed.
- Prepare a substantial completion certificate.
- Ensure compliance with the *Construction Lien Act, 1990.* There is a statutory payment holdback for the warranty period.
- Prepare a final completion certificate (Figure A12–1) and recommend the release of the final holdback.
- Supply as-built information to the municipality for their records and for future maintenance.
- For larger, complex projects, conduct a post-construction meeting with the municipality, the contractor, the affected property owners and the agencies.

Quality of Construction

As a component of site supervision, the engineer is responsible for ensuring that the work meets the project specifications. However, there still may be complaints about the quality of the work. Common complaints involve disposal of material and improper installation of culverts and fences. The engineer should attempt to resolve any

CERTIFICATE OF COMPLETION

Date: October 11, 2016

Township of North
123 Random Street
North, Ontario
Postal COde

Drainage project: Main Drain and Branch A Improvement Project
Municipality: Township of North
Project Number: 123ABC

A final inspection has been made of the subject drainage project.

For the purposes of the Drainage Act, I certify that the work has been completed to my satisfaction and was done generally in accordance with the plans and specifications contained in my report dated September 25, 2014, with the following exception(s), if any:

- additional quarry stone rip rap required at Main Drain outlet to Stone Creek

Yours truly,

REAL GOOD ENGINEERING LIMITED

Sign here

Drainage Engineer, P.Eng.

Figure A12–1. An example of a final Certificate of Completion.

complaints about the completed construction with the municipality, property owners and affected agencies.

Property owners that remain dissatisfied with the quality of construction can appeal to the Agriculture, Food and Rural Affairs Appeal Tribunal during construction and up to one year from the date that the project is certified complete (Section 64).

If an appeal is filed to the Tribunal on quality of construction, the engineer will need to demonstrate that the construction was completed according to the specifications. For information on the Tribunal, refer to Part A, Chapter 11.2.

Grants

After the project is certified complete by the engineer, the project costs are assessed to the property owners in the watershed of the drain. The *Drainage Act, 1990* provides for the payment of grants for the assessments that are levied on agricultural land (Sections 85–90). OMAFRA administers the provision of these grants, and details are provided in the Agricultural Drainage Infrastructure Program (ADIP) policies.

Be familiar with the ADIP policies, particularly as they apply to activities where the grant eligibility may be in question. Consult with OMAFRA about grant eligibility during the writing of the report.

Assist the municipality by:

- determining the actual cost assessments on the individual properties
- reviewing and signing the grant application to be submitted to OMAFRA
- responding to questions from OMAFRA during the grant review

DID YOU KNOW? Grant applications for the construction or improvement of a municipal drain must be claimed within one year from the date the work was certified complete.

12.6 Referee and Tribunal Decisions Related to Construction

12.6.1 General

This section summarizes some of the decisions of the Agriculture, Food and Rural Affairs Appeal Tribunal and the drainage referee related to construction issues. These decisions provide direction to the engineer in administering the construction of drainage projects.

DID YOU KNOW? Prior to the establishment of the Tribunal (1977), construction issues were dealt with by the referee.

12.6.2 Referee and Tribunal Decisions

Most referee and Tribunal decisions (Table A12–1) regarding construction matters relate to changes being made to the engineer's design during construction and/or to inadequate supervision of the construction.

Table A12-1. Summary of Referee and Tribunal Decisions

Case	Key Messages	CanLII Link
Golden Triangle Air Services Ltd. vs. Township of Russell and Graham-Bergman & Associates, Referee Clunis, 1973	a) If there is a significant error in the report, apply to the Tribunal to correct the error. b) In-field changes must still be appropriately designed.	www.canlii.org/en/on/ondr Search "Golden Triangle"
Gardner vs. the Township of Zone, Referee Clunis, 1971 Balvert vs. the Township of Colchester South, Referee O'Brien, 1995	If the municipality decides that the engineer will not be responsible for construction supervision, inform the municipality that: a) the municipality must adhere to the report and b) the municipality is accepting increased liability for the construction.	www.canlii.org/en/on/ondr Search "Gardner Zone" Search "Balvert Colchester"
Parsons vs. the Township of Eastnor, Referee Henderson 1915	The municipality must adhere to the engineer's report.	www.canlii.org/en/on/ondr Search "Parsons Eastnor"
Knight vs. the Township of Dawn, Referee Henderson, 1916	The municipality was negligent in the lack of supervision and the failure to hire a qualified engineer to supervise construction. Projects should include some contingencies for unforeseen circumstances.	www.canlii.org/en/on/ondr Search "Knight Dawn"
McLean Drain 1996, Township of East Zorra-Tavistock, Ontario Drainage Tribunal, 1998	If in-field conditions require a design change that will alter the purpose, capacity or functionality of the drain, an application must be made to the Tribunal. The impact of the changes on individual property owners must be taken into consideration.	http://www.canlii.org/en/on/onafraat Search "McLean Zorra"

CHAPTER 13

OTHER REPORTS AUTHORIZED BY THE *DRAINAGE ACT, 1990*

13.1 Introduction

The primary responsibility of the engineer, under the *Drainage Act, 1990,* is the development and implementation of reports for the construction (Section 4) and improvement (Section 78) of drains. Once the drain exists, the municipality is responsible for the management of these existing municipal drains. Some aspects of this management may require the involvement of the engineer. These include:

- reports to provide for assessment changes to one or more properties due to the subdividing of land and/or changes in connections or of use of property (Section 65)
- reports to update the existing assessment schedules (Section 76)
- reports where the engineer determines that it is unnecessary, impractical or contrary to the *Drainage Act, 1990* to continue with the report for the construction (Section 4) or improvement (Section 78) of a drain (Section 40)
- reports to relocate a drainage works off of road rights-of-way (Section 77(2))
- reports to address proposed abandonments of drains (Section 84(3))
- assisting in the preparation of a mutual agreement drain (Section 2)
- leading or participating in the preparation of an environmental appraisal for a drain construction or improvement project (Section 6) (Part A, Chapter 5.4)
- leading or participating in the preparation of a Benefit cost statement for a drain construction or improvement project (Section 7) (Part A, Chapter 5.5)
- reports on costs to complete a drainage works where more than one municipality is involved and insufficient funds were provided for by the enacting by-law (Section 62(2))

13.2 Reports under Section 65(1)

Section Summary

When a parcel of land within the watershed of an existing drainage system becomes subdivided (Figure A13–1), the engineer may be instructed to apportion the existing assessments between the new properties.

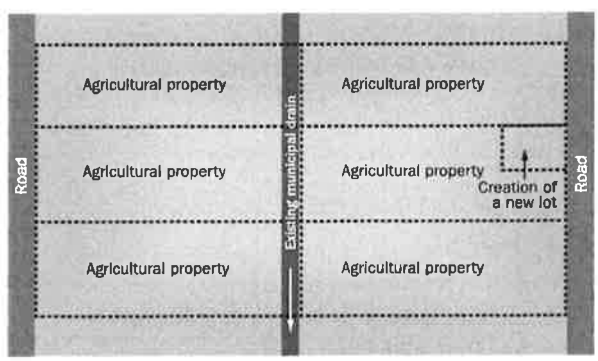


Figure A13–1. A proposed severance.

Use

This section is used to update assessment schedules at the time of:

- a severance or subdivision application to the municipality
- maintenance activities, where severances have occurred in the past

Initiation

The engineer must receive instructions from the clerk to complete the report. The engineer should ensure that copies of the clerk's instructions were also sent to the affected property owners. Note that a resolution of council is not required.

Fieldwork and Evaluation

Use available tools (e.g., municipal drain maps, OMAFRA Agricultural Information Atlas) to determine the municipal drains impacted by the severance or subdivision. For each municipal drain, obtain copies of the applicable by-law and the engineer's report.

Get a copy of any land division committee's report that details the authorization and severance or subdivision of land.

Prepare a sketch or drawings of the area(s) using aerial photography, topographical maps, background severance data and, where necessary, a site examination. The sketch or plan should identify all properties, watershed boundaries and the location of the municipal drains.

To determine the appropriate assessment to be divided, review the report for the existing drain, which will contain one of the following:

- the original construction assessment schedule only
- instructions for the modification of the construction assessment schedule for future maintenance activities
- a separate assessment schedule for maintenance activities

Use the principles of calculating assessments in Part A, Chapter 9 to proportion the applicable assessment(s) against the severed or subdivided properties. The sum of the individual benefit and outlet liability assessments should equal the original(s).

Prepare a summary table for each municipal drain impacted to provide the rationale for the new assessments, including benefit assessment, outlet liability and special benefit.

Each table should describe the land:

- before severance or subdivision, including the area of each parcel and the original assessments
- after severance or subdivision, including the area of each parcel and the new assessment(s)

Report Contents

Prepare a brief report to include the following:

- the work authorization under Section 65(1) and instructions received
- the reason a report is necessary (i.e., to allow for fair and correct future billings of maintenance)
- a summary of the land severance or subdivision
- a listing and brief description of each municipal drain affected by the land severance or subdivision
- a plan of the area affected by the severance or subdivision
- tables showing the assessments for maintenance for both before and after severance or subdivision
- the engineer's cost to prepare the report and who will pay these costs
- a summary of the procedure the municipality is to follow once the report is submitted

Processing the Report

The engineer files the report with the clerk (Section 65(7)). The clerk will attach the engineer's report to the assessment schedule from the original engineer's report. The clerk will send a copy of both, along with information about appeal rights, to the owners of the affected land. After the appeal time period has expired or appeals have been decided, the engineer's assessment is binding on the assessed lands.

DID YOU KNOW? The property owners of land affected by a Section 65(1) report have the right to appeal to the Tribunal if their assessment is over $500 (Section 65(11)).

13.3 Reports under Sections 65(3) and 65(4)

Section Summary

Municipalities have responsibilities for the connections, disconnections and changes in land use in a municipal drain. Section 65(3) applies where a property subsequently connects to a drain or where the land use has changed. Section 65(4) applies where a property wishes to disconnect from a drainage system. The engineer may be instructed to write a new assessment (or report).

The inspection and assessment for Section 65(3) is frequently combined with the engineer's assessment in Section 65(1). For example, a subdivision development (Figures A13–2 and A13–3) would trigger a land use change and the division of land into many lots.

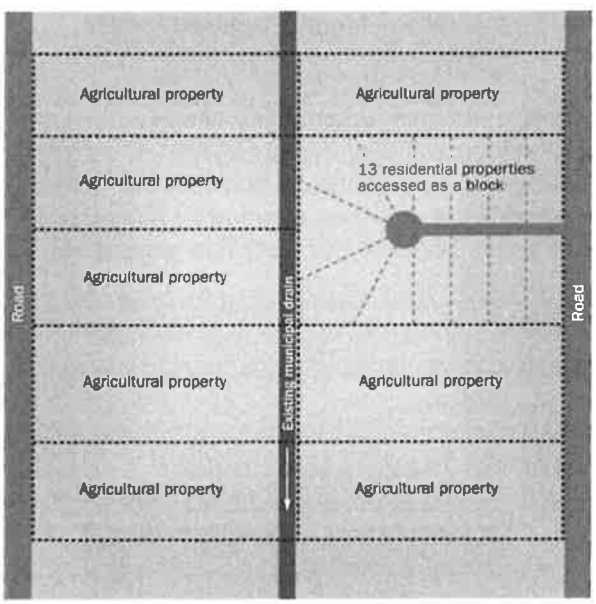


Figure A13–2. Agricultural properties converted into a subdivision.

Figure A13–3. Agricultural properties to be developed into a subdivision.

Source: Owen Brook, Guelph, Ontario.

If the drain also requires improvement (Section 78) or a new assessment schedule (Section 76), then these updates can be combined into one report that addresses all applicable sections of the Act.

Use

Section 65(3) is used when:

- land from outside the watershed is connected to an existing municipal drain
- land within the watershed is changed; normally the land use change results in an increase in the volume and rate of runoff
- land use changes that result in a decrease in volume and rate of runoff (e.g., agricultural land conversion to wetlands or natural area)

For the purposes of this section, the term "connection" is used to broadly describe these three activities.

Section 65(4) is used when land currently assessed into a municipal drain is removed from the watershed.

Initiation

The engineer must receive instructions from the clerk to complete a Section 65(3) or 65(4) report. If more than one property owner or parcel is involved, the engineer should ensure the instructions separately address each parcel/property owner.

The engineer should ensure that copies of the clerk's instructions are also sent to the affected property owners. These instructions confirm the right of the engineer to enter onto land for inspection. Note that a resolution of the council is not required.

The engineer should anticipate that a change in connection to one municipal drain may involve a disconnection from another drain, and the engineer may find it necessary to ensure the instructions address this.

On occasion, before any instructions are received, a municipality may ask the engineer to comment on the potential impacts of a proposed connection to an existing drain.

Fieldwork and Evaluation

Use available tools (e.g., municipal drain maps, OMAFRA Agricultural Information Atlas) to determine the municipal drains impacted. For each municipal drain, obtain copies of the applicable by-law and the engineer's report.

Sections 65(3) and (4) specifically require the engineer to inspect the land.

Prepare a drawing of the area(s) using aerial photography, topographical maps and information from the site examination. The plan should identify all properties, watershed boundaries and locations of municipal drains and emphasize those properties under evaluation.

Determine if the connection has already been made or if it is in the planning stages. Collect information on:

- the area of the land
- physical details of the connections
- land use changes
- hydrologic studies

Impacts of Connection (Section 65(3))

Prior to preparing a new or revised assessment, the engineer should evaluate the ability of the existing municipal drain to accommodate the additional flows from the connection, disconnection or change in land use (Section 15) (Figure A13–4). The engineer should also consider if any structure or right-of-way of the drainage works will be compromised.

Where the connection or other construction has not yet occurred, the engineer should advise if the drainage works will be negatively impacted. Advise of any other construction or new reports that may be required to address the proposed connection or other construction.

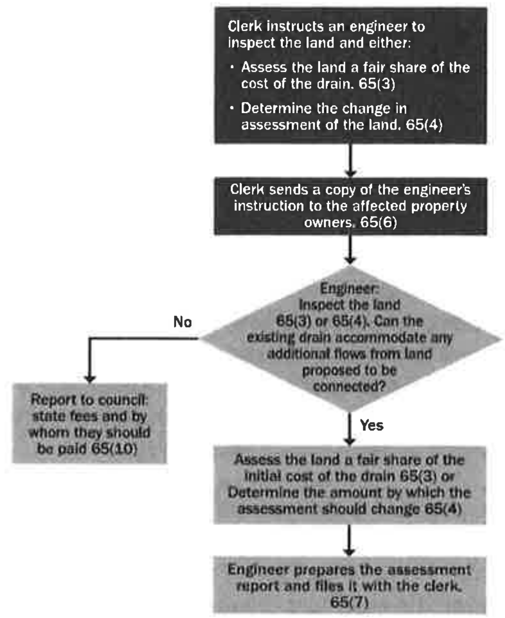


Figure A13–4. A decision tree of the process the engineer follows for reports on the impact of connections.

If the connection or other construction has already occurred, the engineer should advise the clerk if the municipal drain is negatively impacted. Determine what further construction or reporting is necessary prior to the filing of a report of a new assessment.

Where the engineer is satisfied that an existing municipal drain can accommodate a connection, the report should proceed to assessment analysis.

> **DID YOU KNOW?** A municipality can respond to an unauthorized connection by initiating legal action if there is damage to a drainage works (Section 82) or making application to the referee for an order (Section 106).

Assessment Analysis

The engineer is required to assess the connecting land a fair share of the initial cost of the drain to buy into the drain community. The engineer should evaluate the rationale for the assessments in the original report and consider the assessment that would have been made to the connecting land at the time of the original report. The fair share assessment to the connecting land may consider factors such as present value, depreciation and remaining service life of the drain.

DID YOU KNOW? The assessment will result in money being paid to the municipality, which is required to use the funds for future maintenance, repair or improvement of the drain (Section 65 (12)).

Where the connection to one drainage works involves a disconnection from another drainage works, the engineer should evaluate the relative initial assessments that were involved in each drainage works (Figures A13–5 and A13–6).

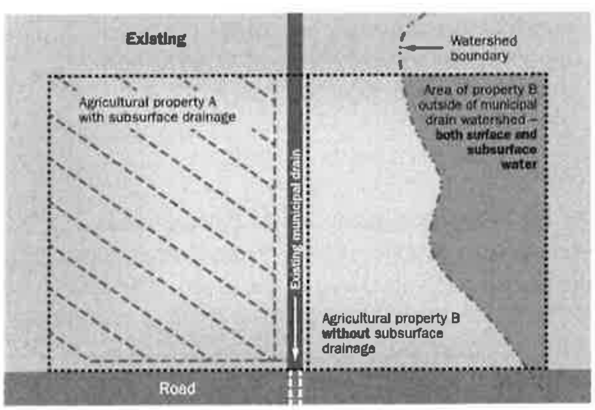


Figure A13–5. Water flow in the existing watershed.

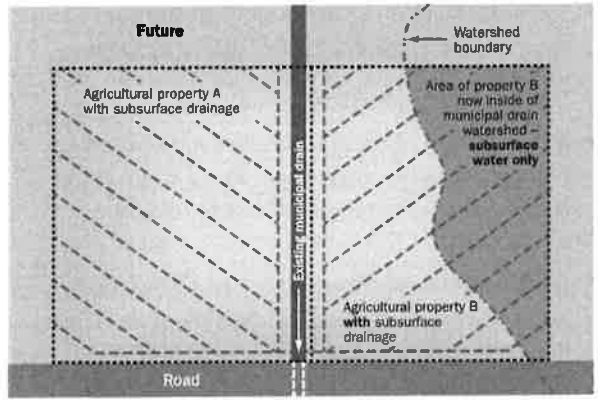


Figure A13–6. Change in water flow in the future watershed.

The engineer should also address the revised future maintenance provisions of the connections and include a table for revised future maintenance as in a Section 65(1) report. To determine the appropriate assessment, review the report for the existing drain, which will contain one of the following:

1. the original construction assessment schedule only
2. instructions for the modification of the construction assessment schedule for future maintenance activities
3. a separate assessment schedule for maintenance activities

Where the assessment analysis indicates that the existing report does not adequately address future maintenance, the engineer can recommend that a new maintenance assessment schedule be developed (Section 76).

Report Contents

Prepare a report to include the following:

- instruction from the clerk authorizing the report
- a description of the municipal drain(s) involved
- a description of the connection
- a plan of the area involved, including the connection(s)

- the authorization of the council of the connection
- the evaluation and impact of the connection(s)
- the assessment analysis
- a statement indicating that the funds collected from a fair share assessment must be used for future maintenance, repair or improvement of the drain
- the costs/fees of the engineer and how they are to be distributed to the owners of the lands involved (Section 65(10))
- the procedure to follow upon the submission of the report

The engineer may want to advise the municipality on the next steps to implement the report, including:

- issue connection approvals (Section 65(5))
- send invoices to property owners (Section 65(10))
- develop a new assessment schedule (Section 76)

Processing the Report

The engineer files the report with the clerk (Section 65(7)). The clerk attaches the engineer's report to the assessment schedule from the original engineer's report. The clerk will send a copy of both, along with information about appeal rights, to the affected property owners. Although not stated in the Act, a good practice is to send a summary of the report to all property owners in the watershed of the drain. Following the conclusion of the appeal process, the engineer's assessment is binding on the assessed lands.

> **DID YOU KNOW?** The property owners of land affected by a Section 65(3) or (4) report have the right to appeal to the Tribunal if their assessment is over $500 (Section 65(11)).

13.4 Reports under Section 76

Section Summary

Section 76(1) of the Act allows a municipality to obtain a new assessment schedule for an existing drain. The municipality appoints an engineer to complete a report that only contains a new assessment schedule. The report is processed (Part A, Chapter 10) in the same manner as for the construction of a drain (Section 76(2)).

Use

A municipality may consider initiating a report under this section when it decides:

- that numerous property divisions or subdivisions have occurred without the preparation of individual Section 65(1) reports
- that a watershed has been expanded/reduced/altered but the schedule of assessment was not revised under Sections 65(3) and 65(4)
- the existing maintenance assessment schedule is unfair or unusable
- that municipal boundaries have been changed, thereby altering the responsibilities for the management for the drain
- to create or expand an area that is block assessed (Section 25)
- to create separate assessment schedules for each main drain, branch drain or designated segment of an existing drain
- to provide assessment instructions for work components that may be subject to special benefit assessments (Section 24) or special assessments (Section 26)

Initiation

The engineer must be appointed by by-law or resolution of council. Where there is more than one municipality involved in the drain, approval of the Tribunal is required before the appointment of the engineer.

Fieldwork and Evaluation

Before the on-site meeting:

- Obtain a copy of the by-law, report, drawings and technical specifications:
    - Review and confirm that sufficient drawings and specifications exist to allow the drain to be maintained or repaired.

  - If plans, profiles or technical specifications are missing, the engineer may advise the municipality that the project should proceed as a drain improvement (Section 78) instead of a Section 76 report.
- Obtain a history of repairs and assessment schedule changes.
- Obtain any correspondence available from the municipality leading to the decision to prepare a Section 76 report.
- Talk to the drainage superintendent to gather any additional information about past and proposed activities.
- Review any other drainage reports, land use studies or other studies affecting the watershed.
- Prepare an up-to-date watershed plan of the drainage works or of the portions to be affected by a variation of the assessment.
- Determine the components of the existing assessment schedule that are to be reviewed as a result of the changed conditions or new circumstances. Also determine those portions of the assessment schedule(s) that may not need a variation.
- Prepare a list of the owners to be notified of the on-site meeting.
- Select an appropriate time and location for the on-site meeting.
- Ensure the notice for the on-site meeting is on the prescribed form (Reg. 381/12 Form 4) and is sent to all owners affected by the assessment schedules (Part A, Chapter 4).

At the on-site meeting:

- Conduct the on-site meeting following the procedures in Part A, Chapter 4.4, excluding the process to determine the sufficiency of petition.
- Determine the following:
  - past or existing drainage problems
  - past or proposed repair or maintenance
  - problems with existing schedules
  - past or proposed changes in land use
  - any jurisdictional or watershed boundary changes
  - other concerns of the municipality and/or property owners

After the on-site meeting:

- Conduct site examinations and/or surveys as necessary to justify changes in the assessment schedule due to physical changes within the watershed.
- Evaluate the adequacy of the existing drain to accommodate the current use. If this evaluation, along with the feedback from the on-site meeting, implies that the existing drain is inadequate, advise the municipality the drain should also be improved (Section 78).
- If the site examination determines that there is land connected to the drain that was not previously assessed or where the nature or extent of assessed land has changed, then determine if these lands should also be assessed a fair share (Section 65(3)).

Report Contents

The report should contain:

- the authority for the report and a brief summary of the applicable *Drainage Act, 1990* process
- a description of the drainage works affected
- a general description of the area affected (e.g., size, soils, topography, hydrology, land use)
- the history of the drain
- the changes or circumstances justifying a variation of assessment
- the rationale for the assessment
- other adjacent drains impacted by the revised assessment schedule
- the cost of preparing the report (Section 8(1)(b))
- how the costs to prepare the report are to be assessed
- a revised watershed plan (Section 8(1)(a))
- the new assessment schedule (Section 8(1)(c))
- a statement that the cost for the report is ineligible for the grant (Section 85(a))

Processing the Report

Ensure the report is filed within one year of appointment or at a later time as extended by a resolution of council (Section 39). The engineer should determine the extent of their involvement from the municipality once the report is submitted. After the report has been prepared and submitted to the council, the procedure to consider and process the report is similar to that for the construction or improvement of a drain (Part A, Chapter 10).

Appeals on a Section 76 report are restricted to assessment matters only. Both property owners and municipalities have the right to appeal their respective assessments (see Part A, Chapter 11 for information).

13.5 Section 40 Reports

Section Summary

At any time during the development of an engineer's report for the construction or improvement of a drain, an engineer may determine that the process should stop because the drain:

- is not required
- is impractical
- cannot be constructed under the *Drainage Act, 1990*

Upon making this decision, the engineer writes a Section 40 report to stop the proceedings.

Use

The following are some examples of situations when a Section 40 report may be used.

Drainage works may not be required when:

- the solution is more cost-effective for petitioners to complete the project privately (e.g., mutual agreement drain) and have agreed to do so
- the owner has arrived at a solution privately, no longer wants to proceed under the *Drainage Act, 1990* and notifies the engineer
- a project has been initiated by a petition of a single property and this owner indicates, in writing, their desire to terminate the project

Drainage works may be impractical when:

- it is not cost-beneficial (e.g., an excessive project cost to improve a small area of farmland, excessive project cost due to unstable soil conditions)
- the objective is unrealistic (e.g., lower the level of a lake)
- a roadway, railway or utility authority objects to a drainage system that affects their infrastructure
- agency approval cannot be practically obtained

Drainage works may not be constructed under the *Drainage Act, 1990* for certain purposes, such as:

- bridge construction over a natural watercourse
- erosion issues only
- irrigation purposes only

Initiation

Most reports under the *Drainage Act, 1990* are initiated by the municipality. A Section 40 report is initiated by a decision of the engineer.

Fieldwork and Evaluation

The fieldwork and evaluation are performed as part of the work done for the construction (Section 4) or improvement (Section 78) of a drainage system.

Report Contents

A Section 40 report contains the following information:

- background for the appointment of the engineer
- a watershed plan, where appropriate
- reason(s) why the drain is not required, is impractical or cannot be constructed under the *Drainage Act, 1990*
- engineering fees and other charges and a statement of how the fees are to be paid

Processing the Report

The Act requires a notice of filing of the report be sent, by the municipality, to all persons who signed the petition. It is recommended that the notice also be sent to other parties involved in the project, such as other property owners, approval agencies, etc. A copy of the Section 40 report should be provided with the notice.

Any property owner or public utility affected by the drainage works has 40 days to appeal to the Tribunal (Section 48(1)(d)).

After all appeals have been dealt with or the time for appeals has expired, the municipality will invoice the appropriate parties for payment.

DID YOU KNOW? There are no grants for Section 40 reports under the *Drainage Act, 1990.*

13.6 Section 62(2) Reports

Section Summary

When a drainage system affects more than one municipality and insufficient funds are provided by the original by-law, Section 62(2) of the Act requires that the initiating municipality appoint an engineer to prepare a report. The report should contain an estimate of the costs necessary to complete the project in excess of the costs set out in the original by-law for the drainage system.

Note: Section 62(2) is rarely encountered in the construction of drainage systems today. Municipalities will fund the construction of a drain and invoice the other affected municipalities for the actual amounts afterwards.

13.7 Section 77(2) Reports

Section Summary

A road authority can request the relocation of an existing municipal drain that is on or adjacent to a road under its jurisdiction (Figure A13–7). The municipality has to appoint an engineer to decide whether the drain should be moved. The engineer evaluates the drain capacity, drain efficiency and any adverse effects to person or property and writes a report.

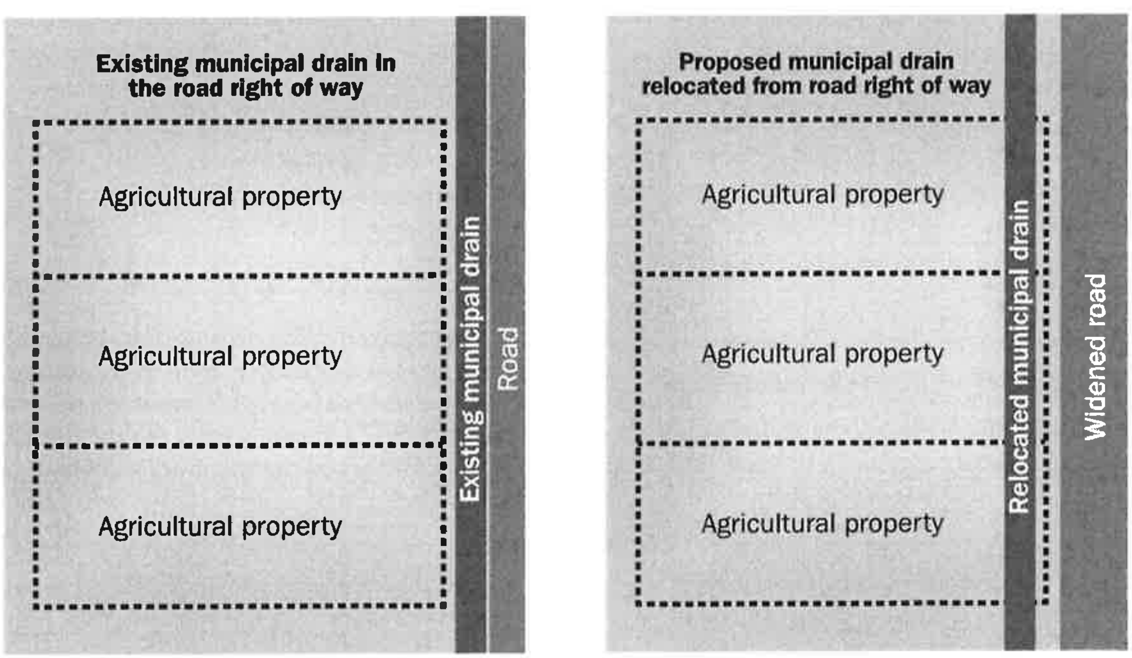


Figure A13–7. An existing municipal drain located in a road right-of-way (left), with a proposed relocation from the road right-of-way (right).

Use

This section allows the road authority to relocate drains without having to go through a Section 78 drain improvement process. This is commonly used to address safety issues (e.g., a drain too close to the roadway).

Section 77(2) requires the engineer to prepare a report; however it does not specify:

- the content of the report
- the rights of appeal
- the process to give the relocated drain legal status

While there have been some Tribunal decisions on Section 77(2), no Tribunal decisions to date have provided clear direction that address these issues.

Fieldwork and Evaluation

The engineer should:

- review the design standards, plan, profiles and specifications of the existing drainage report
- review the specific proposals of the road authority
- review the site and perform a survey as necessary to address the capacity, condition and impact issues
- determine and evaluate other relocation options

Report Contents

The report should include:

- the appointment of the engineer under Section 77(2)
- the request of the road authority (and any options reviewed)
- the office work and fieldwork completed
- a statement on the effects of the relocation on:
  - the capacity and efficiency of the drain
  - any person or property
- the cost estimate
- recommendations
- next steps

Consider developing plans, profiles and specifications for the relocated portion of the drain. This will add extra cost to the project; however, there is a benefit to the municipality in providing the technical design for the relocated drain for future maintenance and repair purposes.

Processing the Report

Section 77(2) does not provide instructions for processing the report. The following are two options that can be used to process a report.

Option 1: The same procedure is used as the processing of a Section 78 report (see Part A, Chapter 10 Processing the Report). The work is only started once a by-law is passed adopting the report.

Option 2: Once the report is filed, the municipality could authorize the work to be done immediately. It is recommended that the municipality and engineer ensure that a Section 78 report is prepared to actually implement the findings of the Section 77(2) report.

DID YOU KNOW? Where the relocation of the drain by the road authority will remain on lands of the road authority, Section 77(3) of the Act allows the engineer to prepare only a written opinion rather than a report as required by Section 77(2).

13.8 Abandonment of a Drain (Section 84)

Section Summary

Section 84 provides direction for the abandonment of part or all of a municipal drain. If an affected property owner has concerns about the potential abandonment of the drain, they can request an engineer's report on the proposed abandonment (Section 84(3)).

DID YOU KNOW? Section 19 allows a drain or section of drain to be abandoned as part of the construction (Section 4) or improvement (Section 78) of a drain.

Use

The abandonment of the whole or any part of a drainage system may be initiated by:

- at least three-quarters of the property owners who have been assessed for benefit and who also own at least three-quarters of the watershed assessed for benefit (Section 84 (1))
- the municipality (Section 84(2))

Some reasons for abandonment include the following:

- the drain may have been physically removed and replaced by storm sewers due to development
- the drain is sufficiently old, undersized and/or out of repair
- the drain cannot be maintained to the standards of the original engineer's report
- the drain has been built over or destroyed
- the drain no longer serves a useful purpose
- property owners are unwilling to invest in improvements or assessment schedule updates to the drain (Section 76 or 78)

Section 84(4) requires that all proceedings in the initiation and processing of an engineer's report are the same (with necessary modifications) as on a report for the construction of a drain (Section 4). These procedures are described in Part A, Chapters 4–11.

DID YOU KNOW? After a drain is abandoned, the municipality has no obligation with respect to the drainage system. Before proceeding with abandonment, carefully consider all implications:

- the municipality is no longer responsible for the maintenance or repair of the drain
- abandonment may result in the reinstatement of common law rules

Initiation

The municipality appoints the engineer to prepare a report (Section 84(3)). It is recommended that this appointment be passed through a by-law or resolution of the council (Section 8).

Fieldwork and Evaluation

Before the on-site meeting:

- obtain a copy of the abandonment request and verify it meets the requirements (Section 84(1))
- collect copies of the by-law, original engineer's report, drawings, any Section 65 reports, any outstanding legal actions, updated assessment roll data, etc.
- examine the municipality's records with respect to any assets of the drainage works, any work outstanding, any billings or assessments outstanding and any costs of repair or maintenance not yet billed out
- collect current information on the watershed
- discuss any concerns with the drainage superintendent or other municipal staff
- determine the utilities, agencies and property owners that may be involved
- determine if there are any outstanding regulatory issues or legal actions related to the drain

Conduct the on-site meeting to:

- determine the reason(s) for the request for abandonment
- determine the reason(s) for the request for the engineer's report
- identify private surface and subsurface drainage systems that may be impacted
- inform the participants of the extent of the drainage system and the proposed portions to be abandoned
- explain to the participants the implications of abandoning the drain, such as:
    - the municipality will no longer be responsible for managing the system
    - the reliance on other property owners to manage the system can result in flooding
    - it may require civil action to establish drainage rights (e.g., access to an outlet)
    - permits and approvals for future maintenance and repair will be the responsibility of the property owners

After the on-site meeting:

- examine the drain in detail, with specific emphasis on the section requested to be abandoned
- evaluate the impacts of abandonment on the watershed, property owners, agencies, utilities and the road authorities
- review other drainage reports, land use studies or other studies that are relevant to the watershed
- determine if any work is to be performed to facilitate the abandonment
- determine if any other watershed may be impacted if the drainage works is abandoned and ensure property owners in those watersheds are notified
- consider if there are assets that should be sold

Report Contents

A report on the abandonment of a drain should contain:

- background information on the drain, the request for abandonment and the request for the engineer's report for abandonment
- recommendations
- the estimated cost of the abandonment, including the engineer's fees
- the estimated proceeds from the sale of any assets
- an assessment schedule to assess the net costs of the abandonment

Processing the Report

Ensure the report is filed within one year of appointment or at a later time as extended by a resolution of council (Section 39). The engineer should determine the extent of their involvement from the municipality once the report is submitted. As soon as the report has been prepared and submitted to the council, the procedure to consider and process the report is similar to that for the construction or improvement of a drain (Part A, Chapter 10).

The rights of appeal on an abandonment report are similar to those on a report for the construction or improvement of a drain (Part A, Chapter 11).

DID YOU KNOW? The cost of abandoning a drain is not eligible for grants (Section 85).

13.9 Mutual Agreement Drains (Section 2)

Two or more property owners may enter into a written agreement for the construction, improvement, financing and maintenance of a private drainage system. Mutual agreement drains are different than municipal drains because they are constructed, owned and maintained by the property owners that are party to the agreement.

The Act does not require the property owners to retain the services of an engineer, but an engineer may be requested to design the drainage system, develop a plan, assist with hiring a contractor and supervise the construction. Additional information on mutual agreement drains is found in the OMAFRA factsheet *Mutual Agreement Drains* (ontario.ca/omafra).

CHAPTER 14

THE ENGINEER AND THE DRAINAGE SUPERINTENDENT

14.1 Introduction

Municipal council has the responsibility for implementing the procedures of the Act and for managing the network of municipal drains. In performing the duties under the Act, the engineer has a strong relationship with the council and staff, particularly with the drainage superintendent.

14.2 The Drainage Superintendent

The drainage superintendent is appointed by by-law and is responsible for the following duties under the Act (Section 93(3)):

- inspect and report periodically on the condition of the municipality's drainage systems
- initiate and supervise the maintenance and repair of the municipality's drainage systems
- assist in the construction or improvement of the municipality's drainage systems
- report to council on the maintenance, repair, construction or improvement activities

The drainage superintendent has two main roles with respect to the preparation of an engineer's report. The first is as a **client** to liaise with the engineer during report preparation to ensure specific concerns and/or needs for the management of the drainage system are addressed. The second is as an **assistant,** providing liaison with property owners and assisting in construction, from tendering through on-site supervision to finalization.

14.3 The Drainage Superintendent as the Engineer's Client

An engineer should consider the drainage superintendent as a client, when the engineer is retained by a municipality to prepare any report under the *Drainage Act, 1990* (Figure A14–1). The drainage superintendent can provide input to the engineer:

- at the start of a drainage project
- at the on-site meeting
- during site surveys and field examinations.
- at meetings with agencies and property owners
- by reviewing and commenting on the draft report

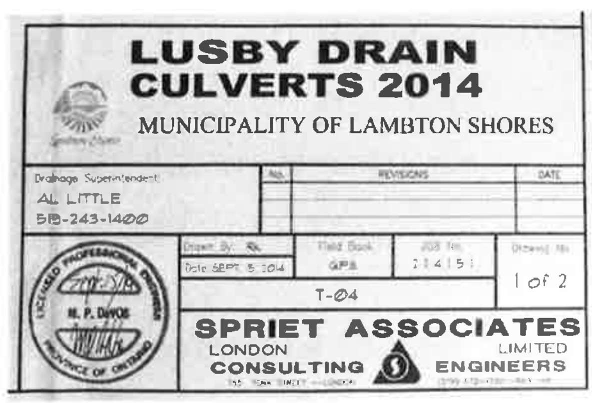


Figure A14–1. A title block from a drawing in an engineer's report for a drain showing the name of the drainage superintendent (left corner).

Source: Spriet Associates Ltd., London, Ontario.

Items to discuss with the drainage superintendent include:

- design options, their implications and new techniques
- access routes, working limits and staging areas
- a practical maintenance assessment schedule that facilitates billings of maintenance costs on a branch-by-branch and interval-by-interval basis
- the location, extent and longevity of benchmarks
- disposal of materials excavated from the drain
- abandonment of drains that are being replaced
- details on the plans, profiles and specifications being developed for the report
- special structures included in the report (e.g., crossings, sediment traps, buffer strips)
- clearing and grubbing to be undertaken and the method of disposal
- as-built drawings or equivalent

In order to assist the drainage superintendent in the future management of the drain, it is recommended that the report contain the following:

- a glossary of technical terms such as benefit, outlet liability, designs storms, etc.
- a statement that crop damage allowances will not be paid for future drain maintenance and repair
- a statement indicating that connections to the drain require approval
- a statement indicating that obstructions and damages to the drainage system are prohibited
- a statement providing instruction for future maintenance and repair
- a method to calculate the value of special benefit assessments

14.4 The Drainage Superintendent Assisting the Engineer

The drainage superintendent may assist the engineer and is often the engineer's point of contact with the municipality. Some municipalities have developed ways for the engineer and the drainage superintendent to work together to benefit the property owners, the municipality and agencies and to reduce costs. Talk to the drainage superintendent to find out what role(s) the municipality may wish them to be involved in.

The drainage superintendent may assist the engineer with some of the following responsibilities:

- Information — the drainage superintendent can provide information on the history of the drain and access to files and reports.
- Liaison — use the local knowledge of the drainage superintendent in communicating with property owners and approval agencies.
- Surveying and site examinations — the assistance of the drainage superintendent can reduce the need for extra engineering services and keep costs down on a project. It is the engineer's responsibility to direct, review and accept the work done by the drainage superintendent in this phase.
- Construction supervision (Part A, Chapter 12.4):
  - The assistance of the drainage superintendent can reduce the need for extra engineering services and reduce costs on a project. For a drain construction or improvement project, only the engineer can approve changes to the design and contract. The engineer must be satisfied with the reporting and quality of the supervision.
  - The drainage superintendent may be able to assist in addressing questions and concerns about the project and resolving conflicts.
  - The *Drainage Act, 1990* allows a drainage superintendent to certify the completion of a project under an engineer's report (Sections 60, 64 and 88(2)). When this occurs, the municipality assumes some accountability for the construction of the drain.
- Contract administration — the drainage superintendent may be able to perform this work at a reduced cost.

14.5 Avoiding Conflict of Interest — the Engineer as the Drainage Superintendent

An engineer may be appointed as the drainage superintendent for a municipality. When preparing reports for a municipality, the engineer should ensure that their role as drainage superintendent does not conflict with their role as engineer (and vice versa).

The referee and the Tribunal have identified that there is a potential conflict in having the same person writing a report for a drain and managing the same drain on a day-to-day basis as an employee of the municipality. The following referee/Tribunal decisions identify this conflict and are found on CanLII (www.canlii.org):

- Horne Dempsey *et al.* vs. North Easthope and the City of Stratford
- Hodgson *et al.* vs. Township of Mariposa
- an appeal by Vanderkloet on the Hyatt Drain in the Township of Enniskillen
- appeals by Hamather and McBride, on the Exeter Municipal Diversion Drain in the Municipality of South Huron

DID YOU KNOW? Where an engineering firm provides both engineering and drainage superintendent services to the same municipality, the provincial Agricultural Drainage Infrastructure Program (ADIP) imposes some limits on grant eligibility.

CHAPTER 15

CASE STUDY

This case study is a work of fiction intended for education purposes only. The names of property owners, roll numbers, municipalities, utilities, drain locations and details are fictional. The purpose of the case study is to demonstrate the assessment principles described in this guide. All monetary values used in the case study have been rounded to include only whole dollars.

15.1 Introduction

The property owners in the Township of North are concerned about the functioning of a main drain and a tributary of an existing municipal drain. They have indicated to the municipality that the system is providing an ever-decreasing level of service to the properties. It is overstressed due to the increasing amount of systematic drainage in the watershed and some changes in land use.

The drainage superintendent has identified:

- the existing pipe crossing of a TransOntario natural gas pipeline (TransOntario pipeline) is not working for the upstream lands
- the channel portion of the drain has been cleaned out periodically but it is undersized and overflows frequently
- the existing channel crossings are old, undersized and need replacing
- the 100-year-old pipe on the main drain requires frequent repairs

An engineer has been appointed (Part A, Chapter 2) under Section 78 of the *Drainage Act, 1990* to complete a report for improved drainage. After the appointment, a project scoping meeting (Part A, Chapter 3) and an on-site meeting (Part A, Chapter 4) were held. Agencies were consulted and their concerns were addressed. A preliminary report (Part A, Chapter 5) was not drafted, but a survey and site examination (Part A, Chapter 6) was completed to determine the information required to complete the project as follows.

Watershed Land Use Features

The watershed features (Figure A15–1) include:

- The watershed is primarily cash cropped, with systematic drainage and moderate slopes.
- The agricultural use is primarily a corn and bean rotation.
- There are a number of smaller bush lots scattered throughout the watershed.
- The drain crosses County Road 137 (C2) and the 4^{th} Line in two locations (C1 and C3).
- The drain crosses a TransOntario pipeline (P1) near the middle of the watershed.
- There is a farm equipment dealership at the northeast corner of the intersection of County Road 137 and 4^{th} Line.

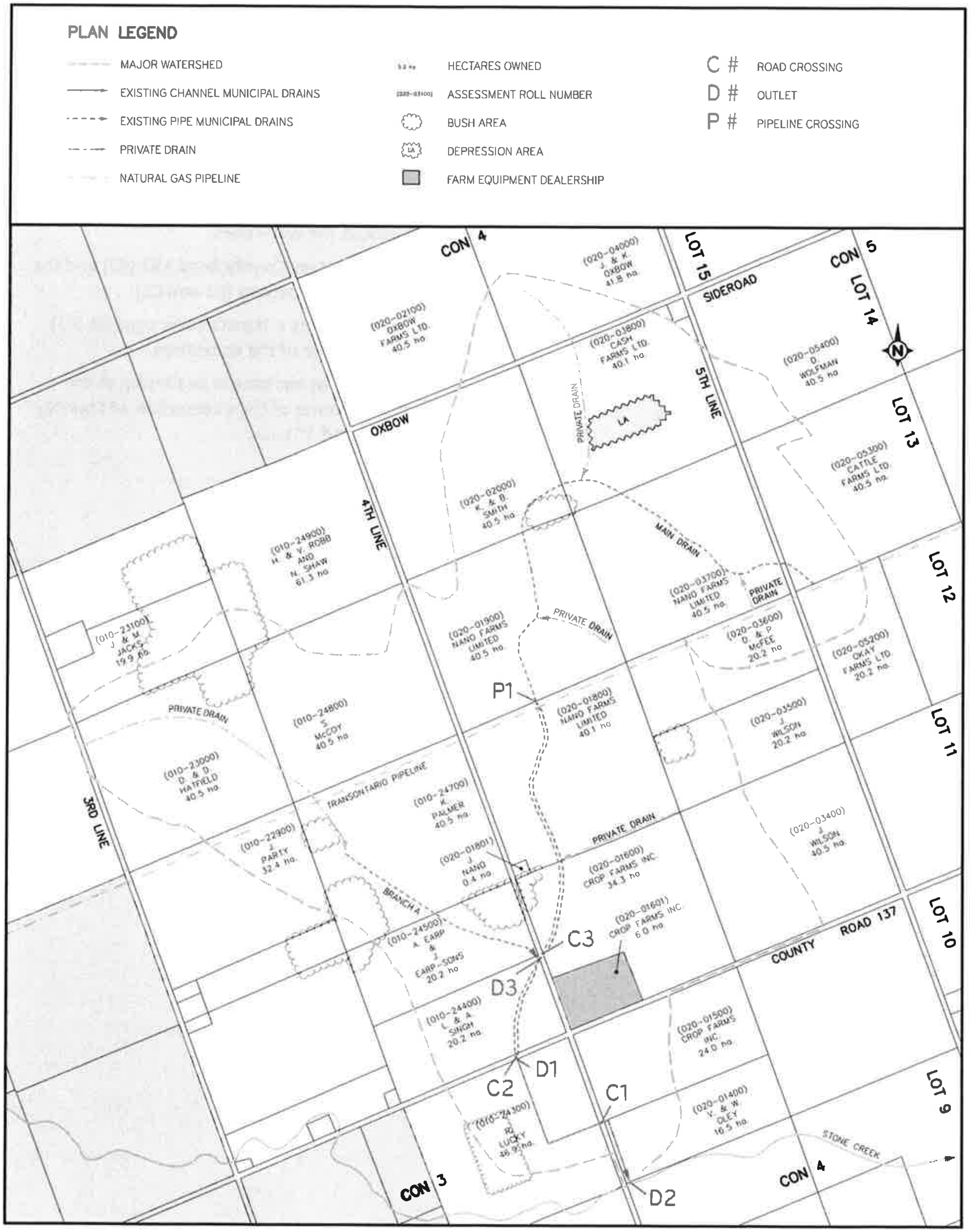


Figure A15–1. Initial conditions of the watershed.

Drainage Features

The existing municipal main drain consists of:

- a pipe portion consisting of two parallel pipes that outlet (D1) into the channel municipal drain:
  - a 45-year-old pipe, ranging in size from 450 mm to 525 mm, provides on average a 9 mm/day drainage coefficient
  - a 100-year-old pipe, ranging in size from 200 mm to 250 mm, provides less than a 3 mm/day coefficient and requires ongoing repairs
  - ponding and minor erosion is occurring along the route
- the channel municipal drain discharges into Stone Creek, a natural watercourse (D2)

Branch A consists of a 450 mm concrete pipe (approximately 80 years old) and outlets into the main drain (D3). This tributary has a greater slope, and the surrounding land has more surface erosion.

Design Considerations

At the on-site meeting, the following items were identified:

- The new drain work should be sized to serve all lands in the watershed, even though new direct outlets to all lands are not required at this time.
- Better drainage (increased drainage coefficient) is needed during the planting, growing and harvesting seasons.
- Lands upstream of the TransOntario pipeline do not have adequate drainage, which suggests a problem with the pipeline crossing.
- The channel floods frequently.
- The 100-year-old pipe, ranging in size from 200 mm to 250 mm, should be broken up or removed, with any connections into it switched to the new tile.
- The 45-year-old pipe, ranging in size from 450 mm to 525 mm, should be inspected and, if functional, maintained and paralleled.

An investigation of the 45-year-old pipe identified no problems except that the TransOntario pipeline crossing gradient was found to be quite flat. The property owners in the watershed upstream of the pipeline suggested that the existing drain upstream of the pipeline did not require any improvements.

The engineer decided to proceed with a pipe drain system designed with a 25 mm/day drainage coefficient. To achieve this design standard, a new pipe is needed to parallel the existing 45-year-old pipe from the upstream end (P1) to the outlet (D1).

The channel portion of the drain also needs improvement to meet current design standards.

15.2 Recommended Design

The recommended design of the drainage system is shown in Figure A15–2 and described in the following sections.

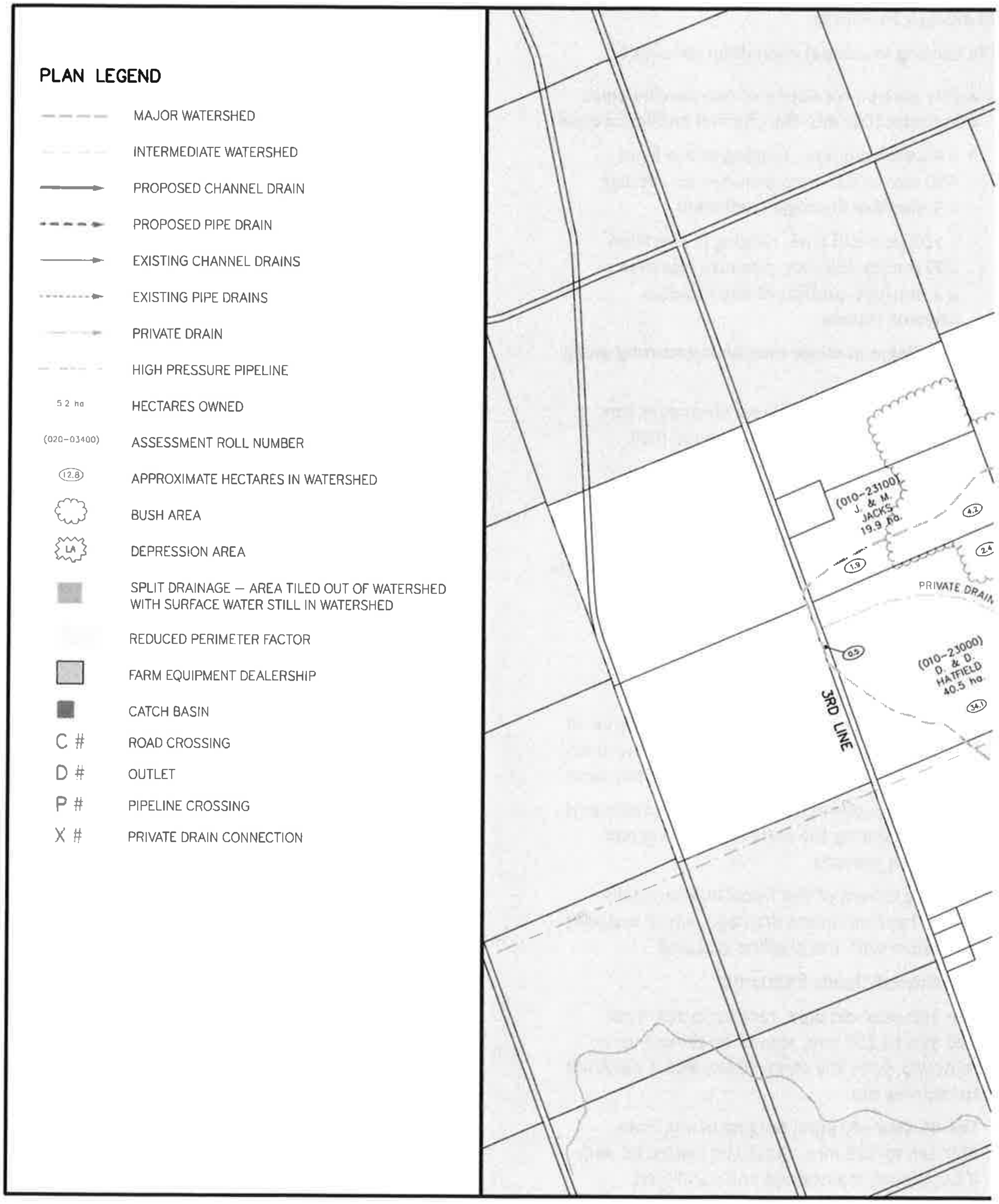


Figure A15–2. Proposed drainage system.

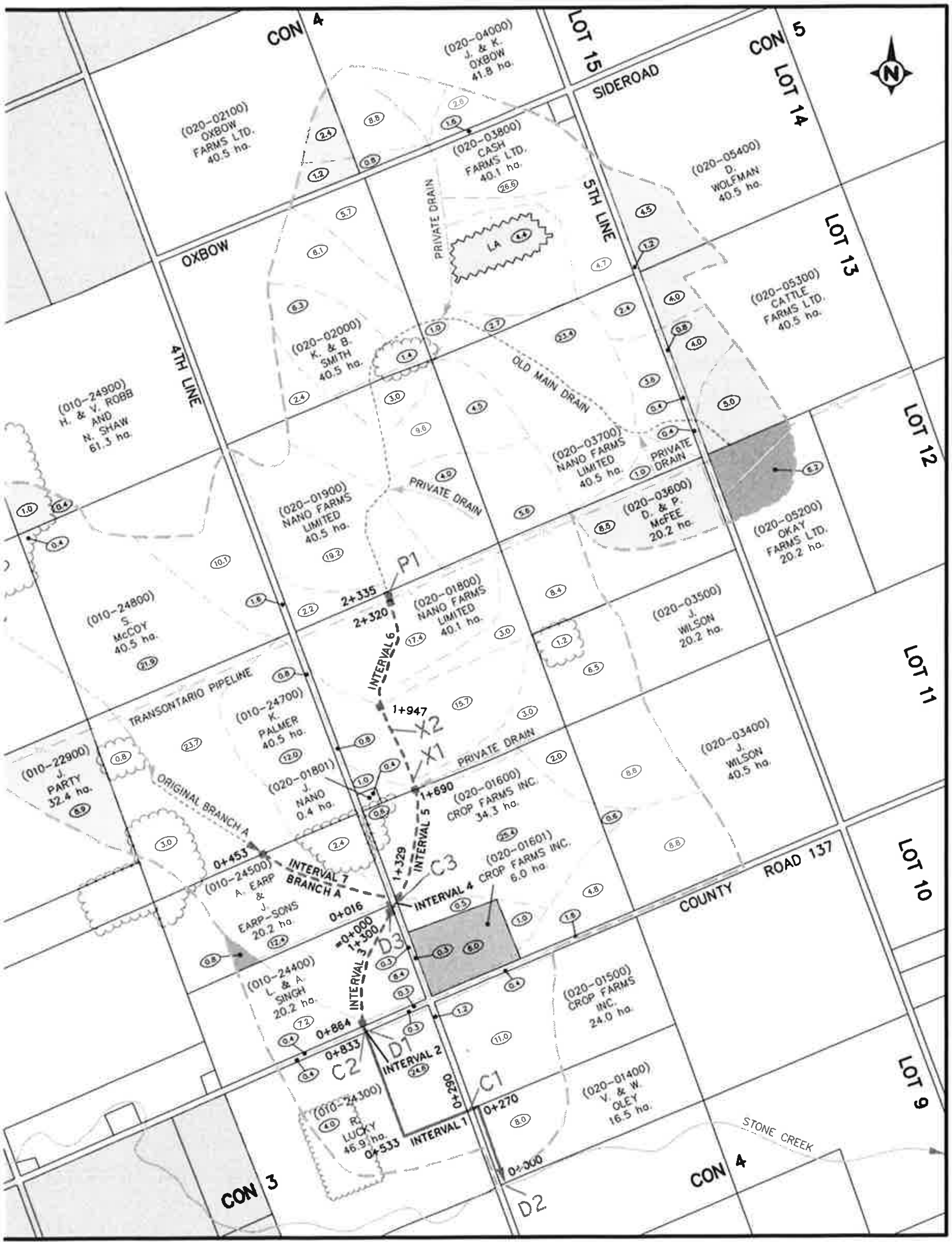


Figure A15–2. Proposed drainage system.

Channel (Station 0+000 to Station 0+833)

- widen and deepen the channel and level materials on-site
- replace the existing undersized culverts with new embedded crossings:
  - the 4th Line Township road crossing (C1)
  - the crossing to the V. & W. Oley property
  - the crossing to the R. Lucky property
- provide a splash pool/sediment area at the pipe outlet (D1)
- ensure minimal disturbance of the channel for 100 m upstream of the outlet to the creek (D2)
- execute other channel design features, including:
  - construction of temporary sediment traps
  - provision of erosion control at specified locations
  - retention of existing trees on the south bank
  - provision of a timber crib wall for habitat enhancement

Pipe Main Drain

- Station 0+833 to 0+864, County Road 137 crossing (C2):
  - replace the crossing with two 750 mm High Density Polyethylene (HDPE) pipes
  - replace the two existing catch basins, located upstream and downstream of the county road
- Station 0+864 to 1+300:
  - install 436 m of new 900 mm concrete pipe parallel to the existing 45-year-old, 525 mm pipe
  - leave the broken 100-year-old 250 mm pipe in place with existing and divert connections to the new pipe
- Station 1+300 to 1+329, 4th Line crossing (C3)
  - execute work described in Figure A15–3

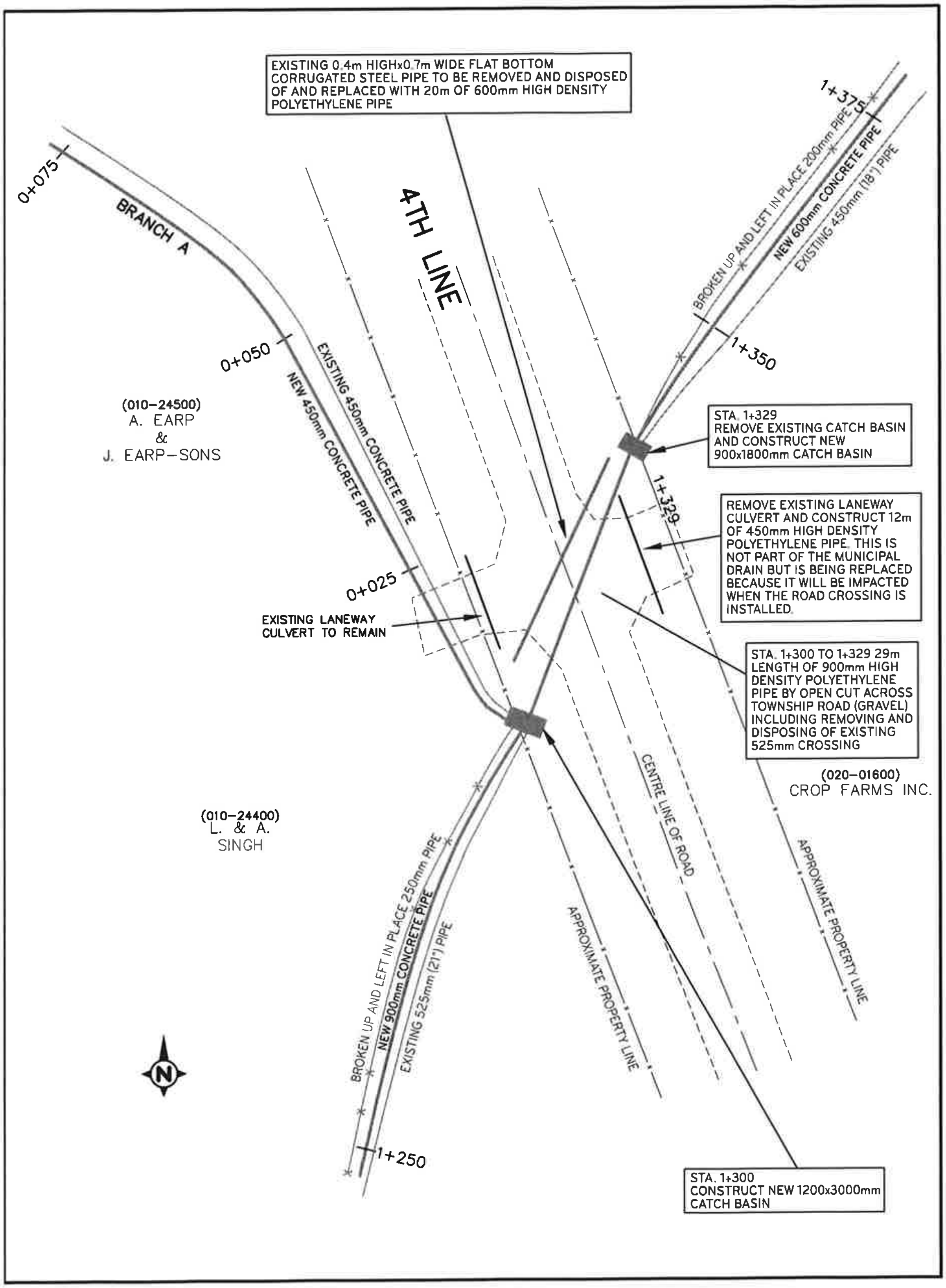


Figure A15-3. 4th Line crossing details.

- Station 1+329 to 1+947:
  - install 618 m of 600 mm concrete pipe parallel to the existing 45-year-old, 450 mm pipe
  - leave the broken 100-year-old, 200 mm pipe in place and divert existing connections to the new pipe
  - install a new catch basin at Station 1+690
  - replace existing catch basin at Station 1+947
  - construct tees at Stations 1+750 (X1) and 1+857 (X2)
- Station 1+947 to 2+335:
  - install 373 m of 600 mm concrete pipe parallel to the existing 45-year-old, 450 mm pipe
  - leave the broken 100-year-old, 200 mm pipe in place with existing and divert connections to the new pipe
  - install a new junction box at Station 2+320
  - at the TransOntario pipeline crossing (P1), remove the 45-year-old, 450 mm pipe and 100-year-old, 200 mm pipe and replace them with three 450 mm HDPE pipes
  - install a new catch basin at Station 2+335

Branch A (connected at Station 1+300 on the Main Drain (D3))

- Station 0+000 to 0+453:
  - install 453 m of 450 mm concrete pipe parallel to the 80-year-old, 450 mm pipe
  - construct a WASCoB with a 150 mm surface inlet at Station 0+227
  - construct a new ditch inlet catch basin (DICB) and reconstruct the berm at Station 0+453

15.3 Cost Estimates and Assessments

Step 1: Divide the Project into Intervals

For purposes of distributing the cost/making the assessments, the drain is divided into intervals (Figure A15–2). In this case study, the drainage system is divided into seven intervals based on key features of the drain, including road crossings, transition from channel to pipe, and pipe size changes. The intervals are as follows:

Main Drain

- Interval 1 is the section of channel from Station 0+000 to Station 0+833. It begins at the outlet at Stone Creek (D2) to the downstream side of the County Road 137 crossing (C2). This includes the existing 4th Line crossing (C1).
- Interval 2 is the County Road 137 crossing (C2) from Station 0+833 to 0+864.
- Interval 3 is the section of pipe from Station 0+864 to 1+300. It begins at the upstream side of the County Road 137 crossing (C2) to the downstream side of 4th Line crossing (C3).
- Interval 4 is the 4th Line crossing (C3) from Station 1+300 to 1+329.
- Interval 5 is the section of pipe from Station 1+329 to Station 1+947; it begins at the upstream side of the 4th Line crossing (C3) to the size change that occurs at Station 1+947.
- Interval 6 is the section of pipe from the size change that occurs at Station 1+947 to the upstream side of the pipeline crossing (P1) at Station 2+335.

Branch A Drain

- Interval 7 is the section of pipe from Station 0+000, where it connects to the Main Drain (D3), to its upstream end at Station 0+453.

Step 2: Determine the Cost of Each Interval

The development of the assessments begins after watershed(s) and land uses are determined. It is refined as the design, drawings, specifications and costs are prepared. The allowances, construction costs, engineering fees, eligible municipal administration costs and contingencies are estimated for each interval.

Step 2a: Create the Equivalent Area and Lengths Table

The Equivalent Area and Lengths Table (Table A15–3) lists all properties in the watershed, the total hectares of each property and the hectares of each property in the watershed (affected hectares). Divide the affected hectares into the appropriate land use type (e.g., agricultural, residential, commercial, split drainage, bush and roads).

Assign the Equivalent Area Adjustment Factors (EAAF) for each land use type (Part A, Chapter 9.3.2). Table A15–1 describes these factors used in the case study.

Table A15–1. Case Study Equivalent Area Adjustment Factors

Land Use	Equivalent Area Adjustment Factor
Agriculture	1.0
Bush	0.5
Residential	1.5
Commercial	2.0
Depressional	0.2
Split Drainage*	0.5
2 Lane Gravel Road	1.5
2 Lane Asphalt Road	2.0

Note: Split drainage refers to properties that contribute surface water to the drain, but subsurface water is directed out of the watershed.

The equivalent affected hectares are calculated for each property and assigned to the applicable drain intervals.

Assign the **Perimeter Factor** for each property with the default being 1.0 (Part A, Chapter 9.3.2). In the case study, the engineer was of the opinion that some higher-lying properties on the perimeter of the watershed qualify for a different perimeter factor. As shown in Table A15–2, only a few properties were subject to a different perimeter factor.

Table A15–2. Perimeter Factors

Property	Perimeter Factor
J. Party	0.8
H. & V. Robb and N. Shaw	0.4
Oxbow Farms Ltd	0.4
D. & P. McFee	0.67
Cattle Farms Ltd.	0.8
D. Wolfman	0.33

For each interval, assign the **Equivalent Length Factor** to each property using the method described in Part A, Chapter 9.3.2.

The **Total Adjusted Area** is calculated for each property in each interval as shown in Table A15–3. Note that properties classified under the Farm Property Class Tax Rate are denoted by FPCTR in all subsequent tables.

Table A15–3. Equivalent Area

FPCTR (Yes / No)	Conc.	Lot	Roll No. (12-58-010)	Owner	Total Owned (Ha)
Yes	3	Pt W½ 12	-010-22900	J. Party	32.4
Yes	3	W½ 13	-010-23000	D. & D. Hatfield	40.5
Yes	3	Pt SW¼	-010-23100	J. & M. Jacks	19.9
Yes	3	Pt 10	-010-24300	R. Lucky	46.9
Yes	Special Benefit to Lucky				-
Yes	3	SE¼ 11	-010-24400	L. & A. Singh	20.2
Yes	3	NE¼ 11	-010-24500	A. Earp & J. Earp-Sons	20.2
Yes	3	E½ 12	-010-24700	K. Palmer	40.5
Yes	3	E½ 13	-010-24800	S. McCoy	40.5
Yes	3	E½ 14	-010-24900	H. & V. Robb & N. Shaw	61.3
Yes	4	SW¼ 10	-020-01400	V. & W. Oley	16.5
Yes	4	NW¼ 10	-020-01500	Crop Farms Inc.	24.0
Yes	4	Pt W½ 11	-020-01600	Crop Farms Inc.	34.3
No	4	Pt W½ 11	-020-01601	Crop Farms Inc.	6.0
Yes	4	Pt W½ 12	-020-01800	Nano Farms Limited	40.1
Yes	Special Benefit to Nano Farms				-
No	4	Pt W½ 12	-020-01801	J. Nano	0.4
Yes	4	W½ 13	-020-01900	Nano Farms Limited	40.5
Yes	4	W½ 14	-020-02000	K. & B. Smith	40.5
Yes	4	W½ 15	-020-02100	Oxbow Farms Ltd.	40.5
Yes	4	E½ 11	-020-03400	J. Wilson	40.5
Yes	4	SE¼ 12	-020-03500	J. Wilson	20.2
Yes	4	NE¼ 12	-020-03600	D. & P. McFee	20.2
Yes	4	E½ 13	-020-03700	Nano Farms Limited	40.5
Yes	4	Pt E½ 14	-020-03800	Cash Farms Ltd.	40.1
Yes	4	E½ 15	-020-04000	J. & K. Oxbow	41.8
Yes	5	Pt W½ 12	-020-05200	Okay Farms Ltd.	20.2
Yes	5	W½ 13	-020-05300	Cattle Farms Ltd.	40.5
Yes	5	W½ 14	-020-05400	D. Wolfman	40.5
No	3 to 5	Pt 12	Special Assessment TransOntario Pipeline		-
Total Assessments on Lands:					-
County Road 137 - County of South					-
Special Assessments to County Road 137					-
3rd Line - Twp of North					-
4th Line - Twp of North					-
Special Assessments to 4th Line					-
5th Line - Twp of North					-
Oxbow Sideroad - Twp of North					-
Total Assessments on Roads:					-
TOTAL:					-

MAIN DRAIN											
Interval 2 0+833 to 0+864 (County Road 137)				Interval 3 0+864 to 1+300 (Singh)				Interval 4 1+300 to 1+329 (4th Line)			
800				4,000				700			
Benefit Assessment ($)	Adjusted (Ha) (A)	Outlet Liability ($) (B=A x F)	Total in Interval ($)	Benefit Assessment ($)	Adjusted (Ha) (A)	Outlet Liability ($) (B=A x F)	Total in Interval ($)	Benefit Assessment ($)	Adjusted (Ha) (A)	Outlet Liability ($) (B=A x F)	Total in Interval ($)
-	7.1	2	2	-	7.1	33	33	-	-	-	-
-	35.3	8	8	-	35.3	166	166	-	-	-	-
-	4.0	1	1	-	4.0	19	19	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	15.6	3	3	2,000	5.6	26	2,026	-	-	-	-
-	14.0	3	3	-	13.6	64	64	-	-	-	-
-	37.6	8	8	-	37.6	177	177	-	-	-	-
-	32.2	7	7	-	32.2	151	151	-	10.1	3	3
-	0.4	-	-	-	0.4	2	2	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	34.0	7	7	-	29.2	137	137	-	29.2	10	10
-	12.0	3	3	-	12.0	56	56	-	12.0	4	4
-	40.1	9	9	-	40.1	188	188	-	40.1	14	14
-	0.6	-	-	-	0.6	3	3	-	0.6	-	-
-	38.0	8	8	-	38.0	179	179	-	38.0	13	13
-	21.2	5	5	-	21.2	100	100	-	21.2	7	7
-	1.4	-	-	-	1.4	7	7	-	1.4	-	-
-	18.0	4	4	-	9.2	43	43	-	9.2	3	3
-	7.1	2	2	-	7.1	33	33	-	7.1	2	2
-	11.3	2	2	-	11.3	53	53	-	11.3	4	4
-	40.5	9	9	-	40.5	189	189	-	40.5	14	14
-	35.9	8	8	-	35.9	169	169	-	35.9	12	12
-	12.2	3	3	-	12.2	57	57	-	12.2	4	4
-	3.1	1	1	-	3.1	15	15	-	3.1	1	1
-	10.4	2	2	-	10.4	49	49	-	10.4	4	4
-	1.5	-	-	-	1.5	7	7	-	1.5	1	1
-	-	-	-	-	-	-	-	-	-	-	-
700	4.6	1	701	-	-	-	-	-	-	-	-
-	0.8	-	-	-	0.8	4	4	-	-	-	-
-	7.6	2	2	-	7.6	36	36	600	4.1	1	601
-	5.6	1	1	-	5.6	26	26	-	5.6	2	2
-	2.4	1	1	-	2.4	11	11	-	2.4	1	1
700	454.5	100	800	2,000	425.9	2,000	4,000	600	295.9	100	700
700	-	-	-	2,000	-	-	-	600	-	-	-
100	-	-	-	2,000	-	-	-	100	-	-	-
454.5	-	-	-	425.9	-	-	-	295.9	-	-	-
0.22	-	-	-	4.70	-	-	-	0.34	-	-	-

Table A15–12. Future Maintenance and Repair Table continued

		In Watershed		MAIN DRAIN Interval 5 1+329 to 1+947 (Crop Farms and Nano Farms)			
TOTAL COST ($) (G)				6,500			
Roll No. (12-58-010)	**Owner**	**Total Affected (Ha)**	**Total Adjusted (Ha)**	**Benefit Assessment ($)**	**Adjusted (Ha) (A)**	**Outlet Liability ($) (B=A*F)**	**Total in Interval ($)**
-010-22900	J. Party	8.9	7.1	-	-	-	-
-010-23000	D. & D. Hatfield	36.5	35.3	-	-	-	-
-010-23100	J. & M. Jacks	6.1	4.0	-	-	-	-
-010-24300	R. Lucky	28.6	13.3	-	-	-	-
-010-24400	L. & A. Singh	15.6	15.6	-	-	-	-
-010-24500	A. Earp & J. Earp-Sons	15.6	14.0	-	-	-	-
-010-24700	K. Palmer	39.5	37.6	-	-	-	-
-010-24800	S. McCoy	32.4	32.2	-	10.1	113	113
-010-24900	H. & V. Robb & N. Shaw	1.4	0.4	-	-	-	-
-020-01400	V. & W. Oley	8.0	1.6	-	-	-	-
-020-01500	Crop Farms Inc.	11.0	2.2	-	-	-	-
-020-01600	Crop Farms Inc.	34.3	34.0	2,000	13.9	156	2,156
-020-01601	Crop Farms Inc.	6.0	12.0	500	-	-	500
-020-01800	Nano Farms Limited	40.1	40.1	1,000	40.1	449	1,449
-020-01801	J. Nano	0.4	0.6	-	0.6	7	7
-020-01900	Nano Farms Limited	38.0	38.0	-	38.0	426	426
-020-02000	K. & B. Smith	21.9	21.2	-	21.2	237	237
-020-02100	Oxbow Farms Ltd.	3.6	1.4	-	1.4	16	16
-020-03400	J. Wilson	18.0	18.0	-	9.2	103	103
-020-03500	J. Wilson	7.7	7.1	-	7.1	80	80
-020-03600	D. & P. McFee	16.9	11.3	-	11.3	127	127
-020-03700	Nano Farms Limited	40.5	40.5	-	40.5	453	453
-020-03800	Cash Farms Ltd.	39.4	35.9	-	35.9	402	402
-020-04000	J. & K. Oxbow	12.2	12.2	-	12.2	137	137
-020-05200	Okay Farms Ltd.	6.2	3.1	-	3.1	35	35
-020-05300	Cattle Farms Ltd.	13.0	10.4	-	10.4	116	116
-020-05400	D. Wolfman	4.5	1.5	-	1.5	17	17
Special Assessment TransOntario Pipeline		-	-	-	-	-	-
County Road 137 – County of South		3.4	6.8	-	-	-	-
3rd Line – Twp of North		0.5	0.8	-	-	-	-
4th Line – Twp of North		5.0	7.5	-	32	36	36
5th Line – Twp of North		2.8	5.6	-	5.6	63	63
Oxbow Sideroad – Twp of North		1.6	2.4	-	2.4	27	27
TOTALS		519.6	473.7	3,500	267.7	3,000	6,500
TOTAL BENEFIT ASSESSMENT (C)		-	-	3,500	-	-	-
OUTLET LIABILITY ($) (D = G- C)		-	-	3,000	-	-	-
Land in Interval (Ha) (E)		-	-	267.7	-	-	-
Outlet Liability Rate ($/Ha) (F = D / E)		-	-	11.20	-	-	-

MAIN DRAIN				BRANCH A						
Interval 6 1+947 to 2+335 (Nano Farms)				**Interval 7 0+000 to 0+453 (Singh & Earp)**				**Combined Total of Main Drain and Branch A**		
4,500				4,000				30,000		
Benefit Assessment ($)	**Adjusted (Ha) (A)**	**Outlet Liability ($) (B=A x F)**	**Total in Interval ($)**	**Benefit Assessment ($)**	**Adjusted (Ha) (A)**	**Outlet Liability ($) (B=A x F)**	**Total in Interval ($)**	**Total Benefit Assessment ($)**	**Total Outlet Liability ($)**	**Total Assessment ($)**
-	-	-	-	-	8.9	7.12	119	-	249	249
-	-	-	-	-	36.5	35.3	591	-	1,238	1,238
-	-	-	-	-	6.1	4	67	-	141	141
-	-	-	-	-	-	-	-	1,500	178	1,678
-	-	-	-	-	-	-	-	2,000	238	2,238
-	-	-	-	2,000	12.4	9.3	156	2,000	411	2,411
-	-	-	-	250	27.5	25.6	428	250	1,118	1,368
-	3	31	31	-	22.3	22.1	370	-	1,106	1,106
-	-	-	-	-	1.4	0.36	6	-	13	13
-	-	-	-	-	-	-	-	500	21	521
-	-	-	-	-	-	-	-	150	29	179
-	-	-	-	-	-	-	-	2,000	766	2,766
-	-	-	-	-	-	-	-	500	224	724
1,500	6.1	63	1,563	-	-	-	-	2,500	1,261	3,761
-	-	-	-	-	-	-	-	-	18	18
1,000	38.0	393	1,393	-	-	-	-	1,000	1,528	2,528
-	21.2	219	219	-	-	-	-	-	852	852
-	1.4	15	15	-	-	-	-	-	57	57
-	-	-	-	-	-	-	-	-	394	394
-	-	-	-	-	-	-	-	-	212	212
-	11.3	117	117	-	-	-	-	-	455	455
-	40.5	418	418	-	-	-	-	-	1,627	1,627
-	35.9	371	371	-	-	-	-	-	1,443	1,443
-	12.2	126	126	-	-	-	-	-	490	490
-	3.1	32	32	-	-	-	-	-	126	126
-	10.4	107	107	-	-	-	-	-	417	417
-	1.5	15	15	-	-	-	-	-	60	60
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	700	92	792
-	-	-	-	-	0.5	0.8	13	-	28	28
-	1.0	10	10	-	-	-	-	1,600	186	1,786
-	5.6	58	58	-	-	-	-	-	225	225
-	2.4	25	25	-	-	-	-	-	97	97
2,500	193.6	2,000	4,500	2,250	115.6	104.6	1,750	14,700	15,300	30,000
2,500	-	-	-	2,250	-	-	-	-	-	-
2,000	-	-	-	1,750	-	-	-	-	-	-
193.6	-	-	-	104.6	-	-	-	-	-	-
10.33	-	-	-	16.73	-	-	-	-	-	-

The report also includes instructions to distribute the costs for future maintenance and repair. When work is performed:

- in a single interval, use the specific "interval total" column
- in two or more intervals, add across the intervals using the "interval total" columns
- over the entire drain, use the "gross total" column

The repair or replacement of the private crossing at Station 0+750 is assessed 40% to the owner of the property and the remaining cost assessed upstream in accordance with the maintenance schedule for Interval 1. The instructions for the assessment of work performed on the special benefit and special assessment items are provided in Table A15–13.

Table A15–13. Specific Instructions for Special Benefit and Special Assessment

Crossing	Assessment Instructions for Repair or Replacement	Assessment Instructions for Flushing and/or Clean-out
4th Line crossing at Station 0+270 to Station 0+290	100% assessed to the Road Authority	Assessed upstream in accordance with the Maintenance Schedule for Interval 1
County Rd 137 crossing	100% assessed to the Road Authority	Assessed in accordance with the Maintenance Schedule for Interval 2
4th Line crossing at Station 1+300 to Station 1+329	100% assessed to the Road Authority	Assessed in accordance with the Maintenance Schedule for Interval 4
Trans Ontario Pipeline crossing at Station 2+320 to Station 2+335	100% assessed to the Pipeline Authority	Assessed 25% to the Pipeline Authority and the remaining cost assessed upstream in accordance with the Maintenance Schedule for Interval 6

Conduct Fairness Test

The engineer conducted a fairness test on the preliminary assessments by:

- comparing the benefit assessments per benefiting area on adjacent properties
- comparing the outlet liability assessments on adjacent properties
- comparing the cost per hectare on adjacent properties
- performing a broader review of assessments and cost per hectare on all properties
- considering any prior assessments on the land or roads (Section 34)

The engineer identified features within the watershed that provide some rationale for any differences in assessments between properties. These features are:

- location of the channel (e.g., property owned by R. Lucky):
  - previously cultivated land is now dedicated to the channel
  - the channel may interfere with agricultural operations
  - market values may be lower compared to a piped drain project
- protected forested lands that will not be drained (e.g., property owned by D. & D. Hatfield)
- steep slopes (e.g., property owned by H. & V. Robb and N. Shaw, where a perimeter factor was applied)
- depressional lands that do not benefit from or contribute water to the drain (e.g., property owned by Cash Farms Ltd.)
- areas with subsurface drainage systems that outlet to a different watershed (e.g., property owned by Okay Farms Ltd.)

The fairness test resulted in adjustments being made to the initial calculated assessments to some properties. The engineer judged the final assessments (as presented in this case study) to be fair since:

- costs per hectare were similar for all owners with pipe work occurring on their property
- costs per hectare were similar, with slight increases towards the upstream end of the watershed, for all owners with no work performed on their property

Assessment Schedules for the Engineer's Report

The assessment information is summarized to create the Schedule of Assessment for Construction (Schedule A) for inclusion in the engineer's report (Section 35). The schedule includes the estimated gross assessments per hectare and is provided in Table A15–14.

Table A15–14. Assessment Schedule for Construction

FPCTR (Yes / No)	Conc.	Lot	Roll No. (12-58-010)	Owner	Affected (Ha) (From Table 15-3)
Yes	3	Pt W½ 12	-010-22900	J. Party	8.9
Yes	3	W½ 13	-010-23000	D. & D. Hatfield	36.5
Yes	3	Pt SW¼	-010-23100	J. & M. Jacks	6.1
Yes	3	Pt 10	-010-24300	R. Lucky	28.6
Yes	Special Benefit to Lucky				-
Yes	3	SE¼ 11	-010-24400	L. & A. Singh	15.6
Yes	3	NE¼ 11	-010-24500	A. Earp & J. Earp-Sons	15.6
Yes	3	E½ 12	-010-24700	K. Palmer	39.5
Yes	3	E½ 13	-010-24800	S. McCoy	32.4
Yes	3	E½ 14	-010-24900	H. & V. Robb & N. Shaw	1.4
Yes	4	SW¼ 10	-020-01400	V. & W. Oley	8
Yes	4	NW¼ 10	-020-01500	Crop Farms Inc.	11
Yes	4	Pt W½ 11	-020-01600	Crop Farms Inc.	34.3
No	4	Pt W½ 11	-020-01601	Crop Farms Inc.	6
Yes	4	Pt W½ 12	-020-01800	Nano Farms Limited	40.1
Yes	Special Benefit to Nano Farms				-
No	4	Pt W½ 12	-	J. Nano	0.4
Yes	4	W½ 13	-020-01900	Nano Farms Limited	38
Yes	4	W½ 14	-020-02000	K. & B. Smith	21.9
Yes	4	W½ 15	-020-02100	Oxbow Farms Ltd.	3.6
Yes	4	E½ 11	-020-03400	J. Wilson	18
Yes	4	SE¼ 12	-020-03500	J. Wilson	7.7
Yes	4	NE¼ 12	-020-03600	D. & P. McFee	16.9
Yes	4	E½ 13	-020-03700	Nano Farms Limited	40.5
Yes	4	Pt E½ 14	-020-03800	Cash Farms Ltd.	39.4
Yes	4	E½ 15	-020-04000	J. & K. Oxbow	12.2
Yes	5	Pt W½ 12	-020-05200	Okay Farms Ltd.	6.2
Yes	5	W½ 13	-020-05300	Cattle Farms Ltd.	13
Yes	5	W½ 14	-020-05400	D. Wolfman	4.5
No	3 to 5	Pt 12	Special Assessment TransOntario Pipeline		-
Total Assessment on Lands (H)					**506.3**
County Road 137 - County of South					3.4
Special Assessment to County Road 137					-
3rd Line - Twp of North					0.5
4th Line - Twp of North					5
Special Assessment to 4th Line					-
5th Line - Twp of North					2.8
Oxbow Sideroad - Twp of North					1.6
Total Assessment on Roads (I)					**13.3**
TOTAL (H+I):					**519.6**

MAIN DRAIN			BRANCH A				Total Assessment ($) (G=C+F)
Benefit Assessment ($) (From Table 15-10) (A)	Outlet Liability ($) (B)	Total Assessment ($) (C=A+B)	Affected (Ha) (From Table 15-3)	Benefit Assessment ($) (From Table 15-10) (D)	Outlet Liability ($)(E)	Total Assessment ($) (F=D+E)	
-	2,604	2,604	8.9	-	2,139	2,139	4,742
-	12,925	12,925	36.5	-	10,603	10,603	23,528
-	1,465	1,465	6.1	-	1,201	1,201	2,666
16,924	2,271	19,195	-	-	-	-	19,195
4,000	-	4,000	-	-	-	-	4,000
30,009	3,900	33,909	-	-	-	-	33,909
-	5,054	5,054	12.4	18,754	2,793	21,547	26,601
-	13,767	13,767	27.5	2,188	7,690	9,878	23,645
-	13,653	13,653	22.3	-	6,638	6,638	20,292
-	132	132	1.4	-	108	108	240
4,432	273	4,705	-	-	-	-	4,705
1,612	376	1,988	-	-	-	-	1,988
27,507	14,282	41,789	-	-	-	-	41,789
3,916	4,826	8,742	-	-	-	-	8,742
35,811	21,501	57,312	-	-	-	-	57,312
1,000	-	1,000		-	-	-	1,000
-	313	313	-	-	-	-	313
9,509	23,592	33,101	-	-	-	-	33,101
-	13,162	13,162	-	-	-	-	13,162
-	894	894	-	-	-	-	894
-	6,421	6,421	-	-	-	-	6,421
-	3,699	3,699	-	-	-	-	3,699
-	7,030	7,030	-	-	-	-	7,030
-	25,144	25,144	-	-	-	-	25,144
-	22,288	22,288	-	-	-	-	22,288
-	7,574	7,574	-	-	-	-	7,574
-	1,925	1,925	-	-	-	-	1,925
-	6,457	6,457	-	-	-	-	6,457
-	922	922	-	-	-	-	922
22,764	-	22,764		-	-	-	22,046
157,484	**216,448**	**373,932**	**115.1**	**20,942**	**31,173**	**52,115**	**426,046**
2,266	1,227	3,492	-	-	-	-	3,492
34,985	-	34,985	-	-	-	-	34,985
-	293	293	0.5-	-	240	240	533
7,143	3,393	10,536	-	-	-	-	10,536
45,690	-	45,690	-	-	-	-	45,690
-	3,477	3,477	-	-	-	-	3,477
-	1,490	1,490	-	-	-	-	1,490
90,084	**9,880**	**99,963**	**0.5**	**-**	**240**	**240**	**100,204**
247,568	**226,327**	**473,895**	**115.6**	**20,942**	**31,413**	**52,355**	**526,250**

Prepare another spreadsheet that shows the estimated "net assessment" where the land allowances and grants are deducted as shown in Table A15–15. This table is not provided in the engineer's report but can be brought to the meeting to consider the report to show to any individual property owner.

The assessment information for future maintenance is summarized to create the Assessment Schedule for Future Maintenance (Schedule B) for inclusion in the engineer's report (Section 35) as shown in Table A15–16.

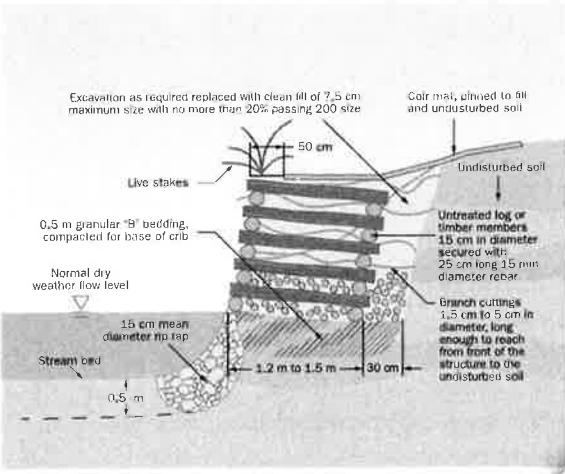
Table A15–15. Net Assessment Schedule for Construction

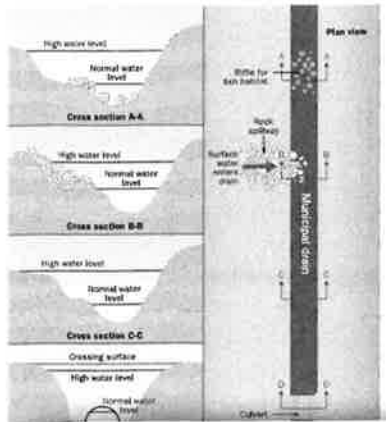
FPCTR (Yes / No)	Conc.	Lot	Roll No. (12-58-010)	Owner	Total Assessment ($) (From Table 15-14) (A)	ADIP Grant ($) (B=1/3*A)	Allowances ($) (C)	Net Assessment ($) (D=A-B-C)
Yes	3	Pt W½ 12	-010-22900	J. Party	4,742	1,581	-	3,161
Yes	3	W½ 13	-010-23000	D. & D. Hatfield	23,528	7,842	-	15,686
Yes	3	Pt SW¼	-010-23100	J. & M. Jacks	2,666	888	-	1,778
Yes	3	Pt 10	-010-24300	R. Lucky	19,195	6,398	10,125	2,672
Yes	Special Benefit to Lucky				4,000	1,333	-	2,667
Yes	3	SE¼ 11	-010-24400	L. & A. Singh	33,909	11,303	3,505	19,101
Yes	3	NE¼ 11	-010-24500	A. Earp & J. Earp-Sons	26,601	8,867	3,475	14,259
Yes	3	E½ 12	-010-24700	K. Palmer	23,645	7,882	100	15,663
Yes	3	E½ 13	-010-24800	S. McCoy	20,292	6,764	-	13,528
Yes	3	E½ 14	-010-24900	H. & V. Robb & N. Shaw	240	80	-	160
Yes	4	SW¼ 10	-020-01400	V. & W. Oley	4,705	1,568	3,375	-238
Yes	4	NW¼ 10	-020-01500	Crop Farms Inc.	1,988	663	-	1,325
Yes	4	Pt W½ 11	-020-01600	Crop Farms Inc.	41,789	13,930	2,590	25,269
No	4	Pt W½ 11	-020-01601	Crop Farms Inc.	8,742	-	-	8,742
Yes	4	Pt W½ 12	-020-01800	Nano Farms Limited	57,312	19,104	4,185	34,023
Yes	Special Benefit to Nano Farms				1,000	333	-	667
No	4	Pt W½ 12	-	-	313	-	-	313
Yes	4	W½ 13	-020-01900	Nano Farms Limited	33,101	11,034	100	21,967
Yes	4	W½ 14	-020-02000	K. & B. Smith	13,162	4,387	-	8,775
Yes	4	W½ 15	-020-02100	Oxbow Farms Ltd.	894	298	-	596
Yes	4	E½ 11	-020-03400	J. Wilson	6,421	2,140	-	4,281
Yes	4	SE¼ 12	-020-03500	J. Wilson	3,699	1,233	-	2,466
Yes	4	NE¼ 12	-020-03600	D. & P. McFee	7,030	2,343	-	4,687
Yes	4	E½ 13	-020-03700	Nano Farms Limited	25,144	8,381	-	16,763
Yes	4	Pt E½ 14	-020-03800	Cash Farms Ltd.	22,288	7,429	-	14,859
Yes	4	E½ 15	-020-04000	J. & K. Oxbow	7,574	2,525	-	5,049
Yes	5	Pt W½ 12	-020-05200	Okay Farms Ltd.	1,925	642	-	1,283
Yes	5	W½ 13	-020-05300	Cattle Farms Ltd.	6,457	2,152	-	4,305
Yes	5	W½ 14	-020-05400	D. Wolfman	922	307	-	615
No	3 to 5	Pt 12	Special Assessment TransOntario Pipeline		22,764	-	-	22,764
Total Assessment on Lands (E)					**426,046**	**131,407**	**27,455**	**267,184**
County Road 137 - County of South					3,492	-	-	3,492
Special Assessment to County Road 137					34,985	-	-	34,985
3rd Line - Twp of North					533	-	-	533
4th Line - Twp of North					10,536	-	-	10,536
Special Assessment to 4th Line					45,690	-	-	45,690
5th Line - Twp of North					3,477	-	-	3,477
Oxbow Sideroad - Twp of North					1,490	-	-	1,490
Total Assessment on Roads (F)					**100,204**	**-**	**-**	**100,204**
TOTAL (G=E+F)					**526,250**	**131,407**	**27,455**	**367,388**

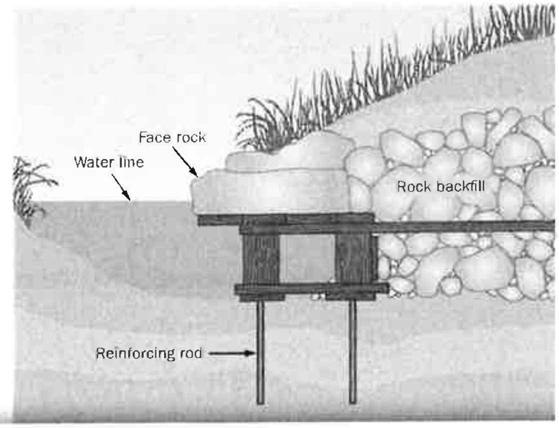
Table A15–16. Assessment Schedule for Future Maintenance

FPCTR (Yes / No)	Conc.	Lot	Roll No. (12-58-010)	Owner	MAIN DRAIN Interval 1 0+000 to 0+833 (Oley, 4th Line & Lucky) (A)
Yes	3	Pt W½ 12	-010-22900	J. Party	95
Yes	3	W½ 13	-010-23000	D. & D. Hatfield	473
Yes	3	Pt SW¼	-010-23100	J. & M. Jacks	54
Yes	3	Pt 10	-010-24300	R. Lucky	1,678
Yes	3	SE¼ 11	-010-24400	L. & A. Singh	209
Yes	3	NE¼ 11	-010-24500	A. Earp & J. Earp-Sons	188
Yes	3	E½ 12	-010-24700	K. Palmer	505
Yes	3	E½ 13	-010-24800	S. McCoy	431
Yes	3	E½ 14	-010-24900	H. & V. Robb & N. Shaw	5
Yes	4	SW¼ 10	-020-01400	V. & W. Oley	521
Yes	4	NW¼ 10	-020-01500	Crop Farms Inc.	179
Yes	4	Pt W½ 11	-020-01600	Crop Farms Inc.	456
No	4	Pt W½ 11	-020-01601	Crop Farms Inc.	161
Yes	4	Pt W½ 12	-020-01800	Nano Farms Limited	538
No	4	Pt W½ 12	-	J. Nano	8
Yes	4	W½ 13	-020-01900	Nano Farms Limited	509
Yes	4	W½ 14	-020-02000	K. & B. Smith	284
Yes	4	W½ 15	-020-02100	Oxbow Farms Ltd.	19
Yes	4	E½ 11	-020-03400	J. Wilson	241
Yes	4	SE¼ 12	-020-03500	J. Wilson	95
Yes	4	NE¼ 12	-020-03600	D. & P. McFee	152
Yes	4	E½ 13	-020-03700	Nano Farms Limited	544
Yes	4	Pt E½ 14	-020-03800	Cash Farms Ltd.	481
Yes	4	E½ 15	-020-04000	J. & K. Oxbow	163
Yes	5	Pt W½ 12	-020-05200	Okay Farms Ltd.	42
Yes	5	W½ 13	-020-05300	Cattle Farms Ltd.	139
Yes	5	W½ 14	-020-05400	D. Wolfman	20
No	3 to 5	Pt 12	Special Assessment TransOntario Pipeline		-
Total Assessment on Lands (I)					**8,190**
County Road 137 - County of South					91
3rd Line - Twp of North					11
4th Line - Twp of North					1,101
5th Line - Twp of North					75
Oxbow Sideroad - Twp of North					32
Total Assessment on Roads (J)					**1,310**
TOTAL (K=I+J)					**9,500**

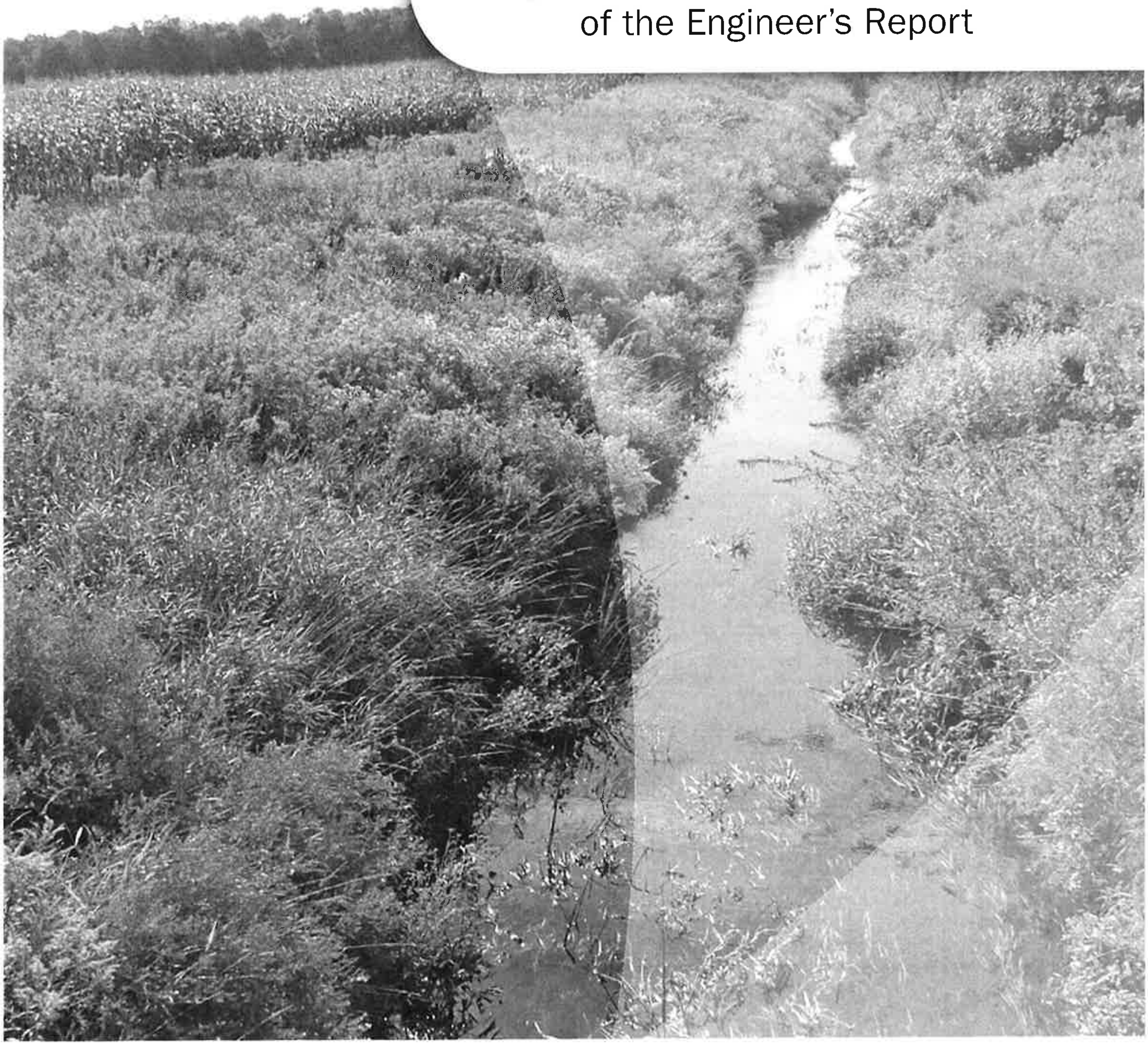
MAIN DRAIN continued						BRANCH A
Interval 2 0+833 to 0+864 (County Road 137) (B)	**Interval 3 0+864 to 1+300 (Singh) (C)**	**Interval 4 1+300 to 1+329 (4th Line) (D)**	**Interval 5 1+329 to 1+947 (Crop Farms and Nano Farms) (E)**	**Interval 6 1+947 to 2+335 (Nano Farms) (F)**	**Main Drain Total ($) (G=A+B+C +D+E+F)**	**Interval 7 0+000 to 0+453 (Singh & Earp) (H)**
2	33	-	-	-	130	119
8	166	-	-	-	647	591
1	19	-	-	-	74	67
-	-	-	-	-	1,678	-
3	2,026	-	-	-	2,238	-
3	64	-	-	-	255	2,156
8	177	-	-	-	690	678
7	151	3	113	31	736	370
-	2	-	-	-	7	6
-	-	-	-	-	521	-
-	-	-	-	-	179	-
7	137	10	2,156	-	2,766	-
3	56	4	500	-	724	-
9	188	14	1,449	1,563	3,761	-
-	3	-	7	-	18	-
8	179	13	426	1,393	2,528	-
5	100	7	237	219	852	-
-	7	-	16	15	57	-
4	43	3	103	-	394	-
2	33	2	80	-	212	-
2	53	4	127	117	455	-
9	189	14	453	418	1,627	-
8	169	12	402	371	1,443	-
3	57	4	137	126	490	-
1	15	1	35	32	126	-
2	49	4	116	107	417	-
-	7	1	17	15	60	-
-	-	-	-	-	-	-
95	**3,923**	**96**	**6,374**	**4,407**	**23,085**	**3,987**
701	-	-	-	-	792	-
-	4	-	-	-	15	13
2	36	601	36	10	1,786	-
1	26	2	63	58	225	-
1	11	1	27	25	97	-
705	**77**	**604**	**126**	**93**	**2,915**	**13**
800	**4,000**	**700**	**6,500**	**4,500**	**26,000**	**4,000**







PART B
Design Components and Considerations of the Engineer's Report



PART B – TABLE OF CONTENTS

DESIGN COMPONENTS AND CONSIDERATIONS OF THE ENGINEER'S REPORT

CHAPTER 1

INTRODUCTION

Under the *Drainage Act, 1990,* a "drainage works" includes a drain constructed by any means, including the improving of a natural watercourse, and works necessary to regulate the water table or water level within or on any lands or to regulate the level of the waters of a drain, reservoir, lake or pond, and includes a dam, embankment, wall, protective works or any combination of these (Figure B1–1). The Act is typically used to build channel and pipe drainage systems and crossings.

Figure B1–1. Rural drainage works.

Source: Dietrich Engineering Limited, Waterloo, Ontario.

Part B provides technical guidance to the engineer to design the construction (Section 4) or improvement (Section 78) of a drainage works. This section introduces technical design components (e.g., hydrology and hydraulics) but does not provide detailed design methodologies. Due to the broad definition of drainage works, environmental and societal values such as climate change, water quality, erosion and sediment control, flood management, wetlands, riparian buffers and other design considerations are also introduced.

The engineer's report is based on the information derived from the process in Part A and technical guidance provided in Part B.

DID YOU KNOW? The Ontario Society of Professional Engineers (OSPE) Land Drainage Committee website contains many useful papers and presentations on design components and considerations of the engineer's report (www.landdrainageengineers.com).

CHAPTER 2

HYDROLOGY

2.1 Introduction

Hydrology is the interaction between precipitation, infiltration, evapotranspiration and surface runoff (Figure B2–1).

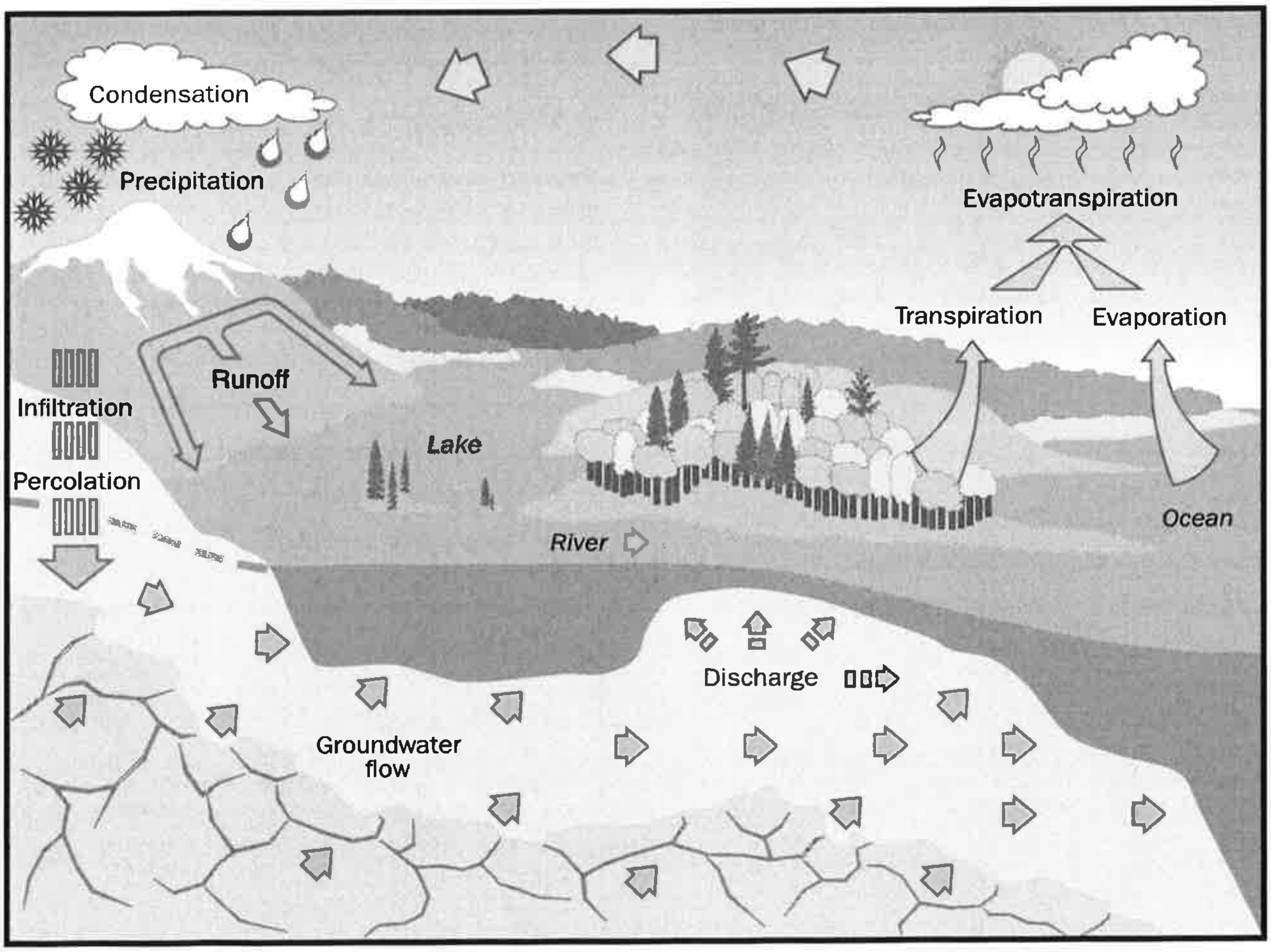


Figure B2–1. The water cycle — understanding groundwater.

The engineer will examine the hydrologic processes to estimate the volume and rate of water flow used to size, design and evaluate components of a drainage works. The engineer should consider climate change when designing drainage works (Part B, Chapter 4).

2.2 Outlet Considerations and Downstream Controls

The *Drainage Act, 1990* places a legal obligation on the engineer to ensure that all drains are discharged at a location where they will do no damage to other lands and roads (Section 15).

Hydrologic design of the drainage works should consider the capacity of the outlet and sections of the broader watershed downstream of the drain. Consider the runoff from the entire watershed when evaluating the sufficiency of the outlet of the drain (Figures B2–2 and B2–3).

Figure B2–2. Example of a good outlet.

Source: Dietrich Engineering Limited, Waterloo, Ontario.

Figure B2–3. Example of an insufficient outlet.

Source: Dietrich Engineering Limited, Waterloo, Ontario.

Outlet considerations and downstream controls should also be included as a component of the hydraulic design (Part B, Chapter 3).

2.3 Hydrologic Analysis Methods

There are several hydrologic analyses used to estimate the peak discharge or runoff hydrograph for a watershed. This chapter provides an overview of these methods and recommends which methodologies to use in various situations:

- rational method
- regional frequency analysis approach
- single station frequency analysis
- unit hydrograph approach
- drainage coefficient method

DID YOU KNOW? Detailed information on the drainage coefficient method is found in OMAFRA Publication 29, *Drainage Guide for Ontario*. The Ontario Ministry of Transportation (MTO) *Drainage Management Manual* provides information on the other four methods. These documents are available from ServiceOntario (ontario.ca/publications).

There are numerous computer models that use different approaches to assist in flow estimation.

Computer simulation models can be used for various sizes and types of watersheds. The MTO has an extensive list of the various computer simulation models available and a description of their applications and capabilities, including detailed evaluations of a number of the models. This information is available on the MTO website (ontario.ca/mto search for "Evaluation of Drainage Management Software").

The following methodologies are summarized from the *MTO Drainage Management Manual.*

2.3.1 Rational Method

The rational method is used to estimate the peak flow from small watersheds that are less than 1 km^2 (100 ha) in size. The method considers rainfall intensity, watershed area and a runoff coefficient. The rainfall intensity is derived from the intensity-duration-frequency (IDF) curves for the storm duration, corresponding to the time of concentration of the watershed. Many existing drains have been designed using flows generated by the rational method.

2.3.2 Regional Frequency Analysis

A regional frequency analysis is completed to estimate peak flow in medium- to large-sized watersheds. It is a statistical method of relating regional characteristics such as watershed and climatic data to calculate peak flows for specific return periods. There are three regional frequency analysis approaches: the unified Ontario flood method, the modified index flood method and the Northern Ontario hydrology model.

Unified Ontario Flood Method

The unified Ontario flood method was developed for calculating the design flow rate in Ontario. The method was based on the statistical analysis of a total 118 stations using Water Survey of Canada stream flow data up to December 31, 2014. A detailed description of this method and associated analysis and background information is provided in the report entitled Unified Ontario Flood Method (UOFM), *Regional Flood Frequency Analysis of Ontario Stream Using Multiple Regressions,* (2015).

Modified Index Flood Method

The modified index flood method is based on the index flood method developed by the United States Geological Survey in 1960. It has been modified for use in Ontario with watersheds greater than 25 km^2 (2,500 ha).

Northern Ontario Hydrology Model

This model was developed by the Department of Civil Engineering, Queen's University, Kingston, Ontario, specifically to account for the effect of the numerous inland lakes in northern Ontario. It is used to estimate the peak discharge from watersheds between 1 km^2 (100 ha) and 100 km^2 (10,000 ha).

2.3.3 Single Station Frequency Analysis

A single station frequency analysis uses statistical methods to analyze data from a single stream gauge to determine the peak discharge corresponding to a specific return period. Select the stream gauge location that has hydrologic characteristics similar to the drain being designed . It may be appropriate to transpose the peak discharge from the stream flow gauge location to another location on the same stream or to a nearby and similar watershed using a ratio of the watershed areas. The modified index flood method is then used to check the transposition.

There are a number of stream locations in Ontario with stream flow gauges maintained by Environment Canada's Water Survey of Canada (www.ec.gc.ca/rhc-wsc). The Ministry of Natural Resources and Forestry (MNRF) collects, monitors and analyzes water flows, levels and climate data through the Surface Water Monitoring Centre (ontario.ca search for "Surface Water Monitoring").

2.3.4 Unit Hydrograph

The unit hydrograph method can be used for any size of watershed. Hydrograph analysis is required when the time distribution of runoff is important. It is often used when routing storm events through water management facilities (e.g., ponds, structures and wetlands).

This approach develops a hydrograph resulting from one unit depth of direct runoff generated from a uniform excess rainfall rate uniformly distributed over the watershed area during a specific time period. A unit hydrograph is usually based on a unit of measurement (1 mm or 1 in.) of runoff. The unit hydrograph is directly proportioned for the required design storm.

There are two methods of developing a unit hydrograph for a watershed. It can be developed from a real storm event recorded from gauged watersheds or a synthetic unit hydrograph can be generated based on watershed characteristics such as area, flow length and slope.

2.3.5 Drainage Coefficient Method

Rural piped drains are usually sized by combining a hydrologic and hydraulic process called the drainage coefficient method. It was developed for use by tile drainage contractors to size subsurface drainage systems for agricultural land. It is also used by engineers to design piped drainage works for agricultural watersheds.

The drainage coefficient is the rate at which water is removed by the drain from an area and is expressed in millimetres or inches per day (24 hours).

A detailed description of this method is available in OMAFRA Publication 29, *Drainage Guide for Ontario* (Figure B2–4) (ontario.ca/publications).

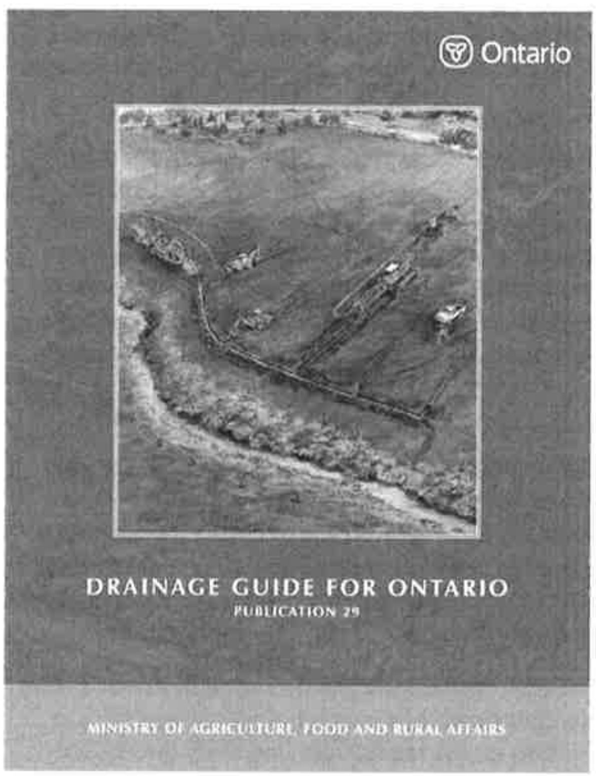


Figure B2–4. *Drainage Guide for Ontario.*

2.4 Selection of Hydrologic Analysis Methods

Select the appropriate hydrologic analysis method based on project type, watershed size and project complexity. Consider the outlet capacity, downstream controls, existing component capacities and commonly accepted practices. Where a regulatory or approval agency is involved, the engineer should confirm the agency requirements for the hydrologic and hydraulic analysis method and design parameters.

Use Table B2–1 as a guide in selecting a design method. More than one design method may be appropriate for a specific project. For added confidence on complex projects, the engineer should use more than one method and then compare the results. Compare the results to each other, the outlet capacity and any previously designed drainage works in the area of the project. Calibrate the flow information from the analysis to the performance of existing features (e.g., road culvert) that are present in the watershed.

For all watershed sizes, a hydrologic analysis may be more efficient using a computer simulation model to mimic rainfall-runoff events. If considering using a computer simulation model, see the MTO website for details on the various models (www.mto.gov.on.ca/english/publications/drainage/software/available.shtml).

Consider using the rational method for watersheds less than 100 ha in size. Peak flow calculations for larger watersheds are done using the modified flood index method, the northern Ontario hydrology model or the unit hydrograph method.

In selecting the method, the engineer will consider the limitations of each process and draw on past experience from other similar situations. The engineer must be able to defend the choice of hydrologic analysis as an appropriate one for the situation.

Table B2–1. Hydrologic Analysis Selection Table

Design Method	Design Method Limitations	Comments
Rational Method	Watershed area should be <100 ha.	Simple, quick method that provides conservative flow estimates. Used in larger watersheds for flow estimates for preliminary design.
Unified Ontario Flood Method	Watersheds should have physiographic characteristics similar to those of the stations used in the analysis.	Easy to apply.
Modified Index Flood Method	Watershed area should be >25 km^2 (2,500 ha).	Easy to apply to medium- and large- sized watersheds. Used to compare results to other methods for watersheds between 5 km^2 and 25 km^2.
Northern Ontario Hydrology Model	Watershed area should be between 1 km^2 and 100 km^2 (100 ha and 10,000 ha). Basin must be located in the Canadian Shield. For a lake outlet situation, area of storage (lakes and wetlands) must be at least 6% of watershed area.	Easy to apply; considers effect of storage by lakes and wetlands.
Single Station Frequency Analysis (Stream Flow Records)	No watershed size limitation. The location of the drain must have similar hydrologic characteristics to the location with stream flow records.	Stream flow records are available from Water Survey of Canada (www.ec.gc.ca/rhc-wsc) and the MNRF Surface Water Monitoring Centre (ontario.ca)
Unit Hydrograph	No watershed size limitation.	Use when a hydrograph is required for design. Use for routing flows through storage.
Drainage Coefficient Method	Only used for the design of piped drains in agricultural watersheds.	This method is available in the *Drainage Guide for Ontario*, OMAFRA Publication 29, (ontario.ca/publications)
Computer Simulation Models	A variety of models are available to determine flows for all sizes of watersheds.	Consider for use with complex projects. MTO has an extensive list of computer simulation models available (www.mto.gov.on.ca/english/publications/drainage/software/available.shtml).

2.5 Hydrologic Analysis Parameters

Many of the hydrologic methods require a basic set of parameters to calculate design flow rates. This section provides a description of some of the parameters used when conducting a hydrologic analysis. The *MTO Drainage Management Manual* provides details on most of these parameters.

2.5.1 Watershed

The first step in conducting a hydrologic analysis is to characterize the watershed. Watershed characteristics affecting runoff include: area, land use, soil type, overland slope, channel length and any existing channel slope.

Determine the watershed area from topographical mapping, existing municipal drain plans, digital elevation data (e.g., LiDAR), site reviews and site surveys. Topographical maps that provide the smallest contour intervals are the most accurate. Topographical mapping also provides information on overland slope, channel length and channel slope. Aerial imagery is useful for determining existing and historical land use and drainage patterns. Get information on imagery and data from:

- AgMaps, OMAFRA (ontario.ca/omafra search for "AgMaps")
- Soil Survey Reports for Ontario, Agriculture and Agri-Food Canada (www.agr.gc.ca search for "Soil Survey Reports")
- Ontario topographic maps, MNRF (ontario.ca)
- Ontario Flow Assessment Tool III (OFATIII) (ontario.ca, search for "OFAT")
- conservation authorities
- municipalities (county GIS data)

It may be necessary to do additional field investigation to obtain more detailed data about the watershed. A field survey can:

- provide detailed topography and confirm the watershed limits
- determine channel and/or land cross-sections
- identify adjacent building elevations
- obtain other information

Watershed information is also used for drainage cost assessment purposes in the engineer's report (Part A, Chapter 9).

2.5.2 Time of Concentration

The time of concentration refers to the length of time it takes for the water from the hydraulically farthest point in the watershed to travel to the point at which the flow is calculated. Time of concentration includes overland and channel flow time.

Time of concentration is a factor in the rational method and is determined when using design storms with computer simulation models.

There are many methods to calculate overland flow time. Two common methods are listed below:

- The Bransby-Williams method is used for a watershed with a runoff coefficient of 0.4 or greater and considers the watershed length, slope and area.
- The airport method is used for watersheds with a runoff coefficient less than 0.4 and considers the watershed length, slope and runoff coefficient.

Any in-channel flow time is calculated using Manning's Equation to determine velocity and time of travel.

The time of concentration is the sum of the overland flow time and channel flow time.

2.5.3 Design Storm/Return Period Selection

The return period chosen for a design storm is a method of defining a design flow and the associated acceptable level of risk of flooding. A design storm with a 2-year return period has a 50% chance of occurring each year, while a storm with a 100-year return period has a 1% chance of occurring each year. This parameter is a consideration in all hydrologic processes other than the drainage coefficient method.

Historical rainfall data is used to develop design storms that have a particular probability of occurring each year, resulting in an identified return period. The designer selects an appropriate return period for the design, which depends on the level of service required, local and regulatory standards and requirements and the acceptable risk associated with flooding.

It may be acceptable to design a crossing in an agricultural setting to a 2-year return period, but a higher design standard is required for a crossing on a MTO highway.

Commonly used return periods include 2, 5, 10, 25, 50 and 100 years (and in some cases, regional storms). The following are factors to consider when selecting a design storm:

- Apply the minimum design criteria in Table B2–2, Design Storm Selection for Drainage Works.
- Use a larger design storm in situations where there is a greater risk of flooding or where the location of flooding may cause significant losses.
- Consider historical and proposed land use changes in the watershed.

Table B2–2. Design Storm Selection for Drainage Works

Component	Design Storm Return Period[1]	Comments
Channel — Rural/Agricultural	2 year	It is acceptable to have a risk of flooding from larger storms that could cause minor damage or temporary interruption to farm operations.
Field Crossings	2–5 year	It is acceptable to have a risk of flooding from larger storms that could erode driving surface.
Residential or Major Agricultural Crossings	5–10 year	It is acceptable to have a risk of flooding from larger storms that could wash out culverts or temporarily isolate a residence or farm operation.
Lower-Tier Municipal Road Crossing	5–10 year	–
Upper-Tier Municipal Road Crossing	10–25 year	–
MTO Highway Crossings	Varies (see Tables B2–3 and B2–4)	See MTO Highway Drainage Design Standards (January 2008).
Channels/Piped Drains in Built-Up Areas[2]	5–10 year for minor flow system	Ensure the existence of a major flow system that ranges from a 100-year storm to a regulatory/regional storm to avoid flooding of buildings.

[1] The municipality and the conservation authority may have specific design standards.
[2] May require an Environmental Compliance Approval from the MOECC.

Use Table B2–1, Design Storm Selection for Minor and Major Flow Systems where minor and major flow paths using overland flow (major storm flows) in combination with piped drains or channels (minor storm flow) are required by some municipalities or where they are advisable. An appropriately designed channel could be built to convey both minor and major storm flows.

The minor flow path refers to the drainage system designed to convey frequent storm events. The 5-year storm event is often used as the design storm. The minor storm flow is often conveyed within a piped drain.

The major flow path refers to an overland flow route that conveys the less frequent, more extreme storm events. The 100-year storm or the regulatory/regional storm event is often used as the design storm for the major flow path.

Figure B2–5 shows an example of a minor and major flow path.

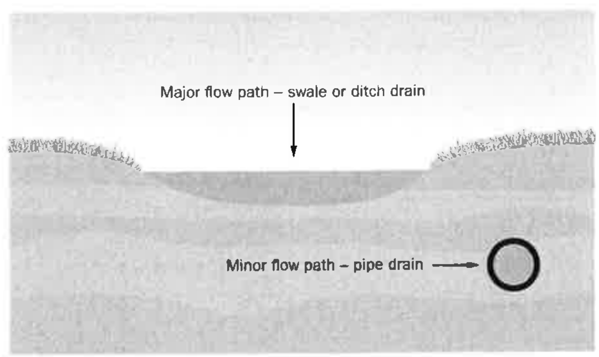


Figure B2–5. Minor and major flow systems.

In a drainage project for a built-up area, the engineer should provide for pipes or channels to carry the minor flow and ensure that there is a major flow path available to prevent unacceptable flooding damage. Roadways are common major flow paths, but in older, built-up areas, consider major flow paths across private lands. In rural areas, major flow paths may be included above the pipe in the form of a grassed waterway or a stormwater management pond.

Use Tables B2–3 and B2–4 for structures and bridges that are designed for MTO crossings and/or approvals.

Table B2–3. Design Storm Selection for Minor and Major Flow Systems

Storm Sewers (Minor Flow System) and Surface Flow (Major Flow System)

Functional Road Classification	Drainage System Type	Design Flow
Freeway Arterial (Urban)	Minor System	10 year
	Major System	100 year
Arterial (Rural) Collector (Urban and Rural)	Minor System	10 year
	Major System	100 year
Local Road (Urban and Rural)	Minor System	5 year
	Major System	Defined by municipality
Depressed Roadways	Minor System	25 year
	Major System	100 year

Source: Section SD-1 of the Highway Drainage Design Standards (MTO, January 2008).

Table B2–4. Design Storm Selection for Bridges and Culverts at MTO Road Crossings

Functional Road Classification	Return Period of Design Flows (Years)		Check Flow (for Scour)
	Total Span ≤6 m	Total Span >6 m	
Freeway, Urban Arterial	50	100	130% of 100 year
Rural Arterial, Collector Road	25	50	115% of 100 year
Local Road	10	25	100% of 100 year

Source: Section WC–1 of the Highway Drainage Design Standards (MTO, January 2008).

2.5.4 Peak Storm Events

Historical rainfall events may be necessary for peak storm design and/or to evaluate potential severe flooding impacts. These historic rainfall events are referred to as regional storms and are unique to different regions of Ontario.

The regional storm is Hurricane Hazel (1954) for southern Ontario (Figure B2–6) or the Timmins Storm (1961) for northern Ontario. The Harrow Storm (1989) may be used in the Windsor area, depending on the regulatory and/or approval agencies involved.

Figure B2–6. Holland Marsh flooded from Hurricane Hazel in 1954.

Source: Town of Bradford-West Gwillimbury, Ontario.

DID YOU KNOW? The spatial extent of zones for application of the regional storms, as well as the rainfall data for Hurricane Hazel and the Timmins Storm, are found in the *MTO Drainage Management Manual*, Part 4, Design Charts 1.02-1.04.

DID YOU KNOW? Further information on the Harrow Storm and its applicability is available from the Upper Thames River Conservation Authority. www.thamesriver.on.ca.

The engineer should consult with the municipality or any regulatory agency to determine if a specific peak storm design standard exists. Use the local requirement if it is more stringent than the regional storms, but both design storms should be evaluated to determine specific results on the watershed.

2.5.5 Intensity-Duration-Frequency (IDF) Curves

IDF curves are statistically derived relationships used for estimating rainfall intensity based on historical rainfall records (Figure B2–7). They provide a relationship between rainfall intensity for specific storm durations and frequencies (return period). IDF curves are used to determine rainfall intensity when estimating runoff using various hydrologic models and methods.

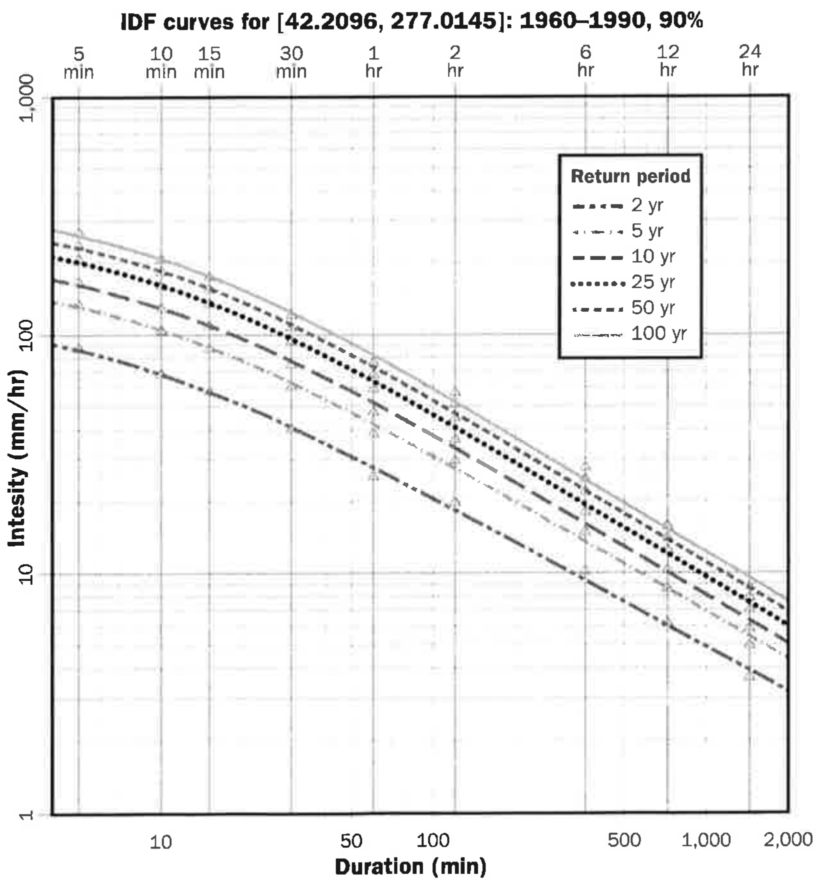


Figure B2–7. Example of an IDF curve.

Source: Ontario Climate Change Data Portal, www.ontarioccdp.ca.

The IDF curve represents weather data from a single geographic location (e.g., weather station). The data from the weather stations across the province are found at www.climate.weather.gc.ca. IDF curve data for highway infrastructure design for Ontario is available from the MTO at www.mto.gov.on.ca/IDF_Curves/.

The rainfall intensity for a specific drain design may not be adequately represented by a single station. Because of the specific location of the station, local extreme rainfall events may not be captured. To accommodate this, the MTO has developed a web-based program called IDF Curve Lookup. The user selects coordinates for any location in Ontario and the application returns IDF parameters for that location. The application interpolates the IDF curve for the specific location based on nearby Environment Canada weather station data. Consult with the municipality to determine if they use different IDF curves.

2.5.6 Design Storm Duration

Once the design storm return period has been selected, determine the duration of the design storm to be used in conjunction with the IDF curves. Storm duration should be equal to or greater than the time of concentration for the watershed. For small watersheds, a storm duration of 1–3 hours may be adequate, while a 24-hour storm duration may be required for larger watersheds.

This parameter is not required for methods that use historical rainfall records (rather than design storms) to generate estimates of runoff.

2.5.7 Design Storm Distribution

The design storm distribution refers to the distribution of rainfall over the storm duration.

Commonly used storm distributions in Ontario are listed below:

- Soil Conservation Service (SCS) (now called the U.S. Natural Resources Conservation Service or NRCS) Type II Distribution is appropriate for urban or rural areas.
- Chicago Distribution is applicable to urban areas with a high percentage of impervious land cover.
- Atmospheric Environment Service (AES) Ontario Distribution.

This parameter is required for all methods that use design storms rather than historical runoffs.

2.5.8 Runoff Coefficient

The runoff coefficient is the ratio of runoff depth to rainfall depth. The runoff coefficient is assumed to be a constant that does not change with rainfall rate or antecedent moisture conditions.

Common runoff coefficients for various land uses and soil types are included in the *MTO Drainage Management Manual.* The runoff coefficient is a parameter used in the rational method.

2.5.9 Infiltration and Surface Runoff

The methods for estimating the amount of infiltration and surface runoff are applied when using computer simulation models or the unit hydrograph method.

The amount of surface runoff is the remainder of the rainfall after infiltration and initial abstractions (evapotranspiration, depression storage). Infiltration is estimated using methodology such as the SCS curve number method, the Horton infiltration method, the Green and Ampt infiltration method and others.

The **SCS curve number** method estimates the depth of runoff based on land use and soil classification. The SCS classifies soil into four hydrological soil groups (A, B, C, D) based on infiltration rates and runoff potential. Recommended curve numbers for various land uses under each hydrologic soil group are recorded in the *MTO Drainage Management Manual.* Detailed guidance on the development and use of the SCS curve number method is found in the *NRCS Engineering Handbook,* Part 630 Hydrology. Appendix A of OMAFRA Publication 29, *Drainage Guide for Ontario* provides information relating the hydrologic soil grouping to the drainage classification of soils.

The **Horton infiltration method** calculates the infiltration rate based on soil properties. Maximum and minimum infiltration rates are selected based on soil type. The infiltration capacity of the soil decreases exponentially with time according to a decay constant, k. Typical values for the maximum and minimum infiltration rates and the decay constant for a variety of soil types are found in the *MTO Drainage Management Manual.*

The **Green and Ampt infiltration method** is one of the most realistic infiltration models available. It considers the hydraulic conductivity, wetting front suction head, porosity, field capacity and wilting point of the soil. Typical values of the Green and Ampt parameters are found in the *MTO Drainage Management Manual.*

2.5.10 Resources

Ontario Ministry of Transportation

- IDF Curve Lookup (www.mto.gov.on.ca/IDF_Curves)
- Evaluation of Drainage Management Software (ontario.ca/mto)
- *Highway Drainage Design Standards,* 2008 (ontario.ca/publications)

Ontario Ministry of Agriculture, Food and Rural Affairs

- *Drainage Guide for Ontario,* 2007, Publication 29 (ontario.ca/publications)

Environment Canada

- IDF Data (www.climate.weather.gc.ca)
- Water Survey of Canada (www.ec.gc.ca/rhc-wsc)

Ontario Ministry of Natural Resources and Forestry

- Surface Water Monitoring Centre (ontario.ca/page/surface-water-monitoring)
- *Technical Guide — River and Stream Systems: Flooding Hazard Limit* (ontario.ca/mnrf)

Upper Thames River Conservation Authority (www.thamesriver.on.ca)

- *Reference Manual for the Use of Precipitation Design Events in the Upper Thames River Watershed*

British Columbia Ministry of Agriculture, Food and Fisheries (www2.gov.bc.ca)

- *B.C. Agricultural Drainage Manual*
- *Drainage Management Guide*

United States Department of Agriculture, Natural Resource Conservation Service (www.usda.gov)

- *Engineering Handbook*
    - Part 630 Hydrology
    - Part 650 Engineering Field
    - Section 16 Drainage of Agricultural Land
- Technical Releases

CHAPTER 3

HYDRAULICS

3.1 Introduction

Hydraulic analysis refers to the determination of flow rate, velocity and depth of water in drains, including channels, culverts and piped drains.

The *Drainage Act, 1990* provides some direction on hydraulic analysis. It requires that:

- A piped drainage works that replaces a natural watercourse must, alone or combined with a channel, accommodate all flows directed towards it (Section 14).
- With some exception, all drains require a sufficient outlet for discharge where they will do no damage to other lands and roads (Section 15).
- The engineer may continue a drain downstream of the initiating municipality in order to achieve a sufficient outlet (Section 20).

3.2 Hydraulic Design and Analysis Methods

3.2.1 Nomographs for Open Channels and Storm Drains

Manning's Equation is most commonly used to calculate velocity and discharge in channels and pipe systems under gravity flow. The equation is applicable to steady uniform flow (see 3.3.1 Types of Open Channel Flow). The equation considers the hydraulic radius, slope and roughness of the channel/pipe. Nomographs relate gradients, pipe diameters and channel geometry to velocities and capacities of flow. The engineer can develop spreadsheets to design channels and pipes using Manning's Equation.

Sources for nomographs:

- *MTO Drainage Management Manual*
- OMAFRA Publication 29, *Drainage Guide for Ontario*
- design information from culvert manufacturers

3.2.2 Nomographs for Culverts

Culvert nomographs are design charts that show the relationship between water level, flow rate and culvert geometry. They are available for both inlet and outlet control flow conditions:

- Inlet control — The capacity of the culvert is controlled by the depth of headwater and the entrance geometry. The roughness, length and outlet conditions do not factor into the capacity of the culvert.
- Outlet control — The capacity of the culvert is controlled by the depths of tailwater and headwater and the characteristics of the culvert. The roughness, length and slope are all factors in determining capacity.

3.2.3 Computer Models for Design of Channels, Culverts and Storm Drains

Nomographs are efficient when dealing with simple systems. For complex situations, computer models are more effective, as they can evaluate backwater effects, pressure flow, unsteady channel flow, non-uniform channel flow, storage facilities, controlled outlets, pumping stations, etc. Commonly used models for drainage systems in rural Ontario include:

- Hydraulic Engineering Center's River Analysis System (HEC-RAS), which was developed by the United States Army Corps of Engineers.
- Stormwater Management Model (SWMM), developed by the United States Environmental Protection Agency. This model provides hydrologic simulation of rainfall-runoff and hydraulic routing through open channels, closed pipes, storage facilities, pumps and flow regulators.
- PCSWMM, a decision support system for the US EPA's SWMM core processes. It can be used for solving everything from small drainage problems to continuous hydrology, hydraulics and quality simulation of major/minor drainage systems.

Additional computer models are CulvertMaster, OTTHYMO, HY-8, StormCAD and FlowMaster.

- CulvertMaster is capable of solving complex culvert hydraulic calculations to assist in culvert design.
- OTTHYMO or Visual OTTHYMO is a single-event hydrologic model used to simulate runoff from design storm events.
- HY-8 is a culvert hydraulic analysis model developed by the United States Federal Highway Administration (FWHA).
- StormCAD is used for modelling storm sewer systems based on the rational method approach.
- Flowmaster is capable of performing hydraulic calculations for open channels, pipes, drop inlets and weirs.

The Ontario Ministry of Transportation has an extensive list of computational methods, including detailed evaluations and a description of their capabilities. The information is available on the MTO's website (ontario.ca/mto and search for "Selecting Computational Methods").

3.2.4 Rural Piped Drains

Rural piped drains can be sized using the drainage coefficient method, which combines hydrologic and hydraulic processes. It was developed for use by tile drainage contractors to size subsurface drainage systems for agricultural land (Figure B3–1). It is also used by engineers to design piped drainage works for agricultural watersheds. When sizing pipes for agricultural watersheds greater than 100 ha, verify the pipe size using other drainage design methods such as computer modelling.

Figure B3–1. A contractor installing a rural piped drain.

Source: Julie Van Mol, Ridgetown, Ontario.

The drainage coefficient is the rate at which water is removed by the drain from an area and is expressed in millimetres or inches per day (24 hours). The coefficient method determines the size of pipes using nomographs, graphs or equations that consider the gradient, pipe material and flow rate.

When contemplating an agricultural piped drain design, consider the following:

- the cost of installing the pipe (it may be more practical to build a channel or relocate a drain)
- pipe strength and bedding for deep drain installation
- the type of installation method
- the condition and capacity of existing piped drains (it may be possible to incorporate the existing pipe and supplement it with the new pipe)
- the inclusion of surface water
- the location of surface water inlets

Consider as well:

- certain pipe materials only come in a range of sizes
- pipes may be a practical solution for unstable soils

More information on this method is available in OMAFRA Publication 29, *Drainage Guide for Ontario.*

3.3 Factors to Consider in Hydraulic Analysis and Design of Channels and Pipes

3.3.1 Types of Open Channel Flow

Open channel flow is classified as either steady or unsteady and either uniform or non-uniform. Steady, uniform flow is calculated using Manning's Equation. Unsteady or non-uniform flow analysis is complex and difficult to perform, and computer models can be used. Drainage works are normally designed under steady, uniform flow conditions.

Flow conditions can be classified as subcritical, critical or supercritical and are identified by the Froude Number. Froude Number calculations are found in the *MTO Drainage Management Manual.*

3.3.2 Hydraulic Grade Line

When designing drainage systems, it is important to determine the maximum permissible hydraulic grade line (HGL) and the calculated maximum hydraulic grade line resulting from the design storm. The HGL corresponds to the water level in the conveyance system.

The engineer should be aware of sudden changes in gradient that may result in a transition between flow classifications. For example, a steep slope that suddenly transitions to a shallow slope may result in a transition from a supercritical flow condition to a subcritical flow condition, which results in a hydraulic jump.

The engineer should determine the maximum permissible HGL to prevent unacceptable flooding or impairment to drainage or structures. The maximum calculated HGL resulting from the design storm should be lower than the maximum permissible HGL.

It may be sufficient to examine the HGL only at certain points of the conveyance system: for example, at road crossings or in the area of buildings where openings are to be considered.

For more complex settings, looking at the continuous HGL throughout the entire drainage system is recommended.

3.3.3 Freeboard

Freeboard is a term used to describe a design safety factor.

Channels — the freeboard is the elevation difference between the water levels for the design hydrologic event and the surrounding land (Figure B3–2). In agricultural areas, the minimum channel freeboard is 0.1–0.3 m.

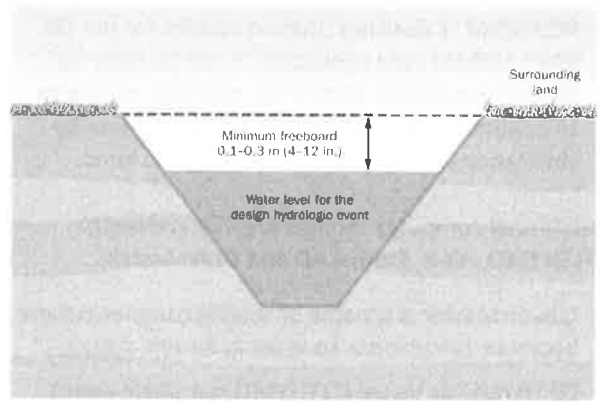


Figure B3–2. Channel freeboard.

Piped drains discharging into a channel — the freeboard is the elevation difference between the outlet pipe and the normal water level (Figure B3–3). This allows for sediment buildup without impacting the outlet pipe. Pipe designs should target a minimum freeboard of 0.3 m.

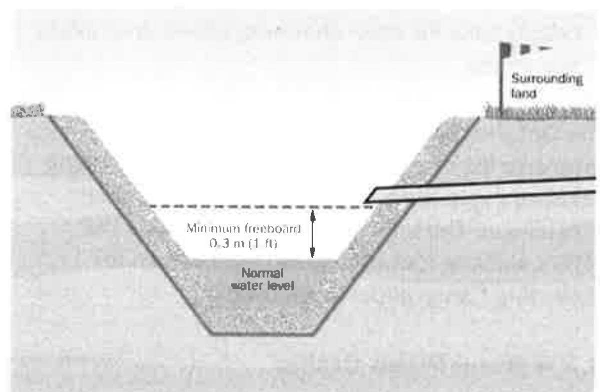


Figure B3–3. Piped drain freeboard.

The MTO design guidelines provide the requirements with respect to minimum freeboard for drainage works requiring MTO approval as shown in Table B3–1.

Table B3–1. MTO Design Standards for Freeboards — Culverts and Ditches

Conveyance Structure	Storm (Refer to Part B, Chapter 2 Hydrology for Design Storm Information)	Minimum Freeboard	MTO Design Drainage Standards (Jan. 2008) Reference Section
Roadside Ditch			
–	Minor System Design Flow	0.3 m to top of sub-grade of road	SD–9
Culvert Not on a Watercourse (associated with runoff from roadways and local catchment areas)			
–	Minor System Design Flow	0.3 m to top of sub-grade of road	SD–13
Culvert on a Watercourse			
Freeways, Arterials and Collectors	Design Flow	1.0 m to edge of travelled lane	WC–7
	Check Flow	High water level not to exceed edge of travelled lane	WC–7
Local Roads	Design Flow	0.3 m to edge of travelled lane	WC–7
	Check Flow	High water level not to exceed edge of travelled lane	WC–7

Source: MTO Drainage Design Standards, January 2008, Section WC-2.

Table B3–2. MTO Design Standards for Freeboards — Bridge Structures for Standard Road Classifications

Road Classification	Design Storm	Minimum Freeboard (High Water Level to Edge of Travelled Lane)	Clearance (High Water Level to Lowest Point on Soffit)
Freeways, Arterials, and Collectors	Design Flow	1.0 m	1.0 m
	Check Flow	High-water level not to exceed elevation of edge of travelled lane	
Local Roads	Design Flow	0.3 m	0.3 m
	Check Flow	High-water level not to exceed elevation of edge of travelled lane	

Source: MTO Drainage Design Standards, January 2008, Section WC-2.

The freeboard and clearances required by the MTO for bridges for standard road classifications are shown in Table B3–2 (*MTO Highway Drainage Design Standards,* January 2008, Section WC–2). The engineer should consult with the municipality to determine if there are additional municipal design standards.

3.3.4 Roughness Coefficient

Manning's Equation is used to calculate velocity and flow in channels or pipes. It uses a roughness coefficient that is selected based on pipe material, channel lining, channel size and condition.

Recommendations for Manning's roughness coefficients are found in:

- *MTO Drainage Management Manual*
- OMAFRA Publication 29, *Drainage Guide for Ontario*
- design information from pipe manufacturers

3.3.5 Drain Depth

The drain depth is the vertical distance from the surrounding land to the drain bottom or invert. The depth should ensure sufficient capacity and the required freeboard to provide an outlet for the watershed, including existing and potential subsurface drainage systems and land uses. Pipe systems must be installed at a sufficient depth to avoid tillage practices.

3.3.6 Strength of Pipe Materials

When designing pipe drains, the engineer must evaluate the strength of the pipe material for:

- static loads (depth of cover over the pipe)
- dynamic loads (traffic loading or other live loads)

Approaches to analyze strength requirements are found in the *MTO Gravity Pipe Design Guidelines,* ontario.ca/mto.

Refer to the *Ontario Provincial Standards for Roads and Public Works* regarding the minimum and maximum height of fill for different pipe materials, diameters, bedding conditions and trench/embankment installations. Tables are available for concrete (reinforced and non-reinforced), steel, HDPE and PVC pipes. The Ontario Provincial Standard Drawing (OPSD) reference numbers for the various tables are 805.01–807.05. The OPSDs are available online through the MTO website (ontario.ca/mto search for "Ontario Provincial Standards for Roads & Public Works").

3.3.7 Utility Considerations

The location of utilities can impact drain depth and grade, which can affect the resulting hydraulic analyses (Part C, Chapter 10). Consult with the utility companies to determine the location of the utility and confirm the minimum recommended separation of the drain from the utility. In most cases, exposing the utility in the field may be required.

3.3.8 Bottom Grade of Channels and Pipe

Set the channel bottom grade line deep enough to allow sufficient freeboard for pipe drains to discharge above the normal water level of the outlet.

To allow for continuous flow of water, channels and culverts should have a positive downhill grade. Zero or reverse grade is discouraged except for specific environmental features (e.g., sediment traps, Newbury weirs).

Establish grades that will provide the flow capacity within acceptable velocity ranges. A flat grade may produce minimum velocities that allow the deposition of sediment. A steep channel grade may produce velocities that result in erosion and bank slumping. A steep pipe grade can result in pipe failure (blowout) and soil movement.

3.3.9 Channel Side Slopes

Base maximum (i.e., steepest) channel side slopes on soil and groundwater conditions to ensure channel bank stability (Figure B3–4). Table B3–3 shows the maximum recommended channel side slope ratios.

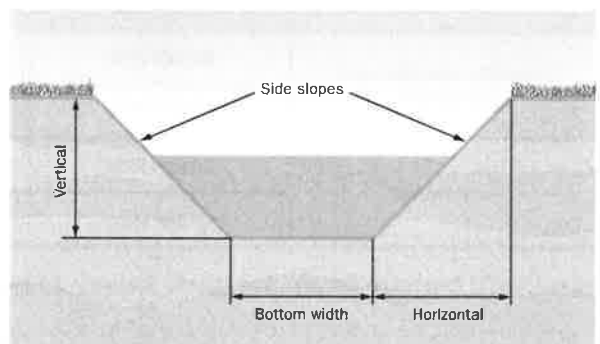


Figure B3–4. A channel showing side slopes and bottom width.

Table B3–3. Maximum Recommended Channel Side Slope Ratios

Soil Materials	Channel Depth <1.3 m (vertical:horizontal)	Channel Depth >1.3 m (vertical:horizontal)	Maximum Velocity m/s (ft/s)
Peat, stable organic	1:1	1:1.5	0.5 (1.6)
Heavy clay (>35% clay)	1:1.5	1:2	1.5 (5.0)
Clay/silt loam (10%–35% clay)	1:2	1:2.5	1.0 (3.3)
Sandy loamy (<10% clay)	1:3	1:4	0.75 (2.5)
Clay of marine origin and/or banded with sand or silt (subject to low stability when saturated)	1:4	1:4	0.5 (1.6)
Sandy or silty with high water table and/or lateral seepage	1:4	1:5	0.5 (1.6)

Source: Table 10 of *Drainage Guide for Ontario,* Publication 29, Ontario Ministry of Agriculture, Food and Rural Affairs, 2007

For safety reasons, MTO recommends using as flat (minimal) a side slope as possible for roadside ditches.

3.3.10 Channel Bottom Width

Channel bottom width is a factor in flow capacity and is a parameter in Manning's Equation, nomographs and spreadsheets. Select widths using hydraulic analyses that consider the hydraulic gradient, maximum permissible velocity, land requirements and environmental concerns.

3.3.11 Channel Velocities

A minimum velocity of 0.3–0.5 m/s for shallow channels is often sufficient to prevent sedimentation.

The maximum velocity should not exceed the shear strength of the channel lining. Recommended maximum velocities for a variety of soil and vegetation linings are found in the *MTO Drainage Management Manual,* Part 4. In situations where the maximum velocity is above the acceptable limit, use channel reinforcement to provide greater shear strength. Some examples of channel reinforcement (Figure B3–5) are:

- riprap
- erosion control blankets
- turf reinforcement mats
- interconnected concrete blocks
- gabion structures
- coir mats
- vegetative methods
- natural channel reinforcement techniques

Chapter 7 Erosion and Sedimentation Considerations and Chapter 14 New Technology (Natural Channel Works) of the *MTO Drainage Management Manual* also discuss channel reinforcements.

Manufacturers of channel reinforcement products provide maximum velocities for each type of reinforcement.

For information on riprap selection and corresponding shear stress, refer to the *MTO Drainage Management Manual,* Part 4.

Figure B3–5. Example of channel reinforcement using riprap.

Source: Dietrich Engineering Limited, Waterloo, Ontario.

3.3.12 Pipe Velocities

Design pipe drains to ensure the minimum full-flow velocity in order to minimize the deposit of solids. OMAFRA Publication 29, *Drainage Guide for Ontario* recommends a minimum velocity of 0.15 m/s for drains with little sediment movement and 0.45 m/s for drains with greater sediment movement. Check pipe manufacturers' specifications and recommendations regarding maximum flow velocity.

The engineer should consult with the municipality or regulatory agencies to determine if there are specific velocity requirements (e.g., maximum velocity for fish movement through culverts).

3.3.13 Headwater Depths at Culverts

Headwater depth is an important factor when determining culvert capacity. It refers to the vertical distance from the culvert invert to the energy grade line (water level plus velocity head) of the pooled water at the culvert inlet. Because the entrance velocity is very low in most situations, the water surface and the energy grade line are assumed to be the same.

3.3.14 Sufficient Outlet

Drainage works constructed under the *Drainage Act, 1990* must be discharged at a location where the water level or flow rates will not damage downstream lands or roads. This is known as a sufficient outlet (Section 15).

If the downstream area is flood-prone, it is important to ensure that the drainage works does not increase the water levels and flooded area. This is accomplished through incorporation of stormwater management techniques to temporarily impound water and restrict the outflow rate. Also consider downstream construction to relieve flooding.

3.3.15 Capacity of Existing Features

Calculate the capacity of existing drainage features (e.g., culverts, weirs, dams, pump stations) and compare them to field observations during actual storm events. This will allow the engineer to assess and calibrate the hydraulic design.

Develop the recommendation for the existing feature based on the hydraulics, the age of the feature, remaining service life and past performance during storm events.

3.3.16 Fisheries Concerns

Flow capacity is affected by:

- fish habitat features (e.g., Newbury weir) (Figure B3–6)
- culvert design modifications to permit fish passage (e.g., embedment, length, bottom substrate, minimum bottom width, minimum flow depth and maximum flow velocity)
- natural channel design to improve fish habitat (Part B, Chapter 11)

Consult with Fisheries and Oceans Canada to determine design criteria for supporting fish habitat. For additional information see Part C, Chapter 9.1 *Fisheries Act,* 1985.

Figure B3–6. A Newbury weir.

Source: K. Smart & Associates Ltd., Kitchener, Ontario.

3.3.17 Low Level Crossings

Low level crossings are a low cost alternative for infrequently used crossings of large channels. These crossings are designed to convey the water underneath during normal flow events and to allow the water to flow overtop during larger storm events (Figure B3–7). Design the crossing to accommodate the base flow plus an allowance for additional flow. Protect the crossing surface against erosion because it will frequently be submerged during storm events.

Figure B3–7. A low level crossing.

Source: Grand River Conservation Authority, Ontario, Canada.

Complete an analysis of backwater effects of the low level crossing to ensure that the water level upstream is not increased beyond acceptable limits and sediment deposition is not increased upstream of the crossing.

3.3.18 Other Hydraulic Design Considerations

Consider the impact of other design considerations (Part B, Chapter 10) on hydraulic analyses.

3.4 Summary

Figure B3–8 is a summary of the recommended approach to hydrologic and hydraulic design of drainage works.

Note: This figure does not apply to the rural pipe drains using the drainage coefficient method. Confirm that the selected computation method is acceptable to any regulatory agencies.

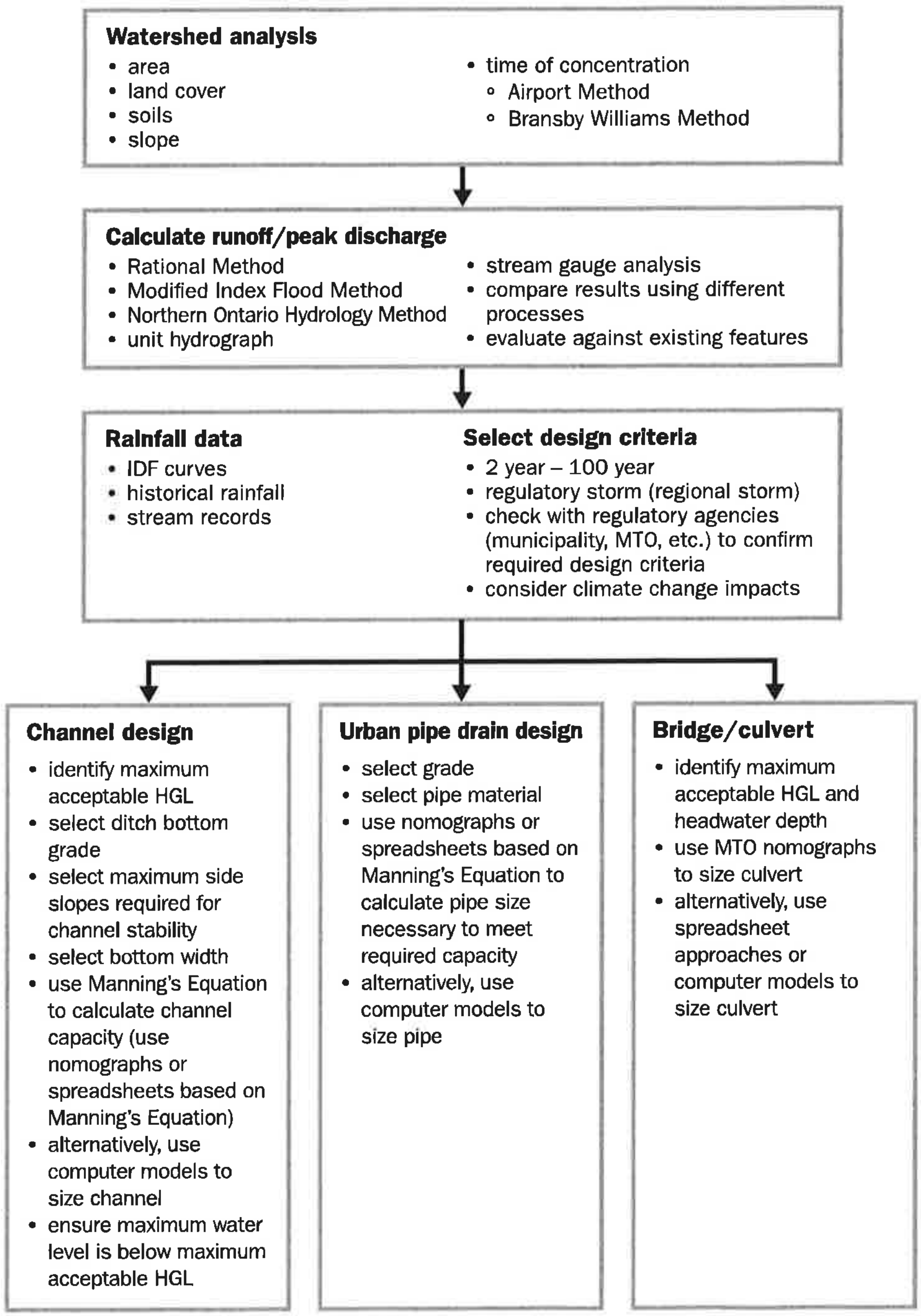


Figure B3–8. Recommended approach to hydrologic and hydraulic design of drainage works (excluding the drainage coefficient method).

Source: K. Smart Associates Ltd., Kitchener, Ontario.

3.5 Resources

Ontario Ministry of Transportation (ontario.ca/mto)

- Evaluation of Drainage Management Software
- *MTO Drainage Management Manual.* Drainage and Hydrology Section, 1997
- *Highway Drainage Design Standards,* 2008
- *MTO Gravity Pipe Design Guidelines*
- *Ontario Provincial Standards for Roads and Public Works*

Ontario Ministry of Agriculture, Food and Rural Affairs

- *Drainage Guide for Ontario,* Publication 29, 2007 (ontario.ca/publications)

Ontario Ministry of the Environment and Climate Change

- *Design Guidelines for Sewage Works,* PIBS 6879, 2008 (ontario.ca/document/design-guidelines-sewage-works)

United States Army Corps of Engineers

- Hydraulic Engineering Center River Analysis System (HEC RAS) (www.hec.usace.army.mil/software/hec-ras)

United States Environmental Protection Agency

- Stormwater Management Model (www.epa.gov/water-research/storm-water-management-model-swmm)

CHAPTER 4

CLIMATE CHANGE

4.1 Introduction

Weather patterns and the climate are changing. This chapter is written to raise awareness about climate change and its impact on drainage works.

The intensity, duration and frequency of extreme weather events are shifting. The uncertainty lies in the level of change that will occur and the resulting impact on the drainage infrastructure. Awareness of the impacts of climate change will allow the engineer to alter drain design to preserve the service life of the drain.

4.2 Projected Climate Trends

Projected climate trends for Ontario to the year 2050 include warmer annual temperatures. Average temperatures in Ontario have increased by 1.4°C since 1948. Northern Ontario will warm faster than other parts of Ontario, and winters will be warming faster than summers. In southern Ontario, the number of days/year exceeding 30°C is likely to more than double by 2050.

Climate change gives rise to erratic weather patterns and a series of impacts:

- annual total precipitation amounts will increase across Ontario
- winter precipitation will increase in both southern and northern Ontario
- more of southern Ontario precipitation will be in the form of rain due to increased temperatures
- southern Ontario will see a decrease in precipitation during the summer months
- southern Ontario will see an increase in the frequency and intensity of extreme weather due to higher temperatures
- northern Ontario will see an increase in spring precipitation, which combined with snowmelt may result in an increased risk of flooding
- heat waves and drought will become more frequent and last longer

There are models that can simulate the present climate and project a future climate. Some models are on a global scale and use a grid spacing of 250–400 km. They do not simulate small-scale, localized events. High-resolution Ontario-specific climate modelling data are available at www.ontarioccdp.ca. This modelling work uses much finer scales (e.g., 10–25 km grid) to project temperature, precipitation, wind speeds, relative humidity, etc. for future climate scenarios (Figure B4–1). The climate data available at www.ontarioccdp.ca also includes IDF curves.

These methods have levels of uncertainty associated with predicting the extent of climate change on a scale useful for drainage projects.

Further details on climate models and their capabilities are found in *Guide for Assessment of Hydrologic Effects of Climate Change in Ontario,* 2010, Ontario Ministry of Natural Resources and Forestry (ontario.ca search for "Natural Resource Management and Climate Change").

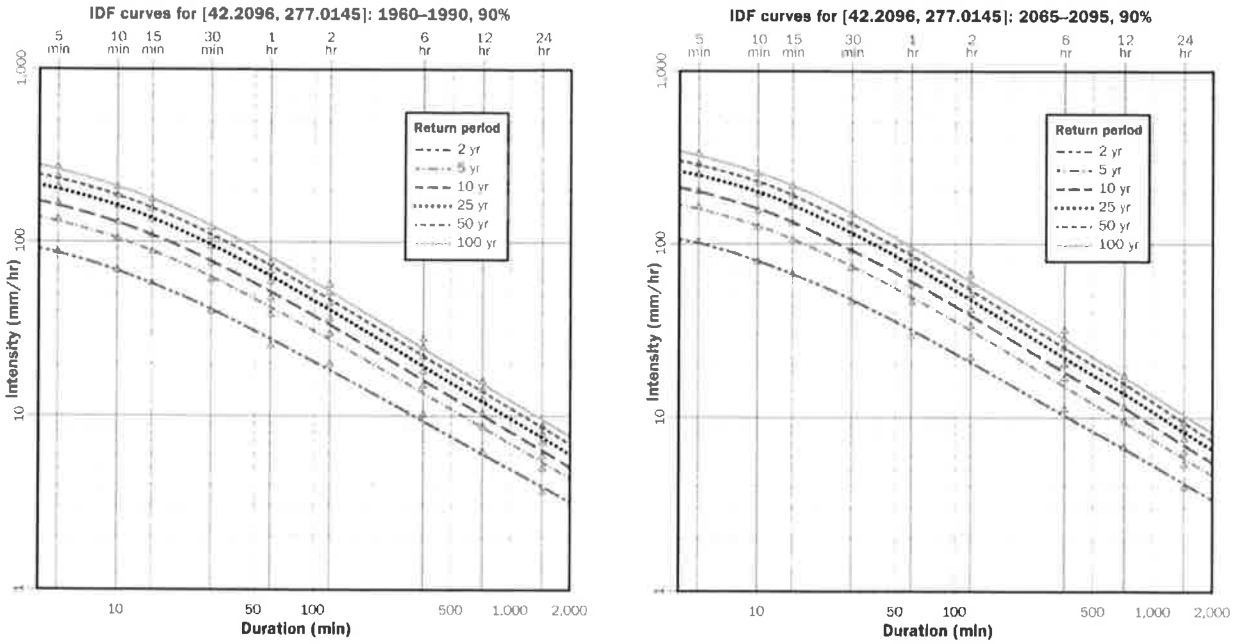


Figure B4–1. Current (1960–1990) and future (2065–2095) IDF curves for a specific 25 km x 25 km grid.

Source: Ontario Climate Change Data Portal, www.ontarioccdp.ca.

4.3 Climate Change Adaptation

A drain design adapted for climate change will reduce the frequency of future maintenance and the need for drain improvements, resulting in sustainability and longevity of the drain. Drainage infrastructure will be vulnerable to climate change due to increased frequency of extreme events. Intense snowfall may block catch basins, culverts or other drainage outlets, increasing the risk of flooding. Channel embankments may be more vulnerable to washout and erosion due to higher peak discharges. Roads may be vulnerable to surface ponding, limiting vehicle access. Gravel surfaces may be eroded and rutted.

4.3.1 Temperature

Higher temperatures during summer months will increase evapotranspiration rates, resulting in drier soils. Drier soils may become hard-packed surfaces that limit infiltration, leading to decreased overland flow times and increased runoff peak flows.

Increased evapotranspiration may also result in smaller wetlands and marsh areas. Wetlands provide storage and flow attenuation during rainfall events. The engineer should consider design options that will avoid impacting existing wetlands, restore or enhance existing wetlands or create new wetlands to mitigate the impact of climate change on the watershed. Wetlands and water retention are discussed in Part B, Chapter 8 and constructed wetlands are presented in Part B, Chapter 11.

Warmer temperatures during winter months will result in more precipitation occurring as rain rather than snow. Winter snowmelt combined with increased spring precipitation will result in greater risk of flooding. The engineer should consider the impact of an extreme rainfall event combined with snowmelt and evaluate the risks associated with flooding. In situations where flooding poses a greater risk to human health and safety, the engineer should consider designing the drain to convey a higher peak storm event.

4.3.2 Precipitation

The impact on quantity of precipitation is important, but it is equally important to consider the climate change impact on seasonality and the nature of the precipitation. The engineer should consider the impact of extreme rainfall events on any drainage works. However, the risks associated with the occurrence of an extreme event are variable and depend on a number of factors, including location and purpose of the drainage works. For example, drainage works located in a rural area for the purpose of providing drainage for agricultural lands do not need to be as extensively evaluated with respect to an extreme rain event as would drainage works that provide drainage for a provincial highway, urban area or any other situation in which flooding could pose a hazard to human health and safety.

4.3.3 Peak Flows

An increase in the frequency of extreme rainfall events will change the peak flow for a given design storm return period. Higher runoff peak flows will occur more frequently, placing more stress on drainage works and increasing the flooding frequency (Figure B4–2).

Figure B4–2. A flooded hay field with water entering a full municipal drain.

Higher peak flows in channels may increase sediment transport, resulting in degraded water quality and sediment deposition in outlet water bodies. The engineer should consider alternative channel designs and design components that reduce sediment transport. Techniques that may reduce sediment transport include two-stage ditches, buffer strips, natural channel design, stormwater management ponds and inclusion of wetlands.

4.4 Climate Change and IDF Curves

Intensity-Duration-Frequency (IDF) curves provide a relationship between rainfall intensity and duration for a specific storm frequency (return period). IDF curves are now updated with recent rainfall data.

DID YOU KNOW? The Public Infrastructure Engineering Vulnerability Committee (PIEVC) was created by Engineers Canada, in partnership with Natural Resources Canada, with the purpose of conducting an engineering assessment of the vulnerability of Canada's public infrastructure to climate change. The four categories assessed are buildings, roads and associated structures, stormwater and wastewater systems, and water resources. The final reports of several case studies are available at www.pievc.ca.

Climate change models attempt to project what the future climate will look like (e.g., precipitation patterns); however, there are many uncertainties. The projected climate changes may suggest that design practices be modified to reflect the changing hydrological scenarios. However, due to the uncertainty of the magnitude and the implications of potential climate change, specific guidelines and standards for modified design practices have been slow to develop.

Consider using IDF curves with climate change projections for the local area or design to a higher standard. Unless mandated by municipal council, it is the engineer's discretion to modify the design to accommodate climate change impacts.

Research initiatives are identifying local climate change impacts and defining design standards that build adaptation and resiliency into drainage design. These prediction models are based on weather station data collected by Environment Canada (Part B, Chapter 2).

4.4.1 Ministry of Transportation

In 2010, the Ontario Ministry of Transportation (MTO) released updated IDF curves based on Environment Canada's rainfall data. The MTO developed a web-based program to provide regional IDF curves for any location across Ontario, www.mto.gov.on.ca/IDF_Curves. In 2016, the MTO implemented an update of the IDF online application, which includes a climate change component. This climate change prediction feature of the IDF curves is based on trend analysis of the historic rainfall record.

The Ministry of Transportation completed an analysis of the effect of climate change on future design standards of drainage infrastructure. Search the internet for *The Resilience of Ontario Highway Drainage Infrastructure to Climate Change,* July 20, 2015, Hani Farghaly, MTO, Ontario.

4.4.2 Municipalities

Some municipalities (e.g., the cities of London and Welland) have completed studies to determine the impacts of climate change on their IDF curves. They developed projected long-term precipitation data and future IDF curves (Simonovic, 2010; AMEC Environment & Infrastructure, 2012).

A number of municipalities in Ontario have undertaken vulnerability assessments to identify weaknesses of infrastructure to a changing climate. They have considered climate change in the design of drainage infrastructure by adjusting their design standards (e.g., using a 500-year design storm event rather than the 100-year design storm event). Check with the local municipality to see if they have completed a vulnerability study.

4.4.3 Conservation Authorities

Some conservation authorities are addressing climate change adaptation at the watershed scale, and they may have updated precipitation data, mapping, erosion mapping etc. that can be useful.

4.5 Resources

Ontario Centre for Climate Impacts and Adaptation Resources (www.climateontario.ca)

- *A Practitioner's Guide to Climate Change Adaptation in Ontario's Ecosystems.* Gleeson, J., Gray, P., Douglas, A., Lemieux, C.J., and Neilsen, G., 2011.
- *Adapting to Climate Change in Ontario: Towards the Design and Implementation of a Strategy and Action Plan.* Expert Panel appointed by the Minister of Environment and Climate Change, 2009.

Drainage Engineers Conference (Ontario) (www.landdrainageengineers.com)

- *The Changing Climate and Increasing Vulnerability of Infrastructure: What Lies Ahead?* Auld, Heather, 2005.
- *Designing for Changing Climate Extremes: Heavy Rainfall and Drought.* Auld, Heather, 2006.
- *Too Much, Too Little and Everything in Between — Designing in the Context of Climate Change.* Douglas, Allan, 2011.
- *Resilience of Ontario Highway Drainage Infrastructure to Climate Change.* Farghaly, Hani. Ontario Ministry of Transportation, 2015.
- *New MTO Drainage Design Tools for Flow Analysis and IDF Curves.* Farghaly, Hani. Ontario Ministry of Transportation, 2016.

Preparing for the Impacts of Climate Change on Stormwater and Floodplain Management: A Review of Adaptation Plans and Practices. Toronto and Region Conservation Authority, 2009. (www.glslcities.org)

Economic Assessment of Climate Change Scenarios on Drainage Infrastructure Design. Scheckenberger, Ronald B., Farrell, Aaron C. and Senior, Matthew (Philips Engineering Ltd.), 2009. (http://trid.trb.org)

Identification of the Effect of Climate Change on Future Design Standards of Drainage Infrastructure in Ontario. Coulibaly, Paulin and Shi, Xiaogang. McMaster University, Hamilton, Ontario, 2005. (www.cspi.ca)

Adapting to Climate Change — Canada's First National Engineering Vulnerability Assessment of Public Infrastructure. Canadian Council of Professional Engineers, 2008. (www.pievc.ca/documents)

Guide for Assessment of Hydrologic Effects of Climate Change in Ontario. EBNFLO Environmental AquaResource Inc., Ontario Ministry of Natural Resources and Forestry, Ontario Ministry of the Environment and Climate Change, and Credit Valley Conservation, 2010. (www.waterbudget.ca/climatechangeguide)

Planning for Extremes: Adapting to Impacts on Soil and Water from Higher Intensity Rains with Climate Change in the Great Lakes Basin. Ontario Chapter of the Soil and Water Conservation Society, 2007.

Climate Change Adaptation Framework — Manual. Alberta Sustainable Resource Development, 2010. (www.aep.alberta.ca)

CHAPTER 5

URBAN AREAS

5.1 Introduction

The term "urban area" refers to an area where the primary land use is residential, commercial or industrial rather than agricultural. Most urban areas would meet the definition of a built-up area for assessment purposes (Part A, Chapter 9.4.1).

The majority of stormwater drainage systems built in urban areas are constructed under the *Municipal Act, 2001* and the *Ontario Water Resources Act, 1990* and funded by municipal taxes. Some restructured municipalities in Ontario have amalgamated former rural townships with former urban municipalities. As a result, there may be an inconsistency in the funding of these drainage systems. Some municipalities are trying to be more consistent in their management of stormwater drainage systems by using the *Drainage Act, 1990* for both the rural and urban components.

Drainage works constructed under the *Drainage Act, 1990* may involve both rural and urban areas. Some smaller urban areas in rural Ontario have historically been serviced by projects constructed under the *Drainage Act, 1990.*

Many of the drainage design methods are similar for both urban and rural areas; however, drainage in urban areas may require different design criteria and construction considerations. Drainage designs in urban areas are subject to MOECC approval under the *Ontario Water Resources Act, 1990.*

5.2 Using the *Drainage Act, 1990* in Urban Areas

When the *Drainage Act, 1990* is applied in an urban area, it introduces new complexities such as:

- a requirement to assess the cost of all work to the property owners
- a larger number of property owners that are not familiar with the Act
- property owners not used to paying for stormwater drainage
- more complex assessments
- more complex construction and site restoration (e.g., roads, utilities, landscaping)
- different pipe materials and strengths
- MOECC approval may be required under the *Ontario Water Resources Act,* 1990

Similar to drains in rural areas, a drain constructed in urban areas under the *Drainage Act, 1990:*

- has legal existence through a municipal by-law
- puts responsibility on the municipality for future maintenance and repair
- involves public consultation to allow municipal council to become better aware of property owner concerns

To obtain an outlet for an urban drainage system, it is sometimes necessary for the drain to cross agricultural lands, roads or railways. The *Drainage Act, 1990* process may be an effective way of achieving this outlet through private property.

When applying the *Drainage Act, 1990* to drains in urban areas:

1. A project scoping meeting (Part A, Chapter 3) is recommended. Expand the invitation to include developers and MOECC.
2. Provide a workshop on the *Drainage Act, 1990* for the property owners and possibly municipal council.
3. A preliminary report to allow for more input and evaluation of alternatives is recommended (Part A, Chapter 5).
4. Consider the official plan and zoning by-law provisions for future land uses.
5. Review past or ongoing studies in the area of the drain regarding roads, development, utilities, services and environmental issues (Part A, Chapter 4.3).
6. Expand fieldwork (Part A, Chapter 6) to cover utilities, existing drains, catch basins, curbs, swales, other roadway details, private services, easement routes, legal survey bars, driveways, foundation/windowsill elevations and landscaping.
7. Develop a traffic plan to include emergency property access, local access and school bus needs.
8. Provide additional details in the final report, including:
    - larger-scale plans to show the complexity of the project, including all services and utilities and major and minor flow paths
    - separate removal drawings showing existing features to be removed prior to installation of new components
    - the transportation and disposal site of extra excavated materials
    - landscaping on private properties (e.g., tree planting, gardens, lawns)
    - restoration of municipal areas (e.g., pavement, curb and gutter)
    - special provisions for construction such as staging, traffic control, construction yards, stockpile areas, preservation of existing features, foundation surveys, noise mitigation and hours of work

5.3 Design Considerations

The risks to public safety and infrastructure integrity associated with flooding are usually greater in an urban area. When designing drainage works that serve an urban area, consider the following:

- Selection of the design storm should take into account the risks associated with exceeding the capacity of the drainage works. In consultation with the municipality, the local conservation authority and MOECC, consider selecting a less frequent (more extreme) storm event for sizing drainage works to reduce the risk of flooding.
- Urban areas have more impervious surfaces than rural areas, which results in higher runoff volumes, greater peak discharges and a shorter time of concentration. Drainage works that require approval from the Ministry of Environment and Climate Change must meet their design guidelines. The MOECC *Design Guidelines for Sewage Works* provides information on minimum design storms, minimum pipe diameter and slope, and manhole and catch basin structure spacing. The design criteria for stormwater management are found in the *Stormwater Management Planning and Design Manual* (March 2003). Refer to Part C for further discussion on MOECC approvals (ontario.ca).
- Stormwater management may be required to provide quantity and quality control of runoff. Stormwater management in urban areas includes conventional end-of-pipe pond systems and low impact development (LID) techniques (Part B, Chapter 11.5).

DID YOU KNOW? LID techniques manage rainwater at the source and more closely mimic the natural hydrologic cycle by promoting infiltration, evaporation, rainwater harvesting, detention and pollution prevention. Some examples of LID stormwater management practices are vegetated channels for conveyance, infiltration trenches, bio-retention facilities to temporarily store and treat runoff, vegetated filter strips and permeable pavement (Figures B5-1 and B5-2). Further discussion on LID design and implementation can be found on the Credit Valley Conservation Authority's website (www.creditvalleyca.ca search for "Low Impact Development Guidance Documents").

Figure B5–1. A bioswale is an example of a LID technique used to reduce surface water runoff.

Source: Credit Valley Conservation Authority, Ontario.

Figure B5–2. Permeable paving is used to increase infiltration of water.

Source: Credit Valley Conservation Authority, Ontario.

5.3.1 Minor and Major Storm Flow Systems

The minor and major storm flow systems are covered in Part B, Chapter 2.3. In an urban area, the minor storm flow system is usually conveyed through pipe drains under roadways, while the roadway curb, gutter and adjacent boulevards provide the major storm flow route. In this situation, identify any low points in the roadway where ponding may occur during major storm events for the placement of catch basins.

If the pipe drains are installed in easements, the major storm flow system could also be along an overland swale or ditch within the easement. Identify any required easements in the engineer's report. Consider the hydraulic grade line to ensure that the major storm event does not overtop the major flow route and result in unacceptable levels of flooding or damage to buildings, roadways or other infrastructure (Section 3.3.2).

5.3.2 Existing Utilities

Underground utilities (e.g., hydro, gas, telecommunications, water mains and sewers) may impact the alignment, depth and/or grade of the drainage design. Consider the following:

- Investigate the location of underground utilities at the beginning of the project.
- Identify the utility companies involved and provide them with information on Section 26 of the *Drainage Act, 1990.*
- Identify plans for future utility expansion and maintenance that may impact the design of the drain:
  - Avoid impacts to existing utilities.
  - Relocate or provide protection to existing utilities during construction activities.
  - Determine the working area required during construction that is near existing utilities.
  - Have the utility company review all proposed drainage works in the vicinity of existing utilities.

5.3.3 Stormwater Services

In residential areas, municipal policy may require stormwater services for each lot to provide an outlet for foundation drainage. Consult with each municipality regarding the requirement to provide stormwater services.

5.3.4 Municipal Design Criteria

Municipalities may have more rigorous design criteria for urban drainage works. Storm sewer systems should meet all municipal design criteria with respect to design sizing method, minimum pipe diameter, minimum velocity, minimum slope, maintenance hole spacing and catch basin spacing.

5.4 Construction Considerations

Undertaking drainage construction in urban areas should include:

- obtaining a building foundations report prior to any construction
- publishing notices in local newspapers or conducting a general public meeting
- ensuring the integrity of all existing infrastructure when working near buildings or on roadways
- protecting existing utilities
- maintaining or minimizing impact to property access
- preserving school bus routes and emergency vehicle access
- providing site restoration such as sodding, tree and shrub landscaping, and road reconstruction

5.5 Resources

Drainage Engineers Conference (Ontario) (www.landdrainageengineers.com)

- *Urban Drainage and the Drainage Act.* Kuntze, John, 1994.
- *Urban Drains and the Ontario Water Resources Act.* Walton, Robert, 1996.

Ontario Ministry of Transportation (ontario.ca/mto)

- *MTO Drainage Management Manual.* Drainage and Hydrology Section, 1997.
- *Highway Drainage Design Standards.* 2008.

Ontario Ministry of the Environment and Climate Change (ontario.ca/moecc)

- *Design Guidelines for Sewage Works.* 2008.
- *Guide to Applying for an Environmental Compliance Approval.* PIBS 8527e. 2012.
- *Stormwater Management Planning and Design Manual.* 2003.

Credit Valley Conservation Authority (www.creditvalleyca.ca)

- *Low Impact Development Stormwater Management Planning and Design Guide,* Version 1.0. 2011.

CHAPTER 6

WATER QUALITY AND QUANTITY

6.1 Introduction

Water is an excellent transport pathway for nutrients and pollutants. Drainage engineers play a key role in addressing water quality concerns when designing drainage works under the *Drainage Act, 1990.* It is important to understand the different water quality parameters and how they enter and affect drainage systems and downstream water bodies.

The engineer should be knowledgeable about water quality parameters, regulations and the impacts of the drainage works on water quality. Legislation related to water quality is covered in Part C.

6.2 Water Quality Parameters

Suspended solids, phosphorus and nitrogen are the main parameters influencing water quality in drainage systems. Other contaminants can also degrade receiving water quality. When these substances reach a receiving water body, there may be negative effects on the environment.

6.2.1 Suspended Solids and Sediment

Suspended solids are particles that are suspended in water due to the movement of the water. When the flow of water slows down, some of the solids will settle and get deposited on the bottom of the waterway, forming sediment. When deposited, they can reduce the capacity of the drains and result in more frequent and costly maintenance of the drainage works.

High concentrations of suspended solids can be detrimental to water quality. Increased suspended solids can cause higher turbidity and reduce dissolved oxygen levels in water (Figure B6–1). This poses a threat to aquatic organisms that depend on clearer water and high oxygen levels. Sediment can negatively affect fish habitat and spawning grounds by covering the natural substrate.

Figure B6–1. Turbid water entering a drain (due to erosion).

Suspended solids and sedimentation are caused by numerous activities including soil erosion, soil excavation and backfilling. These can be minimized during construction works by using best practices (Part B, Chapter 7). Ongoing impact due to agricultural operations and other land uses may be managed through best management practices on the part of the property owner or through design techniques incorporated into the drainage project (Part B, Chapters 8 and 9).

6.2.2 Phosphorus

Phosphorus is important for healthy plant growth, contributing to root and fruit development. However, phosphorus can attach itself to soil particles or dissolve in water and get transported to waterways, where it is the limiting nutrient for algae growth.

Excessive phosphorus encourages the growth of algae, which can negatively impact drinking water quality, health of the ecosystem and recreational uses of water bodies. Lake Erie, the smallest and the shallowest of the Great Lakes, has experienced excessive algae blooms due to the changing ecology of the lake and the availability of soluble phosphorus. Given the direct relationship between phosphorus inputs and algae growth, reducing phosphorus levels is the most direct way to combat this threat and restore the health of the Great Lakes.

DID YOU KNOW? As algae dies, it sinks to the bottom and bacteria use oxygen to decompose the algae. This leads to the formation of dead zones where fish and other organisms cannot survive. Some algae blooms result in the growth of cyanobacteria that release toxins into the water that can negatively affect human and animal health.

Point sources of phosphorus include sewage effluent from municipal treatment plants, industrial waste and urban storm runoff. Non-point sources include septic systems, soil erosion and agricultural sources (i.e., fertilizers and manure). There have been reductions in the amount of phosphorus discharged from point sources such as sewage treatment plants, aided by the removal of phosphorous from detergents. The agricultural community has also greatly reduced non-point source discharges by reducing phosphorus fertilizer applications.

Drainage engineers can also make significant contributions to the reduction of non-point phosphorus transport. During the design process, the engineer needs to consider phosphorus movement during the construction of the drain and during the long-term operation of the drain. This can be achieved through:

- controlling erosion and the movement of sediment during the construction phase (e.g., straw bale check dams, silt fences) (Figures B6–2 and B6–3)
- designing the drain to minimize erosion and sediment deposition (Part B, Chapter 11)
- using alternative design techniques (e.g., wetlands, buffers) to stop phosphorus from moving downstream
- including sediment traps and water control structures in the drain design

Figure B6–2. A straw bale check dam.

Source: Ausable Bayfield Conservation Authority, Ontario.

Figure B6–3. A silt fence installed next to a drain.

6.2.3 Nitrogen

Nitrogen exists in the environment as inorganic (e.g., nitrate, nitrite) and organic nitrogen. Nitrate in surface waters can increase algae growth, impact aquatic life and cause health problems in drinking water when present at high concentrations. Organic nitrogen in the form of ammonia is toxic to aquatic organisms, including fish.

Nitrogen is a component of commercial fertilizers, manure and sewage effluent. Nitrate is very water-soluble and moves easily through the soil. As a result, nitrate is easily leached into groundwater and surface water. Innovative design techniques (e.g., wetlands, buffers) that detain water are used to stop nitrogen from moving downstream (Figure B6–4).

Figure B6–4. A riparian buffer.

6.2.4 Other Contaminants

There are other contaminants that can enter a drain and may be the result of land use, agricultural practices and spills. Examples include milk house wash water, septic system discharge, pesticides, herbicides, pharmaceuticals, road drainage, fuel and oil.

6.3 Water Quality Standards

There are water quality standards and objectives for surface water in Ontario, including drains. The Ministry of the Environment and Climate Change (MOECC) has established *Provincial Water Quality Objectives*, which protect aquatic life (ontario.ca/moecc).

The Canadian Council of Ministries of the Environment (CCME) has published *Canadian Environmental Quality Guidelines*, including *Water Quality Guidelines for the Protection of Aquatic Life, Water Quality Guidelines for the Protection of Agricultural Water Uses, Guidelines for Canadian Drinking Water Quality* and *Guidelines for Canadian Recreational Water Quality*. These guidelines are found on the CCME's website (http://ceqg-rcqe.ccme.ca).

6.4 Impact of Drainage Works on Water Quality Issues

Drainage works act as a conduit for nutrients, suspended solids and other contaminants into the natural environment. Drain designs can mitigate the impacts of nutrients, suspended solids and other contaminants. There a number of innovative practices that can be incorporated into the municipal drain to mitigate water quality impacts. These include constructing wetlands, two-stage ditches, buffer strips, control structures, saturated riparian buffers, drainage water management, woodchip bioreactors, etc. (Part B, Chapters 7–11). Some contamination issues are best controlled at the source though changes to land management practices that are outside the scope of the *Drainage Act, 1990*.

The drain itself may also be a source of sediment due to soil disturbance during construction and maintenance activities or natural erosion processes.

DID YOU KNOW? If any spills and/or point source contamination are noted, report the incident to the Ontario Ministry of the Environment and Climate Change through their Spills Action Centre (1-800-268-6060 or 416-325-3000).

6.5 Impact of Drainage Works on Water Quantity Issues

The purpose of drains is to assist in the movement of water. However there are situations when it is advantageous to attenuate water in strategic locations for the following purposes:

- limiting flooding
- improving base flows of watercourses
- reducing nutrient and sediment runoff
- providing a potential source of water for area property owners (recreation, irrigation)
- increasing the resilience of the watershed to manage the volume of precipitation generated in short-duration, high-intensity storms
- increasing biodiversity and connectivity between natural areas
- improving landscape aesthetics

When designing a drain, the engineer must balance the need for drainage with the benefit of retaining water on the landscape (Figure B6–5), while considering the costs and challenges. Some common water retention techniques are discussed in Part B, Chapters 8, 10 and 11.

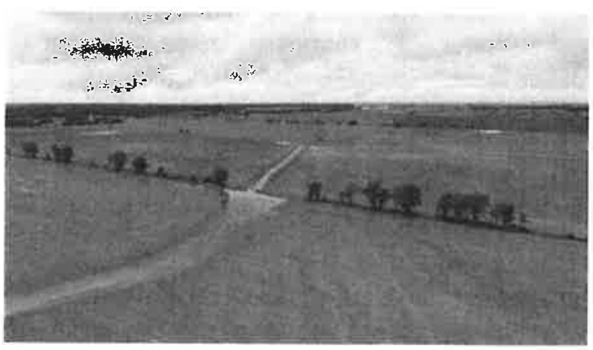


Figure B6–5. An example of water retention in a drain.

Source: Maitland Valley Conservation Authority, Wroxeter, Ontario.

Shallow wells or ponds may be temporarily impacted during dewatering activities for construction or improvement of the drain (Part C, Chapter 3.2). In rare situations, the local groundwater elevation may be more permanently altered following drain construction or improvement projects.

6.6 Engineer's Water Quality and Quantity Checklist

For drain construction or improvement projects:

- Determine any regulatory requirements for water quality and quantity.
- Obtain any studies or reports on the receiving water body that may relate to water quality and have an impact on drain design.
- Identify any source protection areas in the vicinity of the proposed drainage works. Incorporate appropriate design measures consistent with the source protection plan.
- Identify which properties are included as part of a nutrient management plan and/or strategy that may be affected by the drainage works.
- Consider the advantages and disadvantages of incorporating water retention into the drain design.
- If there are concerns regarding the potential impact of the drain on nearby water wells or ponds, inspect the wells and ponds and measure water levels prior to, during and after construction of the drain. If well water quality is a concern, consider taking well samples for water quality analysis.
- Provide for design and construction techniques to minimize erosion and sediment transport. Refer to Part B, Chapters 7, 10 and 11.
- Be prepared to advise involved parties of practices that could be used to improve the water quality during construction or improvement of the drain.
- Geo-reference all as-constructed drainage works features, including surface water entry locations.

CHAPTER 7

EROSION AND SEDIMENT CONTROL

7.1 Introduction

Erosion is a natural process where soil particles are separated, removed and transported by water or wind. Sedimentation is the process where those soil particles are deposited elsewhere (e.g., watercourses or on adjacent lands) as the velocity of the water or wind slows down. The best way to limit sedimentation is to avoid activities that cause erosion. Activities that disturb land (e.g., drain construction) or remove vegetation (e.g., clearing and grubbing) can increase erosion by destabilizing soil and increasing the soil exposure to water or wind. Minimizing erosion will extend the life of the drain, reduce maintenance costs, reduce sedimentation and keep topsoil on the field, where it should be.

Erosion control measures can be temporary or permanent. There are a number of methods of controlling erosion and sedimentation, although they are all guided by one or more of the following principles:

- Stabilize soil through natural or synthetic material.
- Eliminate concentrated water flow through potentially erosive areas.
- Reduce the velocity of surface runoff to limit the erosive potential of water.
- Trap sediment on-site to prevent degradation of water quality and habitat.

Design an erosion and sediment control plan and strategy that also take extreme weather events into account. The following temporary measures are designed to be implemented during construction:

- Maintain as much of the native vegetation in and around the channel as possible.
- Move excavated material away from the channel to avoid re-entry.
- Use seeding, riprap and sediment traps, silt fences, temporary pooling areas, turbidity curtains, erosion control blankets, dust control, etc. (Figures B7–1 and B7–2).

Figure B7–1. Riprap placed at the bend of a drain.

Source: Ausable Bayfield Conservation Authority, Ontario.

Once construction is complete, the restoration of the site should include permanent erosion control measures such as seeding to ensure soil stabilization and to limit erosion. The engineer should be knowledgeable in the design and implementation of erosion and sediment control techniques. Legislation related to erosion and sediment control is covered in Part C.

Figure B7–2. An off-line sediment trap.

Source: Ausable Bayfield Conservation Authority, Ontario.

7.2 Erosion Susceptible Sites

Conditions in a drainage channel can result in turbulent water flow with high velocities. Some areas of the channel are more susceptible to erosion and may require permanent erosion protection. Examples include:

- steep sections
- drainage outfalls
- sections immediately upstream or downstream of culverts
- locations where surface water enters a ditch
- sharp bends
- backfilled areas
- locations with abrupt changes of grade

Drain construction activities increase the potential for erosion and sediment transport. The removal of vegetation during construction exposes the soil to rainfall and runoff until the vegetation is re-established. As a result, temporary erosion protection and sediment control measures are often required at culverts and bridgework sites, construction yards and staging areas to minimize erosion.

Drain construction activities may require temporary storage of excavated materials on-site. These spoil piles are highly susceptible to erosion. Wherever possible, avoid the use of spoil piles by spreading or removing the excavated materials. If a spoil pile is necessary, locate it as far away from the drain as possible and install silt fences.

7.3 Erosion and Sediment Control Measures

The best management practices introduced in this section are intended to give the engineer an idea of available sediment and erosion control practices. For additional information consult:

- suppliers about new and innovative products
- *Agricultural Erosion Control Structures: A Design and Construction Manual,* Publication 832, Ontario Ministry of Agriculture, Food and Rural Affairs (ontario.ca/omafra)
- *Environmental Guide for Erosion and Sediment Control during Construction of Highway Projects, Appendix E,* Ontario Ministry of Transportation (ontario.ca/mto)
- *Ontario Provincial Standard Drawing,* Ontario Ministry of Transportation

7.3.1 Establishing Vegetation

Establishing vegetation on exposed soil reduces the potential for erosion. Sow with a suitable seed mixture, based on soil type and climate, to ensure good vegetative growth. Ontario Provincial Standard Specification 804 (OPSS) provides seeding specifications and selection criteria. Local experience may have identified seed mixtures that are more appropriate than the OPSS recommendations. The engineer should be aware of previous successful seeding practices in the area of the drainage works.

Seed during the growing season (approximately late April to mid-October) depending upon the local climate). The mid-summer months may be too hot and dry to allow for good seed germination and vegetation growth. Weather conditions may require changes to seeding times.

If the construction is completed too close to the end of the growing season, place straw/hay mulch or other suitable material on the exposed soil to prevent erosion until seeding can be done in the spring (Figure B7–3).

Figure B7–3. Straw/hay mulch spread on exposed soil surrounding a sediment trap.

Source: Ausable Bayfield Conservation Authority, Ontario.

If high channel velocities are anticipated before vegetation can become established, install temporary erosion control blankets over the seed to protect the seed and ditch banks.

7.3.2 Rolled Erosion Control Products

Rolled erosion control products are prefabricated blankets made of natural or synthetic materials (Figure B7–4). Erosion control blankets are made of natural materials that biodegrade over time, while turf reinforcement mats are made of synthetic materials for permanent erosion control measures. These blankets or mats are installed on steep slopes, channels or shorelines to protect seeding, stabilize soil and prevent erosion until the seeded vegetation is established.

Figure B7–4. Rolled erosion control product installed on the banks of a drain.

7.3.3 Riprap Armouring

Large angular stones (underlined with geotextile) are placed on slopes or in channels to protect the underlying soil from the erosive velocities of water. In riprap applications, a gradation of stone sizes is important to ensure stability to resist the force of the water (Figure B7–5).

Figure B7–5. Riprap armouring of a drain.

Source: Tulloch Engineering, Espanola, Ontario.

7.3.4 Mulching

Organic mulch, compost or other biodegradable material is spread over bare soil that has been seeded. This protects the soil while conserving soil moisture to promote seed growth.

7.3.5 Drop Inlets

Drop inlets are pipes that are designed to convey water from the top of a slope to the bottom (Figure B7–6). The intent is to prevent concentrated water from running down the slope and eroding the soil.

7.3.6 Level Spreaders

Level spreaders are used to convert concentrated runoff into sheet flow. This reduces the velocity and the potential for erosion. A shallow stilling basin is constructed with an overflow weir to allow water to be released as sheet flow.

7.3.7 Silt or Sediment Trap

A silt or sediment trap creates an area within a channel where water is ponded to reduce its velocity and allow sediment to settle out. The trap is formed either through excavation or construction of embankments.

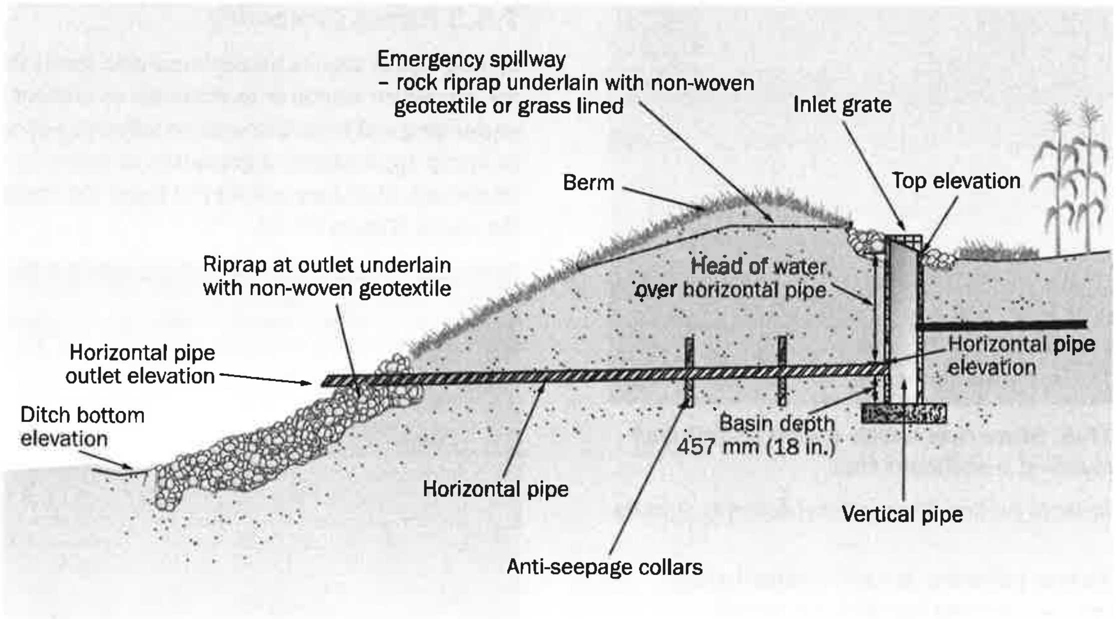


Figure B7–6. Drop Inlet.

7.3.8 Check Dams

A check dam creates an area within a channel where water is ponded to reduce its velocity and allow sediment to settle out (Figure B7–7). Check dams are constructed across drainage channels and can consist of rocks, sand bags, straw bales or logs.

Figure B7–7. A rock check dam installed in a drain.

Source: Tulloch Engineering, Espanola, Ontario.

7.3.9 Silt Fence

A silt fence holds the runoff from a construction area long enough for the sediment to settle out and be retained on-site. It is made of a porous geotextile material that is anchored to the ground and supported by posts.

7.3.10 Turbidity Curtain

A turbidity curtain is a non-porous geotextile material used in slow-moving water to contain suspended sediment during construction activities. The turbidity curtain is anchored or weighted to the bottom of the water body and supported by posts or suspended by floats. This sediment control measure works well in situations with slow currents (e.g., the outlet of a lake or wetland) and fine sediment that has a long settling time.

7.3.11 Temporary Pooling Area

Working in conjunction with silt fences, a temporary pooling area can minimize the movement of sediment into a drainage works. Surface water runoff containing sediment is collected and stored, allowing the sediment to settle out over time. They are constructed off-line with overflow provisions to a channel outlet. The clean water is diverted or pumped from the temporary pooling area. The size of a temporary pooling area is defined by the space available and topography. Construct them downstream of stockpiles, large areas of exposed soil or other areas prone to erosion.

7.3.12 Native Vegetated Sod Mats

Native vegetated sod mats are strips of vegetation, including the underlying root and topsoil structure, that are taken (with property owner permission) from the vicinity of the drainage project. Consider the use of native vegetated sod mats when:

- channel banks are completely exposed
- channel bank protection cannot be achieved with seeding
- sod mats are available close by from an area not susceptible to erosion

Strip sod mats from an adjacent area and place them on the roughly graded bank. Carefully tamp the sod mats and water them as soon as possible. Reseed the land where the mats have been removed.

7.3.13 Riparian Buffers

Riparian buffers are vegetated strips of land along drainage ditches or natural watercourses. Riparian buffers establish a permanently vegetated area between cultivated fields and watercourses (Part B, Chapter 9).

7.4 Engineer's Erosion and Sediment Control Checklist

Based on site reviews, soil information, hydrologic and hydraulic analyses:

- determine the components of the drainage works and work area that are susceptible to erosion and require sediment control measures
- select and design appropriate erosion and sediment control measures considering material availability, previous experience, agency requirements and costs
- ensure sediment and erosion control measures comply with agency regulations

DID YOU KNOW? Sediment retention measures (incorporated into the design of a drain) require frequent observation and maintenance to ensure that they are working as intended. If not, the measure that was a sediment-phosphorus-nitrogen sink will become a source and feed back into the system.

7.5 Resources

Ontario Ministry of Agriculture, Food and Rural Affairs (ontario.ca)

- *Best Management Practices 26: Controlling Soil Erosion on the Farm*
- *Best Management Practices 15: Buffer Strips*
- *Agricultural Erosion Control Structures: A Design and Construction Manual, Publication 832*

National Engineering Handbook, Section 3 — Sedimentation. United States Department of Agriculture, Soil Conservation Service, 1983. (www.nrcs.usda.gov)

Environmental Guide for Erosion and Sediment Control during Construction of Highway Projects. Ontario Ministry of Transportation, 2007. (ontario.ca/mto)

Erosion and Sediment Control During Construction. Greater Golden Horseshoe Area Conservation Authorities, 2006. (www.creditvalleyca.ca)

Erosion and Sediment Control Inspection Guide. Toronto and Region Conservation Authority, 2008. (www.creditvalleyca.ca)

Erosion and Sediment Control Guideline for Urban Construction. Toronto and Region Conservation Authority, 2006. (www.creditvalleyca.ca)

CHAPTER 8

WETLANDS AND WATER RETENTION

8.1 Introduction

Wetlands are saturated areas that have hydric (waterlogged) soils and water-loving or water-tolerant plants (Figure B8–1). Wetlands occur where the water table is at or close to the surface, in low-lying areas or along the edges of lakes and rivers. While some wetlands are permanently flooded, others only flood periodically. The period of time that water is present in a wetland is referred to as the hydroperiod.

Figure B8–1. A wetland adjacent to a farm field.

Source: Dietrich Engineering Limited, Waterloo, Ontario.

Wetlands have an important hydrological role within the watershed. They attenuate high flows while decreasing velocity, store water and increase infiltration and groundwater recharge. Wetlands also improve water quality by allowing vegetation to remove excess nutrients (e.g., phosphorus, nitrogen) and by reducing suspended solids due to the reduction in flow velocity.

8.2 The Role of the *Drainage Act, 1990*

Historically, the *Drainage Act* was frequently used to drain marginal farmland, swampy areas and wetlands to increase the productivity of agricultural land. Today, it is being used to balance the need for drainage in agricultural and rural areas while maintaining existing wetlands and restoring degraded wetlands.

Water management structures such as dams, dykes or weirs can be incorporated into drainage projects to raise the water level in areas that have historically been wetlands. These water control structures extend the hydroperiod of affected wetland areas, allowing them to naturalize.

Water management structures may also provide flood attenuation and improvements to water quality by impounding water. The site of the impounded water must be strategically located based on topography and land use and in consultation with property owners.

DID YOU KNOW? The broad definition of "drainage works" under the *Drainage Act, 1990* provides the engineer with the unique opportunity to design solutions to drainage problems that incorporate water retention, wetland protection/enhancement and soil management techniques. These opportunities are best explored at the project scoping meetings.

8.3 Wetland Legislation

The engineer should be knowledgeable about and consider the legislation related to wetlands. Contact the municipality, conservation authority and MNRF to identify the wetland limits. Wetlands are regulated through the *Conservation Authorities Act, 1990* (Part C, Chapter 5) and the *Provincial Policy Statement* (Part C, Chapters 2.7 and 7.3). Use the project scoping meeting to discuss balancing the drainage objectives with protection of the wetland (Part A, Chapter 3).

8.3.1 Identifying and Scoping Existing Wetlands

As part of collecting the background collection and prior to starting detailed design work, it is important to identify and delineate potential wetland areas within the watershed. Sources of information include:

- topographic maps and orthophotography
- the municipality's official plan, to determine wetland protection mapping
- conservation authority mapping
- MNRF mapping
- field verification of the wetland information

8.3.2 Drainage Designs Involving Wetlands

Regulatory agencies will likely have comments or concerns about the establishment of drainage works in or around wetlands. There are many design approaches that will achieve the agencies' requirements in terms of wetland hydrology and ecology. Discuss the scope of the project with the conservation authority and negotiate a way to achieve the desired drainage while avoiding or minimizing impacts on the wetland.

The engineer has the opportunity for collaboration with other agencies (e.g., Ducks Unlimited) in the design of drainage works near wetlands. Collaboration may take the form of funding or technical advice to balance the needs of the property owners with the protection or enhancement of the wetlands.

Design the drain to minimize the permanent and temporary impacts on wetlands. Look for opportunities to avoid or minimize impacts, restore wetlands or retain water on the landscape.

Avoid — Where possible, design the drain to avoid impacting the wetland. This may include selecting drain routes that avoid the wetland area, routing a pipe drain around a wetland or terminating a drain with an outlet into the wetland.

Minimize impacts — The engineer may minimize impacts to the wetland by applying specific design measures. This may include the incorporation of an existing channel through a wetland without performing any channelization work but providing the ability to remove barriers to flow (e.g., beaver dams, debris).

Wetland restoration — This refers to re-establishing or enhancing historical wetlands and involves the use of structures to regulate the level and flow of water (Figure B8–2). Obtain and review similar project designs, consult design references and retain qualified professionals (e.g., biologist, wetland ecologist). Features such as dykes, berms, diversions or depressions can be used to restore the wetland hydrology. Water control structures that incorporate stop-logs, weirs and valves allow the water level in the wetland to be controlled throughout the year (Figure B8–3).

Design the water control structure to ensure that the upstream water level does not impact subsurface drains and other land uses.

Figure B8–2. A wetland drain restoration project.

Figure B8–3. A water control structure.

Source: Dietrich Engineering Limited, Waterloo, Ontario.

Figure B8–4. A water retention area.

Source: Maitland Valley Conservation Authority, Ontario.

DID YOU KNOW? The Wetland Drain Restoration Project is a joint effort between MNRF and municipalities. The goal of the project is to use the *Drainage Act, 1990* to balance the benefits of drainage with the beneficial functions of wetlands by restoring wetlands without negatively affecting agriculture. There must be property owner support for the project, and the municipality must continue to manage the existing drainage works. Water management structures such as dams, dykes or weirs may be incorporated to raise the water level in areas that have historically been wetlands. The water control structures extend the hydroperiod of affected wetland areas and encourage naturalization. There is a maintenance and ongoing monitoring requirement for these projects (www.conservationontario.ca search for "Wetland Drain Restoration Project").

Water retention — This is the creation of small shallow depressions that may hold water for several hours to a day after a runoff event, as well as larger, deeper depressions that may hold water for several weeks or months (Figure B8–4). Topographical variation within the watercourse will ensure a range of hydroperiods, from permanent retention to short-term ponding.

DID YOU KNOW? The grants provided under the *Drainage Act, 1990* are guided or limited by the Agricultural Drainage Infrastructure Program (ADIP). One ADIP policy states that, with some exceptions, grants are not paid on the construction or improvement of drainage works that drain through or from a provincially significant wetland unless the engineer's report demonstrates that there are no negative impacts on the wetland's natural features or their ecological functions.

8.4 Resources

Drainage Engineers Conference (Ontario) (www.landdrainageengineers.com).

- *F. R. Gregory Wetland Restoration Project, Norfolk County.* Nancekivell, Greg, 2012.
- *Innovation in Wetland & Riparian Buffer Restoration through the Drainage Act in Southern Ontario.* Emons, Sarah, 2012.
- *Westside Natural Channel/Wetlands Restoration Project.* Taylor, R. Shawn, 2004.
- *Wetland Drain Restoration Project: Water Quality and Quantity Restoration.* Berman, Leora, 2002.
- *Wetland Restoration: A Key Component to Achieving Sustainable Water Management.* Christl, Leo, 1997.

Wetland Drain Restoration Project

- *Wetland Drain Restoration Project: Enhancing Water Storage and Water Quality within a Watershed through Wetland Restoration* (www.conservationontario.ca)
- *Headwater Wetland Restoration Techniques — The Wetland Drain Restoration Project* (www.trca.on.ca/dotAsset/184005.pdf)

Ontario Wetland Evaluation System. Ministry of Natural Resources and Forestry, 2013. (ontario.ca/mnrf)

Engineering Field Handbook — Part 650, Chapter 13 Wetland Restoration, Enhancement, or Creation. United States Department of Agriculture, Natural Resource Conservation Service. (www.usda.gov)

CHAPTER 9

RIPARIAN BUFFERS

9.1 Introduction

Riparian buffers are vegetated strips of land along drainage ditches or natural watercourses and are sometimes referred to as buffers or buffer strips. Riparian buffers establish a permanently vegetated area between cultivated fields and watercourses.

9.2 Benefits of Riparian Buffers

Riparian buffers provide benefits to the environment, agriculture and drainage works by retaining soil on the land, stabilizing channel banks, reducing nutrient transport, providing ecological improvements and reducing drain maintenance. In some cases, the strategic location and design of riparian buffers is more effective than a one-size-fits-all approach.

Soil retention — Riparian buffers remove sediment by slowing down surface water and filtering sediment particles. Larger sediment particles are more easily removed by the buffer, although some finer particles can be removed as well.

Bank stabilization — Riparian buffers can also stabilize stream banks and minimize bank erosion. Plant roots help hold soil in place and reduce the sediment loading to the watercourse.

Nutrient transport — Riparian buffers remove nutrients through sedimentation and, during the growing season, through plant uptake.

Ecological improvements — Riparian buffers can provide wildlife habitat or corridors if they are of sufficient width. Narrow riparian buffers may allow for the movement of small animals, but most species require larger corridors. Riparian buffers with vegetation of sufficient height can provide shade to reduce water temperatures and improve fish habitat.

Reduced drain maintenance — Riparian buffers minimize the movement of sediment into the drain, which may reduce maintenance costs and extend the life of the drain.

DID YOU KNOW? Some American jurisdictions (e.g., Minnesota and Ohio) mandate the establishment of riparian buffers along channels.

9.3 Riparian Buffer Design

Establishing permanent riparian buffers will take land out of production. Consider the wishes of the property owner when making design decisions. It may be more realistic to focus the use of riparian buffers in strategic locations (incorporating varying widths and vegetation types). The effectiveness of the buffer is determined by the slope of the land, buffer width, vegetation and location.

Design and implement riparian buffers to meet the objectives of the drain, regulatory agencies and property owners. Consider a cost-benefit analysis to determine the most appropriate design of a riparian buffer as a component of the drainage works.

It is ideal to have riparian buffers along the full length of the municipal drain to set back agricultural activities from the drain (Figure B9–1). However, it is most important to have riparian buffers in sensitive habitats and areas prone to erosion.

Figure B9–1. An example of where agriculture is not set back from the drain (no buffer).

9.3.1 Transverse Slopes

The transverse slope of the riparian buffer affects the ability of vegetation to slow down sheet flow and filter out sediment and nutrients. The greater the slope, the less sediment is filtered out. In general, a slope of 5% or less is ideal. Riparian buffers on land with a greater slope will need to be wider to achieve the same objectives.

9.3.2 Buffer Width

The width of riparian buffers is dependent on available land and the purpose of the riparian buffers (Figure B9–2). A 3 m riparian buffer is recommended along all channels for erosion protection and bank stabilization. The following are factors that influence the width(s) of a buffer selected for a specific project:

- Increasing the buffer width results in taking more land out of production.
- High cropland values can lead the property owner to desire a narrower riparian buffer in order to have more workable land.
- If the riparian buffer is to be harvested for forage, the width should be sufficient to accommodate harvesting equipment.
- Wider buffers offer greater benefits in terms of sediment and nutrient removal.
- The slope of the riparian buffer and the adjacent land is a key consideration when determining the appropriate width. For areas where wildlife habitat is important, consider using wider riparian buffers.

Also consider:

- adjacent land use (e.g., agriculture, forested)
- the purpose of the buffer (i.e., nutrient and/or sediment removal, provide shade to cool the water in the drain or to set back agricultural activities)

In agricultural areas, delineate the width of the buffer with stakes (at time of construction) for future reference by the drainage superintendent and property owner.

Figure B9–2. An example of a wide buffer.

Source: Ausable Bayfield Conservation Authority, Ontario.

9.3.3 Vegetation

Consider the local growing conditions when selecting plants for riparian buffers. Buffer strip vegetation includes native species of grasses, wildflowers, shrubs and trees (Figure B9–3). Avoid the use of invasive species and noxious weeds. The property owner may want vegetation planted for the purpose of harvesting (e.g., forage grasses, switchgrass).

Figure B9–3. A grassed buffer with tree growth.

Source: Ausable Bayfield Conservation Authority, Ontario.

Grasses with strong root systems and upright stems are effective at trapping and filtering sediment and nutrients in runoff. A description of several cool-season and warm-season grasses suitable for use in riparian buffers is included in OMAFRA's *Best Management Practices: Buffer Strips,* BMP 15 (Figure B9–4), ontario.ca/omafra.

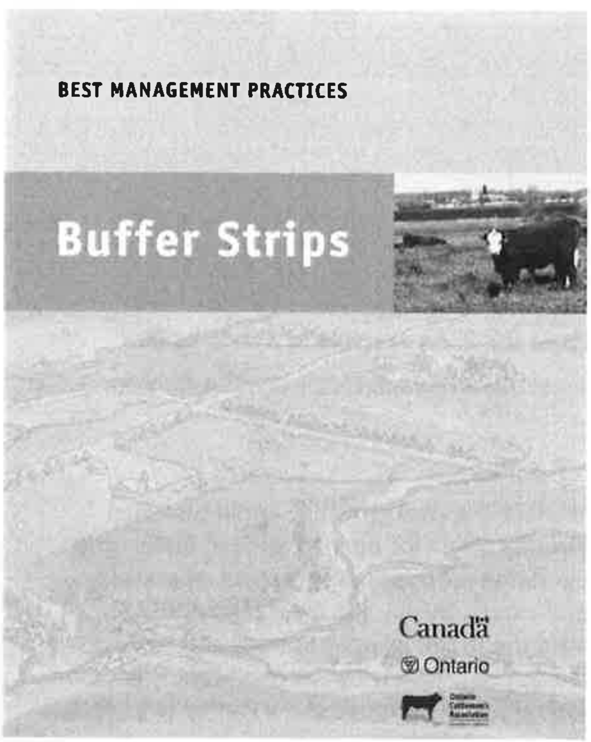


Figure B9–4. *Best Management Practices: Buffer Strips,* BMP 15, OMAFRA.

Trees and shrubs are generally used in wider riparian buffers for bank stabilization and enhancing fish and wildlife habitat by providing shade and shelter. Consider the following before planting trees and shrubs:

- Locate trees and shrubs so they don't restrict drain maintenance and repair activities (e.g., plant on one side of the drain).
- Avoid selecting trees and shrubs, such as poplar, that appeal to beavers.
- Choose trees and shrubs that will not plug subsurface drains (Figure B9–5). See OMAFRA Factsheet *Farm Tile Drains and Tree Roots,* ontario.ca/omafra.

Figure B9–5. A tile plugged with tree roots.

9.4 Riparian Buffer Maintenance

Riparian buffers require maintenance such as:

- mowing
- removing accumulated sediments
- replacing damaged or dead vegetation
- repairing concentrated flow channels
- creating berms or diversions in areas of concentrated flow
- controlling weeds throughout the buffer and specifically around any trees

9.5 Resources

Ontario Ministry of Agriculture, Food and Rural Affairs (ontario.ca/omafra)

- *Best Management Practices: Buffer Strips,* BMP 15

Drainage Engineers Conference (Ontario) (www.landdrainageengineers.com)

- *Considerations in Agricultural Buffer Strip Design along Municipal Drains.* Marshall, Andrew and Bos, Art. HSP Inc. Engineers and Environmental Scientists, 1992.
- *Innovation in Wetland & Riparian Buffer Restoration through the Drainage Act in Southern Ontario.* Emons, Sarah. Ministry of Natural Resources, 2012.

A Review of the Efficiency of Riparian Buffers for the Maintenance and Enhancement of Riparian Ecosystems. Hickey, M. Brian C. and Doran, Bruce. *Water Quality Research Journal of Canada* Vol. 39, No. 3, 311–317, 2004.

Conservation Buffers — Design Guidelines for Buffers, Corridors, and Greenways. Bentrup, Gary. National Agroforestry Centre, U.S. Department of Agriculture, 2008. (http://nac.unl.edu/buffers/index.html)

CHAPTER 10

OTHER DESIGN CONSIDERATIONS

10.1 Crossings

Public road and private crossings are important design components of municipal drainage works. The *Drainage Act, 1990* requires the engineer to provide for:

- the construction, improvement and reconstruction of drain crossings where the drainage works crosses any public road (Section 17)
- the construction improvement and reconstruction of drain crossing serving other properties unless an allowance is provided (Section 18) (Part A, Chapter 8.7)

The hydrology and hydraulic design considerations for crossings are found in Part B, Chapters 2 and 3. Other design considerations include:

- structural design
- erosion and scour protection
- fish passage
- surfacing
- overflow
- selection of materials
- trenchless crossings
- at-grade crossings
- low-flow crossings
- future maintenance

The *MTO Drainage Management Manual* is a valuable resource for hydrology, hydraulics and structural design of crossings, ontario.ca/mto.

10.1.1 Structural Design

Pipe material — For culverts, the engineer should consider if the water and soil conditions could affect the selection of pipe material. A thicker wall or a surface protection on the pipe material may be required to ensure a reasonable lifespan.

Height of fill — Culverts must be structurally capable of withstanding the expected dead and live traffic loading. "Height of fill" tables provide minimum and maximum fill heights for concrete, steel, HDPE and PVC pipe materials. These tables are found in the Ontario Provincial Standards for Roads & Public Works or from specifications provided by pipe manufacturers and suppliers.

Bedding and backfill — Specify bedding and backfill material needed to provide sufficient structural support to the culvert. The Ontario Ministry of Transportation's *MTO Gravity Pipe Design Guidelines* (May 2007) is a valuable resource for the structural design, bedding and backfill of concrete, steel, HDPE and PVC pipe. Manufacturers and suppliers may provide specific installation requirements for bedding and backfilling of their products.

Design requirements — The *Ontario Structure Inspection Manual* and the *Canadian Highway Bridge Design Code* set out the following design requirements for bridges and culverts:

- A structural culvert is any structure that forms an opening through soil. These include pipes, multi-plate arches, steel boxes and precast or cast-in-place concrete boxes. There must be at least 600 mm of soil above the structural culvert.

- A bridge is any structure that has a span greater or equal to 3 m and does not classify as a structural culvert. These include cast-in-place and precast concrete rigid frames, slab-on-girder bridges, concrete slab and voided slab bridges and trusses.
- Multi-cell crossings with earth cover are not considered bridges if
  - individual cell spans are less than 3 m; and
  - the distance between the cells is greater than the smallest cell span.
- All cast-in-place structures and bridges must:
  - be designed by an engineer with training and experience in bridge design
  - conform to the *Canadian Highway Bridge Design Code* if the span exceeds 3 m
- For crossing projects on a MTO corridor, MTO requires:
  - any firm involved with bridge engineering to be registered in the Registry, Appraisal and Qualification System (RAQS)
  - engineering drawings, regardless of the span, to be signed and sealed by both a qualified design engineer and a checking engineer

10.1.2 Erosion and Scour Protection

Many crossings cause higher flow velocities, which may result in increased erosion and scour. The engineer should reduce the potential for erosion and scour by:

- designing the crossing with hydraulic capacity sufficient to minimize the increased head at the crossing entrance
- selecting the appropriate cross-section for the crossing
- positioning and aligning culverts with the flow
- protecting inlets, abutments and other erosion-prone areas

10.1.3 Fish Passage

Changes in velocities, depth, discharge rates and ponded areas caused by culvert crossings can be a barrier to fish passage. Consult with Fisheries and Oceans Canada (Part C, Chapter 9.1) or retain the services of a fisheries biologist regarding requirements for fish passage.

Culvert designs for fish passage should consider all fish species present in the drain when determining flow velocities, depth and discharge rates.

- Ensure the appropriate amount of ponding on the upstream side of a crossing operating under inlet control. This avoids hiding the crossing from migratory fish.
- Mimic the existing stream characteristics by installing
  - an open-bottom culvert (Figure B10–1); or
  - an embedded culvert with non-uniform substrate material that is similar to the existing stream bed substrate (Figure B10–2).
- Install baffles to provide resting areas if velocities are too high.
- Increase the slope of the crossing if velocities are too low.
- Maintain a minimum flow depth to avoid injuring fish or inhibiting migration.

Figure B10–1. An open-bottom crossing/pipe arch.

Source: Municipality of Chatham-Kent, Ontario.

Figure B10–2. An embedded culvert.

Source: Municipality of Chatham-Kent, Ontario.

10.1.4 Surfacing

Where the bridge or culvert is below a roadway, the engineer should consult with the road authority to determine if they will complete some or all of the work themselves (Section 69(1)). In some projects, the crossing is constructed as part of the drainage project but the road authority may wish to install the surface treatment (e.g., gravel or asphalt) on the roadway.

Where the road authority does not wish to complete the work themselves, the engineer should:

- ensure that the reconstruction of the roadway matches the existing roadway
- determine if the road authority is planning any widening or reconstruction
- determine minimum requirements for sub-base, granular base and surface construction
- determine if the construction specifications provide for the replacement of the existing surface treatment

For private crossings, the engineer should:

- consult with the property owner to determine the required location, width and use (type of equipment) of the driveway (Figure B10–3)
- consult with the road authority or local municipality to determine if there are any entrance, permitting or sizing requirements
- ensure that the surface of an existing crossing is replaced with a new equivalent surface
- provide a solid granular surface for all new crossings

Figure B10–3. Farm equipment on a private crossing.

10.1.5 Overflow

The engineer may need to accommodate flows in excess of the culvert design storm to protect the integrity of the crossing and to reduce the potential of upstream flooding.

Additional capacity for up to the 100-year storm event should be provided with:

- an overflow spillway, protected against erosion in the lane or road adjacent to the crossing (Figure B10–4)
- a relief culvert at a higher elevation through the embankments in situations with little or no overflow capabilities

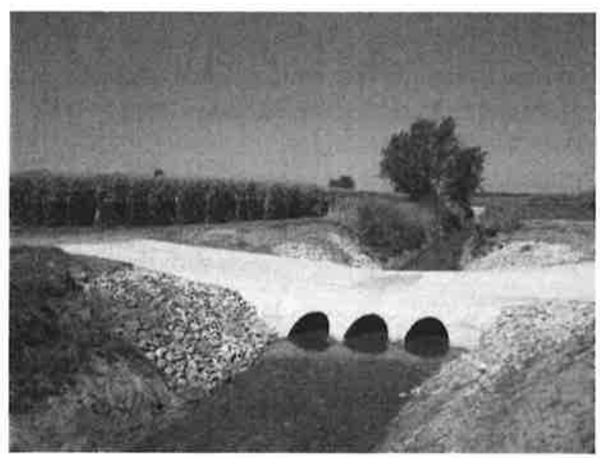


Figure B10–4. A crossing with an overflow spillway.

Source: Dietrich Engineering Limited, Waterloo, Ontario.

If the additional capacity is not possible or practical, the engineer should do the following:

- Verify that the extent of ponding caused by the crossing will be less than the existing ponding. The ponding area must not cause additional property damage.
- Ensure that the crossing is sufficiently protected against washout.
- Advise road authorities and property owners that additional capacity is not provided and could result in flooding or washouts during severe events.

10.1.6 Trenchless Crossings

Trenchless methods of installing crossings are becoming common practice under high-traffic roadways or where open-cut methods have a higher cost (Figure B10–5).

The trenchless methods that are commonly used are:

- boring and jacking
- horizontal directional drilling

Other techniques include:

- boring and jacking with hydraulic control/steering of the augers
- pipe ramming
- micro-tunnelling

Figure B10–5. A trenchless crossing.

Source: Dietrich Engineering Limited, Waterloo, Ontario.

Consult with road authorities, railways and utilities to determine their requirements for trenchless work.

Check with or retain the services of a trenchless technology specialist. Designing a trenchless crossing should include:

- ensuring sufficient geotechnical work is conducted to determine the suitability of the soil material for the trenchless crossing and for the sending and receiving pits
- determining groundwater conditions and providing for dewatering if necessary
- locating all utilities, including any older tile or pipe drains
- ensuring an area is available to construct the sending and receiving pits
- developing contingency plans for:
  - unexpected boulders or other hard material that cannot be practically removed by the trenchless equipment
  - unexpected groundwater conditions

DID YOU KNOW? The Centre for the Advancement of Trenchless Technologies provides information and training on the use of trenchless technologies (www.cattevents.ca).

10.1.7 At-Grade Crossings

An at-grade or bed-level crossing provides a means of crossing the channel without the installation of pipes or culverts (Figures B10–6 and B10–7). The crossing should not reduce the design capacity of the channel.

Figure B10–6. At-grade or bed-level crossing for machinery.

Source: K. Smart & Associates Ltd., Kitchener, Ontario.

Figure B10–7. At-grade or bed-level crossing for livestock.

Source: Grand River Conservation Authority, Ontario.

The engineer should consider the following when designing an at-grade crossing:

- the proposed location and use of the crossing
- the normal flow depths in the channel and the ability to use the crossing when required
- the need for a recessed hard bottom (e.g., concrete, stone) in the channel
- the need to ensure approaches to the crossing:
  - do not exceed a 10% gradient
  - are protected (e.g., riprap, seed, sod)
- the width of the crossing
- the impact of the crossing on fish and their habitat
- future maintenance

Note: These also apply to low-flow crossings.

10.1.8 Low-Flow Crossings

A low-flow crossing is designed to accommodate base flows through one or more culverts but allow water to flow overtop during larger storm events (Figure B10–8).

Figure B10–8. A low-flow crossing.

Source: K. Smart & Associates Ltd., Kitchener, Ontario.

Base flows may be estimated by:

- using a 12–25 mm/day coefficient with the drainage coefficient method (refer to the *Drainage Guide for Ontario*, Publication 29, OMAFRA)
- conducting field observations of the low channel flows
- using site observations from the drainage superintendent and property owners

All the considerations listed for an at-grade crossing apply to a low-flow crossing. The engineer should also consider the impact of the low-flow crossing on the hydraulic grade line.

To minimize the impacts of water during high-flow conditions:

- ensure the elevation of the crossing is as low as possible

- ensure the surface consists of materials that will resist erosion (e.g., poured concrete or equivalent)
- consider bevel cutting the ends of any pipe in the low-flow crossing and continuing the hard surface over the pipes and down along the bevelled slopes to facilitate the movement of debris over the crossing
- consider continuing the hard surface from the slopes into the channel bottom as cut-off walls to guard against undercutting

10.2 Grassed Waterways

Grassed waterways are permanently vegetated channels that are broad, shallow and usually parabolic shaped (Figures B10–9 and B10–10). Their purpose is to convey surface water from larger storm events with minimal erosion. The permanent vegetative cover slows the water velocity and protects the channel surface from erosion. Grassed waterways are most effective in areas of high gradients and erodible soils.

Figure B10–9. Aerial view of grassed waterways.

Source: Ausable Bayfield Conservation Authority, Ontario.

Figure B10–10. Field view of a grassed waterway.

As components of a drainage works, grassed waterways are usually used in combination with a piped system. In consultation with the municipality, the engineer must specify in the engineer's report whether or not the waterway is to be included as part of the municipal drainage works.

- If the waterway is to be included, the municipality assumes responsibility and property owners are restricted from interfering with the waterway.
- If the waterway is not to be part of the municipal drainage works, the waterway is a private drain. As such, each property owner is responsible for its management and the municipality would have no control over its management.

10.2.1 Design of Grassed Waterways

OMAFRA's Publication 852, *Agricultural Erosion Control Structures — A Design and Construction Manual* (revised 2017), provides detailed information on the design of grassed waterways. Other options for sizing the grassed waterway are to use:

- Manning's Equation with the appropriate roughness coefficient for the selected vegetation
- open channel curves and data for flows to be carried by various waterway sections, gradients and vegetation

Some key considerations in the design of grassed waterways include the following:

- The selected vegetation should have a good root structure, not block tile drains and be capable of being maintained by farm equipment.
- The waterway should be formed in the native soil, topped with a thin layer of topsoil and seeded with the selected vegetation.

10.3 Rural Piped Drains

Rural piped drains provide an outlet for private subsurface drainage systems and can potentially address surface drainage problems. There are advantages to using piped drains in place of ditches:

- minimized regulatory setback requirements
- reduced loss of land
- efficiency and safety of the farming operation

The disadvantages of piped drains are:

- higher construction costs
- potential erosion from overland flow occurring during larger storm events
- elimination of fish and wildlife habitat

10.3.1 Rural Piped Drain System Design

The *Drainage Guide for Ontario* (Publication 29, OMAFRA) is the primary reference for piped drain design in rural Ontario. The hydraulic design of rural piped drains is also covered in Part B, Chapter 3.2.4.

Location

The location or route of rural piped drains is determined by land topography, land use, soil type, presence of bedrock, proposed drain connections and outfall location (Figure B10–11). Typically, the piped drain is not installed in the surface water flow path in order to minimize the risk of the pipe being exposed due to erosion. The route selected for the drain will be determined in consultation with the affected property owners and the drainage superintendent.

Figure B10–11. Installation of a rural pipe drain.

Source: K. Smart & Associates Ltd., Kitchener, Ontario.

Vertical Alignment

Vertical alignment is the elevation of the piped drain along its route. It is influenced by:

- available outlet depth
- capacity considerations
- the elevation of the surface inlets, drains and private subsurface drainage systems that need to connect to the pipe drain
- minimum cover requirements to provide strength to the pipe and to protect it from equipment damage

Cover

Minimum cover requirements for piped drains are provided in the *Drainage Guide for Ontario* (Publication 29, OMAFRA) and from pipe manufacturers' specifications.

Depth

Maximum depth is determined by the strength of the pipe to withstand the dead load of the soil, the live loads imposed, bedding and safety factor considerations. This information is available from manufacturers or may be calculated by the engineer.

Pipe Material

Rural pipe drains may be plastic, steel or concrete. The engineer should specify either

- the required pipe material and thickness/class; or
- the minimum required strength/design basis of the pipe material.

Other factors influencing the selection of pipe materials include:

- use of the land above the pipe
- pipe size availability
- the flow capacity of the pipe — a smooth wall pipe has greater capacity than a corrugated plastic pipe of the same diameter at the same gradient
- soil stability
- proximity of trees to the drain — if trees are nearby, non-perforated pipe may be required
- cost

Soils

Pipe drains depend on the surrounding soil for their strength and bedding. This is usually achieved by compacting the soil under the pipe haunches. Occasionally, the soil conditions do not provide the adequate support and additional measures are required. It is important to determine the capability of the soil in the proposed location of the pipe drain. This can be achieved by reviewing county soil maps, probing the soil or digging test pits.

Experienced drainage engineers, contractors or geotechnical engineers may provide valuable advice on the required construction techniques for these conditions.

Unstable soils such as gleysolic soils and saturated sands, have limited bearing capacity. Where unstable soils are encountered, use of clear crushed stone may provide satisfactory bedding for pipe. Methods that minimize disturbance to the soil, such as drainage plow installation, can also be evaluated.

In areas of shallow bedrock, the engineer should:

- determine the extent of affected area
- investigate the type and strength of bedrock
- evaluate alternate routes to avoid bedrock
- evaluate removal techniques such as using a hoe ram or blasting and provide appropriate bedding and backfill

If used as bedding and backfill, very coarse native soils (e.g., cobbles and boulders) may damage the pipe. The engineer should evaluate the soil:

- if native soils can be used, carefully bed and backfill the trench
- if native soils cannot be used, import bedding and backfill material

Soil Transport

Some soils such as fine sands and silts are susceptible to movement into the drainage pipe. These soils can be deposited in the pipe, reducing its capacity, or they may enter the receiving water body, causing water quality concerns.

To avoid soil transport:

- Concrete pipe joints must be properly aligned and wrapped with geotextile (Figures B10–12 and B10–13).
- In certain soil conditions, corrugated plastic pipe must be installed with woven or non-woven geotextile (Figure B10–14).

Figure B10–12. Concrete pipe (with geotextile) prior to installation.

Source: Municipality of Chatham-Kent, Ontario.

Figure B10–13. Installed concrete pipe (with geotextile-wrapped joints).

Source: Municipality of Chatham-Kent, Ontario.

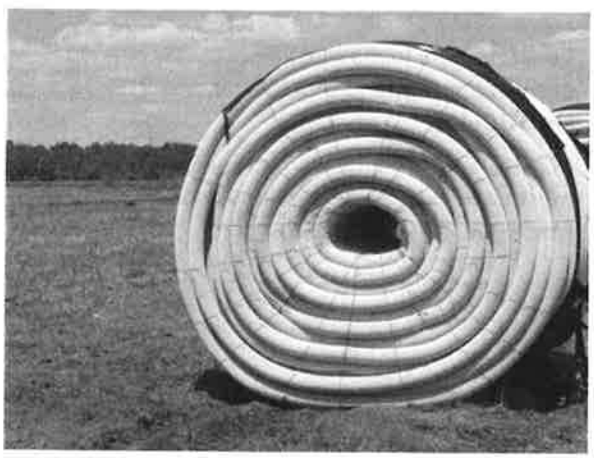


Figure B10–14. Plastic pipe with geotextile.

Rural Piped Drainage Outlets

In this section, outlet means the receiving water body and outfall means the discharge pipe from the rural piped drain (Figure B10–15). Design considerations for outfalls include:

- outlet capacity
- use of proper end pipe material, complete with rodent gates
- protection of the outfall location with erosion-resistant materials (e.g., stone riprap)
- provision of a freeboard of at least 300 mm above the normal water level
- use of an outfall marker

Figure B10–15. A drainage outlet.

Source: Ausable Bayfield Conservation Authority, Ontario.

10.3.2 Surface Water Inlets

Surface water inlets allow surface water to directly enter a subsurface drain. They should only be used on agricultural land where the surface drainage is not sufficient.

Examples include:

- in depressional areas to reduce ponding and crop damages
- with constructed berms to minimize erosion and runoff by reducing the overland surface flow

Factors that influence the number and location of inlets include: crop damage, tillage practices, proximity to potential contamination sources, erosion control, access for pipe inspection and maintenance and need for air admittance.

Surface water inlets are designed to reduce blockage by debris. However, they still require frequent inspection and maintenance. Mark the location of any constructed surface water inlets in the field and record the GPS coordinates to allow inlets to be easily located for future inspection and maintenance.

In order to design surface water inlets, the engineer needs to:

- perform a hydrologic analysis of the catchment area for the inlets
- determine the flow rate and amount of water that will be admitted into the inlets
- determine the number and locations of inlets
- determine the drain capacity:
  - For new or improved drains, size the pipe to accommodate the surface water.
  - For existing piped drains, ensure the flow from any new inlets does not exceed the remaining capacity of the pipe.
- record all surface water inlet locations on drawings

There are different types of surface water inlets, including riser inlets, catch basin inlets and blind inlets. Water and sediment control basins (WASCoBs) are systems that use inlets to regulate the flow of water and sediment to the subsurface pipe.

Riser Inlets

Riser inlets are vertical pipes with holes or slots to allow surface water but not debris to enter the pipe (Figure B10–16). A riser inlet can be offset from the pipe or installed directly online (Figures B10–17 and B10–18).

Figure B10–16. A riser inlet installed at the edge of a field of corn.

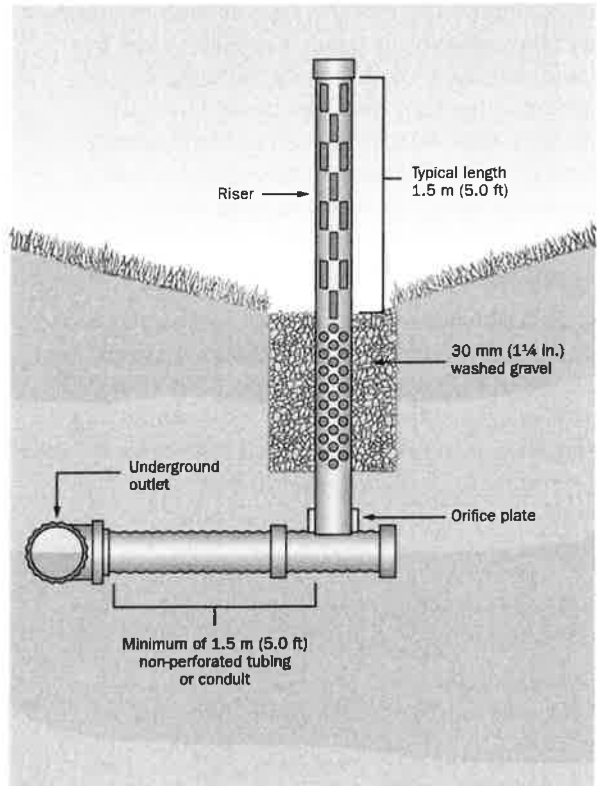


Figure B10–17. Offset riser inlet.

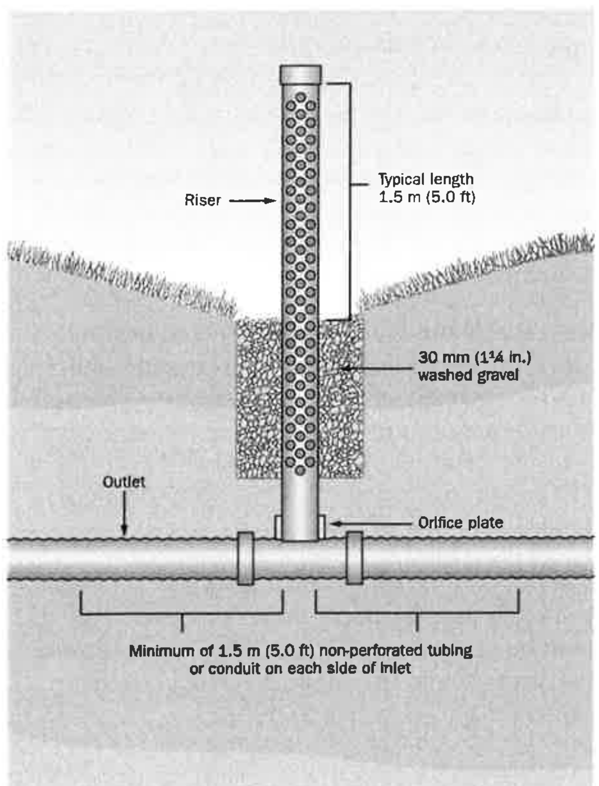


Figure B10–18. Online riser inlet.

Design information for this type of inlet, including inlet flow rate versus head, is available from the manufacturer. An orifice plate, installed at the bottom of the riser pipe, can control the rate of water entering the pipe drain. The discharge through the orifice plate in the riser inlet can be calculated using the orifice flow equation.

Catch Basin Inlets

Catch basin inlets are concrete, steel or plastic structures covered by a grate that allows the entry of surface water into a pipe. They should be installed at an elevation above the surrounding land, thereby allowing soil particles to settle out and minimizing the entry of soil into the drain. Catch basins can also serve a number of other purposes such as:

- acting as junction boxes to join multiple pipes and accommodate abrupt changes in alignment
- capturing sediment that may move through the pipe with a properly designed sump
- allowing access for pipe inspection and maintenance
- acting as relief wells and breathers to relieve pressure in the pipe
- providing inline flow control

A catch basin inlet can be installed online, where the flow of the main pipe passes through the structure. Alternatively, it can be installed offset from the main pipe with its own separate connection, called a catch basin lead. The catch basin lead is sized to control the flow of water into the main pipe.

There are various types of catch basin inlet grates (e.g., sloped grate inlet, birdcage inlet, etc.) with different characteristics for surface water entry and debris control. Ensure the grates are secured. Catch basin inlet capacity can be determined by consulting MTO design charts available in the *MTO Drainage Management Manual.* Design data for this type of inlet is available from the manufacturer.

The design should include an outlet marker and minimize soil entry by incorporating erosion control measures around the catch basin (e.g., riprap, vegetation, etc.) (Figure B10–19).

Figure B10–19. Birdcage grate with stone apron.

Source: Tulloch Engineering, Espanola, Ontario.

Blind Inlets

A blind inlet is an excavated trench over the pipe that is backfilled with granular material, covered with a geotextile and topped with topsoil or granular material (Figures B10–20 and B10–21). It provides an indirect connection for surface water to reach the pipe. Blind inlets convey water from the surface more effectively than the native soil but not as quickly as a direct surface inlet such as a riser or catch basin. They are used in locations where a riser inlet or catch basin would be an obstacle to cropping practices. It is especially important to document the location of these types of inlets because they are not visible from the surface.

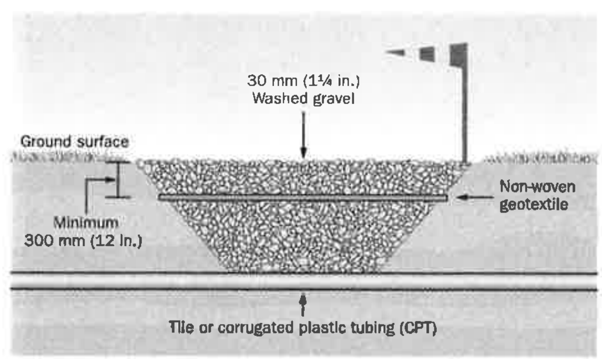


Figure B10–20. Side view of a blind inlet.

Figure B10–21. A blind inlet in a field.

WASCoBs

A water and sediment control basin (WASCoB) is a method of erosion control that involves construction of an earthen embankment or berm to intercept surface runoff (Figure B10–22). The temporarily ponded water is released slowly through a riser inlet to the piped drain.

Figure B10–22. A WASCoB.

For WASCoB design information, refer to *Agricultural Erosion Control Structures: A Design and Construction Manual,* OMAFRA Publication 832 (ontario.ca/omafra).

10.4 Existing Private Drains

Accommodating existing private drains is an important consideration in the design of municipal drainage works. Private drainage systems are installed to address drainage issues on individual properties. These can include subsurface and surface systems from all rural land uses, including roads and agricultural land, as well as residential, industrial, commercial and institutional sources.

Identify the location of any private systems by:

- conducting visual or other site inspections (e.g., ground penetrating radar, drones)
- consulting current or former property owners
- referring to any tile drainage maps available from the municipality, property owners or licensed tile drainage contractors
- using aerial photography or other technologies that may identify approximate locations and patterns of subsurface drainage

Design the municipal drain to optimize the location and minimize impacts on any private systems. Existing private drains will require connection to ensure continuation of flow. Pay particular attention to the impacts on private drainage systems when:

- widening or relocating a ditch
- levelling spoil
- reconstructing banks in the area of any private system outlet(s)
- designing a piped drain across an agricultural field that has an existing tile drainage system

Ensure the piped municipal drain has the capacity and depth to accommodate all connected private drains.

When a private drain is severed by the construction of a municipal drain, reconnect the private drain. If the private drain cannot be reconnected to itself, determine if it should be connected to the municipal drain:

- Private drains can be connected to the municipal drain if there is no visible sign of sediment or pollution.

- Private drains containing sediment can be connected indirectly to the municipal drain. An indirect connection is where granular material is placed between the drains to strain the sediment from the water.

Backfill all pipe connections with clear crushed stone for support. Record the locations of all private drains, whether connected or not, using GPS, and provide the coordinates to the municipality.

10.5 Existing Municipal Drainage Works

When the project involves the improvement of an existing pipe municipal drain, evaluate the existing drain and decide what should be done with it. Options include:

- abandon as a municipal drain (Section 19) but leave in place for private use
- abandon as a municipal drain (Section 19) and destroy
- incorporate into the final design

Clearly state in the report whether or not the existing drain is to be abandoned as a municipal drain.

If it is decided that the existing drain is to be abandoned and destroyed, the specifications should indicate that the drain should be left in place until the new drain is constructed in order to reduce subsurface water affecting the new drain installation.

10.6 Stormwater Management Ponds

A stormwater management (SWM) pond is a constructed pond or water retention area with a constricted outlet. It attenuates flows by temporarily retaining and releasing water to the downstream portion of a drainage works. It also reduces the amount of sediment transported downstream by slowing down the water and allowing sediment to deposit. See Part C, Chapter 3.2 to determine if approvals are required under the *Ontario Water Resources Act, 1990*.

There are three types of SWM ponds:

- wetlands are usually larger in surface area and have a permanent shallow water depth (e.g., less than 0.5 m deep) (Figure B10–23)
- wet ponds always hold water and have a greater water depth than wetlands (Figure B10–24)
- Dry ponds only hold water during storm events (Figure B10–25)

Hybrid wetland/wet pond systems combine the two types of ponds in series. SWM ponds can be designed to be either online or offline.

Figure B10–23. Wetlands.

Source: Ministry of Natural Resources and Forestry, Ontario, Canada.

Figure B10–24. A wet pond always contains water.

Figure B10–25. A dry pond.

The design should consider pond configuration, vegetation, maintenance requirements, cold-weather considerations and fisheries concerns. Various approvals may be required (Part C).

For specific guidelines and recommendations, refer to the Ministry of the Environment and Climate Change's *Stormwater Management Planning and Design Manual,* March 2003 (ontario.ca/moecc).

10.7 Pumped Systems

A pumped system may be necessary if a municipal drainage works cannot be constructed to function by gravity alone. Pumped systems generally have higher construction and maintenance costs and increased operational and maintenance demands (Figure B10–26). It is beneficial to reduce the water contribution to a pump station by diverting as much of the drainage area as possible to gravity drainage components (e.g., ditches, pipes). Pump stations require specialized design expertise; consult qualified and experienced designers and installers. Sources of design information for pumped drainage works include pump manufacturers, OMAFRA's Publication 29, *Drainage Guide for Ontario* and the Hydraulic Institute (www.pumps.org).

Figure B10–26. A pumping station.

Source: Municipality of Chatham-Kent, Ontario.

Pump station design elements include watershed hydrology, pump selection, available storage capacity, main power supply, backup power, access and maintenance requirements, cold-weather considerations and foundation considerations. Consider the inclusion of a gravity bypass, where possible, in the pump station design. The construction of dykes may also be necessary to keep the pumped water from returning into the drained land (Part B, Chapter 10.8).

10.7.1 Hydrology

Select the design storm event for the pump station, considering the associated safety and flood risks, regulatory requirements and local practices. Regardless of the design storm selected, the impacts and extent of flooding resulting from the 100-year storm or regional storm event should be determined to assess the associated safety risks.

10.7.2 Pump Selection and Sizing

Size the pump for the peak flow determined from the selected design storm event, and consider the following:

- peak inlet rate
- available storage volume
- outlet capacity and conditions (the pumping rate should not exceed the capacity of the outlet)
- acceptable duration of flooding of agricultural land, roads and other land uses

It is recommended that a minimum of two pumps are installed to provide emergency backup and to alternate pump usage.

10.7.3 Available Storage Capacity

The design of a pump station is impacted significantly by the storage volume. A larger storage volume can reduce the pumping capacity required. Storage is generally in the form of a wet well; however, there can be additional storage upstream of the pump station.

The wet well design should:

- take into account the frequency of pump on/off cycles, since the increased wear from frequent cycling can reduce the lifespan of the pump
- ensure the maximum allowable water level in the wet well is set to minimize impacts on agricultural land, roads and other land uses

10.7.4 Main Power Supply

Pumping stations can be powered with electric, diesel fuel, natural gas or solar energy. The choice of power supply depends on:

- the proximity of the proposed pump station to existing power supply
- the size of the pump
- the voltage and phase (i.e., single vs. three) requirements

10.7.5 Backup Power

A backup power source for pump stations will minimize the risks associated with power loss. Consider keeping a permanent generator on site or have a temporary portable generator available.

10.7.6 Operation and Maintenance

Pump station design should address operation and maintenance requirements by:

- providing roof hatches to allow mobile cranes to lift larger pumps
- providing a vehicle access laneway
- designing the wet well to reduce inlet flows to allow the facility to be dewatered with a smaller temporary pump when the permanent pumps are being repaired

10.7.7 Cold Weather

Pump station design considerations for cold weather may include frost cover over pipes, building heater requirements to prevent frozen pumps and ice blockages. Design submersible pumps to be removed or elevated to avoid being frozen in the wet well.

10.7.8 Geotechnical Information

A geotechnical investigation may provide information to:

- assess the ability of the soil to provide a suitable base for the pump station foundation
- guard against buoyancy issues with the wet well

10.8 Dams and Dykes

Dams are structures that are constructed to **retain water** with a controlled release. They are used to recreate or enhance wetlands, regulate water levels and augment downstream flows. Dams can be as simple as a Newbury weir or a small water-control structure (Figure B10–27). They can also be larger, more complex structures that involve a combination of embankments, spillways and stop-log type controls.

Figure B10–27. A small dam.

Source: Ministry of Natural Resources and Forestry, Ontario.

Dykes are structures that are constructed to **keep water out** of low-lying lands and may be used in conjunction with pump stations (Figure B10–28). They are usually installed along the full length of the land that is being protected and are typically made out of earth (Figure B10–29).

Figure B10–28. An aerial view of a dyke constructed along the full length of farmland that it is protecting from flooding.

Source: Town of Bradford-West Gwillimbury, Ontario.

Figure B10–29. A dyke used to keep water out of the adjacent low-lying land.

The definition of drainage works in the *Drainage Act, 1990* provides the engineer with the authority to include dams and dykes as part of the design. The engineer may be required to consult with geotechnical or structural engineers, contractors and regulatory agencies. Project scoping meetings are recommended to address any regulatory requirements.

10.8.1 Design Considerations

General design considerations for dams and dykes include:

- a geotechnical survey to determine soil properties such as permeability, porosity, bearing strength and sliding resistance
- detailed hydrology, hydrogeology and hydraulic studies to examine the impacts of all design storm events
- the identification of property boundaries and the undertaking of surveys to determine:
  - the topography of land adjacent to the proposed construction
  - existing high water levels in the area
  - changes that may occur to the high-water levels after construction
  - the impact on property owners
- a determination of how the structure will be affected by climate, such as high winds, wave action, freeze/thaw cycles, snow load, extreme rainfall events and extended periods of wet or dry weather

- access to the site and working limits
- the operation, maintenance and repair of the structure
- safety precautions such as fencing, railings and signage

Flow considerations for dams include:

- methods to draw down the water level behind the dam
- overflow provisions for peak runoff

For earth embankment dams or dykes, consider:

- the necessity of cut-off walls
- the necessity of an impervious centre core
- embankment protection (i.e., riprap, plantings, etc.)

For dams controlled with stop-logs, include:

- mechanical means of hoisting the stop-logs
- the provision of heat or power to allow for stop-log adjustments in freezing conditions
- security measures to prevent tampering with the logs

DID YOU KNOW? MNRF has guides and technical bulletins. Go to the Ontario Waterpower Association, www.owa.ca, and search for "Technical Bulletins".

10.9 Trees, Brush and Shrubs

Trees, brush and shrubs at the site of a proposed drainage works will need to be evaluated for their impact or benefit on the drainage works design and the provision of allowances. Factors include:

- economic value
- ecological value
- aesthetic value
- regulatory restrictions or prohibition under the *Endangered Species Act*, 2007 (e.g., butternut tree)
- local forest management by-laws
- future maintenance of the drainage works
- property owner preferences
- usefulness of the removed material in the drain design (Part B, Chapter 11)
- the salvage value and the disposal method of the removed material

After the evaluation, the engineer should consider the following options:

10.9.1 Selective Cutting

Selective cutting:

- retains more valuable trees
- provides some protection to ditch banks
- provides some shade to minimize summer water temperature
- removes trees whose roots are prone to enter and plug piped drains

10.9.2 Removal

Removing trees, brush and shrubs is used in the following situations:

- when the presence of trees, shrubs and brush will negatively impact the drainage works
- when the value of the trees, shrubs and brush is minimal

Power techniques include brushing and root grinding. Determine whether the roots should be removed or kept in place. If in doubt, leave roots in place for stream bank stabilization.

10.9.3 Targeted Clearing

This approach involves selecting appropriate vegetation or clearing width to prevent root entry into a piped system.

10.9.4 Relocating or Replacing Trees and Shrubs

Relocation or replacement:

- should only be used for high-value trees and shrubs
- may be used to address a regulatory restriction

10.9.5 Rerouting the Drain

This approach is used:

- to avoid valuable trees
- to avoid root penetration into a piped drain
- where removal is not an option due to regulatory restriction

Talk to the landowner in advance about a plan to deal with the brush, shrubs and trees cut or removed during the project.

10.10 Management of Excavated Materials

The engineer is required to specify the methods of disposal of materials removed in the construction, improvement or repair of a drainage works (Section 16). The feasibility of the disposal method is determined by the volume and type of materials to be excavated.

The standard practice for disposal of excavated materials is to spread it on the land adjacent to the drain (Figure B10–30). This may require the payment of an allowance to the affected property owner (Part A, Chapter 8 Allowances).

Figure B10–30. Excavated material spread to the right of the drain on farmland.

Source: Tulloch Engineering, Espanola, Ontario.

In the following situations, another management method (e.g., stockpiled and removed from the site) may be more appropriate:

- The material is not suitable to be spread on the land adjacent to the drain.
- There are regulatory restrictions.
- The land adjacent to the drain cannot accommodate the excavated material (e.g., because it is residential land or a road).
- The cost for providing an allowance and spreading the material is more than the cost of removal from the site.
- There is insufficient area available to spread the material.
- The property owner or municipality prefer other options.

The report should specify how the excavated material is to be managed in future drain maintenance and repair activities.

DID YOU KNOW? The ADIP policies indicate that the grant will not be paid for the increased cost to the project caused by hauling away the spoil material.

When specifying the spreading of material, keep the following points in mind:

- Consider the adjoining land use when specifying the width and depth of the spread material.
- The spread material can become an impediment to surface drainage. Provide a means for the surface water from the adjacent land to enter the drainage works.
- Consider removing large stones and woody materials from the spoil before spreading.
- Property owners may request the topsoil be stripped, stockpiled and re-applied. This may add to the drain cost and could be assessed as a special benefit (Part A, Chapter 9).

Piped drains, installed with drainage plows, may cause some temporary mounding over the pipe, but there will be no excavated material to manage. For piped drains installed by trench:

- Strip the topsoil and keep it separate from the rest of the excavated material.

- Use the excavated sub-soil as backfill, if suitable.
- If the excavated sub-soil is not suitable as backfill, import backfill for use around the pipe and dispose of any excess sub-soil.
- Mound the stripped topsoil over the pipe to allow for settling of the trench.

10.11 Utilities

Utilities can affect the horizontal and vertical alignment of a drainage works. During the design stage, the engineer may need to relocate or alter the utility or the drainage works. The increased cost to the drain to accommodate these changes is assessed:

- as a special assessment to a public utility as defined by the *Drainage Act, 1990* (Part A, Chapter 9.3.4)
- to the drain for a private utility, taking into consideration the special benefit provisions of the *Drainage Act, 1990* (Part A, Chapter 9.3.3)

> **DID YOU KNOW?** Ontario One Call provides a free planning and design service to identify underground public utilities throughout Ontario. Contact Ontario One Call at 1-800-400-2255.

10.11.1 Large, Complex Utilities

Large, more complex utilities (e.g., railways, high-pressure transmission lines, telecommunication lines and electricity transmission and distribution systems) are difficult and expensive to relocate. Therefore drainage works are more likely to be constructed around them. Guidance for working with these types of utilities is found in:

- Part C, Chapter 10.1 — railways
- Part C, Chapter 10.2 — high-pressure transmission pipelines
- Part C, Chapter 10.3 — telecommunication conduits
- Part C, Chapter 10.4 — electricity transmission and distribution

10.11.2 Small, Less Complex Utilities

Small, less complex utilities (both public and private) can usually be relocated, altered or supported during construction to accommodate drainage works. They include:

- telecommunication service lines (underground and overhead)
- natural gas distribution pipes
- electricity distribution lines (underground and overhead)
- water distribution pipes
- storm and sanitary sewers

10.11.3 Working with Utilities

It is recommended that the engineer:

- Determine the existence of utilities through field examination and discussion with the municipality.
- Review applicable municipal franchise agreements for gas lines (Part C, Chapter 8) and municipal access agreements for telecommunication lines (Part C, Chapter 10.3.1).
- Notify the affected utilities of the on-site meeting (Part A, Chapter 4.2) and any project scoping meeting (Part A, Chapter 3), as their input is essential to the design of the drain.
- Identify all utilities on the plan and profile drawings, including those not expected to impact the drainage design.
- Track all increased engineering and construction costs for the purpose of assessment.
- For utilities that affect the drain during design:
  - during the survey, expose the buried utility to determine its elevation and location
  - work with the utility contact to develop a design that addresses the drain or utility alteration
- For utilities that affect the drain during construction:
  - work with the utility to provide guidelines to the contractor to avoid and protect the utility during construction

- For utilities discovered during construction:
  - determine the type of utility and its ownership
  - notify the utility and the property owner
  - evaluate the impact of the utility on the design of the drainage works and the construction schedule

10.12 Resources

Drainage Engineers Conference (Ontario) (www.landdrainageengineers.com)

- *Design and Selection of Pumps for Municipal Drains.* Sass, Metro J., 1976.
- *Catchbasins and Inlets.* Kuntze, John, 1983.
- *Small Pumps as an Alternative to Deeper Outlets.* McGeorge, Don, 1986.
- *Review of Design and Installation of Pumped Drainage System — The Holland Marsh 1986–1994.* Janse, Art, 1996.
- *Status of Access Culverts — Prior to the 1975 Drainage Act.* Rood, Gerard, 2003.
- *How to Reduce Construction Costs and Improve the Environment using trenchless Technologies.* Knight, Mark, 2013.

Ontario Ministry of Agriculture, Food and Rural Affairs (ontario.ca/omafra)

- *Drainage Guide for Ontario,* Publication 29, 2007
- *Cropland Drainage — Best Management Practices Series,* 2011
- *Agricultural Erosion Control Structures: A Design and Construction Manual,* Publication 832, Revised 2017

Ontario Ministry of the Environment and Climate Change (ontario.ca/moecc)

- *Stormwater Management Planning and Design Manual,* March 2003

Ontario Ministry of Transportation (ontario.ca/mto)

- *MTO Drainage Management Manual,* 1997
- *MTO Gravity Pipe Design Guidelines,* 2014
- *Highway Drainage Design Standards,* January 2008.
- Ontario Provincial Standards for Roads and Public Works

Stormwater Pollution Prevention Handbook. Ontario Ministry of the Environment and Climate Change and the Toronto Conservation Authority, 2001. (www.sustainabletechnologies.ca)

Centre for the Advancement of Trenchless Technologies (www.cattevents.ca)

Concrete Pipe Design Manual. American Concrete Pipe Association, Revised October 2011. (www.concretepipe.org)

OCPA Concrete Pipe Design Manual. Ontario Concrete Pipe Association (www.ocpa.com)

Drainage Manual. Chapter 10 Pump Stations. Michigan Department of Transportation, January 2006. (www.michigan.gov)

The Hydraulic Institute (www.pumps.org)

Fisheries and Oceans Canada (www.dfo-mpo.gc.ca)

- Fish Passage Issues

National Engineering Handbook. Part 624, Section 16, Chapter 7 Drainage Pumping. United States Department of Agriculture, Natural Resources Conservation Service. (www.usda.gov)

CHAPTER 11

DRAINAGE IN BALANCE

11.1 Introduction

Traditionally, the *Drainage Act* was used to drain land in the most efficient way for settlement, transportation, farming, disease control, etc. At that time, removing water from the land was the primary focus. Little thought was given to the impact that the design and construction of drains had on the environment.

While drainage is still essential, currently it is important to balance it with other resources or interests in the watershed such as fish and wildlife habitat, water quality and quantity, wetlands and water retention. The definition of drainage works under the *Drainage Act, 1990* is broad enough to introduce techniques that balance these interests into the design, improvement and construction of the drainage system. Some of these techniques include:

- channel design approaches
- channel enhancements
- constructed wetlands
- features on private land

11.2 Channel Design Approaches

Drainage systems have traditionally been designed as straight trapezoidal channels for the most efficient means of drainage. Alternative designs use approaches that mimic channels that exist naturally. These approaches are more complex and require specialized expertise, reviews of research and field examinations of similar natural watercourses.

11.2.1 Two-Stage Channel

Overview

Two-stage channels (Figure B11–1) incorporate a low-flow inset channel (thalweg or Stage 1 channel) to convey base flow and small storm events, with benching on each side to create a floodplain to convey higher flows (Stage 2 channel). A two-stage channel may not be suitable where there are restrictions on channel corridor width.

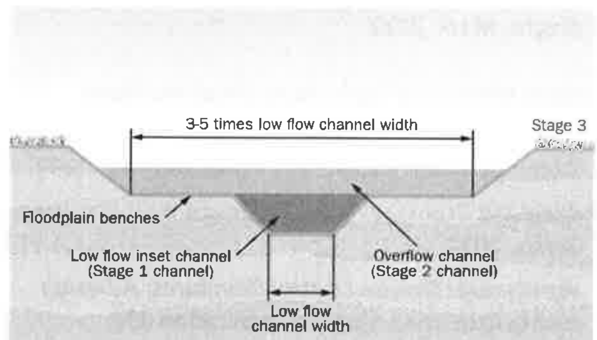


Figure B11–1. Cross-section of a two-stage channel.

Advantages and Disadvantages

Advantages of two-stage channels related to drainage function include the following:

- The smaller low-flow channel promotes higher flow velocity, which reduces sediment deposition and the need for channel maintenance.

- Channel stability is improved because the erosive velocities associated with larger flows are spread out across the vegetated floodplain benches. The water depth is reduced, and there is less shear stress on the toe of the bank.
- The floodplain increases the overall flow capacity, reducing the frequency of flooding onto adjacent lands.

Advantages of two-stage channels related to environmental function include the following:

- Vegetated cover on the benches is improved. This provides:
    - shade for the low-flow channel
    - reduced water temperature
    - terrestrial habitat
- Aquatic habitat is improved due to the greater flow depth in the inset flow channel during low-flow periods.
- Fish habitat is improved by providing greater channel bed variation (pools and riffles), refuge and cover.

Advantages of two-stage channels related to improved water quality include the following:

- Vegetated benches slow flow velocity, which increases sedimentation on the floodplain benches.
- Sediment removal reduces nutrient loading since nitrogen and phosphorus, bound to the particles, are also removed. Plant uptake of phosphorus and nitrogen compounds also reduces nutrient loading.
- Benches positioned to intercept tile drainage discharge reduce the nitrate loading to the channel.

Disadvantages of two-stage channels include the following:

- increased land requirements and acquisition costs
- higher initial construction costs
- increased excavated material to manage at the time of construction

Design of Two-Stage Channels

Find natural channels with similar watershed characteristics that have naturally formed effective discharge channels. Use these to develop a relationship between drainage area and channel width and depth. The low-flow channel conveys the effective discharge, which is the flow that transports the largest cumulative sediment load over the long term. The floodplain channel can be sized based on the required return interval to provide the desired level of conveyance (e.g., 100-year peak discharge, etc.). The floodplain benches are often located in the lower third of the ditch at an elevation to provide for periodic flooding. Use this field data and specific recurrence intervals to determine the effective discharge and size the channel. Transition the two-stage channel to the channel outlet geometry.

Additional information on the design of two-stage channels:

- *Stream Restoration Design, National Engineering Handbook 654,* Natural Resources Conservation Service (www.nrcs.usda.gov)
- Ohio State University (https://cfaes.osu.edu)

11.2.2 Self-Forming Over-Wide Channels

Overview

The self-forming approach to channel design involves construction of an over-wide channel. Within the over-wide channel, a stable inset channel is formed naturally, complete with bars, benches and vegetation, into the optimal form for the watershed and valley conditions. This optimal form could range from a well-defined channel to a channel that has wetland features.

Advantages and Disadvantages

Advantages of over-wide channels are as follows:

- Less maintenance is required compared to other constructed channels.
- Benches develop higher organic matter content and better soil structure than constructed benches, due to the slow process of their formation.

Disadvantages of over-wide channels are as follows:

- The channels undergo various stages of succession over time, which may be considered a disadvantage where:
  - existing habitat is considered valuable and not to be disturbed
  - certain channel forms and habitats that develop are not desired
- When applied incorrectly, self-forming channels can become blocked with vegetation (e.g., cattails, *Phragmites*) and do not resemble a natural channel system.
- Where there are restrictions on channel corridor width or increased land requirements and acquisition costs, a self-forming channel may not be suitable.
- Initial construction costs are higher than traditional channel designs.
- There is more excavated material to manage at the time of construction.

Design of Self-Forming Channels

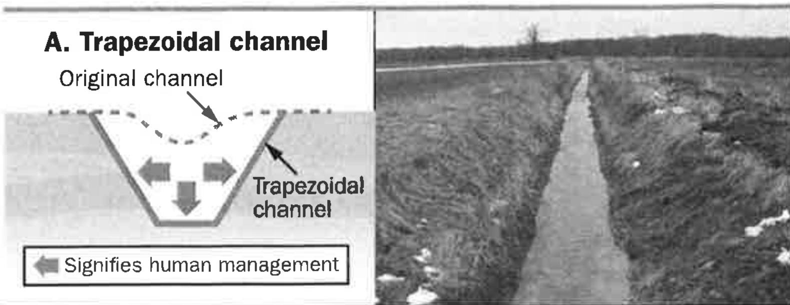
Self-forming channels are more suitable in sandy areas with base flow. This approach is not well suited in:

- heavy clay soils with no base flow
- steep channels prone to erosion
- channels transporting high quantities of coarse bed material with limited vegetation

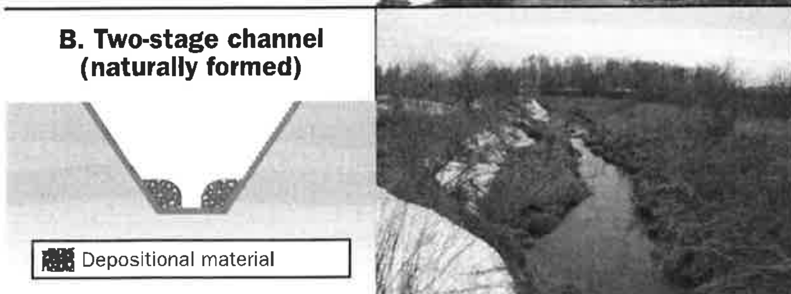
The primary design variables are bottom grade and width of the over-wide channel. For many agricultural drainage projects, the bottom grade will be kept the same as an existing channel. The minimum initial width of the over-wide channel bottom should be at least three times the estimated final bankfull width of the inset channel. The final bankfull width of the inset channel is estimated using the bottom grade and other site and watershed conditions using a hydraulic geometry relationship. See Figure B11–2 for examples of self-forming channels.

Additional information on the design of self-forming channels:

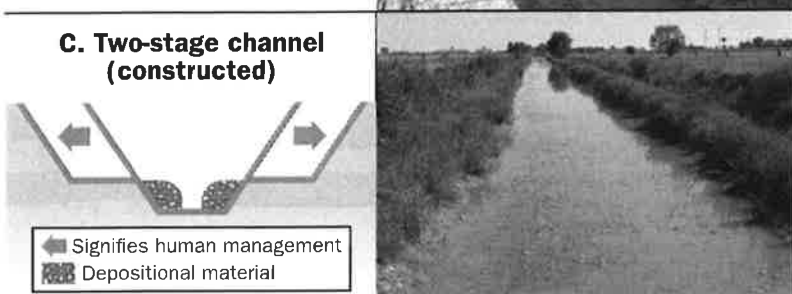
- Ohio State University has published some resources and information regarding self-forming channels (https://cfaes.osu.edu)
- a number of self-forming over-wide channel case studies from the American Midwest can be reviewed online through the Conservancy Registry (www.conservationregistry.org search for "self-forming channel")



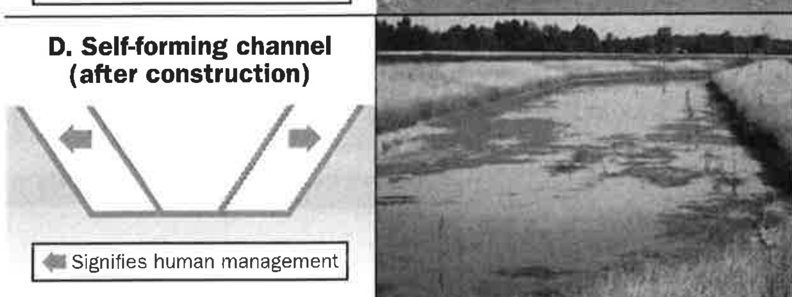
An example of a traditional trapezoidal channel maintenance. It requires regular removal of sediment and vegetation to maintain drain capacity. However, this activity may reduce or eliminate other beneficial ecosystem services.



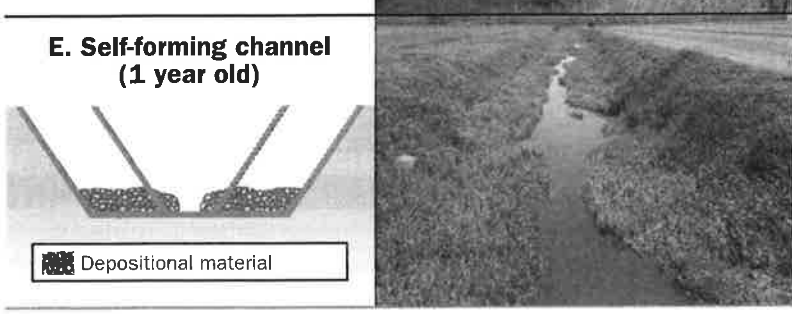
This channel was originally constructed to a trapezoidal shape. It had sufficient space, sediment supply and energy to build small benches within the confines of the channel. This channel has a sustainable form and should require little, if any, maintenance.



A trapezoidal channel was modified using the two-stage design approach to increase conveyance capacity. Rather than removing existing benches, the channel was widened at the bench elevation. The resulting channel meets drainage needs and has stable banks.



A self-forming design where the channel was intentionally built overwide to provide space for fluvial processes to build benches. The design allows formation of alluvial benches, whereas the two-stage design may excavate floodplain benches from subsurface soil horizons.



A self-forming channel one year after construction (same channel as in D above). The benches will continue to build over time until a state of dynamic equilibrium between flow, sediment supply and transport and the channel form is reached.

Figure B11–2. A comparison of channels.

Sources:
Chart: Jon Witter, Ohio State University, Ohio, USA.
Photos A, B and E: Ausable Bayfield Conservation Authority, Ontario, Canada.
Photo C: Municipality of Chatham-Kent, Ontario, Canada.
Photo D: Jon Witter, Ohio State University, Ohio, USA.

11.2.3 Natural Channel Design

Overview

Natural channel design involves constructing a drainage system that mimics natural watercourse functions, including flow capacity, sediment transport, habitat and channel stability (Figure B11–3).

Natural channels consist of base flow or inset channels, overflow channels and channel-shaping features such as meanders, riffles, pools and steps:

- Meanders are recurring bends in a watercourse that results in a snaking pattern across its floodplain.
- Riffles are areas of gravel substrate, shallow depth and steeper slope. The water moves faster over riffles, which oxygenates the water. Riffles are often found where the channel enters and exits a meander bend.
- Pools are located between riffles on flat sections with little or no slope and tend to be deeper than the average channel depth. They remove fine sediment from the water.
- Steps are vertical drops in the channel with a pool located at the bottom of the step to dissipate energy.

Figure B11–3. A natural channel design.

Source: K. Smart Associates Limited, Kitchener, Ontario.

Advantages and Disadvantages

Advantages of natural channel design:

- Aquatic and terrestrial habitats are enhanced.
- Maintenance requirements are reduced.
- The channel is aesthetically pleasing.

Disadvantages of natural channel design:

- The meander of the channel disrupts efficient farming activity.
- Where there are increased land requirements and acquisition costs or restrictions on channel corridor width, a natural channel approach may not be suitable.
- Initial design and construction costs are higher than traditional channel designs.

Design of Natural Channels

Natural channel design is based on fluvial geomorphology and watershed factors such as climate, topography, gradient, geology, vegetation, stormwater management and land use. It incorporates in-stream features such as meanders, riffles, pools and steps. Combinations of steps and pools are often found in channels with high gradients.

After construction, there are going to be areas where the channel is flowing through sections that contain fill and stratified soils with saturated water seams. Erosion control is important for these areas following initial construction.

Additional information on the design of natural channels:

- *Natural Channel Systems: Adaptive Management of Stream Corridors in Ontario,* Ontario Ministry of Natural Resources and Watershed Science Centre, 2002. ISBN: 0-9688196-0-51 (www.iwsstore.ca)
- *Stream Restoration Design* (National Engineering Handbook 654), Natural Resources Conservation Service (www.nrcs.usda.gov)

11.2.4 Summary of Channel Design Approaches

Table B11–1 provides a summary of the various channel design approaches.

Table B11–1. Summary of Channel Design Approaches

1=low 5= high

Drain Considerations	Trapezoidal	Two-Stage	Self-Forming	Natural
Design difficulty	1	4	3	5
Construction cost	1	4	3	5
Future maintenance requirements	5	2	3	1
Conveyance efficiency	5	2	3	1
Quantity of excess material	1	4	3	5
Area of land required	1	4	3	5
Habitat — aquatic benefit	1	4	3	5
Habitat — terrestrial benefit	1	4	3	5
Improvement to water quality	1	4	3	5
Resiliency to climate change	1	4	3	5

11.3 Channel Enhancements

There are features that can be incorporated into most drainage systems, whether they use traditional or alternative design approaches. These features enhance the drainage system by:

- conserving soil to improve water quality and reduce nutrient transport
- improving fish and wildlife habitat
- providing grade control and energy dissipation
- protecting adjacent land and infrastructure

Experience is required when designing these channel enhancements. They can be more complex and require specialized expertise, reviews of research and field examinations of similar natural water channels.

Additional information on channel enhancements:

- *Stream Restoration Design* (National Engineering Handbook 654), Natural Resources Conservation Service (www.nrcs.usda.gov)
- Ontario's Stream Rehabilitation Manual provides information on the design and construction of these features (www.ontariostreams.on.ca)
- *Rehabilitation and Enhancement of Aquatic Habitat Guide,* Fisheries and Oceans Canada, provides information on various design features

The following are examples of channel enhancements that have been incorporated into drainage projects in Ontario.

11.3.1 Littoral Shelves

Littoral shelves are shallow submerged plateau areas along the borders of deeper water bodies that allow the growth of emergent aquatic vegetation (Figure B11–4). Emergent vegetation refers to plants that grow in water and whose tops emerge above the normal water surface. Littoral shelves are constructed along the sides of channels or ponds that are too deep to support emergent aquatic vegetation in order to provide more diversity of habitat or to mimic pre-construction conditions.

Littoral shelves should be a maximum of 1.5 m below normal water surface elevation. Planting of appropriate native species is recommended. Design the side slopes to prevent slumping. Shelf widths can vary between 2 m and 3 m. Place imported substrate on littoral shelves for habitat diversity. Sporadic thin layers of gravel, root masses and/or full tree clumps are examples of imported substrate placed on littoral shelves.

Littoral shelves improve habitat and are generally easily incorporated into channel design. However, the littoral shelf will either reduce channel capacity or require additional land.

Figure B11–4. A dewatered channel with a littoral shelf on the right side of the channel.

Source: K. Smart & Associates Ltd., Kitchener, Ontario.

11.3.2 Newbury Weirs

Newbury weirs are rock riffle structures that are intended to simulate natural riffles and pools in channels (Figure B11–5). They provide grade control over low drops while enhancing diversity of habitat or mimic pre-construction conditions. Unlike traditional weirs, Newbury weirs enable fish passage upstream over grade changes. The riffles also improve water quality by increasing dissolved oxygen concentrations.

Figure B11–5. Newbury weir.

Source: Ian D. Smith, Lydian Environmental Consulting.

11.3.3 Gravel Substrates

The channel substrate determines the type and density of aquatic plant and fish species that can be supported. Gravel substrates limit the growth of aquatic vegetation compared to sand or organic substrates. However, some species of fish such as smallmouth bass need a gravel substrate for spawning.

Design the gravel substrate areas to ensure that the required water depth, velocity and channel shading meets the ecological objectives. Gravel substrate can be introduced as part of the channel bed or on a littoral shelf (Figure B11–6).

Figure B11–6. A dewatered channel with gravel substrates on a littoral shelf.

Source: K. Smart & Associates Ltd., Kitchener, Ontario.

11.3.4 Live Cribwalls

A live cribwall is a retaining wall made from untreated timbers, soil, rocks and live cuttings.

Timbers or logs are fastened together with rebar in an interlocking box-like pattern and are anchored into the bank slope. The base of the structure is filled with rock up to the stream bed elevation. Soil and live cuttings are placed in the structure from the stream bed elevation up to the top of the structure. This structure protects the channel bank from erosion and provides habitat for wildlife. The logs or timbers provide immediate stability above and below the water level, and the live cuttings take root and provide long-term bank stabilization (Figures B11–7 to B11–10).

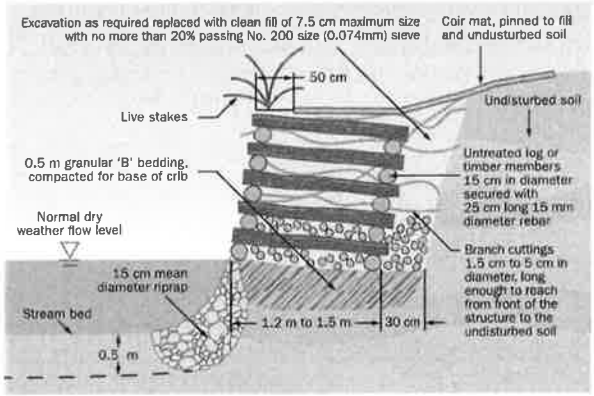


Figure B11–7. A live crib wall.

Source: Ian D. Smith, Lydian Environmental Consulting and Erin Lee, P. Eng., Urban & Environmental Management Inc., Niagara Falls, Ontario.

Figure B11–8. Construction of a live crib wall.

Source: Ian D. Smith, Lydian Environmental Consulting, Niagara Falls, Ontario.

Figure B11–9. Live crib wall 2 years after construction.

Source: Ian D. Smith, Lydian Environmental Consulting, Niagara Falls, Ontario.

DID YOU KNOW? Live cuttings are leafless stem cuttings of woody plant species that are easily established (Figure B11-10). These cuttings are planted in various configurations to achieve certain vegetative and stabilization goals.

Figure B11–10. A live cutting placed in the stream bank.

11.3.5 LUNKERS

"Little underwater neighbourhood keepers encompassing rheotactic salmonids" (LUNKERS) are structures used to stabilize stream banks as well as enhance habitat by providing edge-of-stream cover for fish. They are constructed of wood or stone and resemble a wood pallet with spacers, flow openings and wood planks overtop (Figure B11–11). The structures are installed on the outside bend of a watercourse below the low-flow water level. Stream flow through the structure is required to prevent sediment accumulation.

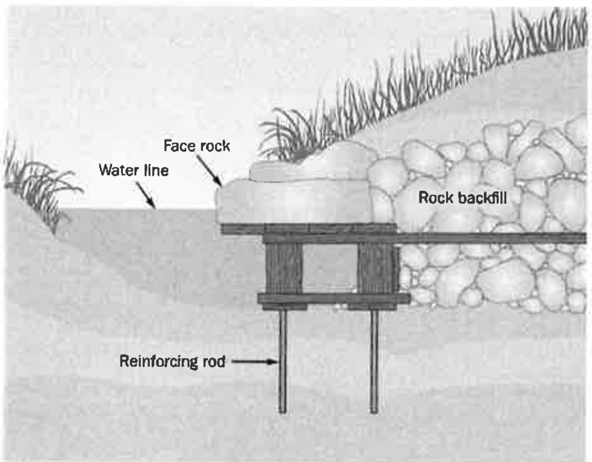


Figure B11–11. LUNKERS.

Source: Wisconsin Department of Natural Resources Fisheries Department, USA.

11.3.6 Deep Pools

Deep pools are created within the channel to provide variable depths for fish habitat and to promote localized sediment deposition. If possible, locate them close to a road or laneway for easy access for the periodic removal of sediment.

11.3.7 Root Wads

Root wads consist of the tree root mass and may include a length of the trunk. Root wads may be placed individually or in groupings on littoral shelves or at the toe of the channel bank to provide bank stabilization and fish habitat (Figures B11–12 and B11–13).

Excavate trenches into the bank to allow placement of the root wads flush with the channel bank and then backfill. Alternatively, the trunk ends can be sharpened and pushed into the bank.

Figure B11–12. A dewatered channel with root wads on a littoral shelf.

Source: K. Smart & Associated Ltd., Kitchener, Ontario.

Figure B11–13. A close-up of a root wad.

11.4 Constructed Wetlands

Constructed wetlands are built in strategic locations within a watershed for the purpose of enhancing flood control, water quality (sediment and nutrients) and/or wildlife habitat. They are different from existing, restored or enhanced wetlands in that they are constructed in areas that are not currently wetland. When a constructed wetland is built as part of a drain, the control structure is normally located along the route of the drain.

11.4.1 Design of Constructed Wetlands

Constructed wetlands (Figure B11–14) include an inflow and an outflow channel. An outflow control structure regulates the water level within the wetland. The wetland should consist of deeper pools as well as shallow areas of emergent vegetation. The flow path should meander through the wetland to slow down the water and encourage sediment deposition.

Investigation of geological conditions is important for the design and siting of earthen embankments, outlet control structures and grade control structures.

Figure B11–14. A constructed wetland.

Prepare a water balance to ensure the wetland maintains the desired water level. The water balance should account for:

- surface water input and output
- water storage
- evapotranspiration
- seepage
- groundwater input and output

DID YOU KNOW? Constructed wetlands may be too isolated from natural wetlands for natural seeding practices to be effective. Seed constructed wetlands with native wetland species to reduce sediment and nutrients, enhance wildlife habitat and prevent the establishment of invasive species.

11.5 Features on Private Land

There are features that property owners can implement privately to manage impacts of water generated from their land. These include:

- water and sediment control basins (WASCoBs)
- private tile drainage system outlet controls (e.g., saturated riparian buffers and controlled drainage)
- low impact development (LID)

The presence of these features may impact the design of the drainage works, including:

- the movement of sediment
- the stability of channel banks
- the amount of water generated from land

These features, when serving multiple properties, can be included in the municipal drain design.

11.5.1 Water and Sediment Control Basins

A water and sediment control basin (WASCoB) consists of an earthen embankment, terrace or berm constructed across the slope of the land; a ponding area upstream of the embankment/terrace/berm; and a pipe or tile outlet to control discharge (Figure B11–15). WASCoBs intercept runoff and release it at a controlled rate, resulting in slower overland flows, reduced erosion and sediment deposition.

When considering WASCoBs in the design of municipal drains, consider that:

- WASCoBs may not be appropriate to serve an individual property
- maintenance requirements are dependent on cropping practices on the adjacent land, which the municipality has no control over

OMAFRA Publication 832, *Agricultural Erosion Control Structures: A Design and Construction Manual,* has a section on WASCoBs (ontario.ca/omafra).

Figure B11–15. A WASCoB with berm and inlet.

11.5.2 Saturated Riparian Buffers

A saturated riparian buffer is created by installing an outlet control structure that directs the water from a private tile drainage system through distribution pipes buried in a riparian buffer (Figure B11–16). The water seeps into the buffer zone soil rather than discharging directly into the drain.

The objective of the saturated riparian buffer is to attenuate the peak discharge from tile drainage outlets and reduce nutrient loading to the drain.

If saturated riparian buffers are used adjacent to channel municipal drains, the engineer may need to ensure the bank remains stable in saturated conditions.

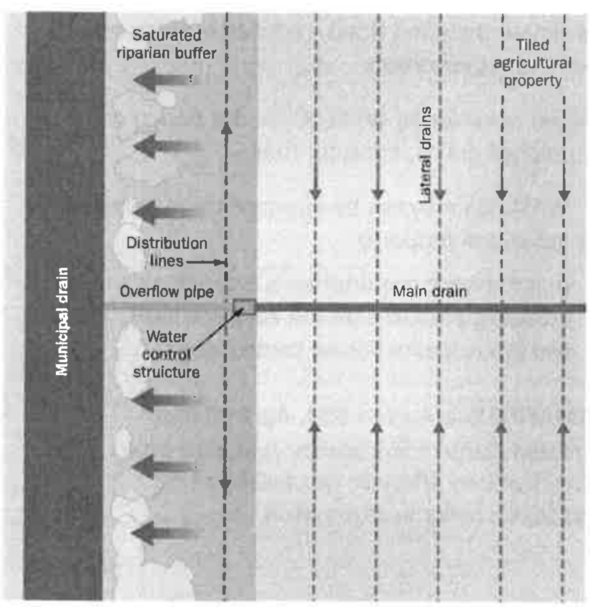


Figure B11–16. Water flow in a saturated riparian buffer.

Source: D. B. Jaynes, Ames, Iowa, USA

11.5.3 Controlled Drainage

Controlled drainage is the practice of managing the discharge from agricultural tile drainage systems. Control structures installed on a subsurface drain are used to raise or lower the water table in the field (Figures B11–17 and B11–18). The water level is raised after harvest and is lowered in the spring prior to planting operations. After planting, the water level is raised again to retain moisture during the growing season.

Figure B11–17. A controlled drainage structure prior to installation.

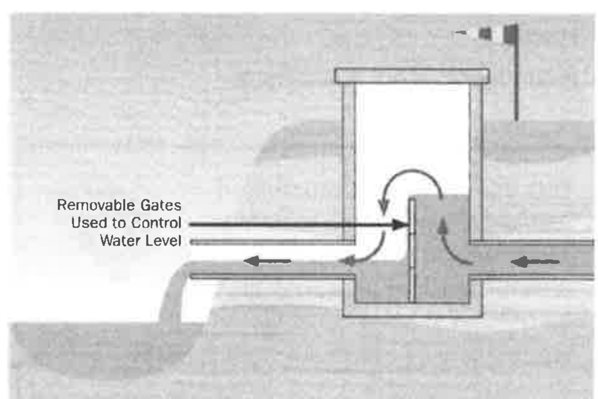


Figure B11–18. A side view of a controlled drainage structure.

11.5.4 Low Impact Development (LID)

Low impact development refers to an approach to stormwater management that focuses on maintaining the natural hydrologic processes. The objectives of LID are to control stormwater volume, peak flow and improve water quality by mimicking natural processes of infiltration, evaporation, evapotranspiration, filtration through plant and soil layers, and biodegradation of contaminants by soil bacteria. Usually LID is used in urban development, but there are principles that can be implemented in rural areas.

Since LID practices are becoming more common, the engineer needs to understand how these practices affect the amount of runoff from a property to appropriately design the drain. Several hydrologic and hydraulic models can be used to account for the impact of LID best management practices.

Information on LID is found in the *Low Impact Development Stormwater Planning and Design Guide* (2010) (www.creditvalley.ca).

11.6 Resources

Alternate Channel Design

- *Stream Restoration Design (National Engineering Handbook 654).* Chapter 10 Two-Stage Channel Design. United States Department of Agriculture, Natural Resources Conservation Services, August 2007. (www.nrcs.usda.gov)
- *Design, Construction, and Assessment of a Self-Sustaining Drainage Ditch.* Kramer, Geoffrie. A Thesis submitted to the Faculty of the Graduate School of the University of Minnesota, August 2011. (http://conservancy.umn.edu)
- *Alternative Design Options for Open Channels: Two-Stage Ditches and Self-Forming Channels.* Witter, Jon. Ohio State University, June 21, 2013. (www.agrentools.com)
- *Agricultural Drainage Ditches: Mitigation Wetlands for the 21st Century.* Moore, Matthew T. and Kröger, Robert, 2010: 195-210. ISBN: 978-81-308-0376-0.
- *Fluvial Processes in Agricultural Ditches in the North Central Region of the United States and Implications for their Management.* Jayakaran, A.D. et al. In Agricultural Drainage Ditches: Mitigation Wetlands for the 21st Century. Moore, Matthew T. and Kröger, Robert, 2010. ISBN: 978-81-308-0376-0.
- Agricultural Drainage. Ohio State University Extension. (https://cfaes.osu.edu)
- *Adaptive Management of Stream Corridors in Ontario.* Ontario Ministry of Natural Resources and Watershed Science Centre, 2002. ISBN: 0-9688196-0-51. (www.iwsstore.ca)
- *"Natural" Channel Design: Perspectives and Practice.* Shrubsole, Dan. Canadian Water Resources Association, 1994. ISBN 0-9694535-7-4.

Water and Sediment Control Basins

- *Agricultural Erosion Control Structures: A Design and Construction Manual — Publication 832.* Ontario Ministry of Agriculture, Food and Rural Affairs, 2018. (ontario.ca/omafra)
- *Field Office Technical Guide.* United States Department of Agriculture, Natural Resources Conservation Service, March 2002. (www.nrcs.usda.gov)

Habitat Enhancement Techniques

- *Ontario's Stream Rehabilitation Manual.* Ontario Streams. (www.ontariostreams.on.ca)
- *Ontario Provincial Standards Specification 812 — Construction Specification for LUNKERS* (ontario.ca/mto)
- *Ontario Provincial Standards Specification 810 — Construction Specifications for Rootwad Structures for Waterbody Banks* (ontario.ca/mto)
- *National Engineering Handbook.* Part 654, Technical Supplement 140 — Stream Habitat Enhancement Using LUNKERS. Natural Resources Conservation Services. (www.nrcs.usda.gov)
- *Stream Analysis and Fish Habitat Design: A Field Manual, 2nd Edition.* Newbury, R., Gaboury, M.N., et al. Newbury Hydraulics, 1993. ISBN 0-969-6891-0-1.
- *Rehabilitation and Enhancement of Aquatic Habitat Guide,* Fisheries and Oceans Canada.

Constructed Wetlands

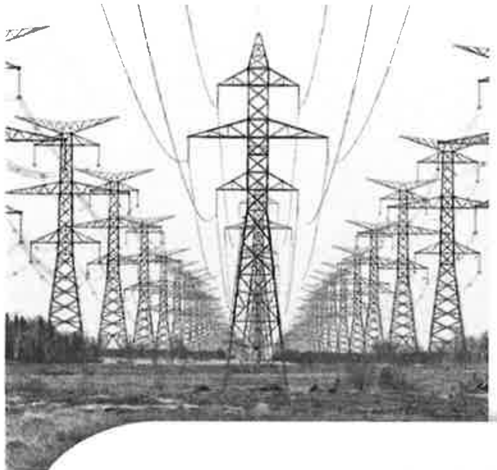
- Wetlands Protection and Restoration. United States Environmental Protection Agency (www.epa.gov/wetlands).
- *National Engineering Field Handbook,* Part 650, Chapter 13 Wetland Restoration, Enhancement, or Creation. United States Department of Agriculture. Natural Resources Conservation Service, April 2008 (www.nrcs.usda.gov).

Denitrifying Woodchip Bioreactors

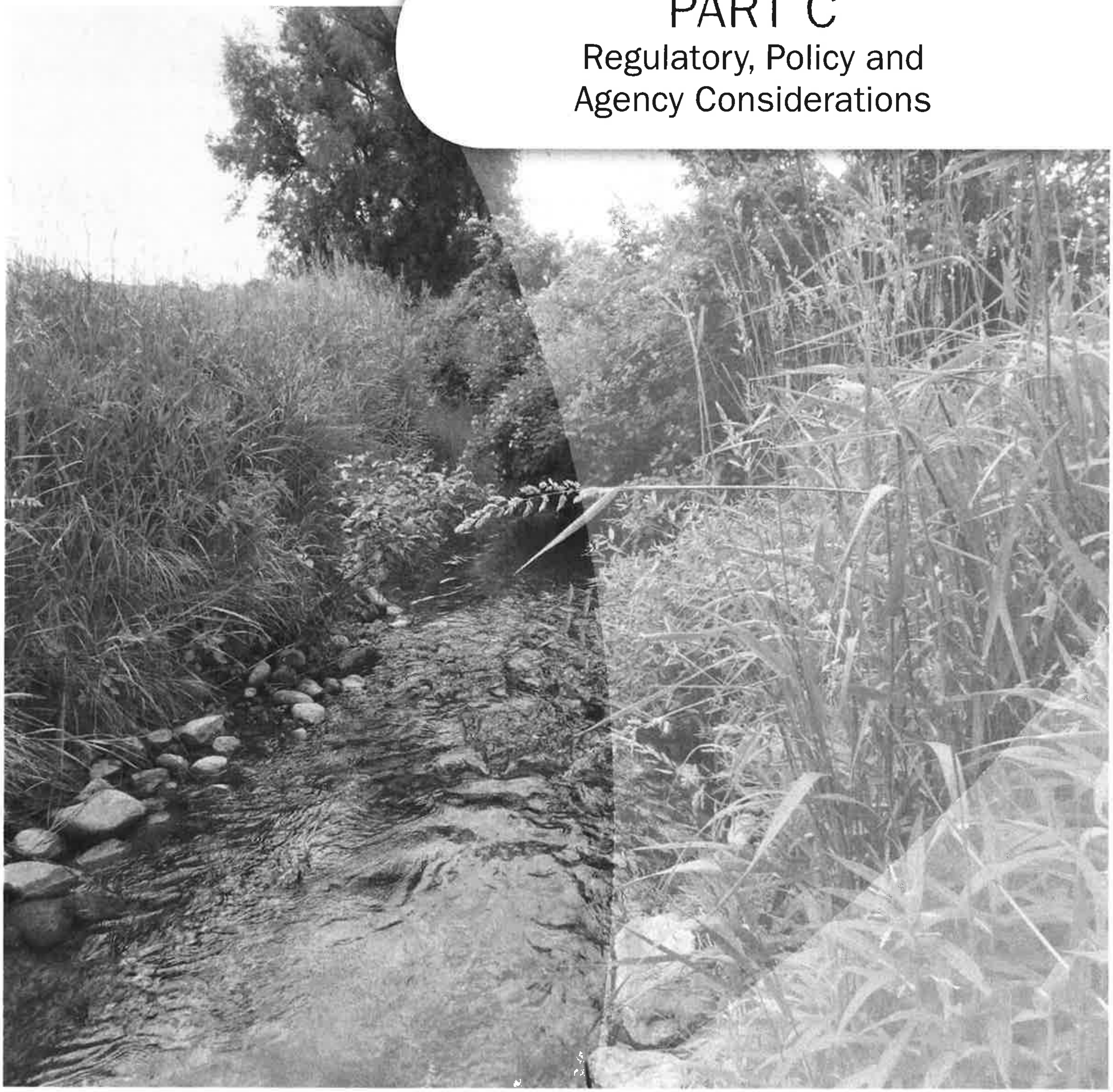
- *Woodchip Bioreactors.* Purdue University, Indiana. (www.engineering.purdue.edu)

Low Impact Development

- *Low Impact Development Stormwater Management Planning and Design Guide,* Version 1.0. Credit Valley Conservation Authority and Toronto Region Conservation Authority, 2011. (www.creditvalleyca.ca)
- Green Infrastructure. United States Environmental Protection Agency. (www.epa.gov/green-infrastructure)
- *Low Impact Development Best Management Practices Design Guide,* Edition 1.1. City of Edmonton, December 2014. (www.edmonton.ca)
- Low Impact Development Center, Beltsville, Maryland (www.lowimpactdevelopment.org)


PART C
Regulatory, Policy and Agency Considerations



PART C – TABLE OF CONTENTS

REGULATORY, POLICY AND AGENCY CONSIDERATIONS

CHAPTER 1

INTRODUCTION

Part A of the guide discusses the application of the *Drainage Act, 1990.* Part B examines the design components and considerations related to the preparation of the engineer's report.

Part C of the guide provides high-level information on other applicable legislation and policies that must be considered when completing a drainage works. Federal and provincial government and other agencies (e.g., utilities, railways) are considered stakeholders under the *Drainage Act, 1990* process. This section does not address legislation that pertains to general engineering practices, construction and contract administration.

For current versions of any of the provincial legislation mentioned in the guide, consult www.e-laws.gov.on.ca

For current versions of any of the federal legislation mentioned in the guide, consult www.laws-lois.justice.gc.ca

CHAPTER 2

MINISTRY OF NATURAL RESOURCES AND FORESTRY

2.1 Introduction

The *Drainage Act, 1990* identifies the role of the Ministry of Natural Resources and Forestry (MNRF) in the development of drainage works in three specific instances:

- the council notifies MNRF regarding the acceptance of a petition by the municipality where no conservation authority exists in the area (Section 5(1))
- MNRF notifies the municipality that an environmental appraisal is required (Section 6(1))
- the council serves the Minister of MNRF with a copy of the filed engineer's report where land under the ministry's jurisdiction may be affected (Section 41(1)(h))

Provincial acts and policies administered by MNRF that may affect drainage works:

- *Lakes and Rivers Improvement Act, 1990*
- *Endangered Species Act, 2007*
- *Public Lands Act, 1990*
- *Beds of Navigable Waters Act, 1990*
- *Fish and Wildlife Conservation Act, 1997*
- *Provincial Parks and Conservation Reserves Act, 2006*
- Wetlands (under the Provincial Policy Statement)

The following sections provide a high-level overview of the acts and policies. For specific information on the application, review and permitting process, contact the Ministry of Natural Resources and Forestry.

2.2 *Lakes and Rivers Improvement Act, 1990* and Regulations

2.2.1 Purpose

The *Lakes and Rivers Improvement Act, 1990* (LRIA) provides for:

- the management, protection, preservation and use of the waters of the lakes and rivers of Ontario and the land under them
- the protection and equitable exercise of public rights in or over the waters of the lakes and rivers of Ontario
- the protection of the interests of riparian owners
- the management, perpetuation and use of the fish, wildlife and other natural resources dependent on the lakes and rivers
- the protection of the natural features of the lakes and rivers, and their shores and banks
- the protections of persons and of property by ensuring that dams are suitably located, constructed, operated and maintained and are of an appropriate nature (Figure C2–1)

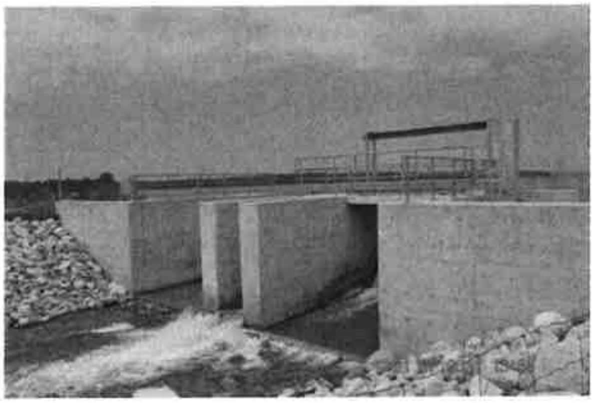


Figure C2–1. Dam constructed under the provisions of the *Lakes and Rivers Improvement Act, 1990.*

The website Dam Management (ontario.ca/page/dam-management) provides links to LRIA, the administrative guide and best management practices.

2.2.2 Relevant Sections

Sections of the LRIA that are of interest to the engineer:

- definition of a dam (Section 1)
- regulations may exist for dams (Sections 3(1) and (2))
- approvals for new dams (Section 14)
- approval for alterations, improvements and repairs to existing dams (Section 16)

2.2.3 Ontario Regulation 454/96, Construction

Sections of this regulation that are of interest to the engineer:

- defines channelization (Section 1)
- provides specific situations where an approval is required (Section 2(1))
- exempts channelizing from approvals if done under the *Drainage Act, 1990* (Section 2(1)(c))

2.2.4 Administrative Guide

The administrative guide is a plain language document used to assist in the understanding of the *Lakes and Rivers Improvement Act, 1990.* Sections of the administrative guide that are of interest to engineer:

- duties of the applicant's engineer (Section 1.3.5)
- riparian and adjacent property owners rights and interests (Section 1.4.2)
- types of works requiring LRIA approval (Section 2.1)
- when LRIA approval is required for dams (Section 2.1.1)
- when LRIA approval is required for channelizations (Section 2.1.3)
- municipal and other drains (Section 2.1.6)
- application review and approval process (Section 3)
- inquiry process (Section 3.6)

2.2.5 Advice to the Engineer

Advice to the engineer:

- Table C2–1 provides guidance on what types of drainage works under the *Drainage Act, 1990* require LRIA approval.

Table C2–1. Types of drainage works under the *Drainage Act, 1990* requiring LRIA approval

Activity	LRIA Approval (Administrative Guide)
a restricted culvert or an embankment with a small outlet (e.g., a stormwater management facility)	may be required
a properly sized culvert	may be required
a dam	required
channelization	not required for the construction or maintenance of a drainage works under the *Drainage Act, 1990* (Section 2(1)(c) of Regulation 454/96)

If, after consulting the *LRIA Administrative Guide,* the engineer is unsure if the work proposed for a drainage works constitutes a dam, contact the MNRF office.

- Where a dam is part of the project, the engineer should follow Section 3.5 of the administrative guide. The steps in the application review and approval process are:

- submit an application to the appropriate MNRF office
- attend a scoping meeting
- obtain location approval
- obtain approval of plans and specifications

2.3 *Endangered Species Act, 2007* and Regulations

2.3.1 Purpose

In Ontario, the *Endangered Species Act,* 2007 (ESA) provides for the identification, protection and recovery of species at risk and their habitats. In general the ESA prohibits the killing, harming, harassing, capturing or taking a living member of an extirpated, endangered or threatened species and prohibits damaging or destroying the habitat of endangered or threatened species. The ESA contains provisions for permits, agreements and regulations to allow activities, including drainage, to occur that might otherwise be prohibited. Species at risk information is found at ontario.ca/mnrf.

The *Species at Risk Act, 2002* (SARA) is federal legislation that provides protection to federally listed species at risk and associated habitat. Where aquatic species at risk or habitat are encountered, the engineer must address both pieces of legislation. SARA is discussed in more detail in Part C, Chapter 9.2.

2.3.2 Relevant Sections

Sections of ESA of interest to the engineer:

- purpose (Section 1)
- definition of species and habitat (Section 2)
- provides for a regulation to list the species at risk in Ontario (Section 7)
- prohibits the killing, harming, harassing or taking species on the Species at Risk in Ontario (SARO) list and their habitat (Sections 9 and 10)
- allows for permits to be issued for activities that would otherwise be prohibited (Sections 16, 17 and 19)

2.3.3 Ontario Regulation 230/08, SARO List

Sections of this regulation of interest to the engineer:

- lists all the species in Ontario classified as extirpated, endangered, threatened or of special concern

2.3.4 Ontario Regulation 242/08, General Regulation

Sections of this regulation of interest to the engineer:

- exemptions for specific species (Sections 1.1–7)
- requirements for the submission of notice of activity through the MNRF registry (Section 23.3)
- regulatory exemptions to Sections 9 and 10 of the ESA for maintenance, repair and improvement activities under the *Drainage Act, 1990* are provided (Section 23.9)
- a time-bound exemption from Sections 9 and 10 prohibitions for eligible drainage activities that may adversely impact newly listed species (Section 23.13)
- regulated habitat provisions for specific species (Sections 24–31)

2.3.5 *Endangered Species Act* Approvals Process

Where *Drainage Act, 1990* activities are proposed that will impact protected species, ESA authorizations may be granted when the activity:

- addresses threats to human health and safety
- provides for legal protection for recovery of species
- provides an overall benefit to the species
- provides significant social or economic benefit to Ontario

The overall benefit permit (Section 17(2)(c)) is the most common type of permit required for projects under the *Drainage Act, 1990* and is summarized in Part C, Chapter 2.3.9.

More information about ESA authorizations and the application process is found at ontario.ca/mnrf (search for "How to Get an Endangered Species Act Permit or Authorization").

2.3.6 Species at Risk Data Analysis

On any drain construction or improvement project, the engineer checks for the potential of species at risk and habitat by:

- reviewing the MNRF Make a Natural Heritage Area Map website (ontario.ca search for "make a map")
- reviewing the information available through the Natural Heritage Information Centre (NHIC) mapping website (ontario.ca search for "Get Natural Heritage Information")
- speaking to the conservation authority (www.conservation-ontario.on.ca)and Fisheries and Oceans Canada (www.dfo-mpo.gc.ca) regarding species at risk
- consulting with a qualified professional (e.g., biologist, arborist, zoologist)

Contact the local MNRF district office for advice and general information on species at risk. The location and contact information for the MNRF offices is available at ontario.ca/mnrf.

2.3.7 Drain Construction or Improvement Project Approvals

If the review indicates species at risk (SAR) or SAR habitat may exist in the area of the project, an ESA authorization may be required. Check with the municipality to see if they have registered with the MNRF under Section 23.9 of ESA Ontario Regulation 242/08.

There are four situations that determine the authorization process:

1. A drain improvement project where the municipality has registered with MNRF and the proposed work and affected species are outlined in the registration.
2. A drain improvement project where the municipality has registered with MNRF but the proposed work and/or affected species are not outlined in the registration.
3. A drain improvement project where the municipality has not registered with MNRF.
4. Construction of a new drain.

1. **A drain improvement project where the municipality has registered with MNRF and the proposed work and affected species are outlined in the registration.** To be exempt from the ESA permit, the municipality must:
   - register the activity and the affected species with MNRF before work begins
   - take immediate steps to minimize the effects to the species and habitat
   - create and implement a mitigation plan for each species
   - report sightings of rare species and update registration documents (if needed)
   - report on species and activities each year

For more information, see ontario.ca/mnrf and search for "Ditch and Drainage Work and Endangered or Threatened Species."

2. **A drain improvement project where the municipality has registered with MNRF but the proposed work and/or affected species is not outlined in the registration.** An overall benefit permit may be required (Part C, Chapter 2.3.9).
3. **A drain improvement project where the municipality has not registered with MNRF.** The engineer should encourage the municipality to register with MNRF:
   - If the municipality registers with MNRF, follow the instructions for situation 1 or 2.
   - If the municipality does not register with MNRF, an overall benefit permit may be required (Part C, Chapter 2.3.8).
4. **Construction of a new drain.** For a new drain construction, an Overall Benefit Permit may be required (Part C, Chapter 2.3.8).

2.3.8 Overall Benefit Permit Process

Where an Overall Benefit Permit is required under the ESA, a municipality should work with MNRF to develop permit conditions that achieve an overall benefit to the species. The engineer should retain the services of a qualified professional (e.g., biologist, arborist, zoologist) to develop any required mitigation plans and/or to assist in the applications for permits. This individual:

- may have access to Natural Heritage Information Centre mapping and other mappings of species at risk
- should be aware of MNRF policies and procedures
- should be familiar with mitigation techniques
- may be able to recommend actions that will avoid the requirement for an overall benefit permit
- may assist with applying for an Overall Benefit Permit

For details concerning the Overall Benefit Permit, see the *Endangered Species Act,* 17(2)(c) or search "Endangered Species Act Submission Standards" and "Species at Risk Overall Benefit Permits" at ontario.ca/mnrf.

2.3.9 Advice to the Engineer

- Review the SARO List regularly for the most current information regarding Ontario's at-risk species and their risk status.
- Determine if there are any protected species or habitats, and contact the municipality to determine the status of any registration.
- Consider a project scoping meeting if there are protected species or habitats present (Part A, Chapter 3).
- Evaluate the impacts of drainage design and construction on species at risk and their habitats.
- Whenever possible, design drains to avoid or minimize impacts on species at risk and their habitats.
- Consult a qualified professional for assistance with applying for an ESA authorization (e.g., Overall Benefit Permit).
- Work can begin once one of the following approvals have been obtained:

For the Overall Benefit Permit application forms, see www.forms.ssb.gov.on.ca and search for "Endangered Species Act" and select:

- Application for an Overall Benefit Permit under clause 17(2)(c) of the *Endangered Species Act, 2007*
- Avoidance Alternatives Form for activities that may require an Overall Benefit Permit under clause 17(2)(c) of the *Endangered Species Act, 2007*

> **DID YOU KNOW?** It may be possible to prevent impacting protected species and habitats and avoid the need for an Overall Benefit Permit. Tips include:
> - timing – conduct the activity at certain times of the year to avoid interfering with the species and their habitat
> - location – move the activity to a slightly different location or reduce the size of the area affected (e.g., plan the layout of a drain so that it doesn't affect the habitat of a plant species at risk)
> - method – use of technologies (e.g., use live crib walls instead of gabion baskets to avoid adverse effects to the shoreline habitat of at-risk fish species)

  - a Confirmation of Registration from MNRF
  - a letter of approval (with or without conditions)
  - a signed and approved Overall Benefit Permit

2.4 *Public Lands Act, 1990*

2.4.1 Purpose

The *Public Lands Act, 1990* (PLA) outlines the use, planning, management, development and sale of public lands and forests administered by the Ministry of Natural Resources and Forestry. Public lands are defined as lands designated as Crown lands, school lands and clergy lands.

The *Drainage Act, 1990* contains provisions regarding public lands:

- Public lands that are exempt from taxation may be assessed (Section 61(5)).
- Assessments on public lands are paid by the municipality, except where the owner of land is a petitioner, a church, a school or an upper-tier municipality (Section 61(6)).
- Grants are not paid on assessments to lands owned by Canada, Ontario or a municipality (Section 86(1)).

2.4.2 Relevant Sections

Sections of the PLA of interest to the engineer:

- definition of public lands – includes Crown lands (Section 1)
- permits required for improvements on public or private lands in areas without municipal organization (Section 13(1))
- regulations governing activities that may be carried out on public lands (Section 14(1))

2.4.3 Ontario Regulation 239/13

Sections of the regulation of interest to the engineer:

- definition of shore lands includes lands covered or seasonally inundated by the water of a lake, river, stream or pond (Section 1)
- the prohibition of the following activities unless authorized by a work permit (Section 2(1)):
  - dredging of shore lands
  - clearing of existing ditches
  - construction of crossings
  - construction of erosion control structures

2.4.4 Advice to the Engineer

- Communicate with MNRF Office when work is required on public lands.
- Drainage works constructed on public lands require a permit (Ontario Regulation 239/13).
- Public lands may be assessed, but the payment of the assessment is governed by the *Drainage Act, 1990* (Section 61(5)) and the *Municipal Tax Assistance Act, 1990.*

2.5 *Beds of Navigable Waters Act, 1990*

2.5.1 Purpose

The ownership of the bed of a watercourse in Ontario frequently depends on the question of navigability through the application of the *Beds of Navigable Waters Act, 1990* (BNWA). Where the bed of a watercourse is deemed Crown land, the MNRF makes administrative decisions regarding the navigability of a watercourse.

2.5.2 Advice to the Engineer

- Contact an MNRF office if any proposed project affects shore lands
- If the watercourse may be navigable, consult Transport Canada, which administers the *Navigation Protection Act, 1985* (Part C, Chapter 9.5)

2.6 *Fish and Wildlife Conservation Act, 1997*

2.6.1 Purpose

The *Fish and Wildlife Conservation Act, 1997* (FWCA) provides for the management, maintenance and rehabilitation of all Ontario's fish and wildlife resources.

2.6.2 Relevant Sections

Sections of the FWCA of interest to the engineer:

- If the FWCA conflicts with the *Endangered Species Act, 2007,* the provision that gives the most protection to animals prevails (Section 2).
- No one can hunt or trap fur-bearing animals (e.g., beaver) unless licensed (Section 6(1)) (Figure C2–2).
- The nest or the eggs of a bird that is wild by nature are not to be damaged (Section 7).
- Beaver dams are not to be damaged unless done to protect the owner's property (Section 8(3) and 8(4)) (Figure C2–3).
- The minister may issue licences that would authorize otherwise-prohibited activities (Section 60).

Figure C2–2. The hunting and trapping of beavers requires a licence.

Source: Land and Wildlife Agency of Eastern Ontario, Ottawa, Ontario.

Figure C2–3. Beaver dams are not to be damaged.

Source: Land and Wildlife Agency of Eastern Ontario, Ottawa, Ontario.

2.6.3 Advice to the Engineer

- If bird nests could be damaged by the proposed work, minimize the impact and obtain any required permits.
- Use only a licensed individual to remove beaver dams and trap beavers.

2.7 Provincial Parks and Conservation Reserves Act, 2006

2.7.1 Purpose

The *Provincial Parks and Conservation Reserves Act, 2006* (PPCRA) permanently protects a system of provincial parks and conservation reserves that:

- include ecosystems that are representative of all of Ontario's natural regions
- protect provincially significant elements of Ontario's natural and cultural heritage
- maintain biodiversity
- provide opportunities for compatible, ecologically sustainable recreation

2.7.2 Relevant Sections

Sections of the PPCRA that are of interest to the engineer:

- definitions (Section 5)
- classification of parks (Section 8)
- designation of a park superintendent, district manager or conservation reserve manager (Section 12)
- prohibition of construction, clearing, dredging and filling activities without a work permit (Section 22)
- lack of applicability of the *Public Lands Act* to provincial parks or conservation reserves (Section 56)

2.7.3 Regulation 345/07, Work Permits

Sections of this regulation that are of interest to the engineer:

- A permit issued by the park superintendent or conservation reserve manager is required for work to be conducted in a provincial park or conservation reserve (Section 1).

2.7.4 Ontario Regulation 347/07, Provincial Parks: General Provisions

Sections of this regulation that are of interest to the engineer:

- Except with the written authorization of the superintendent, no person shall make an excavation for any purpose in a provincial park (Section 2).

2.7.5 Ontario Regulation 319/07, Conservation Reserves: General Provisions

Sections of this regulation that are of interest to the engineer:

- Except with the written authorization of the conservation reserve manager, no person shall make an excavation for any purpose in a conservation reserve (Section 2).

2.7.6 Advice to the Engineer

If a proposed drain construction or improvement project involves provincial parks or conservation reserve lands, contact the park superintendent or the conservation reserve manager. Apply for a work permit, issued under the PPCRA, for any work to be done.

A park superintendent or conservation reserve manager will issue a work permit provided the proposed work is:

- a legal activity
- consistent with management direction for a provincial park or conservation reserve
- consistent with MNRF policy, procedure or directives
- not likely to create a threat to the environment, public safety or a natural resource, (e.g., lands, waters and watercourses, forests, flora, wildlife and fisheries)

2.8 Wetlands Protection

2.8.1 Purpose

The Provincial Policy Statement (PPS) provides the policy for wetland protection through land use planning in Ontario. The purpose of the PPS policies is to provide protections for Great Lakes coastal wetlands and other wetlands that have been evaluated using the Ontario Wetland Evaluation System (OWES) and identified as provincially significant.

The OWES provides a standardized method of assessing wetlands and their function within a watershed. Wetlands are evaluated by MNRF and divided into two categories:

- A provincially significant wetland (PSW) is one that has been identified as most valuable by demonstrating a large array of species, functions and benefits.
- A wetland that is not considered to be a PSW is referred to as an Evaluated Wetland and may have local significance and protection by the municipality.

Wetlands are not static and will change over time. Therefore, the MNRF evaluation file is considered open and can be amended as the wetland evolves.

If an area has been designated as a PSW, the municipality is responsible for including the information into their official plan and ensuring that it is managed within the Provincial Policy Statement (PPS) (Part C, Chapter 7).

The PPS prohibits development and site alteration in all provincially significant wetlands (PSWs) throughout much of southern and central Ontario and provincially significant Great Lakes coastal wetlands anywhere in the province. Development and site alteration is prohibited on lands adjacent to PSWs, in PSWs in northern Ontario and in non-PSW coastal wetlands in central and southern Ontario, unless it has been demonstrated that there will be no negative impacts on the wetlands or their ecological functions. However, the PPS also states that this restriction is not intended to limit existing agricultural uses.

2.8.2 Advice to the Engineer

- For the construction or improvement of drainage works, review the watershed to identify areas that may be considered wetlands.
- Review the municipality's official plan to identify if a wetland area has been designated as provincially significant.
- If the drainage works will impact a wetland area, consult with the municipality, the conservation authority and the MNRF.
- Wetland conservation can also be included in provincial plans such as the:
    - Niagara Escarpment Plan
    - Oak Ridges Moraine Conservation Plan
    - Greenbelt Plan
    - Lake Simcoe Protection Plan
    - Places to Grow Plan

CHAPTER 3

MINISTRY OF THE ENVIRONMENT AND CLIMATE CHANGE

3.1 Introduction

The *Drainage Act, 1990* does not reference the Ministry of the Environment and Climate Change (MOECC). However, the engineer has to consider acts, regulations and guidelines administered by MOECC.

MOECC legislation may apply to a project under the following circumstances:

- The project will have an impact on groundwater or surface water levels or water quality.
- The project will affect an approved nutrient management strategy or plan.
- The watershed includes source water protection areas.
- The project involves the disposal of excavated materials off site or importing backfill material from off-site locations.

Provincial acts, regulations and guidelines administered by MOECC that may affect drain construction or improvement projects:

- *Ontario Water Resources Act, 1990* (OWRA)
    - Environmental Compliance Approval (ECA)
    - Permit to Take Water (PTTW)
- *Nutrient Management Act, 2002* (NMA)
- *Clean Water Act,* 2006 (CWA)
- *Environmental Protection Act, 1990* (EPA)

DID YOU KNOW? The *Environmental Assessment Act, 1990* does not apply to projects under the *Drainage Act, 1990* (*Environmental Assessment Act, 1990*, Regulation 334, Section 5(2)(c)).

The following sections provide a high-level overview of these acts, regulations and guidelines. For specific information on the application, review and permitting process, contact MOECC.

3.2 *Ontario Water Resources Act, 1990*

3.2.1 Purpose

The *Ontario Water Resources Act, 1990* (OWRA) is designed to conserve, protect and manage Ontario's groundwater and surface water resources.

3.2.2 Relevant Sections

Sections of the OWRA of interest to the engineer:

- The definition of "sewage works" includes drainage works (Section 1).
- The discharge of materials that may impact the quality of water is an offence (Section 30).
- A permit to take water is required in certain circumstances (Section 34).
- interference to any person's interest in water and prohibiting any activities that interfere without a permit (Section 34.1)

- Sewage works require an environmental compliance approval (ECA) (Section 53).
- Works carried out under the *Drainage Act, 1990* are exempt from an ECA where the main purpose of the work is to drain land for agricultural activity (Section 53(6)(d)).

DID YOU KNOW? *Groundwater Interference and Drains* by John Kuntze, Kenn Smart Associates Limited, Kitchener, Ontario, 1995 (Drainage Engineers Conference (Ontario)) (www.landdrainageengineers.com) provides a case study of a well interference during the construction of a drain.

3.2.3 Regulation 387/04, Water Taking

Sections of this regulation that are of interest to the engineer:

Permits

- matters to be considered by the director (Section 4(2))
- notice and consultation (Section 7)

Data and reporting

- duties of permit holder (Section 9)

3.2.4 MOECC Guide to Applying for an Environmental Compliance Approval and the Application Form

If the drainage works is not exempt under Section 53 of the OWRA, it will require an ECA to use, operate, establish, alter, extend or replace a new or existing sewage works. In this case, the engineer completes an application for an ECA and submits it to the MOECC for review and approval. The *Guide to Applying for an Environmental Compliance Approval* and the application form are available at ontario.ca/moecc.

3.2.5 MOECC Guide to Permit to Take Water Application Form and the Application Form

There are three categories of water taking. Category 1 is water taking with a low risk of causing environmental impact (e.g., renewals of existing permits). Categories 2 and 3 are water takings that have a higher risk of impacting the environment and require an assessment completed by a qualified professional. Construction dewatering that is under 400,000 L/day is subject to the Environmental Activity and Sector Registry, ontario.ca/page/environmental-activity-and-sector-registry.

The *Guide to Permit to Take Water Application Form* is available at https://www.ontario.ca/page/guide-permit-take-water-application-form. The application form is available at ontario.ca/document/application-permit-take-water.

3.2.6 Advice to the Engineer

- Drainage works constructed under the *Drainage Act, 1990* with the main purpose of providing drainage for agricultural lands do not require an environmental compliance approval for sewage works. If uncertain as to whether or not approval is required, contact MOECC. If approval is required:
  - during the planning stages of the project, discuss with the MOECC the type of documents/reports required to support the application and the need for quantity and quality control measures
  - submit the complete ECA application as early as possible
  - do not undertake work until the approval has been granted
- Minimize the potential water quality impact of sediment or erosion during construction. If the engineer believes the project may affect surface water quality, acquire water quality data (e.g., total suspended solids, turbidity):
  - prior to any work done (to establish baseline data)
  - during construction
  - at the conclusion of the project

- Construction of the drain may be the cause of interference to a well or water supply, resulting in significant additional costs to the drain and additional assessment to the property owners.
  - Identify and locate any wells or water supplies in the vicinity of the drainage works.
  - Obtain information about well construction, aquifer characteristics and depth of water in the wells prior to any work done.
  - Minimize the risk during construction, especially with dewatering activities.
  - Document any events surrounding an interference with a well or water supply.
- Subject to some exemptions, if the project involves water pumping (e.g., dewatering) or diversion (e.g., building a new crossing) where more than 50,000 litres per day is taken, a permit to take water is required (Figure C3–1).

Figure C3–1. Dewatering for a culvert installation.

Source: Dietrich Engineering Limited, Waterloo, Ontario.

3.3 *Nutrient Management Act, 2002*

3.3.1 Purpose

This purpose of the *Nutrient Management Act, 2002* (NMA) is to protect the natural environment by regulating activities including nutrient storage, handling, land application and management. The NMA is jointly administered by the Ministry of Agriculture, Food and Rural Affairs (OMAFRA) and MOECC.

3.3.2 Relevant Sections

Sections of the NMA of interest to the engineer:

- definitions (Section 2)

3.3.3 Ontario Regulation 267/03

Sections of this regulation of interest to the engineer:

- definitions (Section 1)
- construction requirements for nutrient storages, livestock housing and runoff management (Sections 62–88)

A farmer who wants to build a new permanent storage facility is required to identify all drainage tiles and piped municipal drains within 15 m of the perimeter of the permanent nutrient storage facility (Section 63(2)(a)). The flow in a piped municipal drain must be redirected away from a new facility (Section 63(2)(c)).

3.3.4 Advice to the Engineer

- Geo-reference all piped municipal drains, including all surface water inlets. This will allow the drains to be easily located and incorporated into new nutrient management strategies.
- Contact the property owners to determine if any nutrient management plans or strategies are in place for properties adjacent to the drainage works. If plans exist, the nutrient management setbacks requirements from channels may influence the location and form (i.e., pipe drain or channel) of the drain.
- Locate municipal drains a minimum of 15 m away from any existing or proposed nutrient management facility (e.g., manure storages, livestock yards) (Figure C3–2).

Figure C3–2. A drain set back from a nutrient management storage facility.

Source: Grand River Conservation Authority, Cambridge, Ontario.

3.4 *Clean Water Act, 2006*

3.4.1 Purpose

In Ontario, the *Clean Water Act, 2006* (CWA) provides for the preparation of source protection plans to protect existing and future sources of drinking water. Source water refers to streams, rivers, lakes or groundwater aquifers that are used as public drinking water sources.

Source water protection involves delineation of source protection areas across the province and vulnerable areas for municipal drinking water systems within:

- intake protection zones for surface water sources
- wellhead protection areas for groundwater sources
- highly vulnerable aquifers
- significant groundwater recharge areas

The vulnerability of these individual areas is assessed, and potential sources of contamination are identified by source protection committees. Changes in drainage can influence the vulnerability of source water, as they can change the way groundwater and surface water move at a site.

Source protection committees are local bodies that are tasked with developing source protection plans on a watershed basis. Source protection plans contain policies aimed at reducing or eliminating risks to the sources of municipal drinking water systems. They also include policies that may prohibit new activities or put in place certain requirements that need to be met before a new activity can be initiated. Source protection authorities are local bodies that provide technical and logistical support to the source protection committees and other tasks under the *Clean Water Act, 2006*. Source water protection documents are available through MOECC (ontario.ca/moecc) and Conservation Ontario (www.conservationontario.ca).

3.4.2 Advice to the Engineer

- Determine by searching MOECC's Source Protection Information Atlas (an online mapping tool) whether any part of the drainage works falls within a vulnerable area, and find out what source protection plan policies apply to that area.
- If the drainage works falls within a vulnerable area, consult with the appropriate agency to identify any measures that should be incorporated into the design.

3.5 *Environmental Protection Act, 1990*

3.5.1 Purpose

The *Environmental Protection Act, 1990* (EPA) provides for the protection and conservation of the natural environment.

3.5.2 Relevant Sections

Sections of the EPA of interest to the engineer:

- interpretation (Section 1)
- discharge (Section 14)
- environmental compliance approvals (Sections 20.1–20.18)
- spills (Part X)
    - definition of a spill (Section 91)
    - duty to report a spill (Section 92)
    - duty to mitigate a spill (Section 93)

3.5.3 Ontario Regulation 153/04, Records of Site Condition

Sections of this regulation of interest to the engineer:

- Part XV.1 establishes the authority for the *Soil, Ground Water and Sediment Standards*

The *Soil, Ground Water and Sediment Standards* contain the following tables:

- Tables 1 to 9 — *Soil, Ground Water and Sediment Standards for Use* (Part XV.1)
- Table 1 is the reference of acceptable site conditions for land parcels where any drainage activity such as stockpiling soils or equipment operation could damage the site
- Table 2 prescribes the acceptable site conditions where potable groundwater may be affected

3.5.4 Fill Quality Guide and Good Management Practices for Shore Infilling in Ontario

This document provides guidance on protecting aquatic ecosystems by protecting the quality of the sediment and water in areas adjacent to shore-infilling activities.

3.5.5 Management of Excess Soil — A Guide for Best Management Practices

This document provides guidance on handling excess soil, beginning at the place where the soil is excavated and during transportation to a site where it can be reused for beneficial purposes. Note: MOECC has proposed New Excess Soil Reuse Regulation and Amendments to Existing Regulations related to the management of excess soil.

3.5.6 Advice to the Engineer

- During the field investigation stage, if a spill is encountered, report it to MOECC's Spills Action Centre 1-800-268-6060, ontario.ca/page/report-spill.
- Manure storages and livestock yards create a potential for contaminant discharge into a drainage works. Contaminants are transported by leaching, direct connections and runoff. Where possible, avoid locating a municipal drain adjacent to these facilities.
- Design the drain to minimize the opportunities for the drain to collect and convey polluting materials (Part B, Chapters 6 and 11).
- Ensure the contractor has a spill prevention and response plan to minimize any impacts of contaminants during construction. If a spill occurs during construction, the contractor or the engineer must report the spill to the MOECC and try to control the spill.
- If the project proposes to import or export soils:
    - consult the standards in the *Soil, Ground Water and Sediment Standards*
    - conduct soil testing to confirm that the soils to be excavated and transported are within the acceptable standards

DID YOU KNOW? The presentation *Spill Clean-up at the Judson A. Morse Drain* by Eric Chamberlain, 2003 (Drainage Engineers Conference, Ontario, www.landdrainageengineers.com) provides an example of dealing with a spill on a drain.

DID YOU KNOW? MOECC has developed Provincial Water Quality Objectives (PWQO) that set the surface water quality level required to protect all aquatic life, ontario.ca/moecc.

CHAPTER 4

MINISTRY OF TRANSPORTATION

4.1 Introduction

The Ministry of Transportation of Ontario (MTO) is a regulatory agency, a road authority and a property owner in the watershed of many municipal drains.

As a regulatory agency, MTO administers the Public *Transportation and Highway Improvement Act, 1990* (PTHIA). Through this legislation, municipalities are required to obtain encroachment permits if proposing to perform any work on MTO rights-of-way. *Ontario Traffic Manual - Book 7 - Temporary Conditions* provides the basic minimum typical guidelines for traffic control in order to achieve a satisfactory level of safety for workers and motorists.

As a road authority and a property owner, the MTO directives detail their involvement and relationship with drainage projects, including those performed under the *Drainage Act, 1990.*

The following sections provide a high-level overview of the PTHIA and directives. For specific information on the application, review and permitting process, contact the Ministry of Transportation.

4.2 *Public Transportation and Highway Improvement Act, 1990*

4.2.1 Purpose

The *Public Transportation and Highway Improvement Act, 1990* requires the MTO to maintain and repair provincial highways and provides authority to enter into agreements to construct provincial highways and bridges.

4.2.2 Relevant Sections

Sections of the PTHIA that are of interest to the engineer:

- For drainage projects involving MTO highways (Section 25):
  - the PTHIA authorizes the minister or delegate to petition a municipality for a drainage works
  - the drainage works may be initiated by others
  - no drain shall be constructed in a highway right-of-way without the consent of the minister or authorized person
  - the PTHIA designates MTO engineers to be the engineer authorized to carry out the provisions of the *Drainage Act, 1990* for the purpose of obtaining drainage for MTO highways
- No one shall obstruct, deposit material on, or interfere in any way with an MTO highway (Section 31(1)).

4.2.3 Regulation 472/10, Standards for Bridges

This regulation provides standards for the design and construction of bridges on MTO highways.

4.3 MTO Directives

MTO has a number of directives related to the *Drainage Act, 1990:*

- PHY Directive B012: Ministry policy and procedures related to the *Drainage Act, 1990*
  - assists MTO staff in the initiation, review and approval of drainage works implemented under the *Drainage Act, 1990* within or affecting MTO highway rights-of-way and lands
  - includes a Memorandum of Understanding between MTO and the Ministry of Municipal Affairs regarding payment of drainage assessments, including assessments for increased costs of crossings
- PHY Directive B014: Drainage management policy for highway corridors
  - includes MTO's policy on drainage management practice in planning and design for provincial highways
  - includes MTO's policy concerning drainage management for development areas that may have drainage impacts on provincial highways
  - provides direction to consultants undertaking planning and design of drainage management for MTO projects and projects requiring approval or endorsement by the MTO
- PHY Directive B217: Private piped drains on the highway right-of-way
  - describes conditions where MTO will allow private drains to connect to drainage systems on MTO rights-of-way

4.4 Encroachment Permit

An encroachment permit is required from MTO whenever there is an encroachment on lands within the limits of a provincial highway, roadway or structure forming a part of the provincial highway system. Drainage works may be located within these rights-of-way, subject to ministry approval. The application for a highway corridor management encroachment permit is available at ontario.ca/mto.

4.5 Ontario Traffic Manual, Book 7 – Temporary Conditions

The purpose of the *Ontario Traffic Manual* (OTM) is to provide information and guidance and promote uniformity of treatment in the design, application and operation of traffic control devices and systems across Ontario. The OTM incorporates current best practices in Ontario and provides a basis for road authorities to generate or update their own guidelines and standards.

OTM – Book 7 provides the basic minimum guidelines for traffic control in temporary work zones in order to achieve a satisfactory level of safety for workers and motorists. It is used by persons or agencies, including municipalities, that are performing construction, maintenance and utility work on any street or highway open to the public in Ontario, including drainage works constructed under the *Drainage Act, 1990.*

4.6 Advice to the Engineer

Where a drainage works involves MTO roads or lands:

- Notify MTO of the on-site meeting.
- If there are significant technical challenges, consider inviting MTO to a project scoping meeting (Part A, Chapter 3).
- Determine if an encroachment permit is required.
- When designing a drainage works involving an MTO right-of-way, refer to the documents listed at ontario.ca/mto and search for "Drainage Management".
- Consider reviewing the design and the draft report with the MTO prior to final submission to ensure the report meets the requirements of the encroachment permit.
- Obtain all permits and approvals before any construction work occurs.

CHAPTER 5

CONSERVATION AUTHORITIES

5.1 Introduction

The *Drainage Act, 1990* identifies the rights of conservation authorities (CA) in drain construction or improvement projects as follows:

- When a petition is accepted, the municipality must notify the CA (Section 5(1)).
- The CA may request an environmental appraisal (Section 6(1)).
- The municipality must send a copy of the preliminary report and a notice of meeting to the CA (Section 10(2)).
- The municipality must send a copy of the final report and a notice of meeting to the CA (Section 41(1)).
- A conservation authority can appeal aspects of a drainage engineer's report (Section 49).
- When a municipality decides to undertake a drain improvement project, it must notify the CA before the engineer is appointed (Section 78(2)).

5.2 *Conservation Authorities Act, 1990*

5.2.1 The Purpose

The *Conservation Authorities Act, 1990* (CAA) is administered by the Ministry of Natural Resources and Forestry and provides municipalities within a common watershed the ability to request the minister to establish a CA for local resource management work.

5.2.2 Relevant Sections

Sections of the CAA that are of interest to the engineer:

- CAs can build water control structures (Section 21(i)).
- CAs can undertake water and flood control work (Section 21(k)).
- CAs can charge fees for services (Section 21(m.1)).
- With the approval of the Minister of MNRF, individual conservation authorities can make regulations for the purpose of public safety and natural hazard management (Section 28(1)) that apply to:
    - the use of water in or from streams, rivers, inland lakes, ponds, wetlands and natural or artificially constructed depressions in rivers or streams
    - straightening, diverting or interfering with existing watercourses
    - development that may have an impact on flooding, erosion, pollution and conservation of lands
- The terms development, hazardous land, watercourse and wetland are defined in Section 28(25)).

5.2.3 Regulations

- The Minister-approved regulations under Section 28(1) requires each CA through a permitting process to:
  - prohibit, regulate or require the permission of the CA for straightening, changing, diverting or interfering in any way with the existing channel of a river, creek, stream or watercourse or for changing or interfering in any way with a wetland
  - prohibit, regulate or require the permission of the CA for development if, in the opinion of the CA, the control of flooding, erosion, dynamic beaches or pollution or the conservation of land may be affected by the development
- To support permit applications, the CA may require the submission of technical studies.

5.3 Regulated Areas

CAs are required to regulate and protect:

- wetlands (designated provincially significant by MNRF or not)
- watercourses, including shorelines of the Great Lakes and inland lakes
- regulated areas adjacent to wetlands and watercourses
- hazardous lands
- other areas that could interfere with the hydrologic function of the wetland

Individual CAs may have maps that approximate the limits of these regulated areas.

5.4 Advice to the Engineer

- Discuss the need and requirements of a permit under Section 28 of the CAA with the appropriate CA early in the project.
- If the CA has concerns about the project, identify their concerns and permitting requirements through a project scoping meeting, an on-site meeting or individual contact. Discuss conditions and actions to mitigate their concerns.
- If a permit is required under Section 28 of the CAA, the CA will direct the engineer to the application process. Confirm the approval and appeal process.
- Prior to construction, the engineer needs:
  - a Section 28 permit or
  - confirmation from the CA that a Section 28 permit is not required

Information on CAs can be found on the Ontario MNRF website at ontario.ca/page/conservation-authorities.

Additional information on the 36 CAs in Ontario, including a map and contact information, is available at Conservation Ontario's website: www.conservationontario.ca.

DID YOU KNOW? A *Drainage Act and Conservation Authorities Act Protocol* for drain maintenance and repair was created to improve communications, promote best practices and streamline the permitting process under the *Conservation Authorities Act, 1990* for municipal drain maintenance and repair work performed under the *Drainage Act, 1990*. The Protocol is found at ontario.ca/document/drainage-act-and-conservation-authorities-act-protocol.

CHAPTER 6

CULTURAL HERITAGE RESOURCES

6.1 Introduction

Cultural heritage resources have been determined to have cultural heritage value or interest because of the important contribution they make to our understanding of the history of a place, an event or a people. These resources include built heritage resources, cultural heritage landscapes and archaeological resources. While some cultural heritage resources may already be identified and inventoried by official sources, others can only be determined after assessment. Work performed under the *Drainage Act, 1990* may impact on (known and potential) cultural heritage resources.

Examples of cultural heritage resources can include:

- indigenous hunting camps and villages
- battlefields
- pioneer homes
- burial grounds and cemeteries
- shipwrecks
- other evidence of past human activity

The following sections provide a high-level overview of the *Ontario Heritage Act, 1990.* For specific information on the application, review and permitting process, contact the Ministry of Tourism, Culture and Sport.

6.2 *Ontario Heritage Act, 1990*

6.2.1 Purpose

The *Ontario Heritage Act, R.S.O. 1990,* c. O.18 (OHA) provides powers to municipalities and the Province to identify and conserve cultural heritage resources. The OHA is administered by the Ministry of Tourism, Culture and Sport (MTCS).

Drainage works and activities can have a direct effect on cultural heritage resources and may also indirectly affect sites in the vicinity of the project area (Figure C6–1). For example, drainage works could alter the visual setting or other physical relationships that contribute to the cultural heritage value of an archaeological site or a spiritual/ sacred site.

Figure C6–1. A drain located next to a cultural heritage site.

Source: Town of Lakeshore, Ontario.

6.2.2 Relevant Sections

Sections of the OHA of interest to the engineer:

- provincially owned properties (Part III.1)
- conservation of heritage properties (Part IV and V)
- alteration or disturbance of an archaeological site without a licence and requirements for an archaeological licence (Part VI)

6.3 Identifying Cultural Heritage Resources

6.3.1 Project Screening

The most accurate means to determine whether there are cultural heritage resources that could be impacted by the drainage project is by hiring a qualified professional to research the potential presence of cultural heritage resources. A qualified professional can be an engineer, architect or archaeologist that has relevant, recent experience in the identification and conservation of cultural heritage resources.

Alternatively, someone who is not a qualified person can determine whether or not there may be the potential for an area to contain cultural heritage resources. Knowing from an early stage that archaeological resources (and other types of cultural heritage resources) exist allows engineers to plan and implement work in a way that avoids or mitigates impacts to these resources.

To assist non-specialists, MTCS provides the following documents on the Ontario Central Forms Repository (www.forms.ssb.gov.on.ca):

- Criteria for Evaluating Archaeological Potential (Form 021-0478)
- Criteria for Evaluating Marine Archaeological Potential (Form 021-0503)
- Criteria for Evaluating Potential for Built Heritage Resources and Cultural Heritage Landscapes (Form 021-0500)

6.3.2 Archaeological Assessments

An archaeological assessment is required if known or potential archaeological resources (land or marine) are identified through project screening and if the proposed project may have an impact on archaeological resources.

In Ontario, archaeological fieldwork, including archaeological assessment, can only be carried out by archaeologists licensed by MTCS.

Resources available on the MTCS website (ontario.ca/mtc) include:

- stages of archaeological assessments
- *Standards and Guidelines for Consultant Archaeologists*
- a list of licensed archaeologists (professional)

6.3.3 Built Heritage and Cultural Heritage Landscapes

If the project screening process (Part C, Chapter 6.3.1) concludes that a proposed activity may impact potential cultural heritage resources, hire a qualified person to undertake a cultural heritage resource evaluation.

If the evaluation process concludes that a proposed activity may have a direct or indirect impact on known cultural heritage resources, hire a qualified person to prepare a heritage impact assessment report. The report determines the direct and indirect impact(s) of the proposed activity on any identified cultural heritage resources and determines protection or mitigation measures to reduce or avoid impacts on cultural heritage resources.

6.4 Indigenous Engagement

The MTCS technical bulletin *Engaging Aboriginal Communities in Archaeology* provides guidance to archaeologists to engage Indigenous communities (ontario.ca/mtc).

The Ministry of Indigenous Relations and Reconciliation can help identify First Nations communities that might be affected by or interested in a project, based on:

- location of reserves
- land claims or claims in litigation
- Indigenous or treaty rights, such as harvesting, fishing or hunting
- geographic area of the project

CHAPTER 7

MINISTRY OF MUNICIPAL AFFAIRS

7.1 Introduction

The Ministry of Municipal Affairs (MMA) administers legislation for the governance of municipalities and provides direction to municipalities for land use planning, delivery of local services and the Ontario Building Code.

The following sections provide a high-level overview of the legislation. For more specific information, contact MMA.

7.2 *Planning Act, 1990*

7.2.1 Purpose

The *Planning Act, 1990* (PA) sets ground rules for land use planning and describes how land uses may be controlled and who may control them.

7.2.2 Relevant Sections

Sections of the PA that are of interest to the engineer include:

- Provincial interest: The council of a municipality shall have regard to matters of provincial interest such as the protection of ecological systems, protection of agricultural resources and the conservation and management of natural resources. (Section 2).
- Policy statements: The minister may issue policy statements on matters relating to municipal planning that are of provincial interest (Section 3).
- Conformance with official plan: Public work and by-laws must conform to the municipality's official plan (Section 24).
- Site plan control: Municipalities have the authority to review and approve plans and drawings for development (Section 41).
- Plan of subdivision approvals: Subsection 51(24) sets out the criteria for the creation of new parcels of land through the approval of a plan of subdivision (Section 51).
- Consents: Creation of a new parcel of land by consent or severance may be considered in situations where a plan of subdivision is not necessary (Sections 53 to 55).

7.2.3 Advice to the Engineer

The PA provides authority for a municipality to make rules within their boundaries.

- Official plan: All decisions of a local council, including those for projects under the Drainage Act, 1990, must conform to its official plan.
- Zoning by-laws: These are used by many municipalities to identify the location of drainage features such as municipal drains and to regulate the setback distances for buildings or structures from a drain.

The engineer should review any specific policies and regulations of the official plan and/or zoning by-law that may apply to the proposed drain construction or improvement project.

Development under the *Planning Act, 1990* proposed in the location of an existing municipal drain may require the municipality to use the *Drainage Act, 1990* to:

- alter or relocate all or part of an existing municipal drain (*Drainage Act, 1990,* Section 78)
- abandon all or part of an existing municipal drain (*Drainage Act, 1990,* Section 84)
- update assessment schedules for existing municipal drains (*Drainage Act, 1990,* Section 65 or 76)

DID YOU KNOW? Drainage from development can be managed through either the *Drainage Act, 1990* or the site plan control process under the *Planning Act, 1990*. The engineer may be asked to provide advantages and disadvantages of the *Drainage Act, 1990* process.

7.3 Provincial Policy Statement

7.3.1 Purpose

The Provincial Policy Statement (PPS) is the statement of the government's policies on land use planning. It applies province-wide and provides clear policy direction on land use planning to promote strong communities, a strong economy and a clean and healthy environment. It includes policies on:

- the efficient use and management of land and infrastructure
- protection of the environment and resources
- ensuring appropriate opportunities for employment and residential development, including support for a mix of uses

All decisions made under the *Planning Act, 1990* by municipal councils, local and planning boards, provincial government and the Ontario Municipal Board affecting land use planning matters "shall be consistent with" the PPS.

7.3.2 *Drainage Act* Exemptions

Projects under the *Drainage Act, 1990* are not defined as "development" under the PPS and do not require approval under the *Planning Act, 1990.* Regardless of the exemption, both the municipality and the engineer should consider the intent of the PPS. Any other development proposal should consider the impacts on existing drainage works constructed under the *Drainage Act, 1990.*

7.4 Provincial Plans

Provincial plans are created under statutes to provide land use planning policies to address issues facing specific geographic areas in Ontario. Examples include the *Greenbelt Plan, Oak Ridges Moraine Plan, Lake Simcoe Protection Plan,* the *Niagara Escarpment Plan,* the *Growth Plan for the Greater Golden Horseshoe* and the *Growth Plan for Northern Ontario.*

When working in the geographical area of a provincial plan, the engineer should ensure that the proposed drain construction or improvement project conforms with or does not conflict with the provincial plan.

7.5 Provincially Significant Wetlands and the PPS

Provincially significant wetlands (PSWs) are protected through the PPS. For more information see Part C, Chapter 2.8.

CHAPTER 8

MUNICIPAL FRANCHISES ACT, 1990

8.1 Introduction

8.1.1 Purpose

The *Municipal Franchises Act, 1990* defines a franchise as the granting of a legal right, power or privilege from a level of government to a utility company (i.e., natural and other gas distributors). A franchise agreement is required between a municipality and the gas company.

8.1.2 The Model Franchise Agreement

The Model Franchise Agreement gives municipal consent to gas companies to access highways, ditches and road allowances to lay, construct, maintain, replace, remove, operate and repair a gas system for the distribution, storage and transmission of gas in and through the municipality.

The Model Franchise Agreement states that:

> *Where the gas system may affect a municipal drain, the Gas Company shall also file a copy of the Plan with the Corporation's Drainage Superintendent for purposes of the Drainage Act, or such other person designated by the Corporation as responsible for the drain.*

The Model Franchise Agreement also contains provisions for cost sharing when a utility, subject to the agreement, must be altered. This may apply to the payment of special assessments under Section 26 of the *Drainage Act, 1990.*

8.1.3 Advice to the Engineer

- For drainage work that affects a utility in a highway (public road) subject to a Franchise Agreement, the engineer should contact the municipality to obtain as-built drawings.
- The engineer, in making a Section 26 assessment, determines the assessment to the utility as usual. However, the payment of the assessment may be governed by the Franchise Agreement.

DID YOU KNOW? An example of a Model Franchise Agreement between a municipality and a gas company can be found at www.oeb.ca/documents/franmod.pdf

CHAPTER 9

FEDERAL LEGISLATION

The following sections provide a high-level overview of these acts, regulations and guidelines. For more specific information, contact the appropriate agency.

9.1 *Fisheries Act, 1985*

9.1.1 Purpose

The *Fisheries Act, 1985* (FA), administered by Fisheries and Oceans Canada (DFO), requires that fish and fish habitat are protected during all stages of a construction project (Figure C9–1). The FA prohibits the release of substances that degrade or alter water quality to the determent of fish or fish habitat.

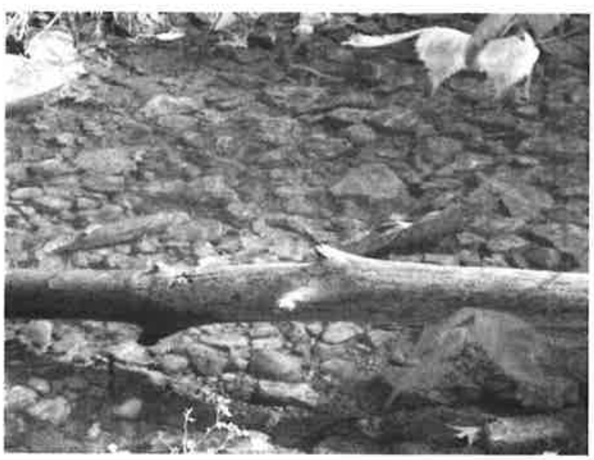


Figure C9–1. Fish habitat.

Source: Fisheries and Oceans Canada.

9.1.2 Relevant Sections

Sections of the FA that are of interest to the engineer:

- prohibition against an activity that results in serious harm to fish that are part of a commercial, recreational or aboriginal fishery or to fish that support such a fishery (Section 35(1))
- prohibition against the release of substances that degrade or alter water quality to the detriment of fish or fish habitat (Section 36(3))
- provision for flow and fish passage (Sections 20 and 21)
- authority of the Minister of Fisheries and Oceans to issue authorization, with terms and conditions, to undertake an activity (Section 35(2)(b))

9.1.3 *Fisheries Act, 1985* Application for Construction and Improvement of Drainage Works

There are three steps to follow when completing drain construction or improvement projects near water.

1. Conduct a self-assessment to determine if DFO needs to review the proposed project.
2. If it is determined that DFO needs to review the project, submit a Request for Review.
3. DFO will respond by
   - authorizing the applicant (engineer and/or municipality) to proceed; or
   - requiring the applicant to submit an Application for Authorization.

Step 1. Self-Assessment

The self-assessment will identify if a DFO review is required or not. Information for conducting a self-assessment is available at www.dfo-mpo.gc.ca.

A DFO review is not required for the following types of water bodies related to proposed drain construction or improvement project:

- Artificial water bodies that are not connected to another water body containing fish. These artificial water bodies include:
    - private ponds
    - commercial ponds (e.g., golf course ponds, stocked fish ponds)
    - stormwater management ponds
    - irrigation ponds or channels
    - agricultural drains and drainage ditches
    - roadside drainage ditches
    - quarries and aggregate pits
- Any other water body that does not contain fish at any time during any given year and is not connected to a water body that contains fish at any time during any given year.

Note: Most municipal drains either contain fish or are connected to other municipal drains or natural watercourses that do have fish.

The self-assessment should identify proposed drain construction or improvement activities and criteria that may not require DFO review. These include:

- bridge repairs
- culvert repairs, replacement or removal
- construction of stormwater management facilities/basins
- water outfall construction or repair
- construction and routine cleaning of drainage channels
- bank stabilization
- aquatic vegetation removal
- repairs to dykes and berms
- repairs to of dams and weirs
- habitat restoration
- beaver dam removal

Confirm the specific activity and criteria are identified in the comprehensive list on the DFO website (www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html).

Step 2. Request a Project Review

When the self-assessment indicates a review by DFO is required, retain the services of a qualified environmental professional. Complete and submit the project for review using the Request for Review application form and guide, available at www.dfo-mpo.gc.ca/pnw-ppe/reviews-revues/index-eng.html.

Upon receipt of the Request for Review, DFO may:

- request the engineer to supply additional information such as mapping and photos (e.g., aerial, site)
- advise no further review is necessary
- issue a letter of advice with conditions
- request the submission of an application for authorization

Step 3. Application for Authorization

If DFO determines that the project will cause serious harm to fish that are part of or that support a commercial, recreational or Aboriginal fishery, submit an application for authorization (Section 35(2)(b)). The application form and guidance on how to fill out the form are available at www.dfo-mpo.gc.ca (search for "Guidance Documents").

If a project must be conducted without delay in response to an emergency such as a risk to public health, safety, the environment or property, apply for an Emergency Authorization.

Use the Application Forms for Authorization (Normal or Emergency Circumstances) and *Applicant's Guide* to apply for a project authorization, and email the application to FisheriesProtection@dfo-mpo.gc.ca.

An application must include the following:

- contact information
- description of proposed work, undertaking or activity
- timeline

- location
- description of fish and fish habitat (aquatic environment)
- description of effects on fish and fish habitat
- measures and standards to avoid or mitigate serious harm to fish, including restricted activity timing windows
- residual serious harm to fish after implementation of avoidance and mitigation measures and standards
- an offsetting plan if harm cannot be avoided or mitigated and there is an application for a project authorization
  - The objective of offsetting is to counterbalance unavoidable serious harm to fish and the loss of fisheries productivity resulting from a project. Offsetting measures support and enhance the sustainability and ongoing productivity of fish that are part of or support a commercial, recreational or aboriginal fishery.
- a Letter of Credit to provide a financial assurance mechanism in the event that an offsetting plan is not completed
  - DFO may draw upon the funds to ensure the offsetting plan is completed.

Restricted activity timing windows are applied to protect fish from impacts of works in and around water during spawning migrations and other critical life-history stages. Timing windows vary depending on the water body, species of fish and geographic location. The engineer can expect that any approvals or authorization granted will restrict drainage works activities if proposed in these timing windows.

In Ontario, the Ministry of Natural Resources and Forestry (MNRF) has the responsibility for setting timing window guidelines. *In-Water Work Timing Window Guidelines* are available at ontario.ca and search for "timing windows."

9.1.4 Advice to the Engineer

- The *Fisheries Act, 1985* will apply to most drainage projects, and almost all channel projects will require some form of authorization.
- Consult a professional for assistance with the Application for Authorization, including avoidance, mitigation and offsetting measures.
- Do not begin work unless there is a letter of advice stating no further review is required or an authorization is received.
- Comply with the conditions of the authorization, including timing windows during construction.

9.2 *Species at Risk Act, 2002*

9.2.1 Purpose

The purposes of the *Species at Risk Act, 2002* (SARA) are to prevent wildlife species in Canada from disappearing; to provide for the recovery of wildlife species that are extirpated (no longer exist in the wild in Canada), endangered or threatened as a result of human activity; and to manage species of special concern to prevent them from becoming endangered or threatened (Figure C9–2). SARA is administered by several federal agencies depending upon the type and location of the species.

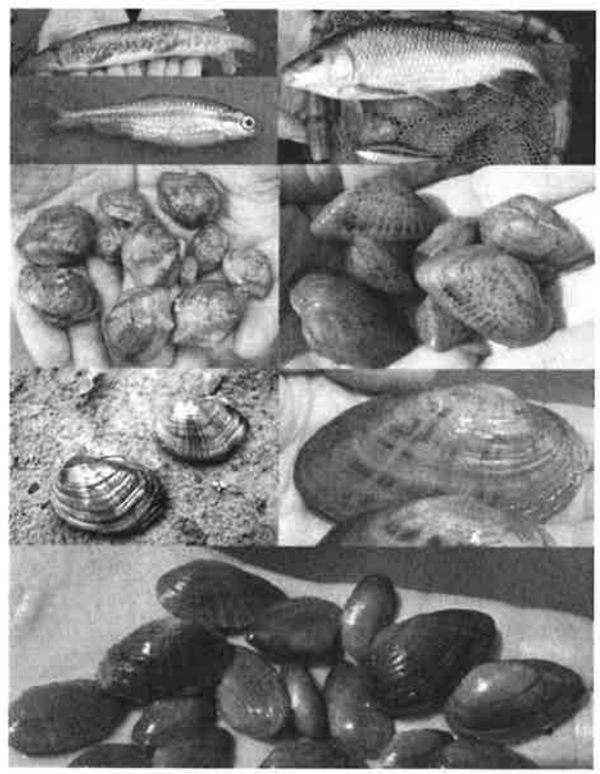


Figure C9–2. Some of the Canadian wildlife species that are protected.

Source: Fisheries and Oceans Canada.

SARA applies to:

- federal lands, including national parks, national marine conservation areas, national historic sites and other protected heritage areas administered by Parks Canada
- provincial and territorial lands and waters for some species protected under the *Migratory Birds Convention Act, 1994* or aquatic species as defined in the *Fisheries Act, 1985*
- provincial or territorial lands on the order of the federal government

9.2.2 Relevant Sections

Sections of SARA of interest to the engineer:

- prohibition against killing or harming an extirpated, endangered or threatened species listed under SARA (Section 32)
- prohibition against damaging or destruction of the residence of an endangered or threatened species listed under SARA (Section 33)
- prohibition against destruction of critical habitat once it is defined in a recovery strategy or action plan (Section 58)
- authority of the minister to permit a person to engage in an activity that affects a wildlife species, its habitat or residences, subject to specified conditions (Section 73)
- a list of extirpated, endangered and threatened species (Schedule 1)

DID YOU KNOW? A list of extirpated, endangered and threatened species is available on the Species at Risk Public Registry at www.sararegistry.gc.ca. The site provides detailed species information including photos, descriptions, biology, habitat, threats, etc.

9.2.3 SARA Permitting for Wildlife Species (Including Aquatic Species)

A SARA permit is required for project activities that may cause incidental harm to a species at risk or its critical habitat or for project activities where any contravention of Sections 32, 33 or 58 may occur.

A biologist may be required to conduct field surveys to detect species at risk and their critical habitat to augment the permit application.

A permit under Section 73 of SARA can be issued if:

- the activity is scientific research related to the conservation of the species at risk
- the activity benefits the species and enhances its chances of survival
- affecting the species is incidental in carrying out the activity
- all reasonable alternatives have been considered
- all feasible measures will be taken to minimize the impact of the activity
- the activity will not jeopardize the survival of the species

A SARA permit application is available at www.sararegistry.gc.ca.

When a proposed drain construction or improvement project may impact a species protected by SARA, contact:

- Canadian Wildlife Service for migratory birds and terrestrial species (except those on Parks Canada lands)
- Fisheries and Oceans Canada (DFO; 1-855-852-8320 or by email at FisheriesProtection@dfo-mpo.gc.ca) for all aquatic species (fishes and mussels) (Part C, Chapter 9.1)
- Parks Canada for species on their lands (Part C, Chapter 9.6)
- Environment and Climate Change Canada for species covered by federal order

9.2.4 SARA and ESA Coordination for Aquatic Species

In Ontario, the *Endangered Species Act, 2007* (ESA) gives the Ministry of Natural Resources and Forestry (MNRF) the first opportunity to protect species and critical habitat found on non-federal lands (Part C, Chapter 2.3). ESA and SARA provide similar protection for aquatic species. Check with DFO and MNRF on the interagency coordination.

9.2.5 SARA and *Fisheries Act, 1985* (FA) Coordination for Aquatic Species

Fisheries and Oceans Canada is responsible for the administration of the *Species at Risk Act, 2002* for aquatic species that are at risk. To coordinate this review with the *Fisheries Act, 1985:*

- Check the DFO SAR list of species, maps and guidance documents to determine if species at risk and/or critical habitat are present (www.dfo-mpo.gc.ca/species-especes/fpp-ppp/index-eng.htm).
- If species at risk and/or critical habitat are present, submit a Request for Review Form which can be found on DFO's website (www.dfo-mpo.gc.ca/pnw-ppe/reviews-revues/index-eng.html) to DFO-Fisheries Protection Program (DFO-FPP) at FisheriesProtection@dfo-mpo.gc.ca.
- If there are no species at risk and/or critical habitat, complete a self-assessment using the guidance on DFO's website to determine if a *Fisheries Act, 1985* review is needed.
- If an authorization is required under the *Fisheries Act, 1985* or a permit is required under SARA, DFO will let you know which permit/authorization application needs to be completed.
- If a permit or authorization is required, DFO's Fisheries Protection Program is regulated to follow set timelines that are identified in FA and SARA regulations and will be outlined in its response to the applicant.
- All project reviews for a proposed drain construction or improvement project are completed by DFO's Fisheries Protection Program.

9.2.6 Design Considerations for Aquatic Species at Risk

Evaluate the impact the drain will have on the species at risk.

- Review the recovery strategies and mitigation guides for the species at risk (www.sararegistry.gc.ca).
- Target mitigation to species at risk that are present (e.g., life history characteristics and habitat requirements). Examples of mitigation options are:
  - redesigning a portion of the drain (e.g., from a low level crossing to a spanning bridge)
  - installing sediment and erosion control
  - salvaging fish and relocating mussels (permits required)

9.2.7 Advice to the Engineer

- Obtain and review lists of species at risk, mapping, recovery strategies and mitigation guides.
- If species at risk or critical habitat are impacted, a SARA permit is required.
- If it appears aquatic species at risk, their habitat or residence may be impacted.
  - For aquatic species, check with the approval agencies to see if permitting can be coordinated with the ESA and/or the *Fisheries Act, 1985.*
  - Consider hiring a qualified professional (i.e., biologist).

9.3 *Migratory Birds Convention Act, 1994*

9.3.1 Purpose

The *Migratory Birds Convention Act, 1994* (MBCA) provides for the protection of migratory birds, their eggs and their nests. It is administered by Environment and Climate Change Canada (ECCC).

9.3.2 Relevant Sections

Sections of the MBCA that are of interest to the engineer include:

- prohibition against the deposition of substances harmful to migratory birds (Section 5)

Sections of the Migratory Birds Regulations (C.R.C., c. 1035) that are of interest to the engineer include:

- The minister may issue a permit, with conditions, for disturbing migratory birds (Section 4).
- It is an offence to "disturb, destroy or take a nest, egg, nest shelter, eider duck shelter or duck box of a migratory bird" (Section 6).9.3.3 Advice to the Engineer

9.3.3 Advice to the Engineer

The disturbance or destruction of migratory birds, their eggs and their nests is prohibited unless a permit is obtained. The list of migratory birds is found at www.ec.gc.ca/nature (Figure C9–3).

Pintail Duck	Swainson's Hawk	Great Blue Heron	White-breasted Nuthatch

Figure C9–3. Examples of migratory birds.

Source: Shutterstock.

When it is determined migratory birds could be impacted, plan for the proposed drain construction or improvement project to be completed outside the restricted time periods defined by ECCC. General nesting periods of migratory birds in Canada are defined at www.ec.gc.ca/nature (search for "nesting periods").

If site alteration needs to occur during the restricted period:

- In most cases, active nest searches are not recommended because of the low probability of detection and the high risk of disturbance. If nest searches are conducted to identify and locate active nests and evidence of breeding activities, have a qualified professional (i.e., avian biologist) conduct a nest survey using non-intrusive search methods to prevent disturbance to migratory birds prior to construction activities.
- Develop a mitigation plan to address any potential impacts on migratory birds or their active nests. Mitigation may require establishing appropriate buffers around active nests or delaying construction activities until the conclusion of the nesting season.

ECCC maintains 10 national wildlife areas (NWAs) and nine migratory bird sanctuaries (MBSs) in Ontario, comprising over 32,000 hectares of the province's protected lands and waters. See the government of Canada web page on protected areas (www.canada.ca/en/services/environment/conservation/protected-areas) to learn more.

If a drain construction or improvement project is proposed in an NWA or in an MBS located on federal lands, a permit is required from ECCC to authorize the start of the project. The permit will be issued only if ECCC is of the opinion that the project:

- will benefit wildlife and their habitat, or
- is not inconsistent with the purpose for which the protected area was established, and
- is consistent with the most recent management plan for the protected area.

In the case of a project in an MBS located on non-federal lands, if the project has potential impacts on birds, eggs and nests, the process described above would apply. If the project has potential impacts related to habitat disturbance, the Chief Game Officer of Ontario is the official authority able to grant permission to start the project.

9.4 *Canadian Environmental Assessment Act, 2012*

9.4.1 Purpose

The *Canadian Environmental Assessment Act, 2012* (CEAA) sets out the responsibilities and procedures for carrying out environmental assessments of projects. It is administered by the Canadian Environmental Assessment Agency. Under CEAA, a federal environmental assessment may be required when a project has the potential to cause environmental effects that are within federal jurisdiction. These effects include changes to fish or fish habitat, aquatic species, or migratory birds, as well as changes to the environment that occur on federal lands, cross boundaries or have specific effects on Indigenous peoples.

9.4.2 Relevant Sections

Sections of the CEAA of interest to the engineer:

- definitions (Section 2(1))
- purpose of the CEAA — to protect the components of the environment from significant adverse effects caused by a designated project (Section 4(1))
- application of the CEAA, including:
  - environmental effects for a designated project including fish and fish habitat, aquatic species and migratory birds (Section 5(1)(a))
  - projects on federal lands (Section 5(1)(b))
  - projects affecting aboriginal peoples (Section 5(1)(c))
- requirement to provide a description of the designated project (Section 8(1))
- requirements for projects on federal lands that are not designated projects (Section 67)
- authority to make regulations defining designated projects (Section 84(a))

9.4.3 Regulations Designating Physical Activities, SOR/2012-147

Sections of these regulations of interest to the engineer

- definitions (Section 1)
- authority to set out a schedule defining designated projects (Section 2)
- designated projects, as defined in the schedule, which may pertain to municipal drains, including:
  - the construction, operation, decommissioning and abandonment of a new dam or dyke that results in the creation of a reservoir with a surface area that exceeds the annual mean surface area of a natural water body by 1,500 ha or more (Schedule Section 4)
  - the expansion of an existing dam or dyke that results in an increase in the surface area of the existing reservoir of 50% or more and an increase of 1,500 ha or more in the annual mean surface area of the existing reservoir (Schedule Section 5)
  - the construction, operation, decommissioning and abandonment of a new structure for the diversion of 10,000,000 m^3/yr or more of water from a natural water body into another natural water body (Schedule Section 6)
  - the expansion of an existing structure for the diversion of water from a natural water body into another natural water body that results in an increase in diversion capacity of 50% or more and a total diversion capacity of 10,000,000 m^3/year or more (Schedule Section 7)
  - the construction, operation, decommissioning and abandonment of a new:
    - canal or lock or associated structure to control water levels in the canal (Schedule Section 24(a))
    - lock or associated structure to control water levels in existing navigable waterways (Schedule Section 24(b))

Note: The Minister of the Environment and Climate Change may also decide that an environmental assessment is required for a project not listed in the Regulations.

9.4.4 Advice to the Engineer

The CEAA protects the environment from significant adverse effects caused by a designated project. Most *Drainage Act, 1990* projects are not designated projects under the CEAA.

Determine if the project is a designated project, is on federal lands or impacts aboriginal peoples. Review the Canadian Environmental Assessment Agency website www.ceaa.gc.ca for:

- an overview *Canadian Environmental Assessment Act, 2012*
- the CEAA flowchart entitled Environmental Assessment Process Managed by the Agency
- policy and guidance documents

If CEAA applies to the project:

- Discuss with the agency the work to be undertaken and the process for getting CEAA approval.
- Engage the services of qualified experts to assist.
- Consult the CEAA guidance documents for details on the process and requirements.

9.5 *Navigation Protection Act, 1985*

9.5.1 Purpose

The *Navigation Protection Act, 1985* (NPA), administered by Transport Canada, prohibits works in a variety of forms that may impact navigable waters, unless the works have been approved by the minister. The NPA came into force in 2014, based on amendments to the *Navigable Waters Protection Act (NWPA), 1985.*

9.5.2 Relevant Sections

Sections of NPA of interest to the engineer:

- The definition of work includes any structure, device or thing, whether temporary or permanent, that is made by humans. It also includes the dumping of fill or the excavation of materials from the bed of any navigable water (Section 2).
- Work that impacts a navigable water listed in the Schedule is prohibited (Section 3).
- Notice must be given to the minister for work that impacts a navigable water listed in the Schedule (Section 5).
- Approval is required to do work that impacts a navigable water listed in the Schedule (Section 6).
- In most cases, depositing material in navigable waters or dewatering navigable waters is prohibited (Sections 21–26).
- Any work previously approved under the NWPA remains subject to the NPA, and a Notice of Work is to be submitted prior to the commencement of any work regardless of whether the waterway is found on the schedule to the NPA (Section 332(1) and (4)).
- Any works deemed minor works under the NWPA are also considered minor works under the NPA and all the corresponding conditions apply, until an order is made under the NPA (Section 334).
- Navigable lakes and rivers are listed in the schedule.

9.5.3 Approvals

If works (e.g., bridges and dams) that may impact a waterway listed in the schedule or a work subject to the NPA by 332(1) or (4) are proposed, the proponent must apply to the Transport Canada Navigation Protection Program (www.tc.gc.ca).

Construction of new dams, bridges and other projects are permitted on non-scheduled waterways without NPA approval (Figure C9–4).

Figure C9–4. A large-diameter culvert on a non-listed waterway.

Source: Tulloch Engineering, Espanola, Ontario.

The Minor Works Order allows for works to be built in navigable waters if they meet the criteria for the applicable class of works, as well as specific terms and conditions for construction. Contact the Ontario Region office of Transport Canada to determine the assessment criteria for the applicable class of work and for the specific terms and conditions for construction.

The classes of works established by the Minor Works Order include:

- erosion protection works
- docks and boathouses
- boat ramps, slipways and launch ramps
- aerial cables — power and telecommunication
- submarine cables — power and telecommunication
- pipelines buried under the bed of navigable water
- pipelines and power communication cables attached to existing works

- works within a boomed-off area upstream or downstream of an existing work for water control
- outfalls and water intakes
- dredging
- mooring systems

Notice to the minister is not required for work meeting the assessment criteria under the Minor Works Order. It is the responsibility of the owner of the work to assess the work to ensure that it meets the criteria established for its class and to ensure that all legal requirements set out in the order are met.

9.5.4 Advice to the Engineer

- Determine if the project is subject to the NPA (listed in the schedule or previously approved under the NWPA).
- If the drainage works is not subject to the NPA, then NPA approval is not required.
- If the drainage works is subject to the NPA:
  - Determine if the class of work is listed in the Minor Work Order.
  - If the work meets the assessment criteria, specific terms and conditions, complete the work under the minor work order.
  - If the work does not meet the assessment criteria, complete and submit a Notice of Works package to Transport Canada, Navigation Protection Program.
- If assistance is required, contact the Ontario Region office of Transport Canada.

9.6 *Canada National Parks Act, 2000*

9.6.1 Purpose

The *Canadian National Parks Act, 2000* regulates activities on Parks Canada lands. It is administered by Environment and Climate Change Canada through Parks Canada (www.pc.gc.ca).

9.6.2 Advice to the Engineer

If a proposed drain construction or improvement project involves Parks Canada lands, contact the superintendent of the particular park. Parks Canada may enter into an agreement with the municipality to allow for the construction of a drainage works on their land.

CHAPTER 10

AGENCY STAKEHOLDERS

Proposed drain construction or improvement projects often involve multiple stakeholders such as the companies and agencies that operate railways, high-pressure transmission pipelines, telecommunication conduits and electricity transmission and distribution systems (Figures C10–1 and 10–2).

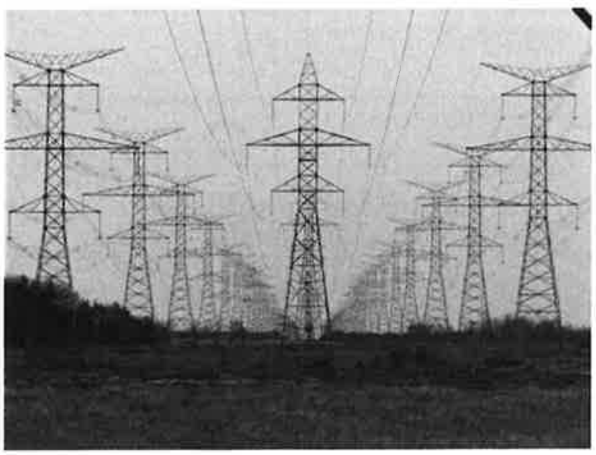


Figure C10–1. Large electricity transmission towers.

Figure C10–2. Utility markers near a drain.

These stakeholders are considered public utilities under the *Drainage Act, 1990.* As such, the engineer is obligated to assess the public utility for the increase in cost of the drainage system caused by the public utility (Section 26 and Part A, Chapter 9.3.4).

There may be debate over who pays these additional costs because of:

- the application of the provincial *Drainage Act, 1990* to federally chartered bodies
- franchise agreements (Part C, Chapter 8)
- the provisions of the *Public Service Works on Highways Act, 1990*
- municipal access agreements under the federal *Telecommunications Act, 1996*

It is the duty of the municipality, in consultation with the stakeholder, to determine how the assessment will be paid.

10.1 Railways

10.1.1 General

The *Drainage Act, 1990* definition of a public utility includes railways. The design and construction of a drainage works can affect, or be affected by, a railway line. Drainage works may cross or be constructed parallel to railway lines.

Railways that cross provincial or federal boundaries are regulated by Transport Canada through the *Railway Safety Act, 1985* and the *Canadian Transportation Act, 1996*. These include the two major freight-carrying railways (Canadian National Railway (CN) and Canadian Pacific Railway (CP)); the passenger rail company, VIA; and some short-line companies.

Railways that operate entirely within Ontario are regulated by the Ministry of Transportation through the *Shortline Railways Act, 1995* and the *Metrolinx Act, 2006*, etc.

10.1.2 Advice to the Engineer

Determine the ownership of the railway affected by the proposed drain construction or improvement project and contact them (www.railcan.ca/who-we-are/rac-members note: the list may not be complete).

Crossings of Federally Regulated Railways

There is no legislative procedure for the design and construction of railway crossings. The following is based on communications with representatives of CN and CP:

- Review the applicable railway company guidelines.
- Complete an on-line contractor orientation course prior to any entry (by engineer, municipality and/or contractor) onto the railway right-of-way.
- Provide the railway company with the option to do the work themselves (Section 69(1) of the *Drainage Act, 1990)*.
- Prepare hydrology calculations for 5-, 10-, 50- and 100-year storm events.
- Work with the railway contact to determine the final crossing size.
- Apply specific railway company specifications.
- Provide a geotechnical report on any tunnelling type of project, where applicable.
- Ensure the contractor fills out and submits a work permit application to the railway.
- If a disagreement occurs with the railway company during the design process, conduct a peer review or use the appeal provisions of the *Canadian Transportation Act, 1996.*
- When the project has been completed, submit as-built information to the railway company.

When dealing with other railway companies, review their specific guidelines and procedures.

Crossings of Provincially Regulated Railways

Determine if the provincially regulated railway owns or leases the tracks:

- If they own their own track, follow the process from the provincially regulated railway involved.
- If they lease the track, follow the process of the track's owner and ensure all communication is copied to both the railway and the owner of the tracks.

10.1.3 Resources

- Contractor orientation (www.e-railsafecanada.com)
- TC E-10 Standards respecting pipeline crossings under railways (www.tc.gc.ca)

10.2 High-Pressure Transmission Pipelines

10.2.1 General

The *Drainage Act, 1990* definition of a public utility includes pipelines. The design and construction of a drainage works can affect, or be affected by, a high-pressure (HP) petroleum or natural gas transmission pipeline. Drainage works may cross or be constructed parallel to HP pipelines.

An existing interprovincial pipeline that transports gas or oil across the province (constructed under CSA Code Z662 and/or National Energy Board approval) is defined as an HP pipeline. Drainage works that cross small-diameter urban or rural distribution gas lines are discussed in Part C, Chapter 8 *Municipal Franchises Act, 1990.*

The Canadian Standards Association document *Land Use Planning for Pipelines* (Plus 663) recommends that whenever construction is proposed within 200 m of a pipeline, the municipality or engineer must notify the pipeline company.

10.2.2 High-Pressure Transmission Pipeline Companies

The common high-pressure transmission pipeline companies that operate in Ontario are:

- Canada Fuels Operations, Imperial (formerly Sarnia Products Pipeline Ltd.)
- Enbridge Pipelines Inc. (formerly Interprovincial Pipe Line Ltd.)
- Enbridge Gas Distribution (formerly Consumer Gas)
- Enbridge Gas Storage (formerly Niagara Gas Transmission)
- Pembina (former Dow facilities)
- Plains Midstream Ltd (formerly Dome Petroleum, BP Canada Energy)
- Sun-Canadian Pipe Line Company
- SCL Pipeline Inc. c/o Shell Canada Ltd.
- TransCanada Pipelines Ltd.
- Trans-Northern Pipelines Inc.
- Union Gas Limited

The complete list of pipelines regulated by the National Energy Board is found at www.neb-one.gc.ca.

10.2.3 Advice to the Engineer

When an existing high-pressure pipeline is in the watershed of a proposed drainage works:

- Determine the existence and location (e.g., mapping) of any transmission pipeline.
- Review the site of the specific drainage works for any field markings of a pipeline that is indicated by mapping.
- Contact the pipeline company and obtain available as-constructed information (e.g., number of lines, diameters, right-of-way widths, approximate average depths, plans for future additional installations, etc.).
- Determine if exposure of the pipelines is required to confirm location and elevation.
- Each pipeline company will have their own specific requirements. The engineer should confirm the application process and crossing guidelines with each company. The National Energy Board also provides general pipeline crossing regulations, which should be considered in the discussions with any pipeline company.
- Provide detailed information about the proposed drainage works to the pipeline company.
- Decide whether the physical locates will be done prior to design completion or during actual construction.
- Determine if it is more economical to adjust the drainage works or the pipeline.
- In consultation with the pipeline company, determine if the drainage works or the pipeline will be adjusted:
  - If the drainage works is adjusted, the materials and construction methods normally used may require alteration.
  - Where the drainage works cannot be realistically altered, request the pipeline company to alter the pipeline. All alterations to a pipeline must be completed by the pipeline company.
- Finalize the work to be done to accommodate the drainage works with the pipeline company and submit all drawings and specifications for approval.
- If required, execute a standard or master agreement with the pipeline company. The *National Energy Board Act, 1998* (Section 112) provides the authorization for these agreements.
- Finalize the drainage report and ensure the report is sent to the pipeline company.
- At the time of tendering, communicate with the pipeline company regarding final details of the work including timing, revised costing, method of construction, access, working limits, temporary protection, environmental measures, notification, on-site inspections, clean-up, restoration, etc.
- Consider any necessary addendums to the agreement.
- After construction, provide as-built information to the pipeline company.

10.2.4 Example of Guidelines for High-Pressure Transmission Lines Crossings

Enbridge's provides a document entitled *Guidelines for Crossing Applications,* which contains application procedures, drawing requirements and typical clearance and offset requirements for Enbridge transmission pipelines.

10.2.5 Resources

Third Party Requirements in the Vicinity of Natural Gas Facilities, Enbridge Gas, 2015.

Guideline for Excavation in the Vicinity of Utility Lines, December 2008.

10.3 Telecommunication Conduits

10.3.1 General

Telecommunication (telecom) companies (e.g., Bell Canada, Rogers) are considered public utilities under the *Drainage Act, 1990.* The design and construction of a drainage works can affect, or be affected by, a buried or overhead line, cable or conduit (referred to as a "plant"). Drainage works that cross small, buried services do not normally cause conflicts requiring the alteration of drainage works or a telecom plant. However, exposure and protection steps are necessary when crossing or working in close proximity to any buried plant. Part B, Chapter 10.11 presents the drainage design impacts that may result from buried utilities.

10.3.2 Advice to the Engineer

Most plants encountered in rural Ontario are owned by Bell Canada. The following is based on the requirements of Bell Canada when a telecom plant is in the watershed of a proposed drainage works:

- Determine the existence and general location of any telecom plant from the municipality.
- Record the exact locations of the plants onto the drainage plan using the information provided by the telecom company.
- If a buried conduit is in the area of the proposed drain location, it may need to be exposed to verify its actual location. The telecom company may want to provide an on-site inspector to watch over any excavation activities and ensure that the plant is protected at all times. They may also require excavating by hand within a specified distance of the markings.
- After determining the location of the plant, one of the following possible outcomes is developed in consultation with the telecom company:
  a) No change is required to the conduit or the drain design.
  b) The conduit requires protection only. Determine any requirements regarding separation between the conduit and the drainage works, conduit support, conduit bedding and backfill, etc.
  c) The drainage works design and/or conduit requires adjustment.
- For outcome c) determine if adjustments are required to the drainage works design or the conduit or both:
  - Determine which of the systems is more economical to adjust.
  - If the drainage works is adjusted, the materials and construction methods normally used may require alteration.
  - Where the drainage works cannot be realistically altered, request the telecom company alter the plant.
- Submit the engineering report, including work to be done and costs, to the telecom company.
- If required, coordinate the alteration of the telecom plant into the drain construction schedule.
- After construction, provide as-built information to the telecom company.

Check the specific conduit requirements when a proposed drain construction or improvement project impacts the plants of other telecommunication companies.

10.4 Electricity Transmission and Distribution

10.4.1 General

In Ontario, 97% of electricity transmission systems and 75% of electricity distribution systems are owned and operated by Hydro One. There are, however, close to 100 local distribution companies. Electricity transmission and distribution companies are considered public utilities under the *Drainage Act, 1990.*

The design and construction of a drainage system can affect, or be affected by, a line, pole or conduit (referred to as the "plant") of an electricity company. Drainage systems that cross small, buried electrical service wires do not normally cause conflicts requiring the alteration of drainage systems or of the electrical plant. However, exposure and/or protection steps are necessary, as a minimum, when crossing or working in close proximity to an electrical transmission or distribution plant.

If a pole line or cable, including underground wires, is on a public right-of-way or on an easement in favour of the electricity company, its physical presence creates a right to have it remain for all times. This includes the right of the company to maintain this line or lines.

10.4.2 Advice to the Engineer

When the design of a drainage works will impact the plant of an electric company:

- Determine the existence of all electrical transmission and distribution lines and note their exact location on plans and field notes. It may be wise to identify every pole and anchor.
- Determine from the municipality the ownership of the distribution company involved and the company contact.
- When a Hydro One plant is encountered that may create a conflict, contact Hydro One.
    - If a pole needs to be moved or supported for structural integrity, the engineer should develop a proposal (include a drawing) and make a request for authorization.
    - Hydro One may want to provide an "on-site" inspector to watch over any excavation/construction activities and ensure that the plant is protected at all times.
- When plants of other distribution companies are encountered, contact the company (www.ieso.ca search for "Find Your Local Distribution Company").

DID YOU KNOW? The *Ontario Underground Infrastructure Notification System Act, 2012* requires that all utility companies are members of Ontario One Call (1-800-400-2255). All excavations require locates, and companies will provide them for engineering purposes free of charge.

ontario.ca/omafra

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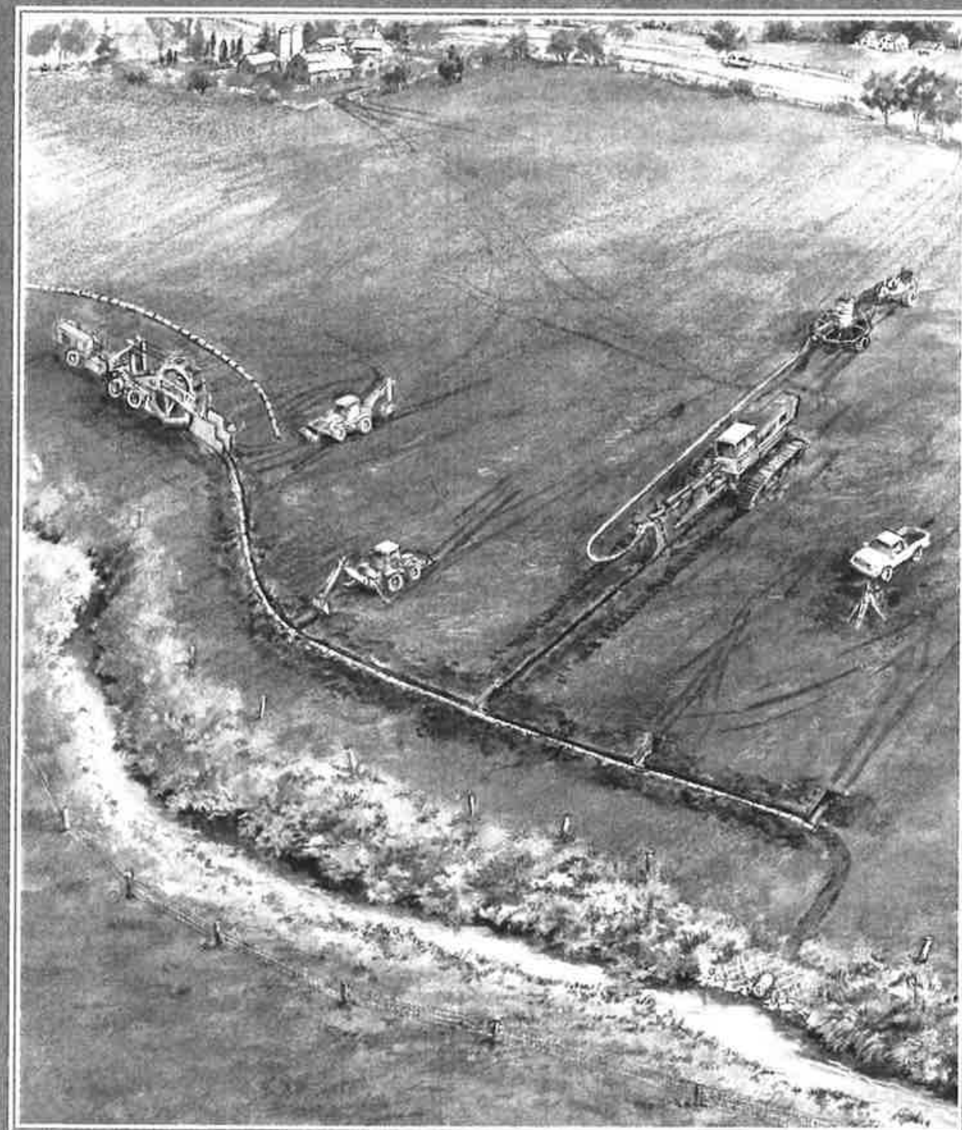
Lynn Kalp Digitally signed by Lynn Kalp Date: 2024.04.02 13:53:44 -04'00'

A COMMISSIONER FOR TAKING AFFIDAVITS (or as may be)

Linda Marie Kalp, a Commissioner, etc.
Province of Ontario, for the
Municipality of Chatham-Kent.
Expires August 31, 2026.

Ontario

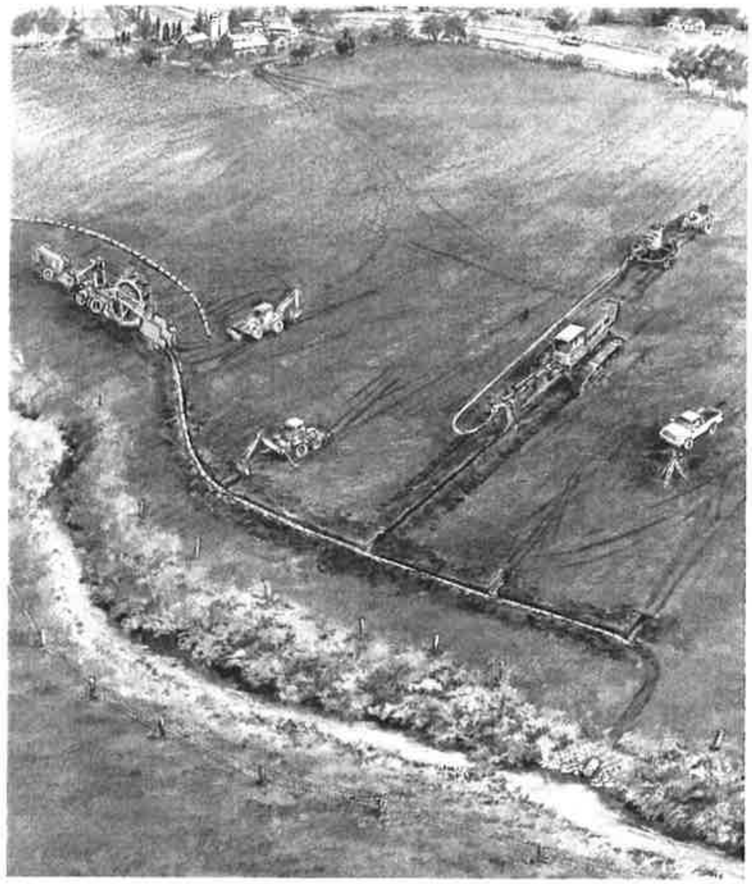


DRAINAGE GUIDE FOR ONTARIO

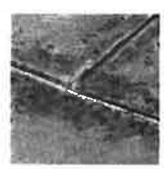
PUBLICATION 29

MINISTRY OF AGRICULTURE, FOOD AND RURAL AFFAIRS

Ontario





DRAINAGE GUIDE FOR ONTARIO

PUBLICATION 29

Editor

Sid Vander Veen, P. Eng., Drainage Coordinator
Ontario Ministry of Agriculture, Food and Rural Affairs

Acknowledgements

The first edition of the *Drainage Guide for Ontario* was authored in 1957 by Ross W. Irwin, professor at the University of Guelph. He also coordinated several subsequent updates to the guide. Through research and extension to farmers, contractors and practicing drainage engineers, Professor Irwin advanced the art and science of soil water management and drainage throughout Ontario and the humid regions of the United States. He's a member of the Ontario Agricultural Hall of Fame and a recent inductee into the International Drainage Hall of Fame established in the Agricultural Engineering Department at Ohio State University.

The 2007 revision to the Drainage Guide was coordinated by the following team:

Ross Irwin, professor emeritus, University of Guelph, Steve Cronsberry, president, Land Improvement Contractors of Ontario and the following Ontario Ministry of Agriculture, Food and Rural Affairs staff: Valerie Anderson, Doug Aspinall, Andy Kester, Jim Myslik, P. Eng., Arlene Robertson and David Rouleau.

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Brief History of the Drainage Guide for Ontario

First published in 1957, this is the eighth edition of the Drainage Guide. Here's a brief look at the development of the guide over the past 50 years.

1956 – Responsibility for the design of tile drainage systems transfers from the Ontario Agricultural College (OAC) to the new engineering service of the Ontario Department of Agriculture Extension Branch, and brings a new opportunity for branch staff.

1957 – OAC produces the first *Drainage Guide for Ontario* in 24-page mimeo form, based on the American Society of Agricultural Engineers *Tentative Recommendation for the Design and Construction of Tile Drains in Humid Areas.*

1960 – Publication 29, *Drainage Guide for Ontario*, joins the list of publications produced by the Department, and includes 256 soil types.

1966 – A revised guide includes specifications for pipe substitutes when clay and concrete tile are in short supply.

1973 – This edition includes a significant number of revisions and is printed in the new A-4 format. With 275 soils, the guide includes the Ontario Farm Drainage Association (OFDA) standards of construction and the voluntary quality control of the new plastic pipe. The design code is upgraded for internal drainage of the soil and touches on subsoil stoniness of economic interest to drainage contractors. The material section is enlarged and ASTM standards of quality tables are included. Outlet pipes are now specified to replace old hot water tanks. Pipeline crossings are included, and plastic tubing is barely mentioned as grading is still done with grade stakes. By 1973, OFDA contractors upgraded their ability to design tile systems through courses, and there's a steady transfer of licensing and tile design to contractors.

1976 – The guide now contains the technical information for the regulations to the *Agricultural Tile Drain Installation Act, 1990.* The same design code and soil list is included, with emphasis on calculation of discharge and drain size. The construction section becomes a standard rather than a how-to section.

1984 – The guide goes metric. Improvements based on new research and the present system of soil classification are added, with little similarity to the old, and based on the Canada Land Inventory. There were now 309 soils types, and an improved method for calculating drain pipe diameter.

1986 – Surface drainage and sub-irrigation are now recognized in the guide. Other additions include a revised construction section, technical information for calculating drain spacing and a procedure for examining a soil profile. This edition is also printed in French.

2007 – This current revision reflects changes in agricultural land management and environmental awareness, and also includes soils for northern Ontario. As with all revisions, the 2007 guide was reviewed and revised by a team of dedicated professionals.




Contents










Figures




1. General

1.1 Purpose

The *Drainage Guide for Ontario* (guide) is the technical reference document for the regulations to the *Agricultural Tile Drainage Installation Act, 1990.* It's also designed as a useful guide for licensed drainage contractors, drainage superintendents, drainage engineers, agricultural engineers, and others interested in the planning, design, inspection and proper construction of agricultural drainage systems, and/or as a basis for writing specifications. Landowners, farm operators and others looking for an understanding of drainage system design, water management and construction technology may also find the information useful.

Recommendations in this guide are specific to the province of Ontario, general in nature and serve as guidelines for designers of agricultural subsurface drainage systems. The guide doesn't eliminate the need for further on-site enquiries into soil conditions, land topography, crops to be grown and economics of investment. Modifications may be required to adapt recommendations to local conditions and current or future tillage practices. Recommendations in this guide are based on the assumption that adequate outlets exist or can be provided.

The guide will be revised and updated as new information becomes available.

1.2 Landowner Responsibilities

Drainage contractors are responsible for ensuring the drainage system is professionally designed and pipe materials installed will allow entry of water into the pipe and convey it to the outlet. Landowners, and not contractors, are responsible for the following items:

Outlet

Before installing a tile drainage system, secure a legal outlet for the system – a location where collected water can be legally discharged without adversely affecting downstream landowners. An outlet may include:

- natural watercourses
- municipal drains
- agreement drains

Obtain agreement (written permission) for outlets in the following cases:

- if property of another landowner is crossed to outlet into a municipal drain or watercourse, from lower landowner(s)
- for outlets into a private drain, road ditch or tile located on a neighbouring property
- for connections into a municipal drain, from the local municipality

Soil Response

Landowners are responsible for ensuring soil responds to tile drainage. Soil may contain chemicals that adversely affect the long-term performance of tile drains. Some farm practices adversely affect the vertical flow of water into the soil profile. Poor subsurface drainage can result from soil compaction, particularly in high traffic areas such as vineyards where soil may already be compacted, inhibiting movement of water through the soil to the tile. Contractors may provide advice to landowners on ways to improve soil drainage. Continuous cash cropping often creates a denser soil layer, reducing the efficiency of subsurface drains. Maintaining and building organic matter in the soil improves soil structure and keeps soil permeable so excess water can readily reach the drain.

Permits

The landowner must obtain any necessary easements or permits well in advance of construction, and contractors must ensure all easements and permits are obtained before their work begins.

Private Utilities

The landowner is responsible for identifying the location of any buried cables, waterlines, septic systems or other private utilities on the property. The landowner is also responsible for ensuring points where the drain and buried utility may intersect are marked and uncovered. The contractor is not responsible for damages to private utilities that are not clearly identified by the landowner.

Public Utilities

Prior to the design of the drainage system, the landowner must determine if any public utility facilities or rights-of-way will be encroached or crossed. In this case, the landowner must advise the public utility during the design stage and acquire any regulatory approval required prior to construction. The public utility must be contacted again, at least 48 hours before construction, to locate and mark the facilities. Work should not begin until the public utility, contractor and owner are satisfied that all requirements and safety precautions are met.

Site Clean-up and Restoration

The landowner is responsible for site clean-up and restoration, and may arrange for the contractor to perform these functions. Site clean-up and restoration may include:

- spreading any surplus soil over the surrounding field
- removing materials from the work site such as large stones, roots, etc.
- repairing, replacing or restoring fencing and other farm property
- removing any surplus pipe material, bands, debris and ties
- any other special arrangements

1.3 Investment

Drainage is an investment designed to produce sufficient increased returns within a reasonable period of time. The longer subsurface drainage systems function properly, the greater the returns. Good soil management practices (particularly in fine-textured soils) help ensure a drainage system works well over a long period of time. These practices include returning crop residue to the soil and including deep-rooted legumes in crop rotation.

1.4 Subsurface Drainage

Subsurface drainage is the managed removal of water from the soil surface and soil profile to provide suitable growing conditions for crop production, while considering the impact on the water ecosystem. Subsurface tile drains manage the shallow water table level within a soil profile, providing a suitable environment for plants to survive and grow within a reasonable length of time after rain. The water table is only managed to the depth of the subsurface drain.




1.5 Surface Drainage

Surface drainage manages the removal of surface ponded water, where necessary, with shallow ditches that can be crossed with farm equipment. Consider the impact on where surface water collects and discharges. Surface drainage reduces the volume of water that would otherwise percolate into soil. By reducing the water that subsurface drains discharge, surface drainage makes the entire system more efficient. Consider the following with surface drainage:

- adapted to flat land where subsoil is fine-textured and dense
- has little positive effect on soil trafficability for seedbed preparation
- doesn't reduce soil profile wetness
- removes water from soil surface but doesn't lower the water table in soil profile
- should be practiced before investing in subsurface drainage
- surface inlets connected to subsurface drains may be used to manage water removal from depressional areas

1.6 Land Smoothing

Many flat, fine-textured soils have shallow depressions on the surface. Ponding of water in these surface depressions for prolonged periods is detrimental to crop production. Removing these slight depressions through land smoothing reduces surface ponding and provides more uniform percolation of water into soil. Shallow vegetated surface ditches bordering fields also help remove excess surface water.

1.7 Sub-irrigation

Sub-irrigation for field crops is a water table management practice with the potential to improve subsurface water quality. It's an expensive practice that's very site specific and requires specialized design. Sub-irrigation applies to areas with low subsoil permeability and an adequate water supply. Here are a few considerations for sub-irrigation:

- Necessary permits are required to take water.
- A supplementary water supply must exist, or be developed, for the irrigation mode.
- Design the water management system for both drainage and sub-irrigation modes.
- Size the system to supply the maximum water required during a peak use period, including percolation losses.
- Plan main drains and laterals parallel to the ground surface.
- Limit the length of laterals to provide adequate capacity for drainage and sub-irrigation.
- Install laterals deeper than recommended in Table 2 to provide an adequate head of water.
- Lateral drain spacing for combined sub-irrigation/drainage systems is dependent on soil type, use Table 1 to determine drain spacing.
- Pipe size must provide the desired flow.
- Install water level control structures where necessary to ensure the water table is held within a 0.3 m (1 ft) variation in elevation.
- Maintenance of a sub-irrigation system is critical to its annual use.

Note: Owners considering use of a combined drainage/sub-irrigation system should seek professional advice about the suitability of the site to produce the desired crop.




Table 1. Lateral Drain Spacing for Sub-irrigation as a Percent of Spacings Recommended for Drainage (See Table 3)

Soil Texture	Percent of Drainage Spacing
Silt	45
Loam, silty clay loam	70
Sandy loam	80
Loamy sand	90

1.8 Organic Soils

There are no general recommendations for the drainage of organic (muck type) soils in this guide. Each case requires consideration and advice from an experienced designer of drainage systems for organic soils. Problems unique to organic soils include initial soil consolidation, water table control, dike construction, seepage, pumping, etc.

Avoid drainage of shallow muck soils, 450 mm (1.5 ft) or less in depth, over sand or impermeable clay. The life of these organic soils is short and subsurface drainage is usually not an economically viable investment.

1.9 Mineral Soils

Recommendations in this guide deal with the drainage of agricultural mineral soils only, as they form the majority of agricultural land. Installing subsurface drains is not often advised in marl – which isn't a soil – or in layered bedrock at shallow depths.




2. Planning and Design

2.1 How to Use this Guide

The first step to develop a drainage plan is evaluating the feasibility of drainage by:

- consulting this guide
- gathering local drainage experience
- reviewing soil survey information
- considering wetland and natural land features
- identifying applicable legislation and regulations
- determining economic factors

Base the design and construction of agricultural drainage systems on:

- available outlets
- appropriate soil investigations
- general water movement and ponding patterns in areas to be drained
- topographic surveys
- proposed land uses

2.2 County Soil Survey Maps

Ontario has a wide variety of different soils, and drainage needs and opportunities vary with each soil. The soil series in Ontario is based on existing soil maps and is divided into major soil groups according to drainage need. As soil mapping continues, and with newer concepts in soil classification, some re-correlation on older soil maps is necessary and revisions will be made as re-correlation progresses. It's also important to consider that minor unmapped variations in soil occur within farms.

In general terms, soil maps and reports are used to determine:

- the nature and properties of soils at a given location
- the suitability of a given location for a particular agricultural use
- the need for improved drainage

Small areas of wet soils can't be shown on maps at the scale commonly used for soil surveys, and a detailed on-site soil survey may be required to identify these areas in the fields to be drained.

Drainage practices are linked to the soil profile characteristics, and structure, texture, depth, stoniness and wetness are the most relevant. These characteristics form the basis of a survey to classify soils into soil series units. Survey maps and accompanying reports are useful information for drainage purposes.

Soil reports for most counties are available in public libraries and may be available on the Government of Canada website, Canadian Soil Information System, *http://sis2.agr.gc.ca/cansis/*

2.3 Collecting Soil Information

Obtain the soils report for the area to be drained, and then:

- Find the location of the farm on the soil map and record the soil map notations.




- Refer to the soil map legend to determine the meaning of each symbol in the notations.
- Determine the soil series from the expanded map legend.
- Consult the table of contents in the soil report to find sections describing the specific soil series. Read these sections for detailed land use and soil technical information.
- Verify conclusions by inspecting the site in the field. Dig into the soil to learn about the internal drainage, and use post holes or trenches to reveal subsoil characteristics.
- Figure A2 maps the general distribution and class of Ontario subsoils, and reflects soil drainability.

2.4 Subsurface Drainage Design Code

Soil-Water Problem Classes

Two broad classes of soil-water problems are recognized in this guide – groundwater soils and surface water soils.

Groundwater soils are generally permeable and water logging results from rising groundwater. There are two important design criteria: mid-spacing water table elevation as determined by crop root requirements and the drainage coefficient rate. The steady-state drain spacing equation in Appendix B is useful for this design. One limitation for lowering the water table in these soils is the available depth of the outfall.

Surface water soils have relatively impermeable subsoils and vertical movement of water is restricted. The soil hydraulic conductivity is low and gravity drainage is restricted to water movement in soil cracks and fissures. Water movement ceases when soil peds swell. Most water movement occurs in the cultivated surface layers. Secondary drainage treatment, such as surface drainage, is often needed in these soils.

The Ontario soils listed in Table 2 are grouped according to the soil characteristics most relevant to the design of subsurface drainage systems. The two primary characteristics are the rate water moves through the soil profile and the degree of wetness before subsurface drains are installed (natural drainage). Two other important characteristics are the soil profile depth, and the topographic position and land slope.

For this guide, each soil series found in Ontario is correlated with a drainage design code (Table 2). Depth and spacing recommendations for each soil series are in Table 3 based on the drainage design code.

Most soil information is extrapolated or estimated from test results or field experience, and some is based on test data. Local conditions and experience may indicate that deviations from these recommendations are desirable and necessary.

Drainage Design Code

Four symbols make up the drainage design code, i.e. S3W8

- The *first symbol* is either S or G and indicates the source of the water (Table A1). S indicates water on the surface because of a restricting layer not more than 1 m (3 ft) below. G indicates where groundwater is, or has been, close to the surface. These classes are determined and mapped during the county soil survey.




- The *second symbol* is a number associated with the first symbol. There are six classes for surface water soils and three classes for groundwater soils. Appendix A, including the illustrations in Figure A1, summarizes the information. Figure A1 illustrates the method used by pedologists to show the range in a soil profile, i.e. the left edge and right edge. The average location for a tile drain is noted in each drainage profile. The general distribution of these soils is shown in Figure A2. Each soil is described in Appendix A, Table A1 and is a function of the soil hydraulic conductivity shown in Appendix A, Table A3.
- The *third symbol* is a capital letter representing the natural drainage class, described in Appendix A5. This symbol doesn't change after tile drains are installed.
- The *fourth symbol* is a topography slope class, outlined in Appendix A, Table A6. The Canada Land Inventory (CLI) slope classes are too broad (1-6) for drainage works, and this guides uses a code with nine symbols.

Source: Soil Classification for Agricultural Drainage in Southern Ontario, University of Guelph, School of Engineering Publication, 126-54, 1980, P.S. Chisholm, A. Baytalan, R.W. Irwin.

2.5 How to Use Table 2

Enter the soil series name determined in Section 2.3 and determine the drainage design code.

Table 2. Ontario Soil Series and Related Drainage Design Code

Southern Ontario

Soil Series	Drainage Design Code	CLI Class with Drainage	CLI without Drainage	Hydrologic Soil Group
Achigan	G2I4	4f		B
Alberton	S1I2	3 i/w	5	D
Allendale*	S3P2	3 w	5	C
Alliston*	G3I2	-	-	B
Almonte	S1W7	-	-	C
Ameliasburg	S6W8	-	-	D
Ancaster	S3W8	-	-	B
Anstruther	S6W7	4fm		B
Appleton	G1W9	-	-	B
Atherley	S1P2	3 w	5	D
Ayr	G3P2	3 w/i	5	C
Bainsville	S3P2	2 w	5	C
Balderson	G1I2	-	-	B
Ballymote	G3P3	2w	4w	C
Bamford	G3I2	-	-	B
Bancroft	G3W8	-	-	A
Barrhaven	S6P2	6rw		C
Bass	S1I2	-	-	D
Battersea	S2I5	-	-	C
Bearbrook	S1P2	3 w/d	5	D
Becketts Creek	S3I4	-		C
Belmeade	S5VI	4 d/w	5	D
Bennington	S3W8	-	-	B
Berriedale	G2W8	-	-	A
Berrien	S3I5	-	-	C
Beverly*	S2I4	-	-	C
Binbrook	S2I4	-	-	C
Blackburne	S5P1	-		D
Blackwell	SIPI	2 w	4	D
Bolingbroke	G3W5	-	-	A
Bondhead*	G1W8	-	-	B
Bookton	S3W6	-	-	B
Boomer	S4W2	3 i/m	5	B
Borromee	S6VP1	-		D
Borthwick	G2VP1	-		C
Brady*	G2I5	-	-	B
Brandon	S1P2	3w		D
Brant*	S3W8	-	-	B
Brantford	S2W7	-	-	C
Bridgman	G3W9	-	-	A
Brighton	G2W7	-	-	A
Brisbane*	G3I2	-	-	B
Brockport	S6M9	-	-	B
Brooke	S6P3	-	-	C
Brookston	S2P2	2 w	5	D
Bryanston	G1W8	-	-	A
Bucke	S3W8	-	-	B
Buckham Bay	G2W8	-		A
Burford*	G3W4	-	-	A
Burnbrae	S6W3	-	-	B
Burnstown*	G1W9	-	-	B
Burpee	G3P1	5 w	6	C
Burrittts Rapids	S5VP1	-		D
Buzwah*	SIW7	-	-	C
Caistor	S2I5	-	-	C
Caledon	G3W4	-	-	A
Camilla	G3I2	-	-	B
Campbell*	S1W7	-	-	C
Cane*	S2P1	2 w	5	D
Carlsbad	G2W4	-		A
Carp*	S2I5	-	-	C
Carsonby	S3P2	-		C
Casey	S416	-	-	B
Cashel	S2M6	-	-	C




Southern Ontario

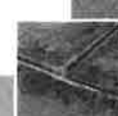
Soil Series	Drainage Design Code	CLI Class with Drainage	CLI without Drainage	Hydrologic Soil Group
Castor*	S3I3	-	-	C
Chateauguay	S3W4	2d		B
Cheney	G2P2	5wf		C
Chesley	S2P2	2 w	5	D
Chinguacousy*	S2I5	-	-	C
Christy	G1PI	6 w/p	6	C
Clyde	S1PI	2 w	5	D
Codrington	S3I4	-	-	C
Colbome	G3W4	-	-	A
Colwood*	G1P2	2 w	5	C
Conestoga	G1I4	-	-	B
Conover	S2I4	-	-	C
Constance Bay	G2W4	-		A
Cooksville	S6I4	-	-	B
Corkery	S5VP1	-		D
Craigleith	S2I4	-	-	C
Cramahe	G3W8	-	-	A
Crombie	GIP2	2 w	5	C
Dalhousie	S1I4	2d		D
Dalton	S3I4	-	-	C
Darlington	G1W8	-	-	B
Deloro*	G1W8	-	-	B
Donald	G3I2	3 i	5	B
Donnybrook	G3WS	-	-	A
Dorking	S2P1	4 d/w	5	D
Dumfries*	G3W8	-	-	A
Dummer*	G1W8	-	-	B
Dundonald	S3W6	-	-	B
Dunedin	S2W8	-	-	C
Dunrobin	G2P2	5wf		C
Dwyer Hill	S3P2	3w		C
Eamer	G1W7	-	-	B
Earlton*	S4I6	-	-	B
Eastport	G3W9	-	-	A
Edenvale	53I5	-	-	C
Eganville*	G1W8	-	-	B
Ekfrid	S1I6	-	-	D
Elderslie	S2I4	-	-	C
Eldorado	G1W8	-	-	B
Ellwood	S2I5	-	-	C
Ellwood	S6I2	-		B
Elmbrook	S2I5	-	-	C
Elmira	G2P1	4w/i	5	C
Elmsley	S6W3	-	-	B
Embro	S3I4	-	-	C
Emily*	G1I4	-	-	B
Englehart	S3P2	4 w	5	C
Evanturel*	S4W9	-	-	B
Fallowfield	S6I2	5r		B
Fanshawe	G3I4	-	-	B
Farmington	S6W3	-	-	B
Ferndale	S2P2	2 w	5	D
Flamboro*	G3P2	4 w	5	C
Floradale	G3I3	-	-	B
Font	G3W9	-	-	A
Fonthill	G3W4	-	-	A
Fox*	G2W7	-	-	A
Foxboro	G1P2	2w	5	C
Franktown	S6I3	-	-	B
Freeport	G1W6	-	-	B
French Hill	G3W6	2ft		A
Galesburg	G1W9	-	-	B
Galesburg	S6W6	3p		B
Gananoque*	S1W7	-	-	C
Gerow	S6P1	-	-	C
Gilford	G3P2	4 w	5	C
Glendale	S5VP1	-		D
Gobles	S2I7			C
Gordon*	S1I2	-	-	D
Goulbourn	S5VP1	-		D
Granby	G2P2	3 w	5	C
Grand	G1W1	2 i	4	B
Greely	S5VP1	-		D
Grenville*	G1W7	-	-	B
Grimsby*	G2W7	-	-	A
Guelph*	G1W8	-	-	B
Guerin*	G1I2	-	-	B
Gwillimbury	G3I4	-	-	B
Haldimand	S1I5	-	-	C
Hampden	S5I2			D
Harkaway*	G1W7	-	-	B
Harrisburg	S3W5	-	-	B
Harriston	G1W8	-	-	B
Harrow	G3W9	-	-	A
Havelock	G3W9	-	-	A
Hawkesville	G3P1	4 w/i	5	C
Haysville	G3I2	3 i	4	B
Heidelberg	G3I4	-	-	B
Hendrie	G3I2	-	-	B
Herbets Corners	G2I4	-		B
Hespeler	G3P2	4 w/i	5	C
Highgate	G3I4	-	-	B
Hillier	S6W8	-	-	B
Hillsburgh	G3W9	-	-	A
Hinchinbrooke*	GIP2	2 w	5	C
Honeywood	S3W8	-	-	B
Howland*	G1I5	-	-	B
Huron	S2M6	-	-	C
Innisville	G1P1	4 w	5	C
Ironside	S3W6	3f		B
Jeddo	S1P2	4 w/d	5	D
Jockvale	G2W4	3f		A
Kagawong	S6W8	-	-	B
Kanata	S6W7	-		B
Kars	G3W4	-	-	A
Kelvin	S2P2			D
Kemble*	S2P4	-	-	C
Kenabeek	G2P3	6 w	6	C
Killean	S1I2	-	-	B
King	S2W7	-	-	C
Kintyre	G3W6	-	-	A
Kirkland	G3W2	3 i/mn	5	A
Kossuth	G1I4	-	-	B
L'Achigan	G2I5	-	-	B
Lambton	S3I5	-	-	C
Lanark	S2I5	-	-	C
Landsdowne*	S1I2	-	-	D
Laplaine	S1P1	-		D
Leith	S3W8	-	-	B
Leithrim	S6W3	-	-	B
Lemieux	S5VP1	-		D
Lily	G1P1	6 w/p	6	C
Limoges	G2W6	-		D
Lincoln	S1P2	4 w/d	5	D
Lindsay*	S2P2	2 w	5	D
Lisbon	G3W8	-	-	A




Southern Ontario

Soil Series	Drainage Design Code	CLI Class with Drainage	CLI without Drainage	Hydrologic Soil Group
Listowel	G1I2	-	-	B
Little Current	S6W8	-	-	B
Lockport	S6M9	-	-	B
London*	G1I2	-	-	B
Lonsdale	S5V2			D
Lovering	S2I5	-	-	C
Lowbanks	GIV2			B
Lyons*	G1P1	3 w	5	C
MacDonald	S3P4	2w		D
Macton	G1I2	3 l	5	B
Magnetawan	G1P4	-	-	C
Mallard*	G2I5	-	-	B
Malton	S2P2	2 w	5	D
Manion Corners	S5VP1	-		D
Mannheim	G1W6	-	-	B
Manotick	S3W8	-	-	B
Maplewood	S3P2	2 w	5	C
Marchhurst	S6W5	-		B
Marionville	S3P2	2 w	5	C
Marsh	S5V1	-	-	D
Maryhill	G1P2	2w	4	C
Matilda	G1I4	-	-	B
Matson	S3I4	-	-	C
Medonte	S1WS	-	-	C
Melbourne	S1W6	-	-	C
Mer Bleue	S5P1	-		D
Mersea	S5VP1	-		D
Miami	S2W7	-	-	C
Mill	S3P1	3 w	5	C
Mille Isle	G2W4	4fm		A
Milliken	G1I2	-	-	B
Minesing	S1P1	2 w	5	D
Mississauga	S1P2	5 w/r	6	D
Monaghan	S2I4	-	-	C
Monteagle*	G1W6	-	-	B
Morley	S2P2	3 d/w	5	D
Morrisburg	S2I4	-	-	C
Moscow*	S2P2	2 w	5	D
Mountain	S3I4	-	-	C
Muck	S5V1	-	-	D
Muirkirk	G3P3	2w	4w	C
Munroe	S5VP1	-		D
Munster	G3W6	-		A
Muriel	S2M7			C
Murray	S3I4	-	-	C
Napanee*	S1P1	3 d/w	5	D
Nelson	S2M6	-	-	C
Nepean	S6W5	6r		B
Newburgh	S3W8	-	-	B
Newcastle	S3W8	-	-	B
Niagara	S2I5	-	-	C
Nipissing	S3I3	-	-	C
Nissouri	G1P3	2w	4w	C
Noiharn	S3WS	-	-	B
Normandale	G1I5			B
North Gower*	S2P2	2 w	5	D
Oakland	G3I3			B
Oakview	S5V2			D
Ohsweken	S3P2	2w	4w-5w	C
Oneida	S1W5	-	-	C
Ontario	S2W4	-	-	C
Osborne	S3I2	-	-	B
Osgoode	S2P2	2 w	5	C
Oshtemo	G2W7	-	-	A
Osnabruck	S2P2	4 w/p	5	D
Osprey	G1W8	-	-	B
Otonabee*	G1W7	-	-	B
Otterskin	S3P4	-	-	C
Parkhill*	G1P1	2 w	5	C
Peat	S5V1	6 w	6	D
Peel	S2I5	-	-	C
Pelham	G3W9	-	-	A
Perch	S1PI	4 d/w	5	D
Percy	S3W8	-	-	B
Perth	S2I5	-	-	C
Petherwick	G1P2	2 w	5	C
Phipps*	S1PI	3 w	5	D
Piccadilly	S3I4	-	-	D
Pike	S1W7	-	-	C
Pike Lake	G3W8	-	-	A
Piperville	S3I6	2f		C
Plainfield	G3W9	-	-	A
Pontypool	G3W9	-	-	A
Preston	G3I3	4 i/r	6	B
Queensway	S6W6	-		B
Ramsayville	G2I4	-		B
Reevecraig	G2P2	3w		C
Renfrew	S1I2	-	-	D
Rideau	S1I2	-	-	D
Ridgeville	G3I2	-	-	B
Rivard	S1P1	3dw	5w	D
Rubicon*	G2I5	-	-	B
Sargent	G3W8	-	-	A
Saugeen	S2W8	-	-	C
Schomberg	S2M6	-	-	C
Scotland	G3W7			A
Seely's Bay	S2M6	-	-	C
Senaca	G1W7			B
Seneca	G1W7	-	-	B
Shashawandah	S6W4	-	-	B
Sidney*	S1P2	3 w	5	D
Silver Hill	G1P3			B
Simcoe	S2P2	2 w	5	D
Smithfield	S2I5	-	-	C
Smithville	S2W7	-	-	C
Snedden	S1I2	-	-	D
Solmesville	S2I5	-	-	C
South Bay	S1W5	-	-	C
Springvale	G3M6	-	-	A
St. Clair	G2P2	2w	4w	A
St. Clements	S2W6	-	-	C
St. Damase	S3I4	-		
St. Jacobs	G3W2	-	-	A
St. Peter	G3W3	-	-	A
St. Samuel*	G2P3	6 w	5	C
St. Thomas	G3W8	-	-	A
St. Williams	GIP2			B
Stafford	G1I2	-	-	B
Stapledon	G2I4	-		B
Ste. Rosalie	S1P2	3 w/d	5	D
Stockdale	G1P2	2 w	5	C
Strathburn	S1P3	3w	5w	D
Styx	G1V2			B
Sullivan	G3W4	-	-	A
Summerstown	S5VP1	-		D
Tansley	S2I5	-	-	C



Southern Ontario

Soil Series	Drainage Design Code	CLI Class with Drainage	CLI without Drainage	Hydrologic Soil Group
Tavistock	S3I4	-	-	C
Tecumseh	G2I5	-	-	B
Teeswater	S3W8	-	-	B
Tennyson*	G1W8	-	-	B
Thames	S2I5	-	-	C
Thorah	G2P3	6 w	6	C
Thorndale	G1I4	-	-	B
Thwaites	G1W9	-	-	B
Tioga*	G3W5	-	-	A
Toledo*	S2P2	2 w	5	D
Trafalgar	S6I4	-	-	B
Trent	S3I4	-	-	C
Tuscola*	S3I4	-	-	C
Tweed	S6W8	-	-	B
Uplands	G2W8	-	-	A
Vanessa	G3P2			C
Vars	G1W8	-	-	B
Vasey*	G1W9	-	-	B
Vaudreil	G2P2	3w		C
Vincent	S2W8	-	-	C
Vineland*	G2I5	-	-	B
Vinette	G2I4	-		B
Vittoria	S3I4			C
Wabi	G1W6	-	-	B
Walshear	S3W6			C
Walsingham	G2I2			A

Soil Series	Drainage Design Code	CLI Class with Drainage	CLI without Drainage	Hydrologic Soil Group
Waterloo	G3W9	-	-	A
Watford	G3W7			A
Watrin	G3P2	6 w	6	C
Waupoos	S2M6	-	-	C
Wauseon	S3P1	3w	5	C
Wayside	G3I2	-	-	B
Welland	SIP2	4 w/d	5	D
Wellesley	S2I2	-	-	C
Wemyss	G1I4	-	-	B
Wendigo*	G3W8	-	-	A
Wendover	S1I2	-	-	D
Westmeath	G3W5	-	-	A
Whitby	G1I2	-	-	B
White Lake*	G3W5			A
Whitfield	S6W8	-	-	B
Wiarton	G1I4	-	-	B
Wilmot	S2P2	2 w	5	D
Wilsonville	G3W7			A
Winona	S3I5	-	-	C
Woburn	G1W8	-	-	B
Wolford	S2W8	-	-	C
Wolsey*	S1P1	2 w	5	D
Wooler	S3W8	-	-	B
Woolwich	G1W4	-	-	B
Wyevale	G3W3	-	-	A

Northern Ontario

Soil Series	Drainage Design Code	CLI Class with Drainage	Hydrologic Soil Group
Abitibi	G2W5	5FM	A
Abram	S1I4	2C	D
Agnewe	S3P4	3W	C
Albany	S1I	3D	D
Alcock	G2I2	4F	B
Alpine	S3M 5	3C	B
Ansonville	G2I4	3C-4F	B
Arbor Vitae	S3P4	3W	C
Arthur	S3I3	3FM	C
Atwood	S2I5	2C	C
Audrey	S2P2	4W	D
Avery	S3I2	3F	C
Azilda	S3P2	3W	C
Bain	G3V2	5WF-6W	C
Baird	S5V1	*	D
Baldwin	S3W7	2C	B
Balmer Bay	S2P2	4WD	D
Barnhart	S2I5	2C	C
Basket	S2P2	3W	D
Bearle	S3I5	3C	C
Beartrack	G2P2	4W	C
Belle Vallee	S5V2	4HF	D
Bergland	G2P2	4FW	C
Berry Lake	S5V2	4HF	D
Binabich	S3W3	2C	B
Biz	S3P2	4W	C
Black Bay	S1P1	3W	D
Black River	S3M 5	3C	B

Soil Series	Drainage Design Code	CLI Class with Drainage	Hydrologic Soil Group
Black Sturgeon	S1M 5	2C	C
Blake	S3 I1	2C	C
Blanche	S3W9	3D	B
Bluett	S2V2	4W	D
Blythe	S5V2	5HK	D
Bob Lake	G3I2	4F	B
Bonfield	S1P2	4WD	D
Boulter	S2I5	3D	C
Bradley	S3I4	3F	C
Breakneck	S3P2	4W	C
Brentha	S6W5	5R	B
Brethour	S3P2	2CW	C
Broadtail	G2W7	4FM to 7PR	A
Bucke	S3W5	4FM	B
Burditt	G1P2	5PW	C
Burnet	S3W2	3FM	B
Burning	S1V2	4W	D
Burpee	G3V2	6WF	C
Burt	S5V2	4HF	D
Burton	S5V2	4HF	D
Cabett	S5V1	*	D
Cache Lake	S5V2	2F	D
Callum	S5V2	3HK	D
Cane	S3P2	4W	C
Capreol	S3P2	4W-5W	C
Carmody	S3W8	4TP	B
Carpenter	S2P4	3W	D
Carterton	S5V2	5HK	D




Northern Ontario

Soil Series	Drainage Design Code	CLI Class with Drainage	Hydrologic Soil Group
Casey	S3I4	4F	C
Casimar	S2P2	3DW-4WD	D
Cedar	S3I5	2C	C
Chamberlain	S5V2	4HFL	D
Chartand	S1I7	3D	D
Cherriman	G2P2	5WF	C
Chiswick	S5V2	4HK	D
Christy	G1P2	6WP	C
Chrystal Falls	S5V2	5HK	D
Claxton	G3P2	5FW	C
Clearway	G1W8	5P	B
Clegg	S1M5	3C	C
Coderette	S5V2	5HK	D
Collins	S2P2	4D	D
Contact Bay	G1W9	4FM to 6TP	B
Corbeil	S5V2	4HK	D
Corn	S1I2	2C	D
Coutts	G1I8	5P	B
Couttsville	S5V2	5HL	D
Cranberry	G3P2	3WF	C
Crozier	S2P4	3W	D
Crystal Falls	S5V2	5HF	D
Curran	S5V2	3H	D
Current River	G1I1	5P	B
Cutler	G3M2	4FM	A
Dack	S1W7	3D	C
Daltes	G1I2	5P	B
Dance	S3I2	3F	C
Dawson	G1W7	3D-4P	B
Dayton	S3V2	4W	C
Deception	G1W7	6FM to 7TR	B
Delamere	S2W7	3D	C
Delray	S1W5	3C	C
Denman	G1M5	4P	B
Devitt	S2I4	3C	C
Devlin	S2I4	2C to 3F	C
Dewart	G3I2	3F to 4F	B
Dilke	G3P2	4FW	C
Dokise	G2W7	4FM	A
Dorion	S1I2	2C	D
Drurey	S5V2	6HFK	D
Drury	S5V2	6HFK	D
Dryden	S5V2	3HF	D
Ducharme	S1W7	2C to 3T	C
Duchesnay	S5V2	5H	D
Dune Sand	G2?2	6I	A
Dunnet	S3M5	3D	B
Dymond	G1I8	4P	B
Eag;le Lake	S5V2	4KHF	D
Eakett	G3P2	6WF	C
Earlton	S3I4	3C-3D	C
Ecclestone	S3I4	2C-3C	C
Elk Pit	G3W9	5TF to 6T	A
Ellice	G1W8	3P	B
Emo	S1P2	3W	D
Englehart	S3P2	4W-5WF	C
English	G1P2	6PW-6PTS	C
Espanola	S5V2	5HFK	D
Estaire	S5V2	3HF	D
Evanturel	S3W9	3T-6T	B
Everard	S1W	*	C
Everend	S3P2	4W	C
Falardeau	S3P2	3DW	C
Farmington	S6W2	6PR	B
Favareau	S3P2	4W	C
Flamingo	S2W7	3T	C
Fleck	S5V2	6HFL	D
Ford	S2P2	4W	D
Formal	G1W3	6PS	B
Fort Frances	S1V2	4W	D
Fort William	G2I2	3FM	B
Frechette	S3W7	2C-6T	B
Frederick	G2P2	5FW	C
Fremlin	S3M5	4FM	B
Frere Lake	S5V2	6HL	D
Fynxal	S1W8	3FD	C
Gaffney	G2P2	4W-5W	C
Gaffney Lake	S5V2	4F	D
Gameland	G2I4	3F	B
Gawase	S6W2	6R	B
Genesee	S5V2	5HK	D
Giante	G3W4	5FM	A
Glen	G3I1	5FM	B
Goughe	S3V2	5FW	C
Goulaise	G2V2	6FW	C
Gouvereau	G2P2	4WF	C
Grace	S1I5	2F	D
Grass	S5V2	5HL	D
Grassey	G1W9	3FM	B
Gullwing Lake	S5V2	4F	D
Guy Lake	G2P2	4WF	C
Haddo	S1P2	3W	D
Hagar	G2P2	4W	C
Haileybury	S1W8	2C-6T	C
Hallam	S3I2	3F	C
Hammerhead	S3I5	3D	C
Hanbury	S1I7	2C-3D	D
Hanna	G1W9	5PS-7TP	B
Harfred	G2W5	4FM	A
Harley	S5P2	3H	D
Harold	S5V2	7HL	D
Harrey	S3P2	3W	C
Harris Hill	S5V2	5HFK	D
Hartman	S1P2	4W	D
Haultain	S2W9	5P to 7TP	C
Hearst	S1I4	3C	D
Heaslip	S5V2	4KHF	D
Hilliard	S5V2	4HF	D
Hilton Beach	G3W7	4FM	A
Hilton Lake	S5V2	3H	D
Himsworth	S3I4	3D	C
Hughes	S5V2	4H	D
Hyndman	S1W2	2C	C
Ilford	S3I5	3F	C
Ingram	S5V2	6HFL	D
Innes Lake	S5V2	4HKF	D
Isbester	G1I2	5P	B
Jaffray	G3W7	5FM	A
Jamot	S1P2	4WD	D
Janden	G1I5	4P	B
Jarvis River	S1M5	5TD	C
Jeannie	G3W77	7TSP	A
Jocelyn	S5V2	3H	D
Jumbon	S5V1	*	D
Kanimiwiskia	S5V2	6F	D
Kapuskasing	S3M5	3C	B
Kawashegamuk	S3V2	4W	C
Keenoa	S3P2	4W	C




2 Planning and Design

Northern Ontario

Soil Series	Drainage Design Code	CLI Class with Drainage	Hydrologic Soil Group
Kellar	S5V2	4HFL	D
Kenabeek	G3P2	5WF	C
Kenogami	S5P2	6HFK	D
Kerns	S5V2	3H	D
Ketchinig	S5V2	6HFK	D
Killaby	S3M4	3F	B
Kim	S2P2	4W	D
Kingsford	S3M4	3F	B
Kushog	S5V2	6H	D
Kynoch	G1M9	5TP	B
La Vallee	S1W8	3T	C
Lappe	S1P1	4WD	D
Larder	S5V2	4KHF	D
Laurence	S3M5	3FM	B
Leeville	S5P2	4HFL	D
Linkor	S5V1	*	D
Lowther	S2M5	3C	C
Macintyre	S5V1	*	D
Magnetewan	S3W9	4T - 6T	B
Makobe	G1I4	5P-7P	B
Mallard	G3I7	4FM-7PR	B
Manders	S5V2	3K	D
Marie	S3V2	5WF	C
Marritt	S3M7	2C	B
Marshal	G1I2	4P-6PR	B
Marten	S3W5	4F	B
Mary	G2W5	4FM	A
Matheson	G1W2	5PS	B
Maybrook	S5V2	3H	D
McCool	S1I2	3WD	D
McKellar	S3P1	3W	C
Medette	G2I2	4FM-6RS	B
Melgund	S3V2	4W	C
Melick	G1W9	3T	B
Menary	G3M2	4F	A
Mennin	S1M2	2C	C
Mickle	S2P2	3W	D
Mietzle	G3W3	5FM	A
Milberta	S1V2	6W	D
Milford	S5V2	3HL	D
Millerand	S1V2	4W	D
Minnitaki	S1P2	3W	D
Miscampbell	G2I2	4FM	B
Misema River	S5V2	3HF	D
Mission	G3P1	5WF	C
Monteagle	G1W9	5TP-7PR	B
Moose	G1P2	5PW-6P	C
Morley	G3W8	5P	A
Morson	G2V2	5W	C
Mud Lake	S5V2	3F	D
Mudcat Creek	S5V2	4HFK	D
Muddy Lake	S5V2	2F	D
Muller	S2W8	2C to 3T	C
Murillo	S5V1	*	D
Muskosung	G3?W7	6FM	A
Musselle	S3P2	3W-5W	C
Naiden	S3W4	3F	B
Neebing	G3I1	4F	B
Nellie	S1W5	3D	C
New Liskeard	S1P2	2CW-4W	D
Newfeld	S3P2	4W	C
Noelville	S3I5	2C	C
Nolalu	G1W4	6TP	B
Norembega	S5P2	5FL	D
North Branch	S3I5	2C	C
Notre Dame	S5V2	3H	D
Nugget	G3P2	5W	C
O	S5V2	*	D
Oak	S3M5	2C	B
Off	G1W8	3FM	B
Orbit Lake	S5V1	*	D
Organic	S5V2	N/A	D
Oskondoga	S1I2	6TP	D
Otterskin	S3I7	4F	C
Ouellette	S1P2	3DW-4WD	D
Ouimet	S1I1	3D	D
Paipoonge	S1W3	2C	C
Parket	S1P2	3DW	D
Parrish	S3I5	2C	C
Parry Sound	S5V2	4KHF	D
Pass	S5V2	4HF	D
Passer	S5V1	*	D
Pearl	G3W6	6F	A
Pearson	G1I6	5P	B
Pedlow	S5V2	5HF	D
Peganels Lake	S5V2	4HF	D
Penassen	S5V1	*	D
Pense	S3I4	3C-3DW	C
Phelans	G3W9	6FM	A
Pinewood	G3I2	4FM	B
Playfair	S3P2	3W	C
Plum	S1W5	2C to 4P	C
Porquis	S3I4	3C	C
Powassan	S3P2	3W	C
Pyne	G2I2	3F-4F	B
Quire	S3P2	3W	C
Raft Lake	S5V2	3KH	D
Rainy River	S5V2	3K	D
Raithe	S5V1	*	D
Recollect	G3V2	6W	C
Redvers	S2W2	2C	C
Richardson	G2W2	4FM	A
Ridger	G2P2	6W	C
Ridout	G1I5	6PR-7PR	B
Robitaille	S2V2	4W	D
Rock	N/A8	7R	N/A
Rockbound Lake	S5V2	5HF	D
Rockland	VAR7	7r to 4FM & 3D	N/A
Rose	S1I5	2C	D
Rowe	G3W5	5FM	A
Ryland	S1P4	4W	D
Sables	G1P2	5PW	C
San Pierre	S3P2	3W	C
Sasaginaga	S5P2	6HL	D
Scaden	G1W8	4P to7PT	B
Sellars	S3W3	2C	B
Sesekinika	S5P2	3H	D
Shenston	S5V2	5FL	D
Shetland	S1P2	4W	D
Siamese	S3P2	4W	C
Sibley	S2P	3W	D
Siflet	S3V2	4W	C
Silver	S3I2	2C	C
Sioux	S1W2	3D to 4TE	C
Slate River	G2W4	3FM	A
Sleeman	G3M5	3FM	A
Smoke	G2P2	4W	C
Solvan	S3P2	4W-4DW	C




Soil Series	Drainage Design Code	CLI Class with Drainage	Hydrologic Soil Group
Northern Ontario			
Spronger Lake	S5V2	2F	D
St Joeseph's	S6W2	6R	B
Stinson	S3M7	2C	B
Strawberry	G1P1	5WP	C
Sturgeon Falls	G2P2	4W	C
Sturgeon River	S5V2	3F	D
Sunderland	S3V2	5W	C
Sunstrom	S5V2	5HL	D
Sutton Bay	G1P2	6P	C
Tarbutt	G1P2	5PW	C
Tarentorous	S1M5	3D	C
Thistle	S3W5	3FM-4F	B
Thompkin	S1M5	2C	C
Thornloe	S1P2	3DW-4WD	D
Thunder Lake	S5V2	4F	D
Thwaites	S3W8	2C	B
Tomiko	S3P2	3W	C
Tomstown	S5P2	6HFL	D
Tovell	G3V2	6W	C
Treaty	S3P2	3W	C
Tribal	S2P2	3W	D
Tunis	S3P2	4W	C
Turner	G2V2	6W	C
Twin Cities	G2P1	4W	C
Twin Falls	G2V2	4W-6W	C
Twyning	G1V2	6W	C
Uno Park	S5V2	5HL	D
Val Cote	S2W7	3C-5T	C
Van Horne	S2W8	3T	C
Vasey	S6W8	6PR	B
Vermillion	G1W8	4TP-6PR	B
vERNER	G2I5	4F	B
Veuve River	S3I5	2C	C
Wabi	G1W	5P	B
Wade	S5P2	4HK	D
Wahnapitne	S5V2	2H	D
Wamsley	S3W4	2C	B
Warren	G2P2	5WF-6WF	C
Wausing	G1W5	4TP	B
Weird	S3W8	3T	B
Wemyss	G1I2	5PR&7R	B
Wendigo	G3W9	4FM-6TS	A
Wickens	G1P2	5WF	C
Wildnerness	S2I2	2C	C
Wildrice Lake	S5V2	5HF	D
Willbank	S3P2	4FW	C
Wistiwasing	S5P2	4HK	D
Withington	G2I4	4F	B
Wolf	S3P4	3W	C
Wolf River	S5V1	*	D
Wolfpup	G3W3	5FM	A
Wolseley	S1I2	2C	D
Wood	S3P2	3W	C
Woodyatt	S3P2	3W	C
Woolley	S3W5	4F-4FM	B
Worthington	G3W5	4FM	A
Yellek	S5V2	4H	D
Zealand	G3P2	4WF	C

* Soil series having phases over bedrock. The hydrologic grouping for the rocky phases of these soils should be reduced one group (i.e. C reduces to B).
** CLI class not available.
***A drainage design code has been assigned to every soil series; however, the effectiveness of subsurface drainage must be assessed on an individual site basis.

Table 2. Additional Information

Canada Land Inventory Ratings

Table 2 provides additional information for special engineering projects. In Ontario, published Canada Land Inventory (CLI) ratings are for soils assuming drainage is in place. The CLI ratings (Table A7) given in the third column are for current CLI maps where excess water or inundation is the major hazard. The rating corresponds to application of the CLI system when the requirement for drainage is recognized only in poorly and very poorly drained mineral soil series. Exceptions to the general rule include three well-drained soil series – Boomer, Grand, Kirkland, and five imperfectly-drained soil series – Alberton, Donald, Haysville, Macton, Preston. In all eight exceptions, inundation by overflow from watercourses is an agricultural hazard. In contrast, CLI ratings without drainage (fourth column for southern Ontario only) are an estimate of agricultural capability when necessary drainage is not in place.

Hydrologic Soil Groups

Hydrologic soil groups estimate runoff from precipitation. They are grouped according to water intake rate after prolonged wetting (measures infiltration capacity), and are interpretations based on United States Department of Agriculture – Soil Classification System criteria for hydrologic soil groups. The interpretation for each soil series is derived from data for soils in that series.




2.6 How to Use Table 3

With the first two symbols of the drainage design code, use Table 3 for a basic design recommendation of a subsurface drainage system. Table 3 provides depth and spacing recommendations for lateral drains for field crops.

Table 3. Depth and Spacing Recommendations for Lateral Drains for Field Crops

Drainage Design Code	Depth of Drain mm (in.)	Drain Spacing Cash Crops m (ft)	Surface Drains Needed?	Remarks
1	2	3	4	5
S1	600-650 (24-26)	6-12 (20-40)	Yes	Subsurface drainage not feasible unless soil structure is well defined when subsoil is wet
S2	600-700 (24-28)	6-15 (20-50)	Yes	
S3	700-1,000 (28-40)	6-15 (20-50)	Yes	Quicksand may be present
S4			Yes	Shallow soil barrier layers limit drain effectiveness
S5	Special investigation required		Yes	Water control works may be needed
S6	600 (24)		Yes	Shallow soil over bedrock limits design possibilities
G1	800-1,000 (32-40)	10-15 (33-50)	No	
G2	850-1,000 (34-40)	10-15 (33-50)	No	Quicksand may be present
G3	900-1,200 (36-48)	10-15 (33-50)	No	Quicksand may be present

Note: Fine sandy loam and sandy loam soils in Class S3, G2 and G3 require envelope protection.

Column 1: Drainage Design Code

- Contains the first two symbols of the drainage design code selected from Table 2.
- Reflects the source of the drainage water problem and the soil drainage characteristics (refer to Table A2).

Column 2: Drain Depth

- Recommended range in depth to the bottom of the trench for lateral drains.
- Design depth should be within the range, and will depend on land slope, soil profile, topography and outlet elevation.




Column 3: Lateral Drain Spacing

- Recommended range in lateral drain spacing when using systematic or pattern drainage systems.
- Actual spacing selected depends on the degree of drainage needed for crops to be grown, and is often an economic decision. Higher annual investments in cash crops, compared to field crops, may mean closer spacing. Lateral drain spacing is also influenced by drain depth, field dimensions, cropping and cultivation pattern, and physical properties of the soil.
- Where a random drain pattern is used to drain isolated wet spots, seepage lines and springs, drain spacing is usually not a design factor, but future system expansion should be considered.

Column 4: Surface Drainage

- Recommends surface drains be used in conjunction with subsurface drains, or where surface drainage is considered to be a feasible solution to a surface water problem.

Column 5: Remarks

- Includes additional information to consider when designing and constructing a subsurface drainage system.

In Table 3, depth, spacing and drain locations recommendations are affected by crops grown (small grains, forage or cash crops) and economics, and should be based on site conditions including soils, topography, groundwater and outlets. Optimal rooting zone conditions are achieved through many combinations of tile spacing and depth. Consider soil series, soil permeability and stratification, desired drainage coefficient and degree of surface drainage, when choosing spacing and depth.

Figure 1 illustrates how wide and deep drain spacing gives similar results to shallow and narrow spacing. In the same soil type, shallow and narrow spacing achieves optimal root zone conditions in a shorter period of time and less total water volume is removed.

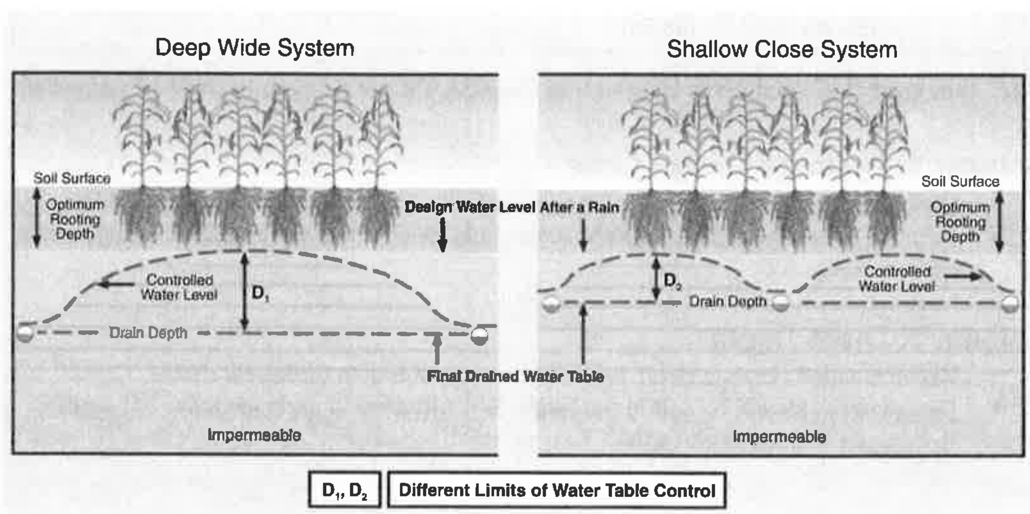


Figure 1. Comparison of Shallow Narrow Spacing vs. Deep Wide Drain Spacing

Maximum spacing – 15 m (50 ft) is the maximum recommended spacing between parallel lateral drains. Fields don't usually have enough uniformity in drainage characteristics or surface elevation to ensure uniform field drying at greater spacing, even though mathematical calculations suggests drain spacing may be greater.

Minimum spacing – 6 m (20 ft) is the minimum recommended spacing between parallel lateral drains. This drain spacing is an economic decision, and drainage of small depressional areas and specialty crops may need even closer spacing.

If a random or combination system is required, design it to accommodate more intensive drainage in the future. This is done by designing main and submain drains large enough to accommodate flow from lateral drains that might be added later.

If a drainage system is used for sub-irrigation, develop suitable drainage and soils criteria for the design (see Section 1.7).

Example Problem
Determine the depth and spacing for subsurface drains to be installed on lot 9, concession VI, Howick Township, Huron County. The principle crop grown is soybeans.

Here's how to find the solution:

- Locate the farm on the Huron County soil map by lot and concession. The map shows the soil is classified as Harriston loam. The soil report states the entire soil profile is stony and may present construction difficulties.
- From Table 2, Harriston soil series is listed under the drainage design code as G1W8.
- Table 3 at soil group G1 shows drain depth should be 800-1,000 mm (32-40 in.). Soybeans are a cash crop so drain spacing of 10-15 m (33-50 ft) is recommended.
- Surface drainage is not required. Surface inlets may be needed for the undulating nature of this well-drained soil. No additional information is given under the remarks column.
- Actual spacing depends on the degree of drainage the farmer wants and can afford for the crop, and is about 15 m (50 ft) for soybeans. Lateral drain depth depends on the outlet and local topography. As spacing gets closer, less depth is needed, and in the case 800 mm (32 in.) will work.

Calculate lateral drain spacing from a theoretical equation when technical information is available on soil profile characteristics and soil physical properties. A popular drain spacing equation is in Appendix B illustrating design parameters. If the hydraulic conductivity of soil is known through measurement or estimation, drain spacing is calculated using Dr. S.B. Hooghoudt's ellipse equation for homogeneous soils.

Recommendations on drain depth and drain spacing are based on research data in Ontario and the experience and practical observation of experts in this field. The recommendations are revised as new information is available.

2.7. Drainage of Special Crops

Special attention is warranted for the design of subsurface drains for high-value crops including fruits, nursery stock, vegetables and turf. The additional cost for closer lateral drain spacing is




small compared to the value of an orchard. Recommendations in Table 4 are based on row spacing rather than soil characteristics for these specialty crops.

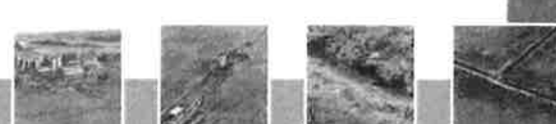
These crops are very susceptible to the injurious effects of poor drainage. In a fruit orchard, for example, the depth of rooting usually determines the size and productivity. Soil should have little or no free water in the top 600-1,000 mm (24-40 in.) – except briefly after a heavy rain – during blossoming and fruit-setting periods. To intercept seepage and prevent prolonged flow into lateral drains, install an interceptor drain along the higher end of the orchard. This addition will also deter roots from entering lateral drains.

TABLE 4. Depth and Spacing Recommendations for Lateral Drains for Special Crops

Crop	Crop Row Spacing m (ft)	Drain Depth mm (in.)	Drain Spacing m (ft)	Remarks
1	**2**	**3**	**4**	**5**
Apples, dwarf	3 x 4 x 1 or 1.5 (10 x 13 x 3.3 or 5)	750 + (30 +)	6-9 (20-30)	Every other row, some sites drainage is not necessary
Cherries, sweet	6 x 3 (20 x 10)	900-1,200 (36-48)	6 (20)	Every row
Cherries, sour	6 x 6 or 4 (20 x 20 or 13)	750 + (30 +)	6-12 (20-40)	Every row, or every other row, some sites drainage is not necessary
Grapes	2.5 to 3 row (8-10)	750 + (30 +)	2.5-3 (8-10)	Every row, every other row in sandy sites
Peaches, Nectarines	6 x 3 (20 x 10)	900-1,200 (36-48)	6 (20)	Every row
	5 x 3 (16.5 x 10)	900-1,200 (36-48)	5 (16.5)	Every row
Pears, Plums, Apricots	6 x 3 or 4 (20 x 10 or 13)	750 (30)	6-12 (20-40)	Every row
Vegetable Crops on Mineral Soils		750 + (30 +)	4.5-6 (15-20)	Surface inlets in depressional areas may be needed
Vegetable Crops on Muck Soils		900-1,200 (36-48)	6-12 (20-40)	Moving towards larger diameter laterals with filter, refer to Section 1.6

2.8 Planning the Drainage System

Contractors should prepare a plan of the proposed subsurface drainage system to use during construction and copy the owner as a record of installation. The plan records the location of utilities and should be based on elevations established by a survey.



The plan will include details about location, size and grade of drains, accessories used in the construction and location of utilities. This topographic plan also provides the basis for obtaining tenders on the cost from several drainage contractors.

Before Construction

- All work follows a definite plan, which has been drawn, or considered, in advance of the construction.
- Contractor and owner inspect the job site to agree on work to be done, and obtain necessary easements/permits and/or facilities and outlets required for the installation (see Section 1.2 Private Utilities).
- Document and agree on the scope and cost of the work. Any changes during construction are also agreed on and documented.

After Construction

- Mark all plan changes on the plan made during construction, and any hazards encountered that may affect future maintenance.
- Contractor provides the landowner with a plan of the work as installed in the field, when construction is complete.
- Consider filing a copy of the plan with the property deed and the municipality. An aerial photograph of the completed work is also a useful record.

2.9 Outlet

Water collected in drainage systems must not discharge where it will damage other landowners, and sufficient outlets are required for a proposed subsurface drainage system. The design of outlets is discussed in Section 8 of this guide.

Ontario drainage laws govern outlets and where applicable, legally register outlet agreements for future protection of all parties. Legal considerations and procedures for obtaining an outlet are in OMAFRA Factsheet, *Drainage Legislation*, Order No. 89-166.

2.10 Drainage Coefficient

The drainage coefficient is the drainage rate the main drain can transfer water from the soil profile above the drain in a specific area. It's a value selected to provide adequate drainage for future crops and is expressed in mm/day (in./day). Use the rate to calculate the required pipe diameter for water transport and, less frequently, to determine drain spacing.

The drainage coefficient may need to be increased:

- for high value crops
- where crops have a lower tolerance to wetness
- in soils with a coarse texture
- when there is little or poor surface drainage
- where planting and harvest times are critical

The following drainage coefficients are recommended for subsurface drainage in Ontario mineral soils under normal surface drainage conditions and where no surface water is admitted directly into the subsurface drain. Apply these criteria only to wet land area to be drained. Increase the area to include any surface runoff from higher land and consider future uses for the area.




- 9 mm/day (⅜ in./day) for improved forage and general grain crops
- 12 mm/day (½ in./day) for cash crops
- 20 mm/day (¾ in./day) for high-value specialized crops

Where surface water is admitted into the subsurface drain, the flow design is based on:

- drainage coefficient from the previous paragraph
- plus 25 mm/day (1 in./day) for the area drained into open inlets
- plus 15 mm/day (⅝ in./day) for the area drained into blind inlets

Apply these criteria to the watershed area likely to contribute surface water to the surface inlet. This calculation is shown in Example 2 in Section 2.11. This recommendation applies to all crops except high value vegetable crops that suffer scalding from ponded surface water. For these crops, install surface inlets in depressional areas and provide a drainage coefficient of 35 mm/day (1⅜ in.) for the area contributing surface water to the surface inlet.
Note: In almost every case, the drain pipe diameter controls the rate of flow rather than the type of inlet, unless flow restrictors are used in the riser pipe.

2.11 Main Drain Pipe Diameter Selection

The design diameter of a drain pipe depends on the drain grade, internal hydraulic roughness of the pipe and the volume of water carried in a 24-hour period. Water volume depends on physical properties of soil, depth and spacing of drains, and area drained. When designing main and submain drains for random or combination systems, choose a pipe size to accommodate the flow from the area if it drained systematically.

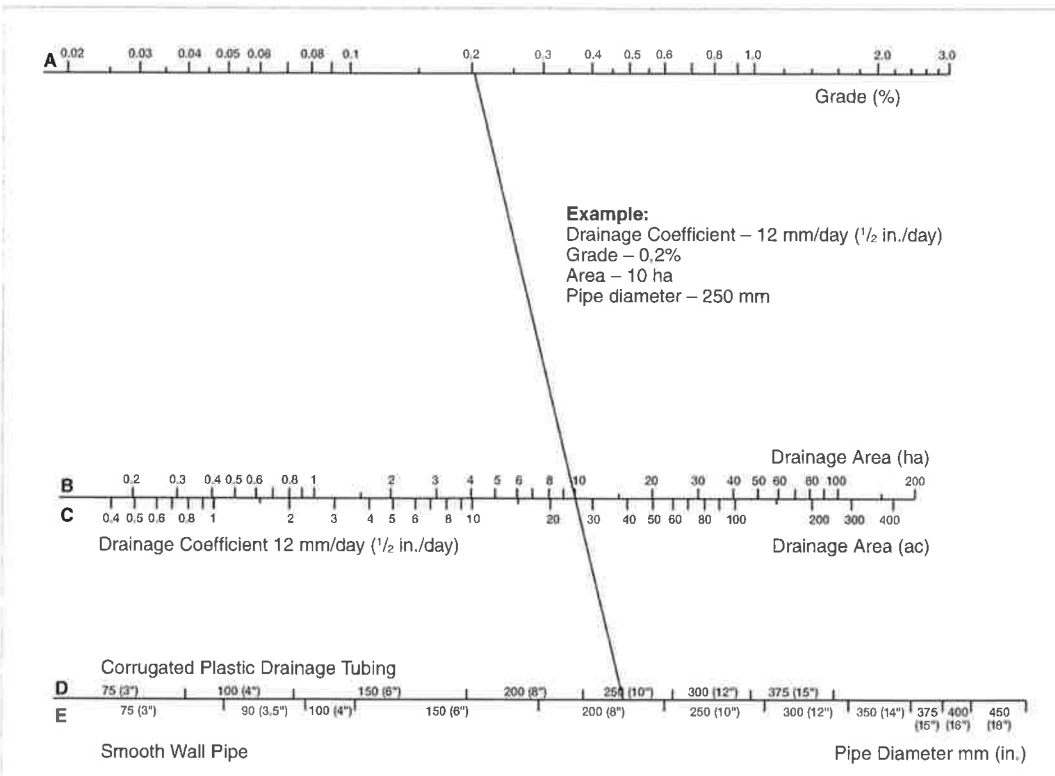


Figure 2. Nomograph for Selection of Main Drain Size

Determining Pipe Diameter

There are two methods for obtaining main drain pipe diameter in this guide – the nomograph method and the graphical method.

Nomograph Method (Figure 2)

Select the required pipe diameter from Figure 2. Knowing the proposed drain grade (A), the area to be drained (B), corresponding to a 12 mm/day (½ in./day) drainage coefficient (C), join these points with a straight edge and read off the required pipe size – (D) if corrugated plastic drainage tubing is used, or (E) if smooth-wall plastic, well-laid clay or concrete drain tile is used.

For example, a main drain on a grade of 0.2% (0.2 m/100 m or 0.2 ft/100 ft) used as an outlet for 10 ha (25 ac) of land at a drainage coefficient of 12 mm (½ in.)/day will require a 250 mm (10 in.) diameter corrugated plastic drainage tubing (D), or 200 mm (8 in.) diameter smooth-wall plastic, clay or concrete drain tile (E).

Figure 2 can also be used to find solutions for drainage coefficients that aren't shown.

For example, a design with a coefficient of 25 mm (1 in.)/day is approximately double the 12 mm (½ in.)/day coefficient used above. In this case, double the drainage area to 20 ha (50 ac), and use a straight edge from 0.2 on (A) through 20 ha (50 ac) on (C) and read the required drain diameter in (D) or (E). To obtain solutions for other drainage coefficients, use the following conversion factors:

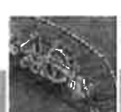
Drainage Coefficient mm (in.)	Factor
9 (⅜)	1.5 x area
12 (½)	1.0 x area
20 (¾)	0.75 x area
25 (1)	0.50 x area
35 (1½)	0.33 x area

Graphical Method (Figures 3, 4, 5 and 6)

An alternative method for selecting the proper diameter of the main drain gives additional information on pipe flow velocity and drain discharge which may be useful in the design. Use this method for large diameter pipe and areas not included in Figure 2.

Enter Figure 3 using the drainage area, in hectares, and move vertically to the diagonal line representing the appropriate drainage coefficient. Move horizontally to the left to obtain the drain discharge, L/s.

Enter the left side of Figure 4 for corrugated plastic drainage pipe, or Figure 5 for clay or concrete drain tile, or Figure 6 for smooth-wall plastic using the drain discharge determined from Figure 3. Move horizontally to the right until to intersect the vertical line indicating the grade of the drain. This intersection determines the diameter of the pipe and the velocity of flow in the drain when running full.

Example 1: A main drain on a grade of 0.2% (0.2 m/100 m or 0.2 ft/100 ft) is used as an outlet for 10 ha (25 ac) of land at a drainage coefficient of 12 mm (½ in.)/day.

An area drained of 10 ha (25 ac) and a drainage coefficient of 12 mm (½ in.)/day in Figure 3 produces a design discharge of 14 L/s. Enter Figure 4 at 14 L/s and move to the right to the grade 0.2, the required diameter of corrugated plastic drainage tubing is 250 mm (10 in.). Similarly, enter Figure 5 at 14 L/s and move to the right to 0.2, the required diameter of clay or concrete pipe is 200 mm (8 in.). Figure 6 yields the same value for smooth-wall plastic pipe.

Example 2: A subsurface drainage system is planned for a 20 ha (50 ac) parcel of land for cash crops. A blind inlet is installed in a 1 ha (2.5 ac) depressional area. In addition, a catchbasin at the field boundary intercepts surface water draining from 4 ha (10 ac) of neighbouring property. Assuming a grade of 0.5%, what size of main is required?

Using the method outlined in Section 2.10, determine the total design flow using Figure 3. The design flow for the main is composed of:

- 20 ha @ 12 mm/day = 28 L/s
- 1 ha @ 15 mm/day = 2 L/s
- 4 ha @ 25 mm/day = 12 L/s

The total design flow for the main is 42 L/s. Enter Figure 4 at 42 L/s and move to the right to the grade 0.5%, the required diameter of corrugated plastic drainage tubing is 300 mm (12 in.). Similarly, enter Figure 5 at 42 L/s and move to the right to 0.5% grade, the required diameter of clay or concrete pipe is 250 mm (10 in.). Figure 6 yields the same value for smooth-wall plastic pipe.

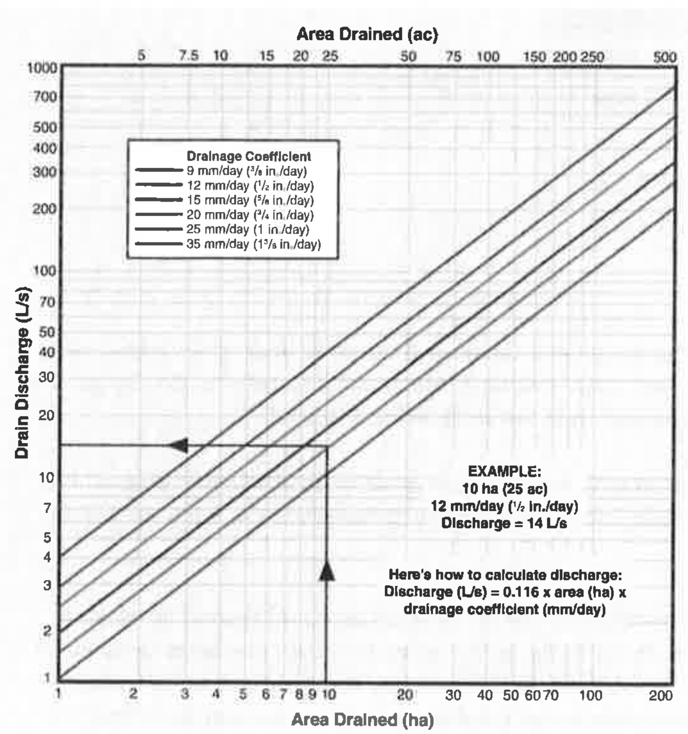


Figure 3. Drain Discharge from Area Drained

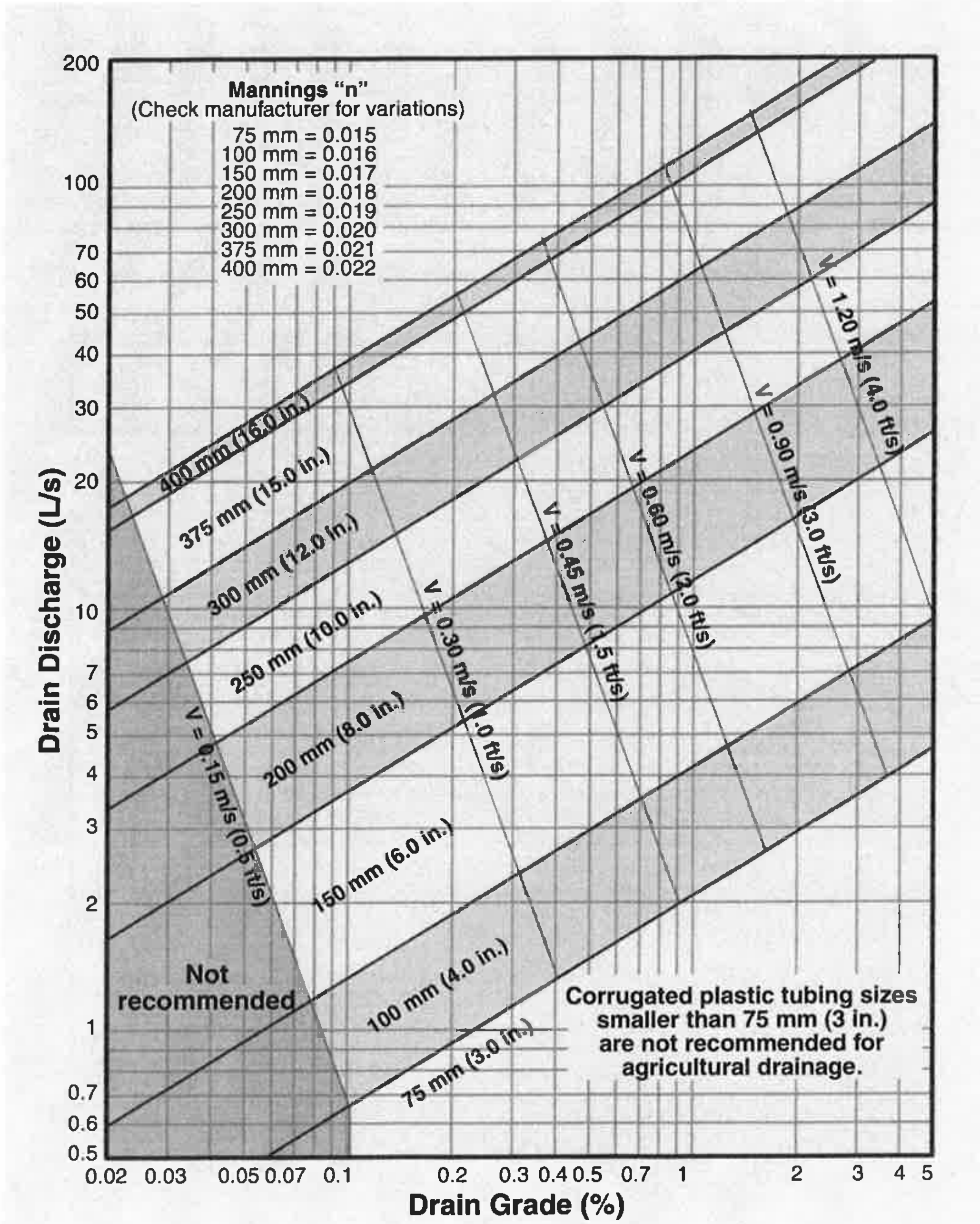


Figure 4. Drain Diameter of Corrugated Plastic Drainage Tubing

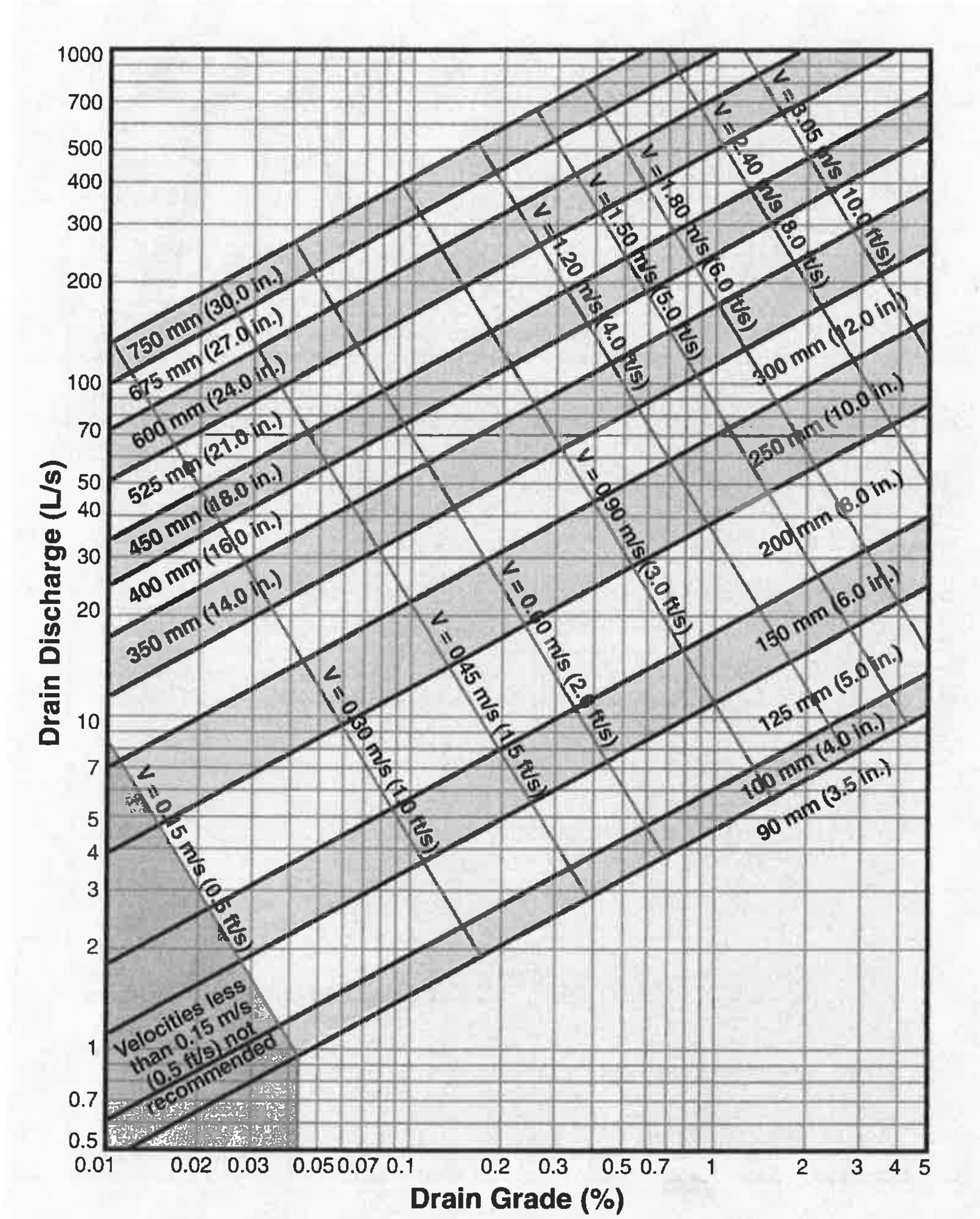
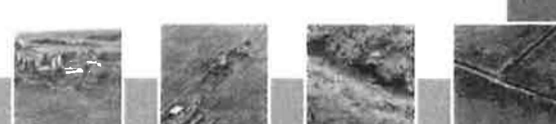


Figure 5. Drain Diameter of Concrete and Clay Pipe



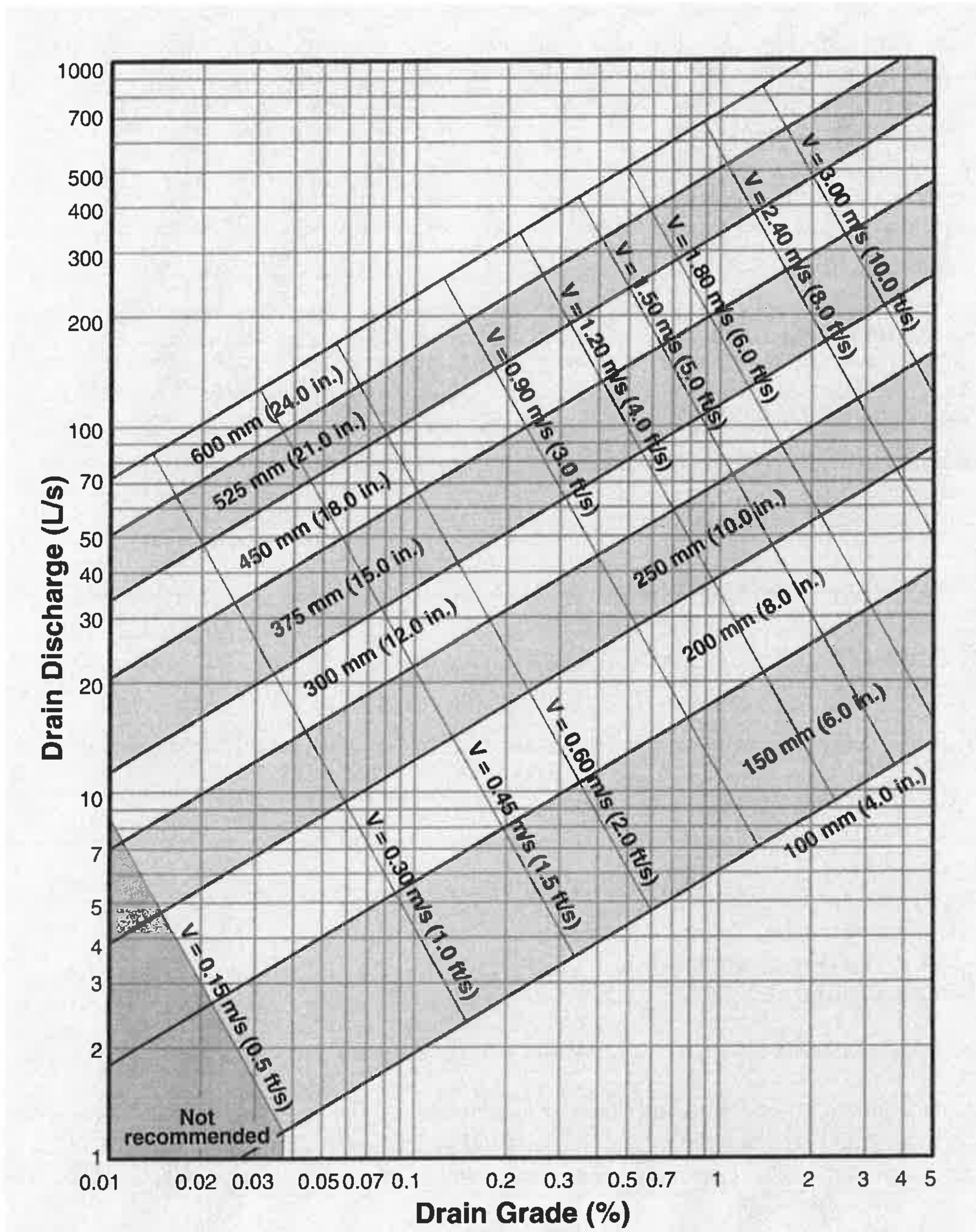


Figure 6. Drain Diameter of Smooth-wall Plastic Pipe

The Manning pipe roughness factors used to calculate Figure 5 for concrete and clay pipe and Figure 6 for smooth-wall plastic pipe is 0.011. Figure 4 (corrugated plastic pipe) is constructed using a variable Manning pipe roughness. These are:

75 mm (3 in.) → 0.015
100 mm (4 in.) → 0.016
150 mm (6 in.) → 0.017
200 mm (8 in.) → 0.018
250 mm (10 in.) → 0.019
300 mm (12 in.) → 0.020
375 mm (15 in.) → 0.021
400 mm (16 in.) → 0.022

Source: Friction factors for corrugated plastic drainage pipe. Ross W. Irwin and Jiri Motycka, Journal of Irrigation and Drainage, A.S.C.E., Vol. 105. No. 1. 29 - 36, 1979.

The required diameter D (mm) for larger drain pipe can be determined from the equation:

$$D = 122.6\,(D_c A n)^{0.375} s^{-0.1875}$$

D_c = drainage coefficient (mm)
A = drained area (ha)
n = Manning pipe roughness coefficient
s = grade in %

The flow rate of large diameter corrugated plastic tubing can be estimated from the equation:

$$Q = 7.56\, D^{2.5}\, s^{0.5} (R/\lambda)^{0.38}$$

Q = pipe discharge (m^3/s)
D = internal pipe diameter (m)
s = unit gradient (m/m)
Ï = spacing between corrugations (m)
R = internal pipe radius (m)

Source: Corrugated Pipeflow Rate from Pipe Geometry. R.W. Irwin, ASCE Journal, Irrigation. & Drainage. 110; #2, 237-241. June 1984.

The minimum pipe size for a small diameter main drain is 100 mm (4 in.). When this size is used as a main or submain drain, use 75% of the design capacity from Figures 4, 5 or 6. This reduction in capacity takes potential losses into account from sediment accumulation, drain connection roughness, etc.

2.12 Seepage Interception

An interceptor drain should cross the slope and intercept seepage water before water reaches the ground surface. Locate the drain up the slope from the seepage area, perpendicular to the flow path and approximately at the impervious layer where groundwater flows.

Place drains closer together and deeper in the wet area when the source of seepage water is vertically from below. Also consider installing a cross-drain between adjacent lateral drains in the wet area, with gravel backfill.




Determine the size and capacity of single random interceptor drains from Figures 4, 5 or 6 when designed for the inflow rates shown in Table 5.

Table 5. Inflow Rate to Interceptor Drains

Soil Texture	Inflow Rate per 100 m of Drain (L/s)[1,2]
Coarse sand and gravel	1.0-3.5
Sandy loam	0.5-1.5
Silt loam	0.2-0.75
Clay and clay loam	0.02-0.50

[1] Discharge of flowing springs, or direct entry of surface water through a surface inlet or blind inlet, must be added to the above. Such flows should be measured or estimated.
[2] Inflow rates for interceptor lines on sloping land should be increased by 10% for land slopes 2 to 5%, by 20% for slopes 5 to 12%, and by 30% for slopes over 12%.

Source: Drainage by the Interception Method, E.W. Gain. US-SCS 1951, NA-ASAE.

To determine the total inflow for an interceptor drain from Table 5, enter the left side of Figures 4, 5 or 6 with this value. Move horizontally to the right to intersect the grade of the drain – this point locates the diameter of pipe required.

For example, assume the inflow rate from a sandy loam soil is 1.50 L/s. The design discharge from a 500 m (1,640 ft) drain across a slope of 7% is 1.50 x (500 ÷ 100) = 7.5 L/s for a land slope less than 2%. This value must be increased by 20% for a 7% land slope, i.e. 7.5 x 0.20 = 1.5 L/s. That makes the design flow 7.5 + 1.5 = 9.0 L/s. If the grade on the drain is 0.5%, Figure 4 shows the required diameter of corrugated plastic drainage tubing is 200 mm (8 in.).

2.13 Minimum Diameter of Lateral Drains

The minimum recommended diameter of pipe for lateral drains is:

- 100 mm (4 in.) for corrugated plastic tubing
- 90 mm (3.5 in.) for clay tile
- 75 mm (3 in.) when grade produces clear water velocity >0.15m/s (0.5 ft/s) (see Table 7)

Although generally not recommended, use 50 mm (2 in.) corrugated plastic tubing in special circumstances and certain soil conditions (e.g. S1 soils, sports fields, lawns, etc.).

2.14 Length of Lateral Drains

The maximum length of lateral drain is restricted by the area that causes the drain to run full. Calculate by entering Figures 4, 5 or 6 with the grade of the drain and determine the discharge.

Use Figure 3 to determine the drained area, in hectares (ha), for a pre-selected drainage coefficient. Calculate the maximum length of drain, L, (m) from the equation. S is the lateral drain spacing.

Metric measurement: L (m) = area (ha) x 10,000/S (m)
Imperial measurement: L (ft) = area (ac) x 43,560/S (ft)

The minimum length of lateral drain is usually greater than two times the drain spacing. To calculate the amount of tile needed to drain an area, see Table C1.




2.15 Depth and Cover of Lateral Drains

Drain depth is the distance from the ground surface to the bottom of the trench. Drain cover is the distance from the ground surface to the top of the drain pipe (see Figure 7).

Many factors impact drain depth and it is important to examine the soil profile before selecting the depth of drains (see Figure A1). For recommended ranges of drain depth see Table 3 or 4. When designing a system, keep in mind that installation cost often increases with depth of drain.

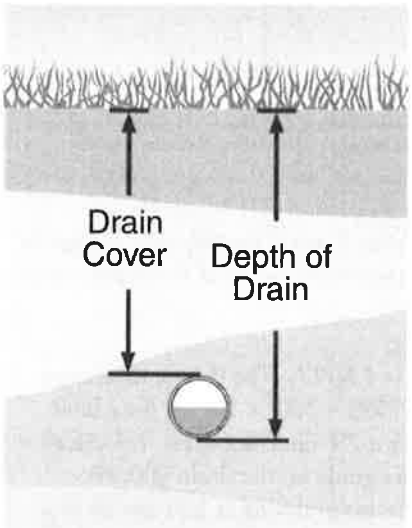


Figure 7. Drain Depth and Cover

Drain depth is affected by:

- available outlet depth
- minimum root zone required for shallow rooted crops
- soil physical properties
- protection of pipe from damage by farming operations
- stoniness of soil profile
- spacing of lateral drains

In medium to coarse sandy soils, keep lateral drains no deeper than 750 mm (30 in.).

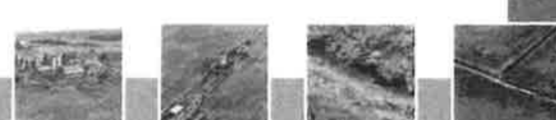
Minimum cover for main drains is 600 mm (24 in.) for pipe diameters up to and including 150 mm (6 in.), and 750 mm (30 in.) for pipe diameters 200 mm (8 in.) or greater.

Minimum cover for lateral drains is 600 mm (24 in.), to protect a drain from breakage by farm machinery. Under the following conditions, 500 mm (20 in.) cover is acceptable provided lateral spacing is adjusted and heavy equipment doesn't traverse drain lines:

- slowly permeable soils
- where rock, stones, sand or dense soil prohibit greater depth
- depressional or impounded areas with an outlet problem
- where outlet depth is limited and cannot be improved
- where drains are to be used for sub-irrigation

If this minimum cover can't be obtained, use continuous high strength rigid perforated pipe, filling the area with earth until sufficient cover is provided.

Pipe that meets the standards in Section 6 will withstand earth pressure up to 2 m (6.5 ft) deep if installed in open or closed trenches with a width no greater than 500 mm (20 in.). Drains installed by conventional agricultural drainage machines in Ontario don't normally exceed these maximum cover limits. If very deep and wide trenches are used, seek advice from a drainage engineer familiar with the design of deep drains.



Install drains so the dead load of the soil, and impact and live loads of machinery, doesn't exceed the minimum strength of the drain pipe. Table 6 shows the percent of live and impact loads transmitted to the drain pipe for a vertical wall trench.

Table 6. Percent of Applied Surface Load on Buried Pipe

	Trench Width at Top of Pipe			
Cover	**300 mm** (12 in.)	**600 mm** (24 in.)	**900 mm** (36 in.)	**1,200 mm** (48 in.)
600 mm (24 in.)	8%	14%	18%	21%
900 mm (36 in.)	4%	8%	11%	14%
1,200 mm (48 in.)	3%	5%	7%	9%
1,500 mm (60 in.)	2%	3%	5%	6%

2.16 Grade

Install subsurface lateral drains as close to uniform depth as topography permits, and maintain continuous grades. In design, the grade of the drain is assumed to be parallel to the hydraulic grade line. For design purposes, assume the hydraulic grade line remains within the drain, i.e. the drain doesn't run under pressure. On flat land, make grades as great as possible without sacrificing drain cover to obtain it (see Section 2.15).

Minimum Grade

Minimum grades are shown in Table 7. Select a grade, where possible, to produce a non-silting velocity of 0.45 m/s (1.5 ft/s). Where this isn't possible, include silt basins in the system design. Where sedimentation isn't a hazard, select a minimum grade for a velocity of 0.15 m/s (0.5 ft/s). Avoid reverse grade, and interpolate between ranges provided.

Table 7. Recommended Minimum Grade

Drain Diameter	Clear Drains* Not Subject to Sediment		Drains Subject to Sediment	
	Smooth Pipe**	**Corrugated Pipe**	**Smooth** Pipe**	**Corrugated Pipe**
1	2	3	4	5
75 mm (3 in.)	0.08%	0.10%	0.48%	1.0%
100 mm (4 in.)	0.05%	0.08%	0.32%	0.7%
150 mm (6 in.)	0.025%	0.06%	0.18%	0.5%
200 mm (8 in.)	0.02%	0.04%	0.12%	0.4%
250 mm (10 in.)	0.018%	0.035%	0.09%	0.3%
300 mm (12 in.)	0.012%	0.03%	0.07%	0.25%

*The grades in columns 2 and 3 provide a minimum velocity of 0.15 m/s (0.5 ft/s) at full flow and in column 4 and 5 provide 0.45 m/s (1.5 ft/s) at full flow.

**Well-aligned clay, concrete and plastic smooth wall pipe.




Maximum Grade

Maximum grades are shown in Table 8. These are for main drains, flowing full but not under pressure, and should not produce velocities exceeding those listed.

Table 8. Maximum Permissable Velocity of Flow in a Drain Pipe

Soil Texture	Velocity m/s (ft/s)
Sand – sandy loam	1.0 (3.3)
Silt – silty loam	1.5 (5.0)
Silty clay loam	1.75 (5.75)
Clay and clay loam	2.0 (6.6)
Coarse sand and gravel	2.5 (8.2)

When these velocities are exceeded, take protective measures to prevent soil movement. Velocity is determined from Figures 4, 5 or 6. Interpolate between ranges for other soils. For effective drainage, the maximum grade of lateral drains should not exceed 2%.

Design of Main Drains on Steep Slopes

- A steep slope is one where a partially filled drain pipe has a Froude Number ($F = V/(gD)^{1/2}$ greater than 1, where $g = 9.8$. The minimum velocity, $V = 3.13\ D^{1/2}$, where V is in m/s and D is the pipe diameter in metres.
- Design short lengths of main drain on steep slopes to flow half-full.
- When the drain flows half-full, and the grade is 1 to 4% in sandy soil, 2 to 6% in silt or loam soil, or 6 to 15% in clay soil, use continuous non-perforated pipe, and wrap and protect drain tile joints. Tamp soil firmly around the drain.
- When the drain flows full, and the grade is over 1% in sandy soil, over 2% in silt or loam soil, and over 6% in clay soil, use continuous non-perforated pipe.
- Install a breather at the top of steep sections to prevent negative pressure in the drain (see Section 3.10).
- Install a relief well at the bottom of steep sections unless the drain discharges directly into an open ditch (see Section 3.10).

2.17 Drainage System Pattern Design

A subsurface drainage system design provides uniform drying of the field surface so crops aren't harmed by excess water and field operations can take place. Topography and physical field obstructions determine the drain layout, and include location of pipelines, hydro towers, ditches, stones, barn and manure storages. Keep the lateral drain layout simple to minimize installation cost and maintenance, while achieving drainage objectives.

Traditional drain patterns or layouts are systematic or comprehensive, random or interceptor. Uniform slopes are most effectively drained by a system of regularly spaced parallel drains connecting into a main drain. Fields with complex slopes are also systematically drained with more sub-mains and main drains. On sloping land, lateral drains are positioned across the slope to intercept the natural downslope movement of water.




Systematic Drain Patterns (see Figure 8A)

- Provides a consistent level of drainage over the area.
- Historically, lateral drain patterns were typically gridiron at right angles to field boundaries.
- Current systems are designed at an angle to the field boundary and across the slope or field working pattern.

Herringbone Patterns (see Figure 8B)

- When used on sloping land, require more connections, higher cost and shorter lateral drains.

Random Pattern Layout (see Figure 8C)

- Suitable for undulating or rolling land with isolated wet areas.
- Lay main drain in the low area.
- Install a few lateral drains and spur drains in low areas between hills.
- Size and locate main drain to include any future growth to this type of system.

Double Main Pattern (see Figure 8D)

- Use when there is a stream, farm lane, pipeline or other obstruction.
- The cost of a second main drain can be a disadvantage.
- Use interceptor drains to intercept the flow of water before it exits on the soil surface, usually side hill seepage (see Section 2.12).

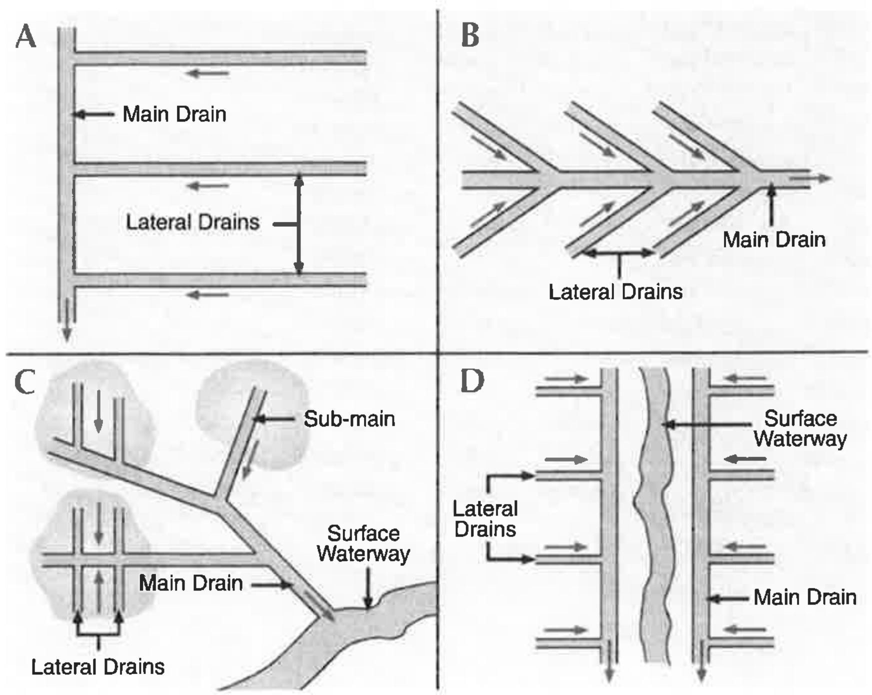


Figure 8. Basic Patterns for Subsurface Drainage Systems

2.18 Initial Investigative Procedures

- Walk the area to determine possible outlets, low problem areas, high ridges, and the history of cropping practices.
- Evaluate the soil profile, determine landowner's assessment of drainability and identify any construction problems such as very fine sand, gravel, large stones, shallow bedrock, iron ochre or high water table.
- Survey the area and draw a topographic map at a large enough scale for planning, showing obstructions such as fences, trees, buildings, utilities and outlets.
- Select the average depth of lateral drains from Table 2 and 3, based on the rooting depth of crops, available outlet elevation, the elevations of key problem areas and Section 2.15.
- Select the spacing width for lateral drains based on Table 2 and 3, and discussions with the landowner.
- Allow for possible sedimentation at the outlet when selecting the outfall elevation, refer to Section 7.17 and Figure 10 and 11.
- Check the legal status of the outlet. Contact the local municipality for municipal drains.
- Check for utility easements and obtain necessary permits.

2.19 Additional Considerations

- Use as few outlets as possible to reduce potential future problems.
- Take advantage of surface slopes and maintain as uniform a depth of drain as the land surface permits.
- Design the system with long lateral drains and short main drains for economics. Be sure long lateral drains are not too deep.
- When feasible, lay out lateral drains at an angle to the direction of surface water flow.
- When feasible, lay out lateral drains at an angle to the normal farming pattern.
- On flat land (0.1% or less) plan lateral drains in the direction of greatest surface slope.
- Follow the general direction of a natural waterway with mains and submain drains. Where possible, offset drains from the lowest elevation to avoid reduced cover and erosion damage.
- Control water table levels deep enough to provide optimum root development for the deepest rooting crop grown.
- Obtain the diameter of the main drain and long lateral drains from Section. 2.11 – changing pipe causes large changes in capacity.
- Use a direct or indirect connection to connect existing functioning subsurface drains to the new system.
- Do not connect drains that carry polluted water.
- If needed, drain small areas of wetter land with stub drain lines at closer spacing.
- Use a cut-off at the high end of fields so surface water won't run onto the field.
- Avoid deep cuts and cut downs.
- Check that the outlet is in the most suitable location.
- The drainage effect of a lateral drain at the upper end is equivalent to one-quarter of the drain spacing.




- At the upper end of the laterals: If using a header tile, locate it no more than one half of the drain spacing away from the ends of the lateral drains (see Figure 9). If a header tile isn't used, end laterals no further than one-quarter of the drain spacing from the field boundary. Other techniques can be used to achieve the same drainage objective.
- Position header tile no closer than 3 m (10 ft) from the field boundary.

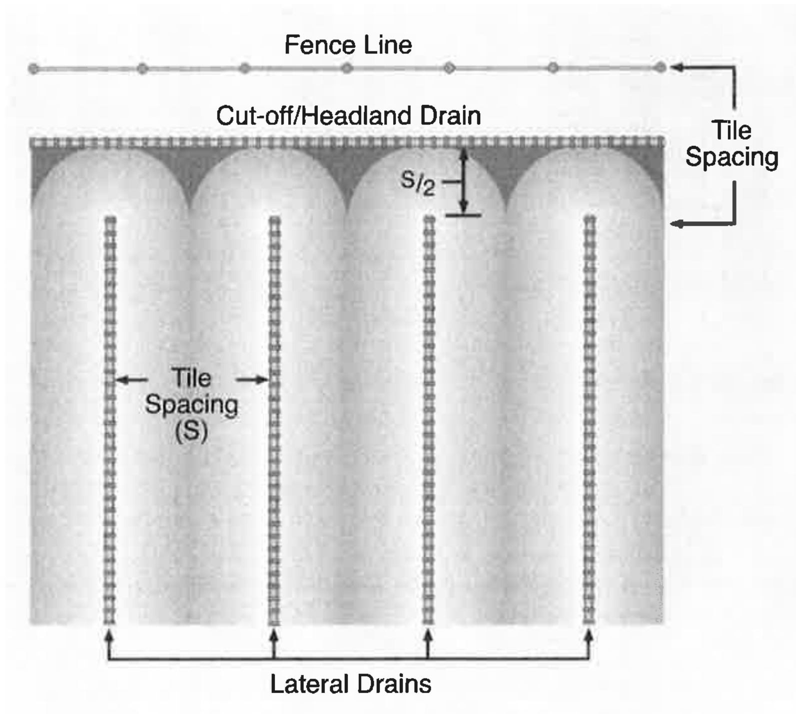


Figure 9. System Layout at Upper End of Laterals




3. Drainage System Structures

3.1 General

A drain system structure is an auxiliary part to a subsurface drainage system. The structure must not unduly impede the flow of water in the drainage system, and its capacity must not be less than the drains feeding into or through them. Typical drainage structures are:

- outfalls
  - o end pipes
  - o headwalls and rock chutes
  - o drop pipe structures
  - o vegetation establishment
- surface water inlets
  - o riser inlets
  - o ditch inlets
  - o silt basins, catch basins, sediment traps
  - o blind inlets
- junction boxes
- relief wells and breathers
- end caps and plugs
- siphons
- drain crossings
- inline flow control devices

Determine the number, type and size of structures during the design of the drainage system. Consider soil borings to ensure a solid foundation for structures.

3.2 Outfall

The outfall is the most important part of a drainage system and must be properly built and maintained. For ease of maintenance, fewer outfalls are better for the drainage system. When designing the system, consider potential damage and legal action that could result from poorly designed outlets. Protect the drain system against erosion from turbulence and high velocities created near outfalls, surface inlets or similar structures. Be sure to protect shallow subsurface drains near the outlet from excessive machinery loads and farm work.

End Pipes

Protect pipes discharging into ditches or watercourse from erosion and undermining. Use a length of continuous rigid, non-perforated pipe for an end pipe. Protect end pipes for plastic tubing drainage systems against weather, fire and animal damage, and crushing. Standard corrugated plastic tubing is not satisfactory for an end pipe.

End pipes are joined to drain tile by sleeve joints or butt joints.

- *Butt Joints:* The inside diameter of the end pipe must be equal to or larger than the inside diameter of the drain pipe, and not exceed the outside diameter of the drain pipe by more than 25 mm (1 in.). Wrap the joint with a material or seal to ensure soil doesn't enter the joint.




- ***Sleeve Joints:*** The drain tile must be inserted a minimum of 300 mm (1 ft) into the end pipe. The inside diameter of the end pipe should not exceed the outside diameter of the drain pipe by more than 50 mm (2 in.). If the inside diameter of the end pipe is less than 25 mm (1 in.) larger than the outside diameter of the drain tile, no wrapping is required. If the inside diameter of the end pipe is more than 25 mm (1 in.) larger than drain tile, wrap the joint.

The minimum dimensions of end pipe are shown in Table 9. Embed the pipe in the bank to provide support, and install the end pipe as soon as the drain is constructed.

Table 9. Dimensions of End Pipe

Nominal Drainpipe Diameter mm (in.)	End Pipe Dimensions			
	Minimum Diameter mm (in.)		Minimum Length mm (ft)	Maximum Cantilever mm (in.)
	Butt Joint	Sleeve Joint		
100 (4)	100 (4)	Maximum Outside Diameter of Drainpipe + 50 mm (2 in.)	3,000 (10)	400 (16)
150 (6)	150 (6)		3,000 (10)	600 (24)
200 (8)	200 (8)		3,000 (10)	600 (24)
250 (1)	250 (10)		3,600 (12)	600 (24)
300 (12)	300 (12)		3,600 (12)	800 (32)
350 (14)	350 (14)		4,800 (16)	800 (32)
400 (16)	400 (16)		5,400 (18)	800 (32)
450 (18)	450 (18)		6,000 (20)	1,000 (40)

Attach a hinged grate or rodent guard to the end pipe at time of installation. Grate openings must not exceed 25 mm (1 in.). The design of the grate must permit removal of debris.

Allow a minimum freeboard of 300 mm (12 in.) in the end pipe above the normal ditch water level, and consider future sedimentation in the outlet ditch.

Use flush mounted end pipes where there is sufficient protection from erosion (see Figure 10). This type of end pipe is less susceptible to ice damage compared to cantilever style end pipes.

Use cantilever style drain end pipes where sufficient erosion control protection has been incorporated (see Figure 11). This type of end pipe is more susceptible to ice damage than flush mounted outfalls.

Markers should be used to indicate the location of each end pipe.



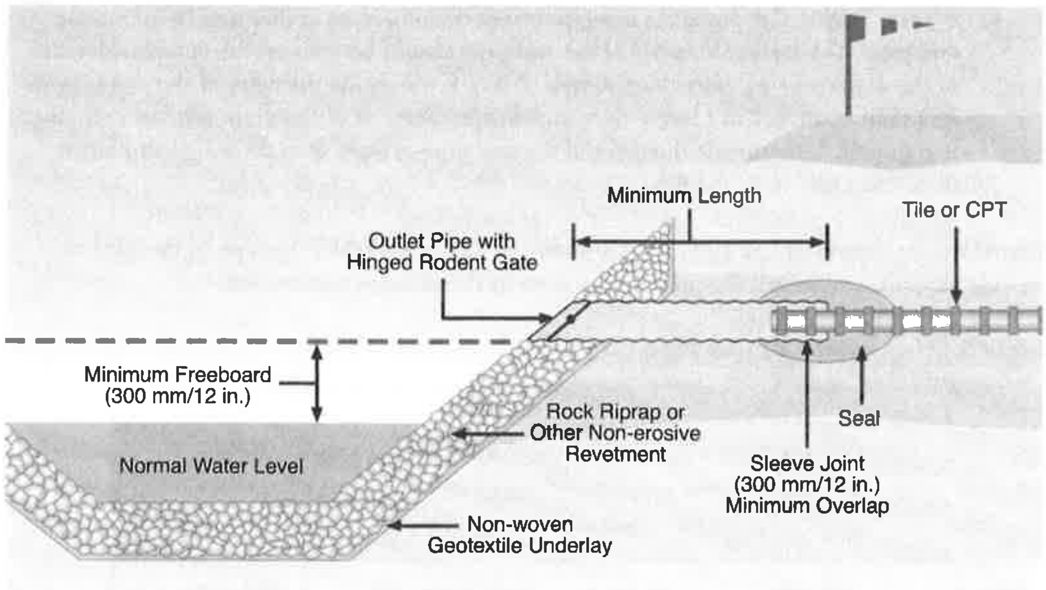



Figure 10. Flush Mounted End Pipe

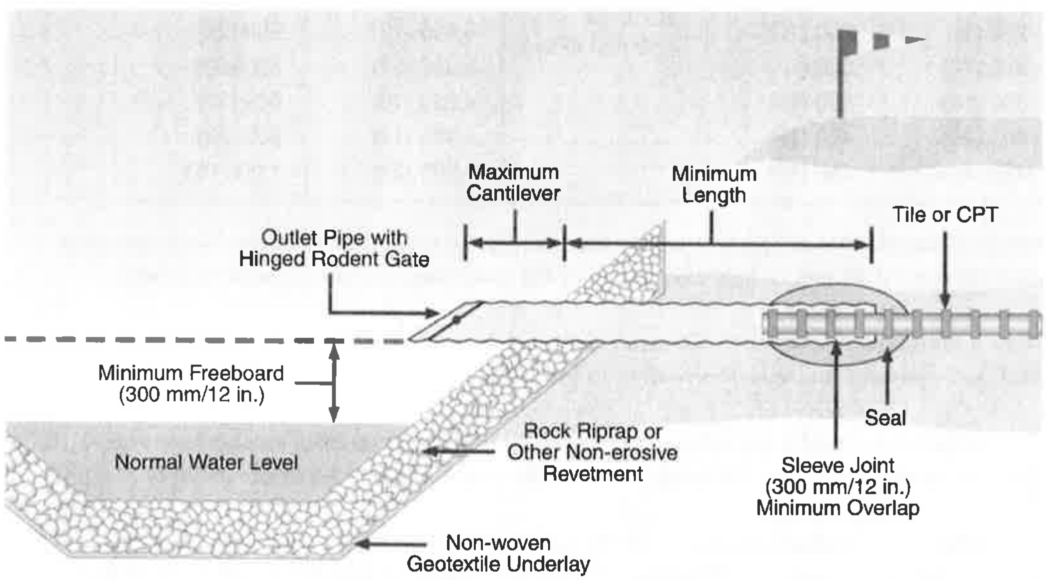


Figure 11. Cantilever Style End Pipe

Headwalls and Rock Chutes

Unless precautions are taken, stream and ditch bank damage can occur when surface water enters the receiving watercourse at the same location as the end pipe. Headwalls and rock chutes structures provide protection against this damage. The choice of the structure used depends on the local site characteristics and availability of materials.

- ***Headwalls:*** A headwall protects the end pipe and receiving stream from erosion, and must be adequate strength and design to avoid failure. Headwalls are used infrequently, but use with a splash plate when necessary (see Figure 12). Construct headwalls of any durable material such as concrete or bagged concrete.

- ***Rock Chutes:*** Rock chutes work similar to headwalls and require more space because of the material used (see Figure 13).

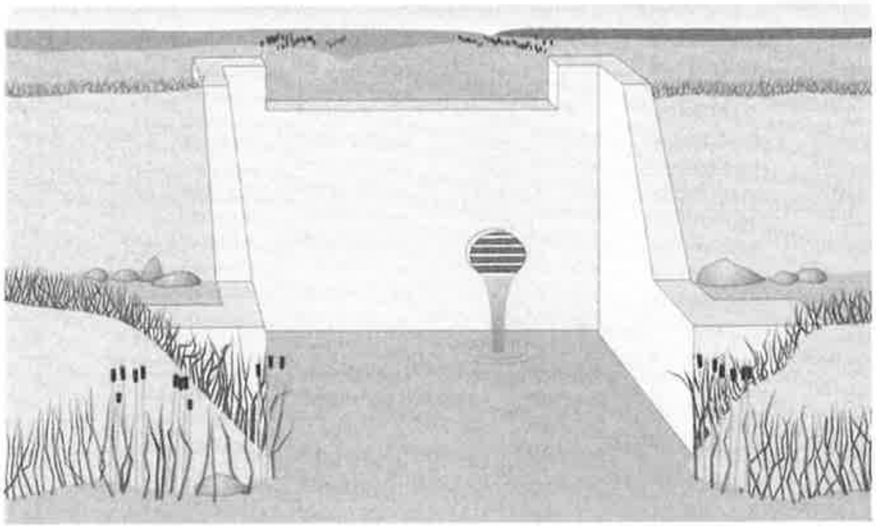


Figure 12. Headwall Outlet

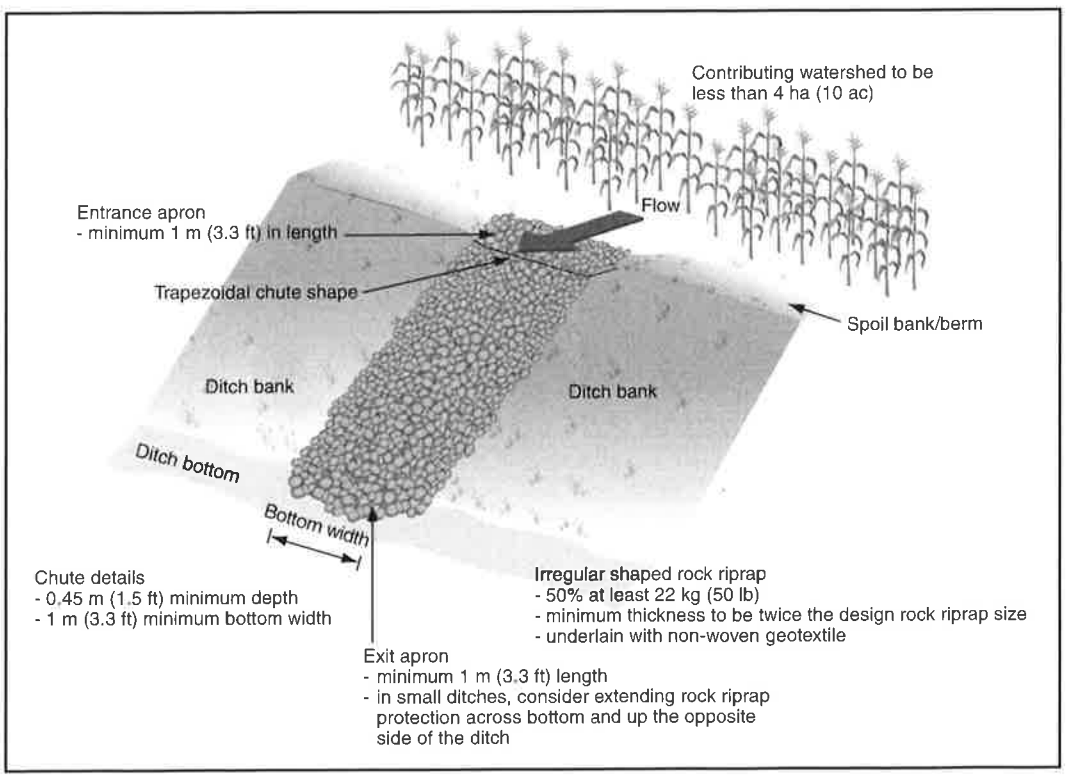


Figure 13. Rock Chute Outlet

Drop Pipe Structures

Drop pipes are erosion control structures that form part of the outlet for a drainage system, or are located at gullies where drainage water discharges. Specialized design and construction is often required (by consultants) when using drop pipe.

Vegetation Establishment

Establishing permanent vegetation in any disturbed area at the outlet, as soon as possible after construction, will minimize erosion and environmental concerns. Landowners and contractors must determine who is responsible for this practice.

3.3 Surface Water Inlets

Surface water inlets allow surface water to enter subsurface drains. This is an expensive practice and inlets are only recommended for draining low areas where it's not feasible to install a surface drainage system. Where feasible, design open channels and waterways in conjunction with subsurface drainage systems to carry as much of the surface runoff as needed (see Figure 14).

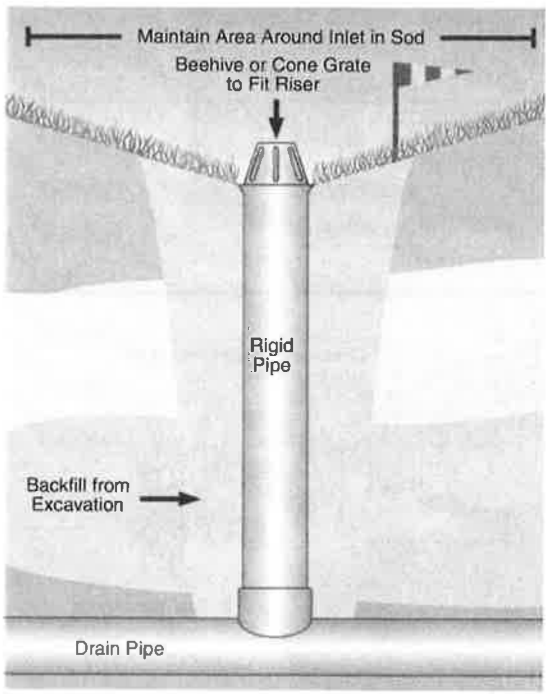
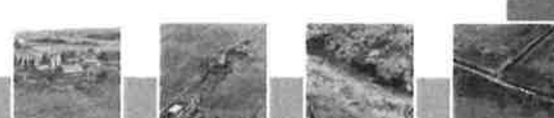


Figure 14. Surface Water Inlet

Installation Considerations

- If used on land intended for manure and biosolids application, consider the impact on the drainage system and to the environment.
- Use only where surface drains are not practical because surface inlets often present a maintenance problem.
- Surface inlets may be needed to help remove surface water concentrated in depressions, where specialized crops are grown, or when routing surface water underground from higher areas to prevent flow across a flat cultivated area.



- Determine capacity needed for surface water inlets by hydrologic procedures for the drainage area served by the inlet.
- Surface water inlet structures should exclude floating debris, field-applied manure and stop the entry of rodents.
- Provide a total flow restrictor device with each surface water inlet structure.

Example applications or locations of surface inlets are:

- A fence line or other boundary where the subsurface system picks up surface water from an adjoining area.
- A ditch where water from the ditch enters a subsurface system.
- A depressional area where specialized crops grown are susceptible to water damage and require the designed removal of surface water.
- A depressional area with low soil permeability where a blind inlet won't have sufficient capacity or isn't appropriate for the situation.
- An erosion control structure where surface waters are diverted to a subsurface system to prevent erosion from the concentrated overland flow. A floodwater storage system is often incorporated into the design. This type of system is usually referred to as a water and sediment control basin.

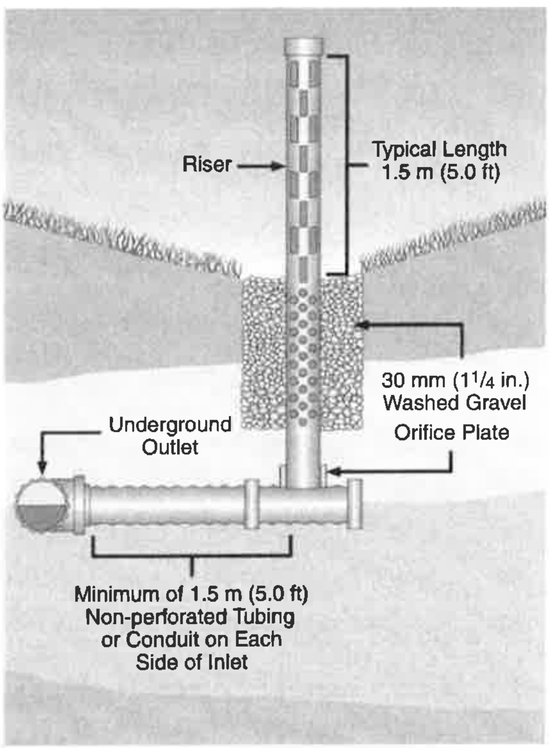


Figure 15. Offset Riser Inlet

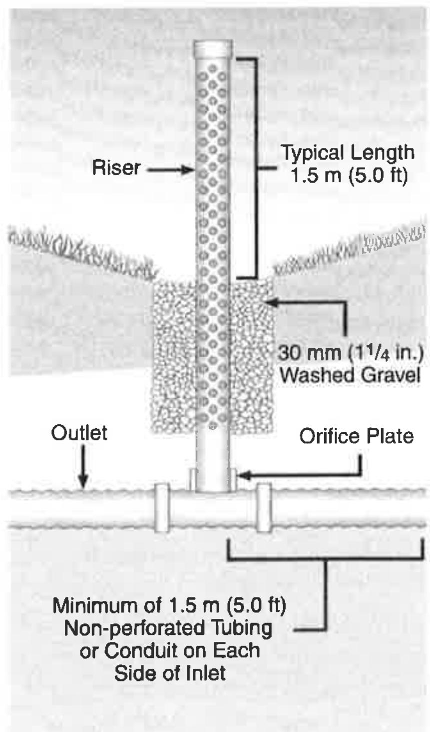


Figure 16. On-line Riser Inlet




Riser Inlets

Use riser inlets for small flows, especially for potential trash problems. To prevent trash from plugging the inlet, be sure the capacity of the holes isn't the limiting factor.

Offset riser inlets from the receiving pipe by 1,500 mm (5 ft) using a non-perforated conduit (see Figure 15). If the riser inlet is installed on-line, use solid tubing on either side of the inlet (see Figure 16). Use riser inlets that are durable, structurally sound, and resistant to fire and rodent damage. Vertical pipes with holes or slots are used as inlets.

To act as a catchbasin, the capacity of a surface water inlet must not be less than the maximum design flow in the drain line. Install a flow control device (e.g. orifice type flow control) in the base of the riser pipe, if necessary, to control the volume of water entering the subsurface drain.

The capacity of an orifice plate can be calculated from the following two equations:

- The design head on a riser inlet orifice plate is $H = 0.7d_1 + d_2$

d_1 = depth of the low area above the design surface elevation to the top of the berm
d_2 = depth to the orifice plate below the ground level of the low area

- The discharge, Q, of a riser outlet is $Q = 2.66\ A\ H^{1/2}$

$Q = m^3/s$
H (head on orifice plate) = m
A (area of orifice) = m^2

For example, a 50 mm (2 in.) orifice plate is installed in a riser inlet, connected to a 100 mm (4 in.) tile at a 0.4% slope. The dimension from the orifice plate to ground level, d_2, is 0.6 m (2 ft). The dimension from ground level to the top of the berm, d_1, is 0.9 m (3 ft). The head, H, on the orifice is $(0.7 \times 0.9) + (0.6) = 1.23$ m (4 ft). The area of the 50 mm (2 in.) orifice is 0.002 m^2 (3.1 in^2). The discharge, Q, into the drain line is $Q = 2.66 \times 0.002 \times \sqrt{1.23} = 0.006$ m^3/s (0.21 ft^3/s).

From Figure 3, a 100 mm (4 in.) drain at a grade of 0.4% has a capacity of 2.8 L/s or 0.0028 m3/s (0.1 ft^3/s). The size of the drain pipe controls the flow and an orifice is not required. This means, however, the inlet will delay flows from higher elevations.

As a variation of a riser inlet, create a surface inlet flush to the ground surface by excluding the above-ground portion of the riser pipe and replace with a grate (cone or beehive) to prevent entry of debris into the underground system. Install a marker to identify the location.



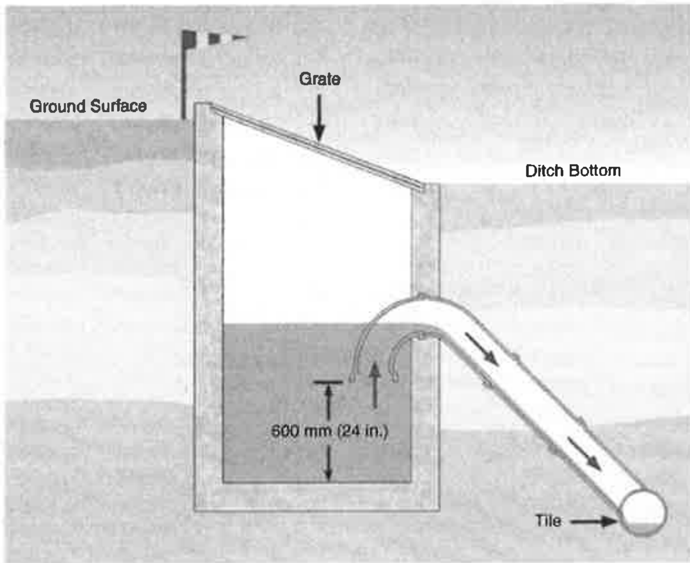



Figure 17. Ditch Inlet

Ditch Inlets

Ditch inlets permit surface water in a ditch to enter a subsurface drainage system (see Figure 17).

- The grade of the ditch has a negligible effect on inlet capacity.
- The crest of the inlet is the same elevation as the ditch bottom.
- Longitudinal bars are spaced on the trash grate to prevent debris entry.
- Install the grate at an approach slope of 1:1.
- Install a trash fence upstream from the inlet.
- Estimate the required horizontal width of the unobstructed inlet from Figure 18.

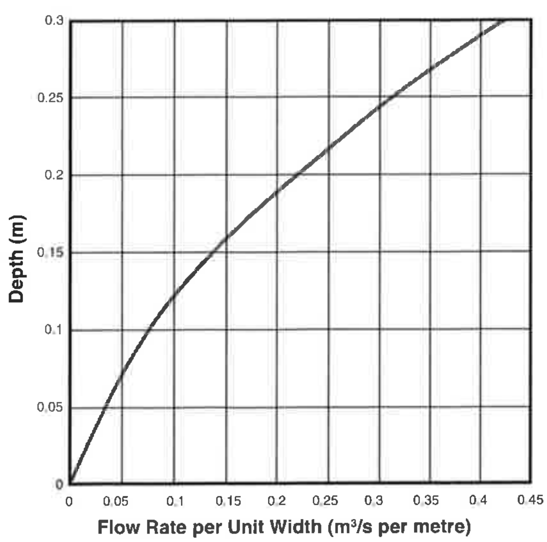


Figure 18. Ditch Inlet Design Chart

For example, assume a ditch has a design flow of 0.15 m^3/s (5.3 ft^3/s) and the design head on the inlet is 0.20 m (0.66 ft). Enter Figure 18 at 0.20 m (0.66 ft) depth of flow and determine the flow rate per unit width of inlet is 0.22 $m^3/s/m$ (2.37 $ft^3/s/ft$). The design width of the inlet is $0.15 \div 0.22 =$ 680 mm (2.23 ft). The width may be increased by 50% to 1.02 m (3.35 ft) to allow for obstruction by corn leaves, etc.

Silt Basins

This type of structure is used as a settling chamber to separate sediment from water and as an access inspection point to the drainage system (see Figure 19).

- Use down grade from where a drain passes through a problem sandy area.
- Locate, where possible, at permanent fences or in non-cultivated areas.
- If used in cultivated areas, install with the top of the structure a minimum of 450 mm (18 in.) below the ground surface, and adequately construct to support any load placed on it by farming equipment.
- Clearly identify the location of a silt basin either on-site with a marker, or record through details on drawing, GPS location coordinates, etc.

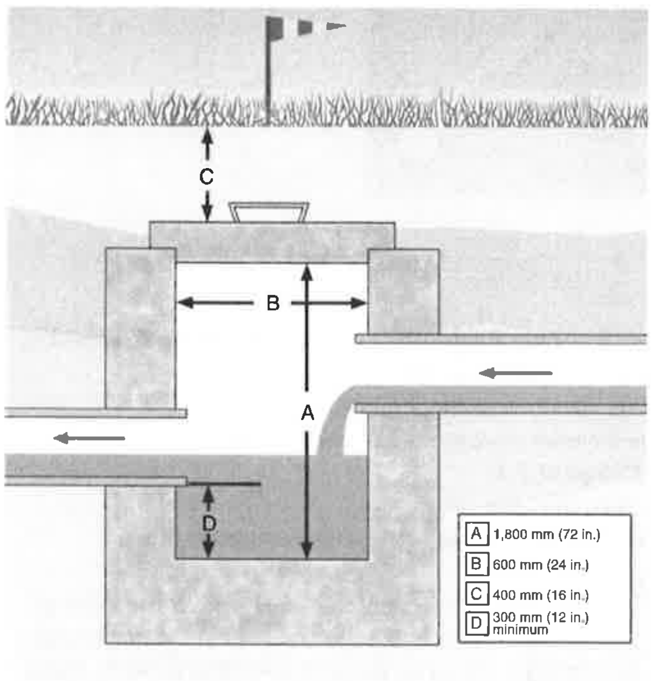


Figure 19. Silt Basin

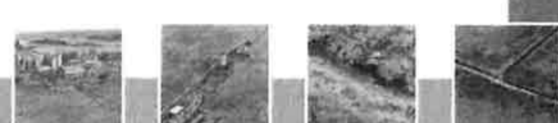
Base the size of the silt basin on accessibility for maintenance.

- circular structures – minimum diameter of 750 mm (30 in.)
- square or rectangular structures – minimum dimension of 600 mm (24 in.)
- depth of sediment trap – minimum of 300 mm (12 in.), increase for longer intervals between maintenance

Catch Basins

Catch basins are covered by a grate and located in low-lying areas. They intercept surface water and are connected to a subsurface drain for transmitting water to an outlet (see Figure 20).

- For maintenance purposes, circular catch basins need a minimum diameter of 600 mm (24 in.) and square or rectangular catch basins need a minimum dimension of 600 mm (24 in.).
- Design the grate to prevent plugging by debris and be removable.



- Position grate vertically or sloped more than 45 degrees.
- Equip them with a sediment trap no less than 300 mm (12 in.) deep.
- Identify the catch basin location clearly on-site with a marker or record through details on drawings, GPS location coordinates, etc.
- Equip all catch basins with a full flow restrictor plate that's readily available if liquid manure or biosolids are applied upslope of the catch basin.

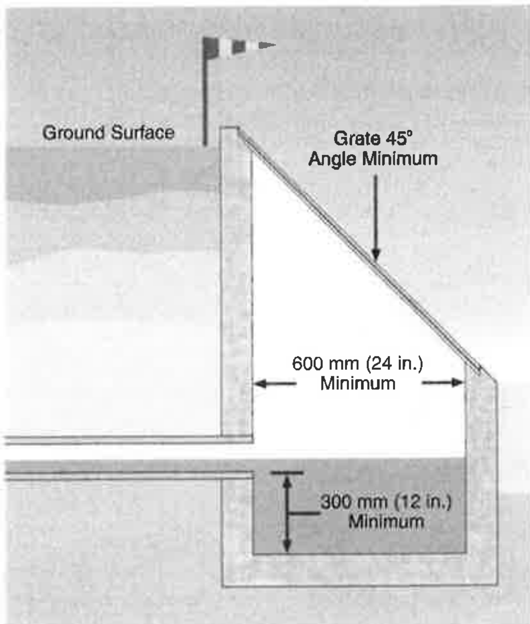


Figure 20. Catch Basin

Blind Inlets

Blind inlets are recommended for depressional areas where shallow surface drains are not practical and/or where surface ponding occurs.

- A 500 mm (20 in.) wide trench 3000 mm (12 ft) long, filled to the top of the trench with 30 mm (1¼ in.) washed stone, serves as an excellent inlet (see Figure 21).
- A geotextile placed horizontally at 300 mm (12 in.) deep will add to the life of the inlet, requiring replacement of only the upper layer of stone (see Section 2.10).
- Identify the location of blind inlets on-site with markers or record through details on drawings, GPS location coordinates, etc.

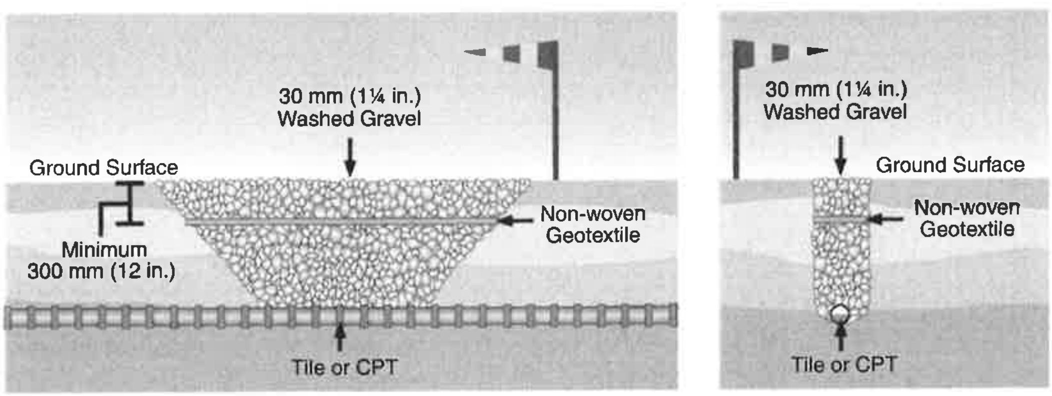
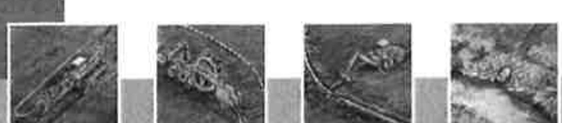


Figure 21. Blind Inlets



3.4 Junction Boxes

Use junction boxes to connect three or more drains, connect two drains at different elevations and serve as a junction where a drain size or drain direction changes abruptly (see Figure 22).

- Base the size of a junction box on accessibility for maintenance:
  - o circular structures – minimum diameter of 750 mm (30 in.)
  - o square or rectangular structures – minimum dimension of 600 mm (24 in.)
- If junction boxes are buried, provide a minimum depth of soil cover of 450 mm (18 in.) where grades permit and construct to adequately support any load placed on the junction box by farming equipment.
- Design junction boxes to facilitate cleaning and other maintenance. Provide a sediment trap with a minimum depth of 300 mm (12 in.), and increase depth for longer intervals between maintenance.
- Clearly identify the junction box location on-site with a marker or record through details on drawing, GPS location coordinates, etc.

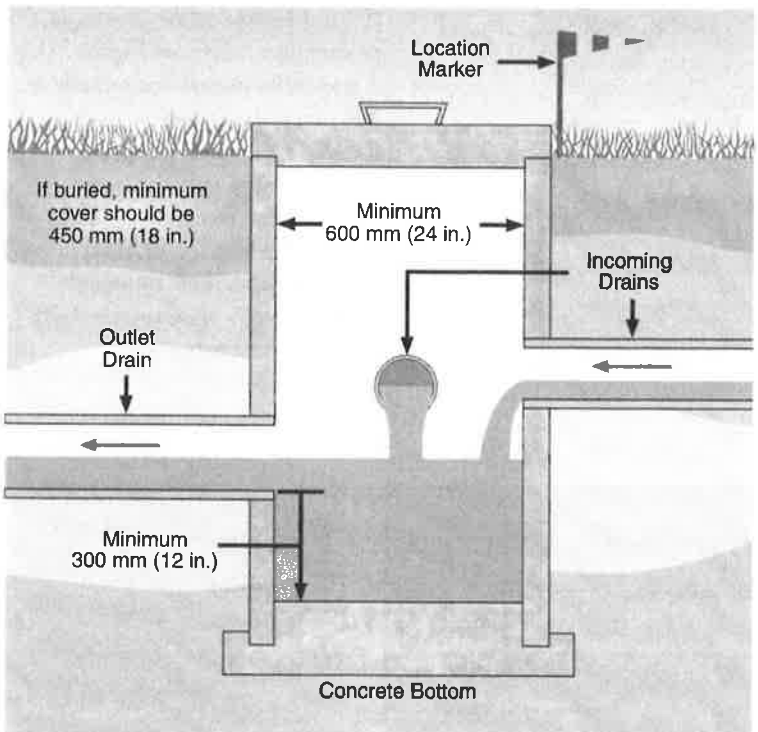


Figure 22. Junction Boxes

3.5 Relief Wells and Breathers

Flow conditions may improve by installing a breather or vent at the upper end of a very steep section of main drain and a relief well at the base of the slope (see Figure 23). These accessories improve the flow in the drain, reduce the hazard of drain failure, and often the need for changing pipe sizes. Where possible locate relief wells and breathers in fence lines (see Section 2.16). Protect relief wells and breathers by a screen or mesh, and locate at ground level in fence rows or where they won't be damaged. Clearly identify the location of relief wells and breathers on-site with a marker or record through details on drawings, GPS location coordinates, etc.

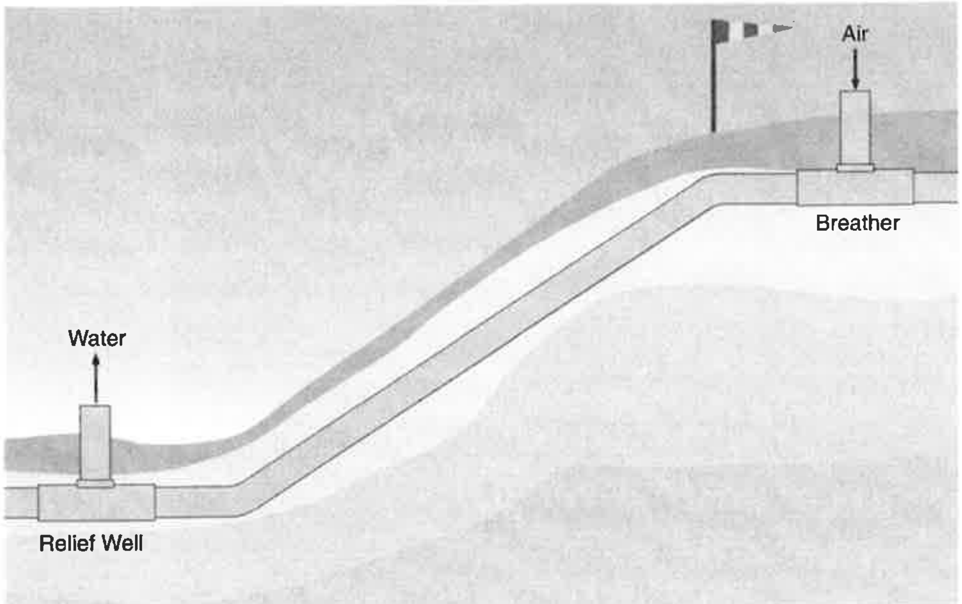


Figure 23. Breathers and Relief Wells

Relief Wells

- Wells relieve the pressure in drain lines that might otherwise cause the lines to blow out and fail.
- Install a relief well near the base of a steep slope where the grade changes abruptly to a flatter slope.
- Use a relief well to relieve internal pressure where there are surface inlets.
- The diameter of the vertical relief well should be equal or greater than the drain line.
- Relief wells are constructed by placing a T connection in the line and fitting a vertical riser into the T.
- Exit the riser to the ground surface, and protect the exposed end by a mesh or screen to prevent the entry of rodents.

Breathers

A breather is a T connected to a short riser in a drain, located at the top of a steep slope to improve flow conditions in the pipe. Breathers improve flow in long lateral drains in saturated soil where air is prevented from entering the drain and the drain gradient is usually quite flat.

3.6 End Caps and Plugs

Cap the upper end of each subsurface drain line – if not connected to a structure – with a tight fitting plug or cap made of the same material as the pipe or other durable material.

3.7 Siphons

Inverted siphons are used where there is a need to run a drain below obstructions such as a pipeline or road. Common practice is to construct inspection chambers on each side of the obstruction and a connecting pipe below (see Figure 24).

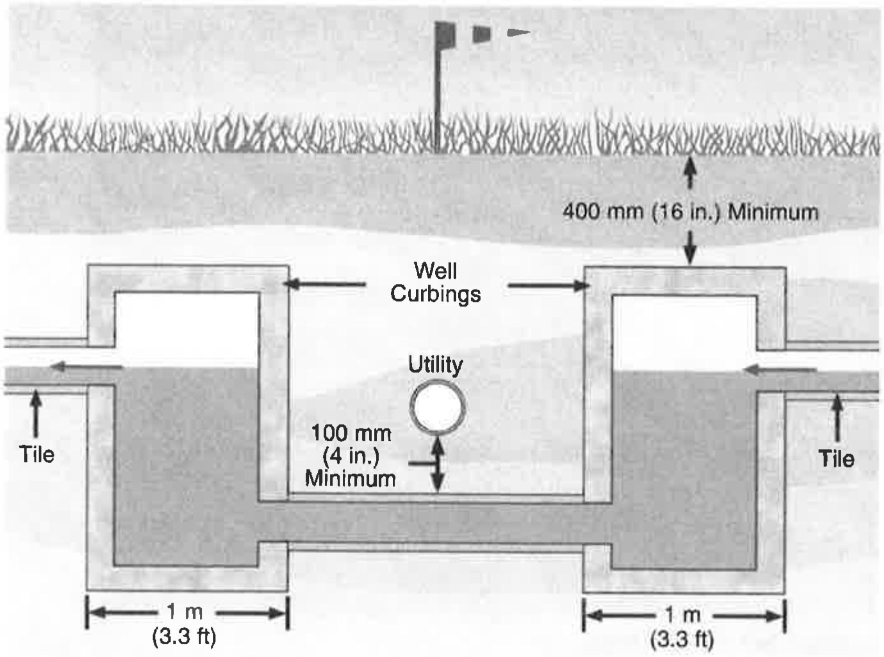


Figure 24. Inverted Siphons
Source: Journal of Hydraulics, ASCE, 1972 No. 1, p. 45.

3.8 Drain Crossings

When a subsurface drain crosses under farm lanes, roads, waterways or ditches, construct it of extra-strength pipe to withstand expected loads and should be watertight (see Figure 25).

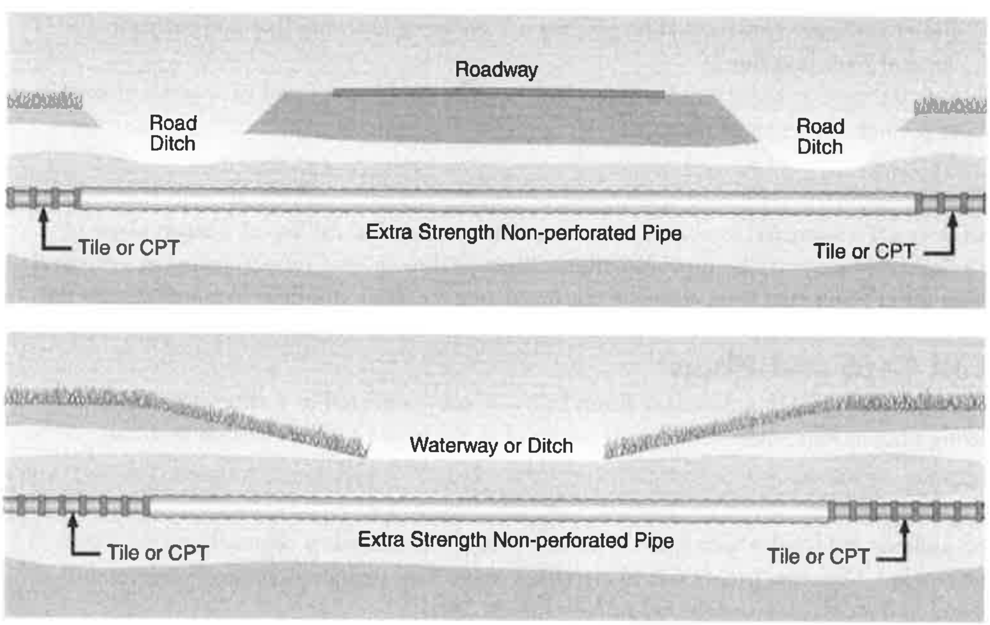
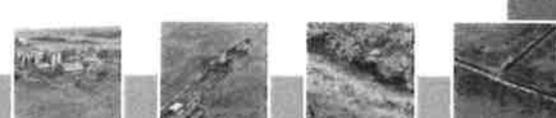


Figure 25. Drain Crossings



3.9 Inline Flow Control Devices

Inline flow control devices are specially designed structures to manage the water flow in a subsurface drain. Often used for water table management, these devices also stop flow in a drain contaminated from a spill e.g. pesticide, gasoline, manure, etc. (see Figure 26). Pick a strategic location for control devices for desired objective and to avoid blowouts and flow restrictions during normal drainage operation mode.

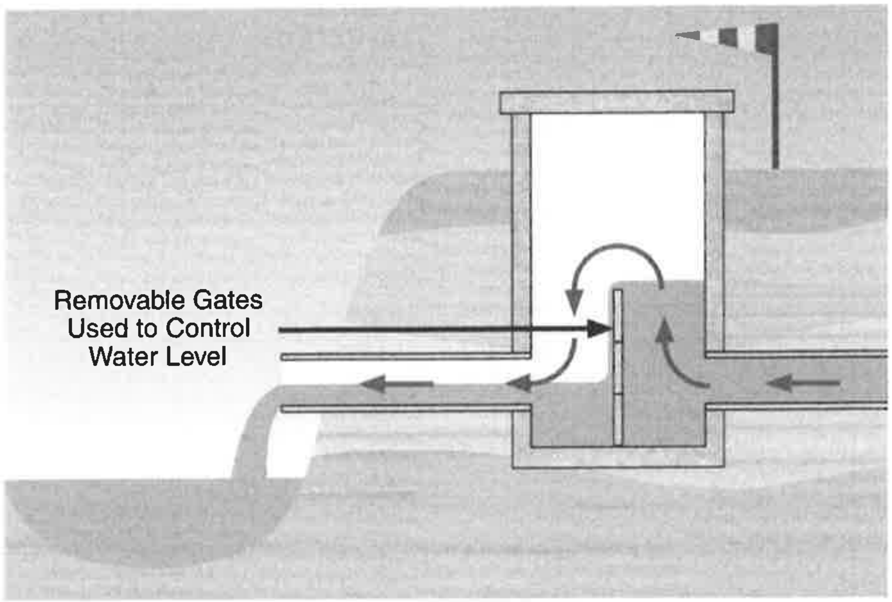
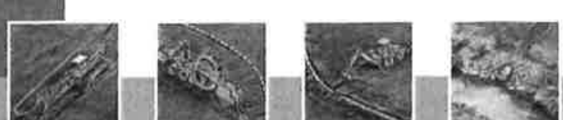


Figure 26. Drain Tile Water Control Device



4. Utilities and Road Crossings

The word utility in Section 4 includes the works of a public utility, defined in the *Drainage Act, 1990*, and the works of a road authority.

4.1 New Utilities Affecting Existing Drainage

Planning

Installing pipelines, cables and other buried utilities on farmland may disrupt existing drainage systems. The utility must ensure that, after construction, the quality of drainage within the right-of-way is equivalent to or better than drainage in the work area and adjoining lands prior to construction.

The location of utilities and roads may affect the design of future drainage systems. Before installing utility works, be sure the utility discusses with owners the plans for new or additional drainage installations across the proposed right-of-way, so suitable arrangements can be made. After construction is complete, inspect the tile drainage systems carefully to ensure proper repair.

Construction of Utilities Affecting Open Ditches

- Install buried utility works at a minimum of 0.75m (2.5 ft) below the bottom of the ditch, and don't interfere with the flow of water in a drainage ditch.
- At the point where a utility work crosses a ditch, protect the ditch banks from slides and erosion.
- Remove all debris and rubbish from the ditch before leaving the site.

Construction of Utilities Affecting Tile Drainage

The utility is responsible for the repair of all subsurface drains damaged by their construction work, on or off the right-of-way or work area.

Repair damaged, cut or removed drains immediately so the system will function properly, or cover the ends to prevent the soil entry. If the drain pipe is damaged, broken or collapsed, or the grade is altered, remove the pipe to 1 m (3.3 ft) beyond the affected area, and replace with new pipe of the same size and on the design grade.

Where a work area extends over land containing lateral subsurface drains, the utility work on the surface must not adversely affect the subsurface drains through breakage or collapse of pipe. This can be checked by:

- visual inspection up the pipe using a strong light where the distance does not exceed 10 m (33 ft), or
- inserting a 75 mm (3 in.) diameter probe through the pipe for the width of the work area to ensure there is no drain failure or blockage through tubing collapse or tile breakage




Where a utility work crosses under a drain line, ensure a minimum clearance of 50 mm (2 in.) between the invert of the drain line and the top of the utility work. If it crosses over a drain line, a minimum clearance of 50 mm (2 in.) is required between the top of the drain pipe and the bottom of the utility work.

Where a utility work crosses under a drainage system, tamp the fill below the drains and compact to the same density as the surrounding soil. Use well-pulverized soil, free from stone, debris or frozen lumps. Shape and plane the trench bottom to the original grade, and place a satisfactory support under the drain. Blind the drain pipe with 100 mm (4 in.) of stone-free soil and backfill the trench, leaving a minimum crown of 200 mm (8 in.).

Drain crossings are the portion of disturbed subsurface drain across the utility work excavation.

If crossings are wider than 3 m (10 ft)

- use metal pipe or other high-strength, continuous, rigid pipe (clamp joints with regular manufactured connecting bands) or a pipe of larger diameter than the drain pipe
- install and tamp the backfill so it won't be crowded out of line by vibration or frost
- seal the joint at each end with concrete

If crossings are less than 3 m (10 ft)

- lay drain pipe on a satisfactory support
- use additional support in unstable soils

Where the utility work excavation has cut a series of lateral drain lines, construct a new main drain parallel to the upstream side of the utility work, or right-of-way easement with a minimum number of crossings of the utility. Construct a silt basin at the downstream side of the right-of-way for each drain crossing. Be sure the upper end of severed drains are closed tightly with an end plug.

Carefully inspect all drain lines prior to backfilling to ensure pipes are on grade, correctly aligned and properly installed. The allowable variation from grade must be not more than specified in Section 7.6. The ground surface should be graded to eliminate depressions where water might collect.

4.2 New Drainage Affecting Existing Utilities

Third-party contractors are the greatest threat to buried utilities. Pipelines companies are required to establish monitoring programs to verify pipeline integrity that follow the requirements established in the Canadian Standards Association Standard Z662 *Oil and Gas Pipeline Systems.*

Planning Your Drainage Tile Installation Work

- Contact the utility company in advance of the tile drainage work and advise them of the site plans for installing new or modified tiles.
- Arrange for locates to verify the horizontal and vertical position of the buried utilities. Stakeout and crossing inspections are provided free of charge by utility companies when arranged in advance of work commencement.




- Discuss the additional work and cost implications of crossing the buried utility with the company before work starts. Utility companies understand the implications of altering conventional drainage systems. Ensure there's a mutual understanding about cost-sharing arrangements for the work. This can only be determined by submitting plans and estimates before starting work.
- Avoid the installation of tile runs within the utility easement in the design of tile systems. Future utility maintenance activities can damage tile facilities. Header pipes can be positioned along the right-of-way boundaries to collect drainage from individual runs.
- Design the tile drainage system to minimize the number of tile runs crossing the buried utility. Use a larger header pipe to facilitate a single crossing of the buried utility.
- Maintain the following minimum clearance from the buried utility for drainage system crossings:
  - o 50 mm (2 in.) for plastic tiles
  - o 300 mm (12 in.) for culverts
  - o 750 mm (30 in.) for ditches

Installing Tile on the Right-of-Way

Drainage system designs must be submitted to the utility for approval. The utility company usually responds to a crossing request within 10 working days. Start by obtaining written permission from the utility company. Their objective is to allow drainage work to be completed while ensuring the utility is protected from damage by construction equipment. Utility companies also want to avoid impacts or damage to the drainage system that may be caused by future utility maintenance along the easement.

- After approval is received, contact the utility at least three working days in advance of starting work near the easement. Notify Ontario One Call (1-800-400-2255, *www.on1call.com*) or the utility company directly.
- Ensure an inspector is present when work takes place on the utility easement. A crossing stakeout is performed when the work begins, and the property owner and contractor will sign the form.
- Hand dig to expose the buried utility before beginning mechanical excavation. Keep mechanical excavation more than 600 mm (24 in.) away from an exposed utility.
- Where drains won't go over or under a work without a deviation from grade, lower the work if the utility can be disrupted, or construct an inverted siphon (see Figure 24).




5. Drain Design Considerations and Problem Solutions

5.1 General

Certain property features can create problems with a tile drainage system and must be considered during the design of the system. This section identifies some of these features and provides recommendations to minimize future problems. If these features result in problems to the tile drainage system, this section also provides recommendations to improve the problem.

5.2 Tree Roots

If tile drains carry water for prolonged periods during the growing season, they can be plugged by tree roots.

Design Considerations

- Route the tile at least 30 m (100 ft) away from water-loving trees such as willow, soft maple, elm and poplar, and at least 15 m (50 ft) away from all other trees.
- If rerouting isn't possible, remove water-loving trees for a distance of 30 m (100 ft) from a drain which carries water during the growing season for a prolonged period. Other trees need a clearance of 15 m (50 ft) from a drain. Refer to OMAFRA article, *Farm Tile Drains and Tree Roots, www.ontario.ca/omafra*
- If a tree can't be removed, or the drain rerouted, use continuous non-perforated pipe for a distance of 15 m (50 ft) on either side of the tree.
- Fruit trees are not included in these recommendations. Locate a header drain at the higher end of an orchard to intercept prolonged summer flow in lateral drains.

If You Encounter the Problem

If a tile drain becomes blocked with tree roots:

- remove and replace the section of blocked tile
- remove the tree causing the problem, or
- replace the tile using continuous non-perforated pipe for a distance of 15 m (50 ft) on either side of the tree

5.3 Quicksand

Quicksand is a condition – not a soil type – that usually occurs in small areas within a field and never the entire field. The upward pressure of groundwater on fine sand or silt prevents soil from settling firmly together. The soil's loss of bearing capacity may adversely affect the grade of the drain and the life of the system because the soil can't support an unconfined load.

Design Considerations

- Install drains when subsoil conditions are dry, if possible, or
- Permit all areas with quicksand to drain through an open channel or a sacrificial tile before laying the permanent drainpipe, or
- Install tile on a solid bedding to provide a stable support.




If You Encounter the Problem

Replace drainpipe if quicksand adversely affects the grade on a section of tile enough to disrupt the gravity flow of water.

5.4 Unstable Soils (need for drain protection)

Many fine sand and silt soils are unstable at drain depth because particles are non-cohesive, move easily when saturated and may enter the drainage pipe. Water from the surrounding soil enters from below the pipe, and soil particles (fine sands and silt) carried by the water are deposited in the pipe. This occurs shortly after the tile drainage system is installed because the soil surrounding the pipe is loose and any pre-existing soil structure is destroyed. Soil material found in the drain pipe is often coarser than parent material because finer soils particles have washed away. Initial installation is a very critical period. Self-cleaning drain grades are usually not feasible in unstable soils. Drains won't flush out naturally when the depth of sediment in the pipe exceeds 20 mm (¾ in.).

Design Considerations

Check the county soil map to determine the subsoil characteristics of the area. Just prior to installation, dig test holes to below drain depth and note if the soil and water is unstable. If still concerned after completing these steps, test if subsoil material is likely to enter a drain and determine if envelope filter protection is needed. The following simple test is an indication of need. It's positive when failure occurs. Be sure to conduct further tests if failure doesn't occur during the test.

1. Cut the top and bottom from two metal coffee cans and solder the two cans together to create an open cylinder 280 mm (11 in.) long and about 100 mm (4 in.) in diameter.
2. Cut the centre out of the plastic lid to leave a 12 mm (½ in.) retaining ring.
3. Fit a circular stiff screen having openings of 2-3 mm (⅛ in.) in the retaining ring on the bottom of the can. Place the can on a flat surface.
4. Take a sample of moist soil from drain depth and gently place it on the screen inside the can.
5. Tamp, using a 25 mm (1 in.) tamper, the soil to the density of the parent material to a depth of 25 mm (1 in.).
6. Raise the can about 6 mm (¼ in.) off the flat surface.
7. Slowly pour water into the top of the can but don't erode or wash the soil. Add water to a depth of 185 mm (7 in.).
8. If the water doesn't wash out the bottom after being left undisturbed for 15 minutes, the drain probably does not require a filter envelope.
9. Test suspect soils in a commercial soil laboratory.

If drain filter protection is required

The types of filter material now available in Ontario provide protection for most problem soils provided the soils don't contain a large proportion of fines. Filter failure can also occur through sealing by fine silt and clay particles, and by iron and manganese oxides and sulphates. Filters also fail by mechanical tearing and abrasion. Roll and unwrapped filter materials rely on good field installation for good performance.




Drain protection material on the market:

- Filter cloth material (sock) such as a polypropylene or polyester knitted woven material is applied to plastic drainage tubing at the plant.
- Pipe wrap material used for larger pipe may be geotextile or filter cloth. Ensure the entire pipe is securely wrapped.
- Graded gravel envelopes are another option, but are expensive.

Filter consideration

- Weather and storage deterioration affect filter material. Protect filter wrapped drainage pipe from ultra-violet radiation of the sun and install as soon as possible. Heat generated within maxi-coils adversely affects the life of the filter. Storage in wet conditions may promote fungus growth on filter material.
- Some cost savings are possible in soils where drains require filter protection, by installing non-perforated corrugated plastic mains. Install a 100 mm (4 in.) drain, protected with an envelope filter, parallel to the main drain if some drainage is required.
- It's not practical to design a manufactured filter for a narrow range of grain sizes. A conservative stability criteria giving protection in the critical particle size range is that the 50% size of the grain size distribution curve is not greater than the average diameter of filter opening. If the average opening of filter cloth is 0.15 mm (⅔ in.), then the $d_{50}/0.15 = 1.0$, and the d_{50} is 0.15 mm (⅔ in.).

If filter protection isn't required, but sediment migration into the tile may occur

- Design and install the tile with as much grade as is available.
- Don't install tile, or remove installed tile because it can't be left unconnected.
- Be sure construction in these problem soils takes place during dry periods.

If You Encounter the Problem

- When a tile is blocked with sediment, investigate the system to locate the source of the sediment and correct the problem. Replace or abandon the section of blocked tile.

5.5 Iron Ochre

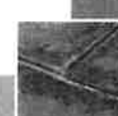
Ochre, an iron oxide, affects about 2% of drainage systems in Ontario. It occurs in two classes of soil – very open soil such as acid sand, and soil in bottom land with perennial groundwater that produces anaerobic conditions making iron ochre soluble in drainage water. Subsurface drainage systems in soils with available soluble iron (Fe+3) and organic matter are adversely affected by bacteria-forming iron ochre in pipe drain openings and inside the pipe.

Ochre accumulates through chemical or microbiological process, or both. It's a natural condition usually found where new land – sandy in nature with high organic matter – is cleared and drained. Recognized by brilliant red accretion at drain outfalls, iron ochre can seal drain openings very quickly.

Design Considerations

- There's no solution as iron ochre is caused by changes in chemical condition within the soil profile, and it's difficult to clearly identify areas where this problem may occur in advance.



If You Encounter the Problem

- Replace or abandon the original system when it fails.

5.6 Blowouts and Cave-ins

Blowouts in a field are recognized by a hole at the surface above a drain. Blowouts can occur due to:

- blockage of the pipe (roots, collapsed pipe, etc.)
- excess hydraulic pressure in the tile due to steep upslope grade
- excess hydraulic pressure in the tile due to inadequate tile size

Design Considerations

- Ensure tile is properly sized to handle flows.
- Incorporate a relief well into the design, or use larger tile, if it's suspected that a particular tile installation will result in excess hydraulic pressure due to steep upslope grade.

If You Encounter the Problem

- Inspect the field surface regularly for blowouts and cave-ins, and repair the drain pipe for any problems found.
- Consider installing a relief well to relieve excess hydraulic pressure if the blowout was a result of a steep upslope grade.
- Consider installing additional tile for added flow capacity if the blowout was a result of inadequate tile size.

5.7 Manure, Biosolids and Waste Water

Organic growths in field drains can obstruct the flow of tile drains. These include manure, biosolids, septage, milkhouse washwater, etc. reaching the drainage system through soil macropores or direct drain connections.

Design Considerations

- Locate drainage pipe away from manure storages or barnyards. Refer to regulations under the *Nutrient Management Act, 2002*, for the distance tile must be located from various structures.
- If existing tiles appear to contain nutrient contaminants or organic growth, don't connect these tiles to a new drainage system.

If You Encounter the Problem

- Replace tile drains obstructed with organic growth, as needed.
- Apply nutrients needed for crop production at rates recommended by best management practices.
- Apply manure at volumes and methods recommended by best management practices and in accordance with the requirements of the *Nutrient Management Act, 2002*.
- Discharges from septic tanks, grey water discharges, milkhouse washwater, silo effluent, etc. must not connect directly to the field tile system.




5.8 Plant Roots

Roots of commercial crops don't usually penetrate into field tile drains. However, when drains carry water during dry periods, crops such as alfalfa, brome grass, rye grass, canola, sugar beets and sometimes corn may create problems when their roots enter the drain. While these roots can cause blockages in the tile, they usually wash out of the drain when the plant dies. Horsetail (*Equisetum*) has a very deep root system and frequently will plug drains.

Design Considerations

- There are none, but ensure landowner is aware of the potential problem.

If You Encounter the Problem

- Avoid growing any problem-causing crops.
- Flush the roots from the tile using low pressure jet cleaning.
- If the blockage persists, remove or replace the blocked section of tile, and consider replacing the problem area with a larger diameter drain pipe.

5.9 Soil Management

An important component of an effective tile drainage system is the ability of gravitational water to flow through the soil to the drain tile. Two types of soil conditions may cause drainage problems – soil management problems and slow drainage in new installations.

Poor soil management restricts water movement through the soil to the tile drain. Examples of these soil management problems include:

- soil compaction of the surface layer
- soil compaction at the plow layer for sandy loam soils
- complete inversion of the plow furrow which seals the layer below

Field drainage systems don't always provide a complete answer to a drainage problem. It's important to encourage water movement in the soil, even after drainage. Tile drains don't pull water – they receive water that gravitates to them. Water movement through compacted and puddled soil layers is very difficult.

Newly installed tile drainage systems often take a few years to reach peak performance. This occurs most commonly with systems installed in land parcels that haven't been tile drained before and where the water level in the soil is close to the surface most of year. The high natural water table limits earthworm and root penetration into deeper levels, and encourages the soil to settle tightly together. Both factors limit the immediate effectiveness of tile drainage system.

Design Considerations

- There are none. It's the landowner's responsibility to ensure soil will respond to tile drainage, and the contractor's responsibility to install the tile professionally.




If You Encounter the Problem

For soil management problems:

- Improve compaction of the surface soil layer with tillage and cultural practices.
- Reduce the effects of deeper soil compaction through deep tillage or plant deep-rooted crops such as alfalfa and red clover.
- Refer to OMAFRA *Best Management Practices for Soil Management*, BMP No. 6.

For slow drainage in new tile installations:

- Use best management practices to improve soil tilth.
- Take no immediate action – soil drainage will improve over time as earthworms create large pores and cracks form, creating flow paths to the drain tile. It may take from 5-10 years to reach optimum drainage.
- Plant deep-rooted crops such as alfalfa or red clover. The roots create pathways in the soil for the water flow.
- Improve pathways for water to move to the tile with subsoiling. It's effect may be short term, and be careful to do it correctly and under proper conditions so the problem doesn't worsen.

5.10 Organic Soils

Thin layers of organic soil over sand or over heavy clay soil don't usually drain.

Design Considerations

- Avoid installing tile in these conditions.

If You Encounter the Problem

- The land is best used for grass or pasture.
- Deep plowing to mix the soils won't alleviate the problem.




6. Materials and Standards

6.1 General

Use material in subsurface drainage systems that meet the requirements of the relevant Standard. Advise contractors of any deleterious chemicals that may be in soil where the drainage system is installed. Don't install concrete pipe in soils containing sulphate unless the pipe is manufactured using sulphate resistant concrete. Examine soils containing traces of iron to ensure the proposed drainage system is effective in these soils (see Section 5.5). Refer to OMAFRA Factsheet, *Drain Problems*, Order No.84-017.

Use straight clay and concrete drain tile that's approximately circular in cross-section. Be sure ends are square and the inside surface smooth. Avoid pipe with cracks, broken pieces and checks that decrease strength or let soil into the drain. Use sewer pipe or corrugated steel pipe where drain pipe may be crushed from loads applied at the surface by machinery or other traffic, or if frost is a problem.

6.2 Clay Drain Tile

Manufacturers in Ontario adopt the following recommendation for voluntary use: that standard clay drain tile meets all American Society for Testing and Materials specifications as set out in designation C4 (clay drain tile) and Designation C498 (perforated clay drain tile).

6.3 Concrete Drain Tile

Manufacturers in Ontario adopt the following recommendation for voluntary use: that concrete drain tile meets the specifications as set out in American Society for Testing Materials Designation C412 (drain tile).

6.4 Corrugated Plastic Drainage Tubing

Plastic tubing manufacturers voluntarily adopt the *Land Improvement Contractors of Ontario – Standard Specification for Corrugated Plastic Drainage Tubing, 2006* for use in Ontario.

6.5 Fittings

- Use fittings to facilitate the construction of a subsurface drainage system and improve its effectiveness, maintenance and efficiency.
- Fittings include: Ts, cross-Ts, Ys, end plugs, end caps, bends, elbows, reducers, clay tile to plastic tubing adapters, adapters for changes in diameter and coupling for lengths of plastic tubing.
- Use strong fittings that are compatible between manufacturers used.
- Use corrugated plastic tubing couplers that meet tensile forces specified in the *Land Improvement Contractors of Ontario – Standard Specification for Corrugated Plastic Drainage Tubing, 2006.*




6.6 Envelope and Filter Materials

Many soils are unstable at drain depth from upward water pressure, fine non-cohesive soils and fine organic materials. An envelope sock produces a hydraulic benefit, and the envelope material restrains the entry of base soil material which surrounds the drain. Experience has shown that soils, such as fine sandy loams and some silts, with a single grain structure in the range of 50-250 microns are susceptible to erosion into drains.

- Completely surround the drain pipe with the envelope to prevent particle movement into the drain.
- Use envelope material suitable for underground use with a long life expectancy (see Section 7.3).
- Thin synthetic filter materials deteriorate in sunlight. Check the date on the production tag to ensure it wasn't stored too long.
- Use material with permeability as large as the design criteria will permit while still retaining soil material.
- Repair or replace any envelope material damaged in transit, storage or during construction.
- Install drains in sand and silt soils only under dry conditions, or when the water table is at the lowest elevation. Envelope materials can plug immediately when installed in sand and silt soils with a high water table (see Section 7.4).

6.7 Geotextiles

Geotextile materials are synthetic products used in land drainage to improve the drainage, or improve stability of a structure or the soil. The most important use for geotextiles is a base material between the soil and armour to prevent bank erosion and prevent mechanical failure at outfalls. Geotextiles are also used for vertical drainage as a substitute for gravel.




7. Construction

7.1 General

This section of the guide defines the minimum standard of work the Ontario Ministry of Agriculture, Food and Rural Affairs considers satisfactory for the construction of subsurface drainage systems used to drain agricultural land.

Install all agricultural tile drainage systems in accordance with the *Agricultural Tile Drainage Installation Act, 1990.* The Act requires the licensing of tile drainage contracting businesses, their equipment and equipment operators. Landowners installing tile on their own property with their own equipment are exempt from this legislation.

This section is not a complete specification since conditions vary across Ontario. Work conditions may dictate the use of other construction practices, equal to or higher than this guide, to meet specific performance criteria. Landowners may impose more rigid requirements but lesser requirements are not accepted.

Ensure workmanship, materials and methods of construction conform to industry standards and practices. If a pit excavation is required to observe the standard of workmanship or materials, the contractor must make labour available for this work.

Review other sections in the guide that apply to the construction section before work is done.

7.2 Safety

- Contractors must comply with existing federal, provincial and municipal laws, with particular attention to the *Occupational Health and Safety Act, 1990*, and regulations.
- Protect people working in a trench from cave-ins, ensure excavations are safe and adequately supported, and don't allow anyone to work alone in a trench. Refer to Regulation 213/91 of the *Occupational Health and Safety Act, 1990.*
- Erect safety barricades and warning signs where there is public access to drain construction.
- Adopt systems of work and use equipment that is safe and won't risk people at work or others affected by the activities of workers, within reason.
- Call before digging. Identify and mark the location and depth of underground utilities before construction.
- Avoid hazards by protecting moving parts of the drainage machine with proper guards.
- Don't permit casual observers close to construction operations.
- Keep livestock away from the field where construction is in progress or where trenches are open.

7.3 Inspection and Handling of Material

Contractors must inspect drain materials before and during installation. All material must be satisfactory for the intended use and meet the material requirements in Section 6. Protect material from hazards and exercise care during handling to avoid damage to the material.




Inspection Before Installation

- Examine material for damage after delivery to the site. Return damaged or unsatisfactory material to the supplier.
- Keep clay and concrete pipe away from flooding. Stockpile it on suitable material to eliminate direct ground contact during periods of freezing and thawing.
- Protect coils of plastic pipe from damage and deformation.

During Installation

- Ensure contractors do final inspection of all pipes. Reject any defective or damaged clay, concrete or other rigid drain pipe. Cut out defective or damaged sections of plastic pipe and join the tubing in accordance with Section 7.13.
- Install perforated plastic tubing when plastic tubing is used, unless otherwise specified on the plan.

7.4 Working Conditions

Install drains during favourable working conditions – usually between May and October – and ideally during June, July and August.

- Avoid installing a drainage system in saturated land surface conditions and very wet soil profiles as it greatly diminishes the drainage system response.
- If the drainage system can't be installed during dry soil conditions, the system may not perform effectively until the internal drainage of the soil is re-established.
- If soil conditions are extremely saturated, delay installation until conditions are favourable.
- Be careful when using a drainage plow in wet conditions on fine-textured soil. If the soil surface doesn't heave substantially, soil structure and drainability will be impaired.

7.5 Control of Direction

Fix horizontal direction or alignment to ensure lateral drains are straight and parallel as topography allows and where uniform depth can be maintained. The tolerance for horizontal alignment of lateral drain lines intended to be parallel is 3% of drain spacing.

Change horizontal direction to maintain the specified grade, not impede the flow of water because of excessive roughness and allow tile joints to be fitted according to soil conditions.

Horizontal direction may be changed by one of the following methods:

- Construct the drain on a gradual curve so the drainage machine can install the pipe in the trench while maintaining grade.
- For concrete or clay tile systems, construct a gradual curve by shaving the inner side of the curve and chipping the drain tile. The radius of curvature is not less than 1.5 m (5 ft).
- For plastic tubing, make directional changes without fittings, provided the centre-line radius of the bend is not less than five times the tubing diameter.
- Use manufactured bends or fittings so the change in directions is a smooth curve.
- Use junction boxes and silt basins.




7.6 Control of Grade

- Install all drains to a predetermined grade and line, and constantly maintain grade control during installation.
- Construct the grade so the drain provides the capacity required for the drained area.
- A variation in grade is tolerated where the actual drain capacity exceeds the required capacity.
- No reverse grade is allowed (see Figure 27A).
- Grade tolerances are specified by the regulations under the *Agricultural Tile Drainage Installation Act, 1990*. Do not deviate the constructed grade from planned grade by more than 15% of the internal diameter for drain sizes of 200 mm (8 in.) or less, or 10% of the internal diameter for diameters greater than 200 mm (8 in.) (see Figure 27B). These deviations are allowable, provided they're gradual over a distance of not less than 10 m (33 ft) (see Figure 27C) and don't occur consecutively both above and below grade in any 30 m (100 ft) length of drain (see Figure 27D).

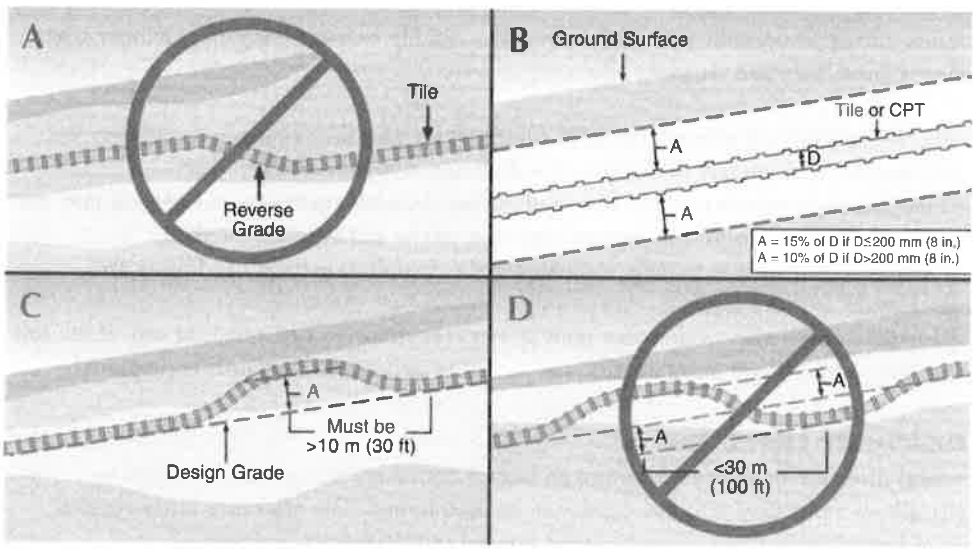


Figure 27 - Allowable Variation in Grade

7.7 Laying Pipe - General

- Use an installation method that's compatible with the drainage system design and the existing soil conditions.
- Install drains to the design depth, true to line and gradient, and the trench bottom formed to secure the pipe in a straight line.
- Ensure the bed is firm and free of loose soil.
- Support drain pipes with a formed bottom – e.g. curved, v-shaped or trapezoidal.
- Avoid laying pipes on soil backfill or in slurry, and secure them to avoid displacement before backfilling the trench.
- Keep the inside of the drain pipe clean during construction, and remove all soil and debris before laying additional pipe.
- Avoid stretching or compressing plastic tubing by more than 7% of its normal length.

- Corrugated plastic drain tubing is affected by temperature.
  - o At colder temperatures, plastic tubing becomes stiff and less flexible – be careful when uncoiling rolls and installing tubing.
  - o At very warm temperatures, plastic tubing deflects, stretches and compresses more easily – be careful when handling under these conditions.

Clay or Concrete Tiles

- In all soils, make the opening between clay or concrete tile wide enough to permit entry of the design flow but small enough to prevent entry of soil.
  - o Make the maximum joint spacing 3 mm (⅛ in.), except where special conditions indicate a wider spacing.
  - o Cover joints with protective material where joint spaces between adjacent drain tiles exceed those such as on the outer side of a curved drain.
  - o Lay perforated tile with the greatest number of perforations closest to the bottom of the drain – or make the drain deeper.
- When shale rock is at grade level, excavate the trench approximately 75 mm (3 in.) below grade level and fill to the planned grade.
- When the trench is excavated below design grade, fill to grade with small gravel or well pulverized soil and tamp to provide a firm foundation for the pipe.
- Install drain tubing so surface and earth loads don't deflect tubing more than 20% of its normal diameter.
- Provide a suitable plug at the upstream end of each pipe to prevent entry of soil into the drain.

7.8 Laying Pipe – Open Trench Installation

Cut drain trenches to the design depth, true to line and gradient, and shape or groove the trench bottom to bed, fit and secure the drain pipe. Ensure trench width allows sufficient space to join tubing and do other minor work in the trench. Start trench construction at the outlet and proceed up slope.

Be sure the width of the trench (measured at the top of the pipe) gives enough clearance between the trench wall and where the pipe is laid, for blinding material to fill the space under the haunch of the pipe and provide lateral support for the drain pipe.

- Maintain a minimum clearance on each side of the pipe of 75 mm (3 in.).
- Take special precautions to protect plastic tubing from failure by deflection when laid in shallow, deep or wide trenches (see Section 2.15).
- Protect plastic tubing from deformation and floating in wet soil conditions.

7.9 Blinding and Backfilling the Trench

Inspecting the installed drain tile may be required prior to blinding and/or backfilling.

- Ensure required drain pipe protection, such as filter, envelope, or stone material, is in its proper place before blinding.
- Connect existing drains, as required, into the new drain pipe before blinding.
- Re-align any tile that is misaligned from trench wall cave-ins before blinding.
- Rectify any deviation of the drain pipe grade, from foreign materials, before blinding.




Blinding

Blinding ensures the pipe and any envelope material remains in place and provides adequate cover to protect the drain pipe from the backfilling operation.

- Blind drain pipe by placing selected material, not more than 40 mm (1½ in.) in size, preferably top soil around the pipe.
- Blind all tiles before backfilling, especially where there is bulk dumping of backfill into the trench.
- Blind the drain pipe immediately after installation by hand shovel or mechanical means. Ensure the pipe and envelope material remains in place.
- Where clay tile is subject to frost, make the depth of blinding 300 mm (12 in.).
- All pipe sizes benefit from compacting the bedding and blinding material along the side walls of the pipe, where allowed.
- Use loam or clay soil (if available) for blinding material on steep grades or where the topsoil contains fine sand.

Backfilling

Carefully backfill trenches with excavated material placed so that pipe is not damaged or displaced.

- Backfill all open trenches at the end of each day.
- Cover the exposed end of the drain at the end of each day to prevent the entry of debris or sediment in wet conditions.
- Ensure fill is firm and not compacted enough to prevent the passage of water to the pipe.
- Fill all trenches to a level sufficiently above the surface of the ground to allow for settlement.
- Do not run a wheel up and down the trench to compress the backfill as this could damage the installed pipe.
- Have traffic cross the trench on the same path each time, and avoid random crossing in several locations.

7.10 Laying Pipe – Plow Installation

- Construct an opening in the soil using drainage plow equipment with a smooth trench bottom, and maintain the opening until the drain pipe is properly installed.
- To provide structural strength, shape the trench bottom to closely conform to the outside diameter, or groove to bed, fit and secure the drain pipe.
- Protect plastic tubing from deformation and floating in wet soil conditions.
- Do not run a wheel up and down the plow trench buildup as this could damage the installed pipe.
- Have traffic cross the plow trench on the same path each time, and avoid random crossing in several locations

7.11 Construction in Non-cohesive Soils

- Non-cohesive soils – including fine sand and possibly some silt – require special construction features depending on soil type and conditions.
- An unstable open trench wall or fluid soil conditions in saturated silt or sand can cause the trench sidewalls to cave and prevent the drain pipe from maintaining alignment. Pipes must be protected until they have been properly laid and blinded.




- Where the trench bottom is unstable such as in fine sandy soil, prevent sediment from entering the drain and provide a firm foundation for the pipe by wrapping the joints or providing a filter envelope.
- Protect tubing from floating off grade when installing plastic tubing in saturated soil conditions.

7.12 Existing Drains

- If existing field drains carrying sewage or farmstead waste are encountered during construction, don't connect them to the drainage system.
- If existing field drains encountered during construction are free from sediment, connect directly to the new system, or connect indirectly with permeable fill carried up or down to the level of the old drains.
- If existing field drains encountered during construction have sediment deposits but will carry water, connected indirectly to the new drain with permeable fill carried up or down to the level of the old drains.

7.13 Connections

- Use manufactured T, Y, couplers, adapters or elbow fittings for connections at the junction of two drains.
    - o Make plastic tubing connections to clay or concrete drain tile using plastic adapters manufactured for this purpose.
    - o Make plastic tubing connections with plastic tubing using manufactured plastic fittings designed for the type of connection made.
    - o Remove a proper length of plastic tubing to allow for a secure connection fit.
    - o Use a junction box or catchbasin to connect multiple drains together. Securely fasten and seal all connections (see Section 3.9).
- Ensure all fittings are compatible with the pipe used.
- Use a plastic coupling when joining lengths of plastic tubing to secure the ends of the tubing in proper alignment and prevent the joint from separating during installation.
- When making connections by cutting a hole in the main drain, be sure the connected pipe doesn't protrude into the drain and obstruct water flow.
    - o Make each connection with manufactured connectors to ensure that capacity or structural strength of the main drain is not compromised.
    - o Make each connection at or above the centre of the drain.
    - o Make the cut hole consistent in size and shape to allow a good fit for the manufactured connector.

7.14 Connections to Municipal Drains

- Obtain approval from local municipalities responsible for the drain for each connection to a municipal drain (*Drainage Act, 1990*, Section 66).
- Do not directly connect lateral drains to a municipal drain, except through a sub main.
- Avoid obstructing the flow of water in the drain with any connections to a municipal drain.
- Use pea stone backfill, filter cloth or mortar for structural support around connections to closed municipal drains.
- Include well-constructed outfall structures with connections to open municipal drains, as indicated in Section 7.17.




7.15 Site Clean-up and Restoration

- Site clean-up and restoration is a landowner responsibly (see Section 1.2).

7.16 Inspection

Conduct inspections during construction to ensure conformance with plans and specifications. For inspection purposes, under the *Agricultural Tile Drainage Installation Act, 1990*, the contractor provides equipment and services required for the inspection.

The following items should be inspected:

- Quality of pipe (Section 6)
- Drain location (Section 7.5)
- Pipe depth and grading (Sections 2.16 and 7.6)
- Trench width at top of pipe (Section 7.8)
- Joint spacing and alignment of drain tile (Section 7.7)
- Laying pipe (Sections 7.7 to 7.9)
- Connections (Section 7.12)
- Blinding (Section 7.14)
- Backfilling (Section 7.14)
- Filter, envelope, stabilizing materials and placement (Section 6.6)
- Outfalls (Section 3.2)
- Auxiliary structures (Section 3)
- Recording of alterations to the original plan (Section 2.8)

Correct the problem if a drain pipe is not installed to specification. If the deviation from specification occurs along the whole length, install a new drain pipe and don't attempt remedial measures. If the deviation occurs only over a section of the drain pipe, just replace the affected section.

7.17 Outfall Structures

Protect drains discharging into a ditch with a length of continuous rigid, non-perforated end pipe (see Section 3.2). Provide ultra-violet protection for plastic end pipes.

- Install the end pipe as soon as the trench is constructed.
- Follow end pipe diameter recommendations in Table 9.
- Attach a hinged grate to the end pipe, with grate openings that don't exceed 25 mm (1 in.).
- Ensure the outfall is a minimum of 300 mm (12 in.) above normal water level and extends beyond the toe of the slope.
- Control erosion at the outfall.
- Place backfill at the outfall in 75 mm (3 in.) layers and tamp well for a distance of 5 m (16.4 ft) from the outfall to the same density as the surrounding soil.
- Seal the joint between drain pipe and end pipe securely using filter cloth and a coupler.
- Offset the subsurface drain from the centre line of a surface watercourse by one-third the width of the watercourse.
- Place geotextiles under bank erosion control materials for drainage and stability.
- Install an erosion control structure when a surface watercourse enters the ditch at the same location as a subsurface drain.
- In areas where fine sand or iron compounds may enter a drain, consider an individual outfall for each drain.
- Install permanent markers showing the location of the outfall structures.







8. Outlets

8.1 Existing Subsurface Drains

Carefully examine any existing subsurface drains to be used as an outlet for a drainage system. Ensure drains are functioning properly and free from defects which may cause them to fail. Existing drains must be able to provide sufficient capacity to carry the added flow from the proposed drainage system, and provide enough depth to install all drains in the new system at their optimum depth.

8.2 Private Open Ditches

Open ditches provide an adequate outlet for surface and subsurface drainage when the drainage area is less than 200 ha (500 ac) and the ditch-bottom slope is greater than 0.05%, and when these recommendations are followed.

- A minimum distance of 300 mm (12 in.) between the bottom of the tile outfall and the normal water level, if available.
- Increase this clearance to 450 mm (18 in.) if the ditch is in soil subject to erosion and deposition.
- Minimum bottom width of the ditch is 1 m (3 ft).
- Limit maximum side slopes for unprotected ditch banks to ratios listed in Table 10.
- Design for as uniform a cross-section as possible.
- Review existing channels in similar material to verify the stability of a selected side slope ratio.
- Increase the side slope ratio when ditch banks remain submerged. Ensure side slopes of an open ditch are not steeper than the angle of repose of the soil the ditch passes through.
- Ditches of small section need frequent cleaning.

For watershed areas greater than 200 ha (500 ac), individually design ditches that serve as outlets for flow and capacity.

Table 10. Maximum Side Slope Ratios for Open Drains

Soil Materials	Channel Depth <1.3 m (4 ft) (vertical:horizontal)	Channel Depth >1.3 m (4 ft) (vertical:horizontal)	Maximum Velocity m/s (ft/s)
Peat, stable organic	1:1	1:1.5	0.5 (1.6)
Heavy clay (>35% clay)	1:1.5	1:2	1.5 (5.0)
Clay/silt loam (10-35% clay)	1:2	1:2.5	1.0 (3.3)
Sandy loamy (<10% clay)	1:3	1:4	0.75 (2.5)
Clay of marine origin and/or banded with sand or silt (subject to low stability when saturated)	1:4	1:4	0.5 (1.6)
Sandy or silty with high water table and/or lateral seepage	1:4	1:5	0.5 (1.6)




8.3 Pump Outlets

- Consider a pumped outlet instead of a long, costly drain or a deep outlet ditch. A pump can also drain small, isolated areas which can't drain by gravity on individual farms. This is helpful as very productive land is often in lower areas.
- Design a subsurface drainage system as outlined in Section 2 and connect the main drain into a sump, and, or a pond storage ditch. A pump lifts the water to a gravity outlet.
- Using a self-priming submersible sump pump handles high capacity at a low cost. Determine pump capacity required from Table 11, and select pump on the basis of pump capacity and lift. Pump lift must not exceed 3 m (10 ft).

Table 11. Design Values for Pump Drainage

Pump and Motor Capacity					Minimum Storage Volume Required		
	Tile Drain Discharge		Surface and Tile Drain Discharge		Automatic Operation		Manual Operation Surface and Tile Drain Discharge
Drainage Area	Pump	Motor	Pump	Motor	Tile Drain Discharge	Surface and Tile Drain Discharge	
ha (ac)	L/s (gal/m)	kW (hp)	L/s (gal/m)	kW (hp)	m^3 (ft^3)	m^3 (ft^3)	m^3 (ft^3)
4 (10)	**10** (132)	**1.1** (1.5)	**11** (145)	**1.1** (1.5)	**1.0** (35)	**1.2** (42)	**200** (7,063)
8 (20)	**20** (264)	**1.1** (1.5)	**23** (304)	**1.1** (1.5)	**1.5** (53)	**1.8** (64)	**400** (14,126)
16 (40)	**30** (396)	**1.1** (1.5)	**38** (502)	**1.5** (2)	**2.8** (100)	**3.4** (120)	**600** (21,189)
24 (60)	**40** (528)	**1.5** (2)	**45** (594)	**2.2** (3)	**4.2** (150)	**5.0** (177)	**800** (28,252)
32 (80)	**50** (660)	**2.2** (3)	**60** (792)	**3.7** (5)	**5.7** (200)	**6.8** (240)	**1,000** (35,315)
40 (100)	**60** (792)	**3.7** (5)	**75** (990)	**3.7** (5)	**9.5** (336)	**11.5** (406)	**1,200** (42,378)
60 (150)	**90** (1,188)	**5.5** (7.4)	**115** (1,518)	**5.5** (7.4)	**14.0** (495)	**16.8** (593)	**1,800** (63,566)
80 (200)	**125** (1,650)	**5.5** (7.4)	**150** (1,980)	**7.4** (10)	**18.9** (667)	**22.7** (800)	**2,500** (88,287)




- Where electric power is available, connect an electric motor directly to the pump or by V-belts. Automatic operation is best, when starting and stopping the motor by a float-operated switch or electrode controls located at selected water levels.
- Manual-control pumps have a motor powered by gasoline or diesel fuel or by tractor power-take-off. Ensure the storage capacity doesn't require more than two starts per day.
- Figure 28 shows a typical drainage pump with storage sump, using a submersible sump pump for small areas and subsurface drainage. Figure 29 shows a typical propeller type drainage pump with storage sump where water is from subsurface drainage.
- In silty and sandy soils, don't use the subsurface drain as part of the pumped storage – it may fail because of soil instability. Ensure the stop level is below the outfall of the inlet drain.
- Use a storage sump for subsurface drainage to minimize the number of off-on cycles of the pump. A circular form is best, constructed of corrugated steel, pressure treated wood or poured concrete.
- When using a ditch for storage, deepen it at the pump to provide adequate depth of pump submergence. In Figures 28, the depth to be removed at each operation can be varied, but is usually 600 mm (24 in.) for sump storage with automatic operation, and 300-400 mm (12-16 in.) for ditch storage with manual operation. Minimum storage requirements are given in Table 11. Pump capacity can be reduced when more storage is available than shown in Table 11.
- When surface water is to be pumped, consider additional design information on rainfall rate and recurrence interval, crop damage and surface runoff.

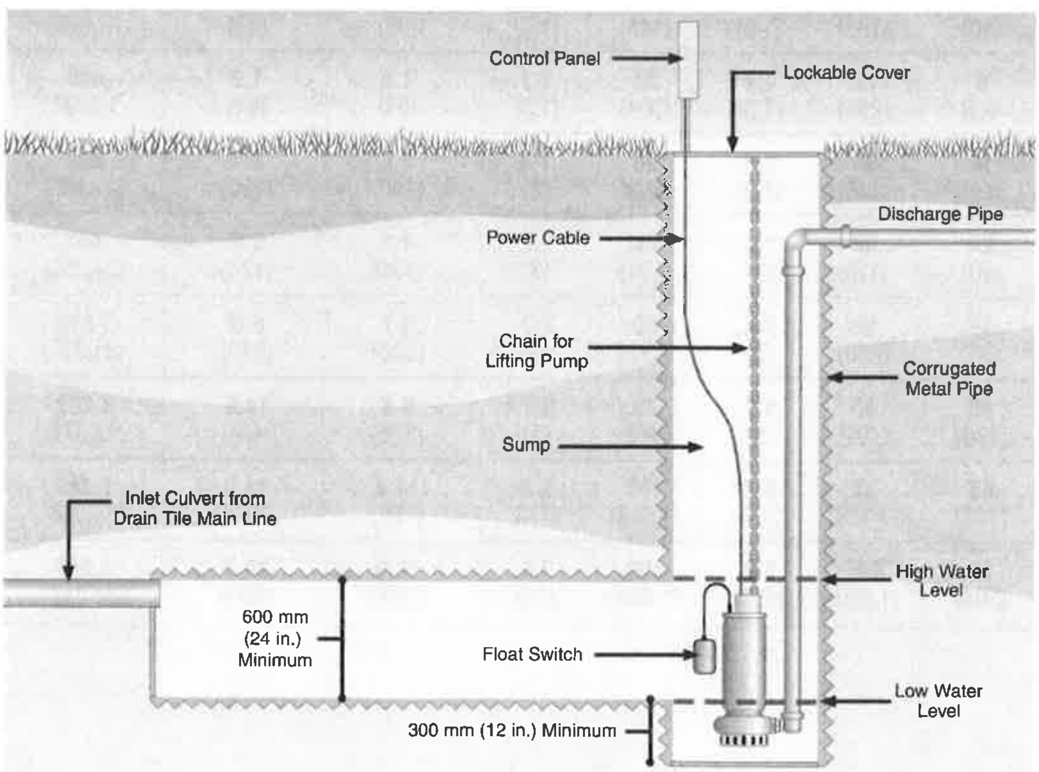


Figure 28. Typical Submersible Drainage Pump

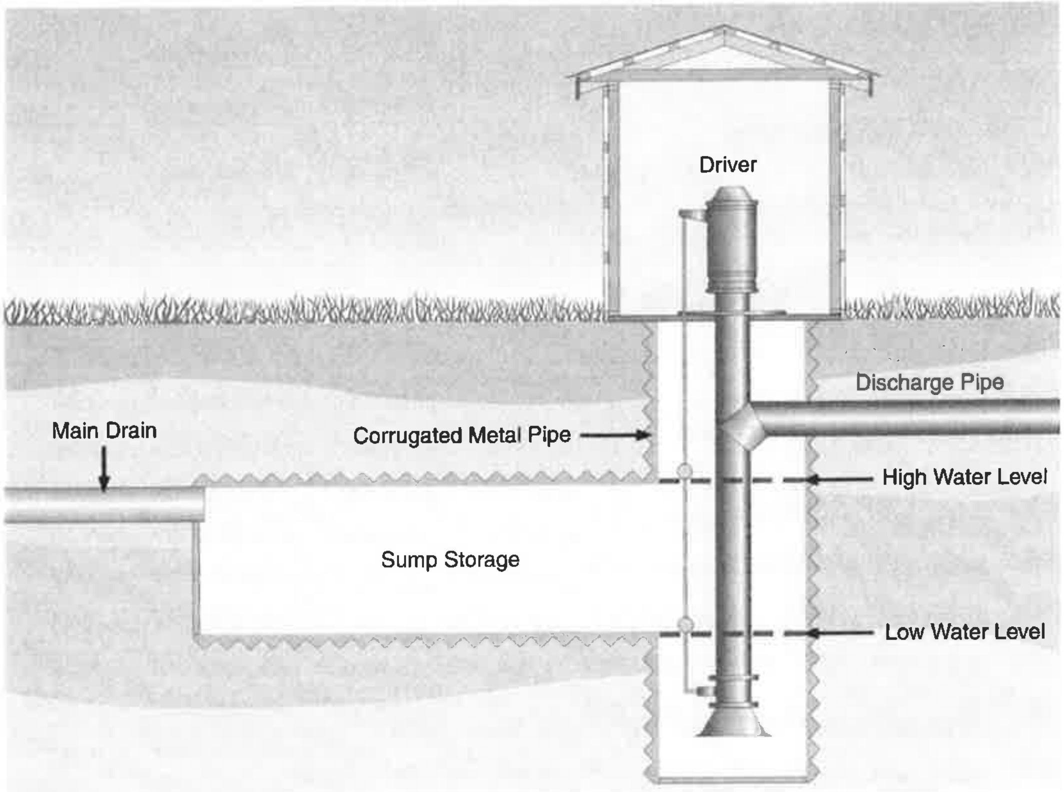


Figure 29. Typical Propeller Drainage Pump

Appendix A

Design Code Detail (see Section 2.4)

Soil maps at many scales cover all or part of a county. On each map, soils are classified broadly into areas known as map units. These units usually comprise a single soil series, soil family or soil association.

Soil series is the name given to a range of soil properties developed on similar parent material with the same soil horizons or layers and properties.

Soil type is the mapped unit consisting of the soil series name plus a descriptor such as clay loam, clay, sand, etc. A soil family is a group of soil series.

Soil association is a group of different soil series developed on similar characteristics and distribution. The soil family and soil association are of primary interest in land drainage although the soil type is the mapped key to the soil family.

Table A1. Generalized Soil Profile Descriptions
(Source of drainage water and order of characteristics)

Group	General Description	"A" Horizons	"B" Horizons	"C" Horizons	Families Included
S1	Overall fine texture. Poor development, soil becomes more compact with depth.	Fine to medium texture; C,SiC or SiCL. Granular structure.	Fine texture; C. Coarse blocky structure.	Fine texture; C. Medium to coarse, blocky, to massive structure.	Clyde, Haileybury, Lincoln, Minesing, New Liskeard, Renfrew, Rideau, South Bay.
S2	Overall medium texture and well structured. Soil becomes more compact with depth. Free water saturation at depths less than 1 metre on parent material.	Medium texture; L, SiL, CL or SiCL. Platy or granular structure.	Fine to medium texture C, SiCL, CL. Medium to coarse, subgranular to angular blocky structure.	Fine to medium texture; C, SiC, SiCL, CL. Medium to coarse, blocky, prismatic to massive structure.	Beverly, Brantford, Brookston, Cane, Conover, Dorking, Elderslie, Haldimand, Huron, Miami, Ontario, Perth, Renfrew, St. Clements, Wellesley, Wilmot.
S3	Overall medium to coarse texture. Sola are deeper than S-2. Fee water saturation at depths less than 1 metre on II C.	Medium to coarse texture; L, SL, LS or S, single grain or fine platy structure.	Medium to coarse texture; SCL, L, SL, S. Platy or fine to coarse subgranular blocky structure.	Fine to medium texture; C, SiC, SiCL, CL, SCL, SiL. Coarse angular blocky structure.	Allendale, Bainsville, Berrien, Bookton, Bucke, Honeywood, Maplewood, Mountain, Nipissing, Tuscola.
S4	Overall medium to coarse texture, with fine textured "B" horizon that may impede internal drainage.	Medium to coarse texture; SCL, SiL, L, SL, LS, S. Medium granular. structure.	Medium to coarse texture. SCL, SiC, SiCL, SCL. Medium subgranular to medium angular. blocky structure.	Medium texture, L, CL, SiL, SCL, SiCL. Weak prismatic to blocky. structure.	Boomer, Earlton, Evanturel. Some northern Ontario Gray, Luvisols will be in this group.
S5	A bog-like depressional soil. The surface layer is organic.	Organic.	Fine to medium sand.	Fine texture; C. Massive.	Belmeade.
S6	Shallow soil over bedrock.	Medium to coarse texture. Medium structure.	Fine to medium texture. Medium subangular to medium angular blocky structure.	N/A	Ameliasburg, Bastard, Brooke, Farmingotn, Franktown, Gerow, Lockport, Shashawandah, Trafalgar, Tweed.



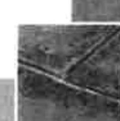



Table A1. Generalized Soil Profile Descriptions (cont'd)

(Source of drainage water and order of characteristics)

Group	General Description	"A" Horizons	"B" Horizons	"C" Horizons	Families Included
G1	Soils developed on loam, silt loam and stratified by ponding. Seasonal free water saturation in relation to perched groundwater.	Medium texture; L, SiL. Granular structure.	Medium texture; S, SL. Single grain to medium subangular blocky structure.	Medium texture; L, SiL. May be stratified. Coarse subangular blocky to massive structure.	Colwood, Conestoga, Coutts, Freeport, Grand, Grenville, Guelph, Howland, Killean, London, Lyons, Macton, Magnetawan, Mannheim, Maryhill, Matilda, Moose, Osprey, Otonabee, Vasey, Wabi, Woolwich.
G2	Outwash sands, more than 1 metre deep over clay till, or lacustrine clay. Seasonal free water saturation in relation to perched groundwater.	Coarse texture; S, S1. Granular structure.	Coarse texture; S, SL. Single grain to medium subangular blocky structure.	Coarse texture, S, SL. Single grained loose structure.	Berriedale, Brady, Elmira, Fox, Granby, Kenabeek, Rubicon.
G3	Deep coarse textured soils with seasonal free water saturation in relation to regional groundwater.	Medium to coarse texture; L, SL. Granular structure.	Medium to coarse texture; S, S.L. Granular structure.	Sand or gravel possibly over bedrock.	Alliston, Ayr, Brisbane, Burford, Burpee, Donald, Dumfries, Eastport, Floradale, Fort, Gwillimbury, Hawkesville, Haysville, Heidelburg, Hendrie, Hespeler, Kirkland, Lisbon, Pontypool, Preston, Sargent, Springvale, St. Peter, Sullivan, Tioga, Wendigo.

Source: Estimating Saturated Hydraulic Conductivity from Soil Morphology. J.A. McKeague, C. Wong, G.C. Topp. Soil Science Society of America . 46:1239-1244. 1982.

Table A2. Descriptions of Drainage Classes (see Figure A1)

Drainage Characteristics by Soil Class
S1 soils are difficult to drain. The surface is fine-textured and the lower layers are blocky or massive which inhibit rapid water movement. The soil density increases with depth and the hydraulic conductivity is very low. Subsurface drains have been installed in a few soils in the poorly drained class. However, these rely on soil cracking and porosity aids, such as deep tillage to make them successful. Surface drainage is the best water management practice.
S2 soils are somewhat coarser in texture than SI soils and drain better. A finer textured B horizon varies from 600-900 mm (2-3 ft) in depth and will inhibit drainage. Subsurface drainage is quite common in this class. Poorly drained soils are most commonly drained, however, extensive areas of imperfectly and well-drained soils also have subsurface drains. Drains should not be deep and should be placed in the B horizon for best results.
S3 soils are similar to S2 soils inasmuch as a saturated zone occurs at shallow depth due to a perched water table. The A and B soil horizons are coarser in texture. Better soil structure favours subsurface drainage. Drains should be located in the B horizon, above the dense C horizon. S3 soils represent less than 10% of Ontario soils. Subsurface drainage is largely in the imperfectly drained members, with some in the poorly and well-drained members.
S4 soils have a coarse textured surface with good soil structure, and similar qualities for the C horizon. These soils create drainage problems due to the fine textured impermeable B horizon which usually occurs at 300 mm (1 ft) depth. Drainage pipe placed in the parent material may not receive any drainage water due to this dense layer except where a tile trench has disrupted the internal drainage. Soil management will include good surface drainage and a program of deep tillage to break up the B horizon, if the profile permits. There are not many S4 soils in Ontario.
S5 soils have an organic layer of varying depth over sand, or over clay. Before artificial drainage of such soils it is very important to survey the depth of the organic soil. Organic soil over sand is unlikely to drain satisfactorily. Organic soils over clay will consolidate when drained and should be at least 1 m (3 ft) in depth before drainage is even considered. S5 soils are a special problem requiring special considerations. Iron ochre is often a problem in these soils.
S6 soils are usually medium to coarse grained over bedrock at shallow depth. The feasibility of subsurface drainage depends on a detailed soil survey to ensure there is sufficient depth of cover for the drains. Since these soils have so much variation the guide does not give information on the depth and spacing of drains. Each case must be considered on its merits.
G1 soils represent a large area in Ontario (20%) of the drainage activity is in this soil. In terms of soil texture and soil structure all groundwater soils drain readily; however, the differences are in the depth of the soil and whether the cause of the wetness is due to a regional or local water table. The majority of the G1 soils are classed as well drained. The soil profile tends to be a medium texture which does not vary greatly with depth. The G1 and S3 soil profiles are similar inasmuch as wetness is from a perched water table on the C horizon. Less than 1 m (3 ft) for the S3 and over 1 m (3 ft) for the G1. The hydraulic conductivities are different, the G 1 being twice as high.
G2 soils develop wetness from the regional water table, with a summer groundwater at 3 m (10 ft) depth which will create a persistent supply of water in the spring. These soils tend to be coarse-textured and do not represent a very substantial area of drainage activity. Drains should be deep in these soils.
G3 soils also develop wetness from a regional water table, but at a greater summer depth of 12 m (40 ft) or more. About 15% of Ontario soils are in this class with drainage activity being spread over each natural drainage class. Drains should be placed deep in the C horizon to intercept the rising groundwater. These soils are usually coarse grained to gravel.




A

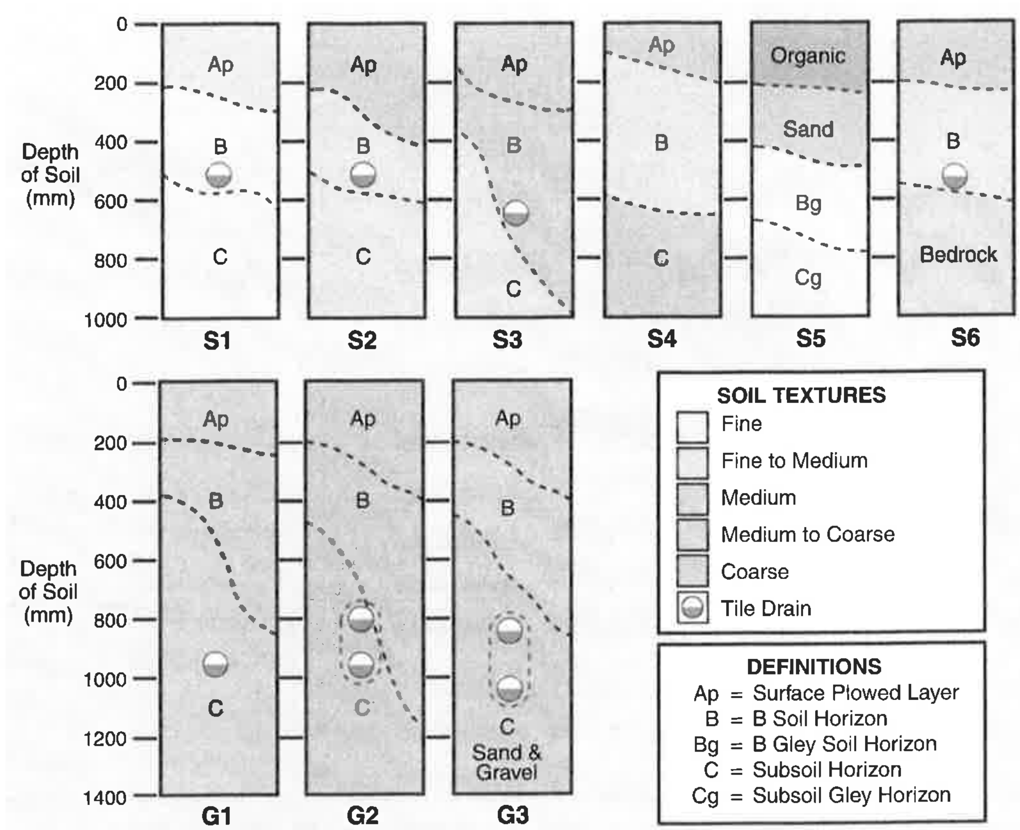


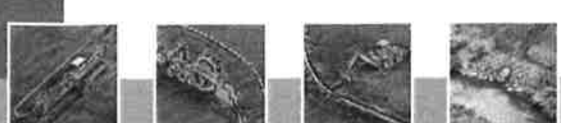
Figure A1. Generalized Soil Profiles of Drainage Codes

Table A3. Hydraulic Conductivity Classes

Drainage Class	Relative Rate	Drainage Code	USDA Hydrologic Group	Hydraulic Conductivity, K			
				m/s	(in./hr)	m/day	(ft/day)
High	R		A	1.4×10^{-4}	(19.84)	12.0	(39.4)
	VR		A	4.6×10^{-5}	(6.52)	3.97	(13.0)
Medium	MR	G2, S3, G1, G3	B	1.2×10^{-5}	(1.70)	1.037	(3.40)
	M	G2	B	4.6×10^{-6}	(0.652)	0.397	(1.30)
	MS	S2	C	1.2×10^{-6}	(0.170)	0.104	(0.33)
Low	S	S3, G3, G1	C	4.6×10^{-7}	(0.0652)	0.040	(0.130)
	VS		D	4.6×10^{-8}	(0.0065)	0.004	(0.013)
	ES	S1, S2	D				

Key: R – rapid, VR – very rapid, MR – moderately rapid, M – moderate, MS – moderately slow, S – slow, VS – very slow, ES – extremely slow

Appendix A



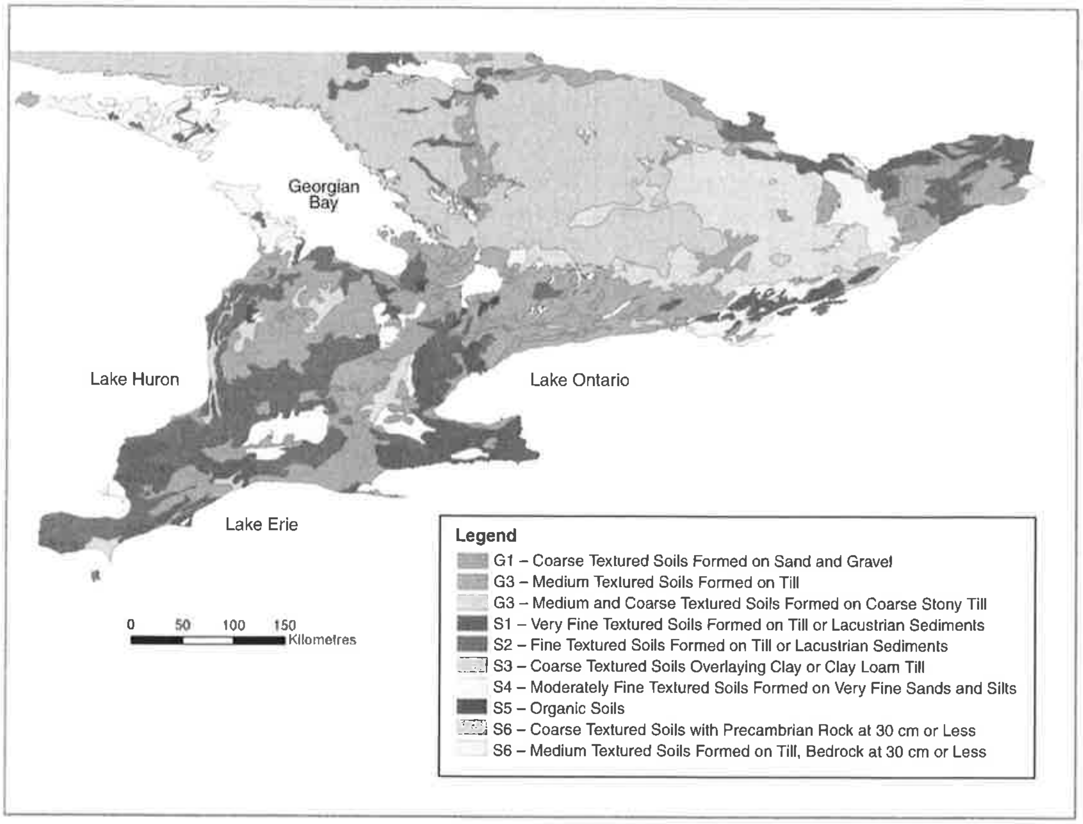


Figure A2. Generalized Subsoil Map Used for Drainage Code Soil Profiles

Sources: Soil Resources and Land Use Hazards in Southern Ontario. B.C. Matthews. Canadian Geographer. 8: 55 – 62. 1956. Overcoming Barriers to Yield. B.D. Kay, R.W. Sheard, L.A. Battison, Notes on Agriculture, p. 17, Vol. XIX, No. 2. 1984.

Table A4. USDA Hydrologic Groups (see Section 2.5)

Hydrologic Soil Groups	Description
A. Low runoff potential	Soils having a high infiltration rate which includes deep sands with very little silt and clay.
B. Moderately low runoff potential	Soils having a moderate infiltration rate when wet includes mostly sandy soils less deep than A. The group has above-average infiltration after thorough wetting.
C. Moderately high runoff potential	Soils having a slow infiltration rate when wet comprise shallow soils and soils containing considerable clay and colloids, though less than group D. The group has below-average infiltration after thorough wetting.
D. Highest runoff	Soils having a very slow infiltration rate, when thoroughly wet, includes potential mostly clays of high swelling percentage. The group also includes shallow soils with nearly impermeable horizons near the surface.

Note: A soil may be placed in two hydrologic soil groups if the soil is drained or undrained.




A

Natural Drainage Class (drainage code symbol 3)

Natural drainage class refers to the frequency and duration of periods of saturation, or partial saturation, during soil formation, as opposed to altered drainage. Five classes of natural soil drainage are used in this guide.

Table A5. Natural Drainage Classes[1]

Symbol	Description
W	**Well drained** – The soil moisture content does not normally exceed field capacity in any horizon (except possibly the C) for a significant part of the year. Soils are usually free from mottling in the upper metre but may be mottled below this depth. B horizons, if present, are reddish, brownish, or yellowish. Water is removed from the soil readily, but not rapidly.
M	**Moderately well drained** – The soil moisture in excess of field capacity remains for a small but significant period of the year. Soils are commonly mottled in the lower B and C horizons or below a depth of 750 mm (30 in.). The Ae horizon, if present, may be faintly mottled in fine-textured soils and in medium-textured soils that have a slowly permeable layer below the B horizon. In grassland soils the B and C horizons may be only faintly mottled and the A horizon may be relatively thick and dark. Water is removed from the soil somewhat slowly during some periods.
I	**Imperfectly drained** – The soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year. Soils are commonly mottled in the B and C horizons; an Ae horizon, if present, may be mottled. The matrix generally has a lower chroma than in the well-drained soil on similar parent material. Water is removed slowly enough that the soil is wet for significant periods during the growing season.
P	**Poorly drained** – The soil moisture in excess of field capacity remains in all horizons for a large part of the year. The soils are usually very strongly gleyed. Except in high-chroma parent materials the B, if present, and upper C horizons usually have matrix colors of low chroma. Faint mottling may occur throughout. Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods.
V	**Very poorly drained** – Free water remains at or within 300 mm (1 ft) of the surface most of the year. The soils are usually very strongly gleyed. Subsurface horizons usually are of low chroma and yellowish to bluish hues. Mottling may be present but at depth in the profile. Very poorly drained soils usually have a mucky of peaty surface horizon. Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season.

[1]Descriptions are taken from p 220 - 221, The System of Soil Classification For Canada, Agriculture Canada, 1972.
Refer to Table A2, Estimating Saturated Hydraulic Conductivity from Soil Morphology. J. A. McKeague, C.Wong, G.C. Topp. SSSA 46 #6. 1239 – 1244. 1982.

Appendix A




Table A6. Slope Classes (drainage code symbol 4)

Code Symbol	Slope Range	Definition	Canada System Soil Classification Slope Classes
1	0-0.5%	Level	1
2	0-2%	Level to nearly level	1 and 2
3	0.5-2%	Nearly level	2
4	0.5-5%	Nearly level to very gentle slopes	2 and 3
5	2-5%	Very gentle slopes	3
6	2-9%	Very gentle to gentle slopes	3 and 4
7	2-15%	Very gentle to moderate slopes	3, 4 and 5
8	6-15%	Gentle to moderate slopes	4 and 5
9	10-30%	Moderate to strong slopes	5 and 6

Soil Capability Subclasses

Subclasses are divisions within classes listed below with the same kind of limitations for agricultural use. There are 13 different kinds of limitations recognized at the subclass level. A brief discussion of six of these subclasses and their designation on maps is as follows.

Undesirable soil structure and/or low permeability (D) – used for soils difficult to till, that absorb water very slowly, or where the depth of the rooting zone is restricted by conditions other than a high water table or consolidated bedrock.

Inundation by streams or lakes (I) – includes soils subjected to inundation causing crop damage or restricting agricultural use.

Moisture limitation (M) – soils where crops are adversely affected by drought owing to inherent soil characteristics. They are usually soils with low water-holding capacity.

Stoniness (P) – soils that are sufficiently stony to significantly hinder tillage, planting and harvesting operations. Stony soils are usually less productive than comparable non-stony soils.

Consolidated bedrock (R) – soils where the presence of bedrock near the surface restricts agricultural use. Consolidated bedrock at depths greater than 1 m (3 ft) from the surface is not considered as a limitation, except on irrigated lands where a greater depth of soil is desirable.

Excess water (W) – soils where excess water, other than that brought about by inundation, is a limitation for agricultural use. Excess water may result from inadequate soil drainage, a high water table, seepage or runoff from surrounding areas.




Table A7. Soil Capability Classes (see Table 2)

Class 1	Soils in this class have no significant limitations in use for crops.
Class 2	Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices.
Class 3	Soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practices or both.
Class 4	Soils in this class have severe limitations that restrict the range of crops or require special conservation practices.
Class 5	Soils in this class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible.
Class 6	Soils in this class are capable only of producing perennial forage crops, and improved practices are not feasible.
Class 7	Soils in this class have no capability for arable culture or permanent pasture.




Appendix B

Flow Chart of Possible Drainage Situations and Solutions

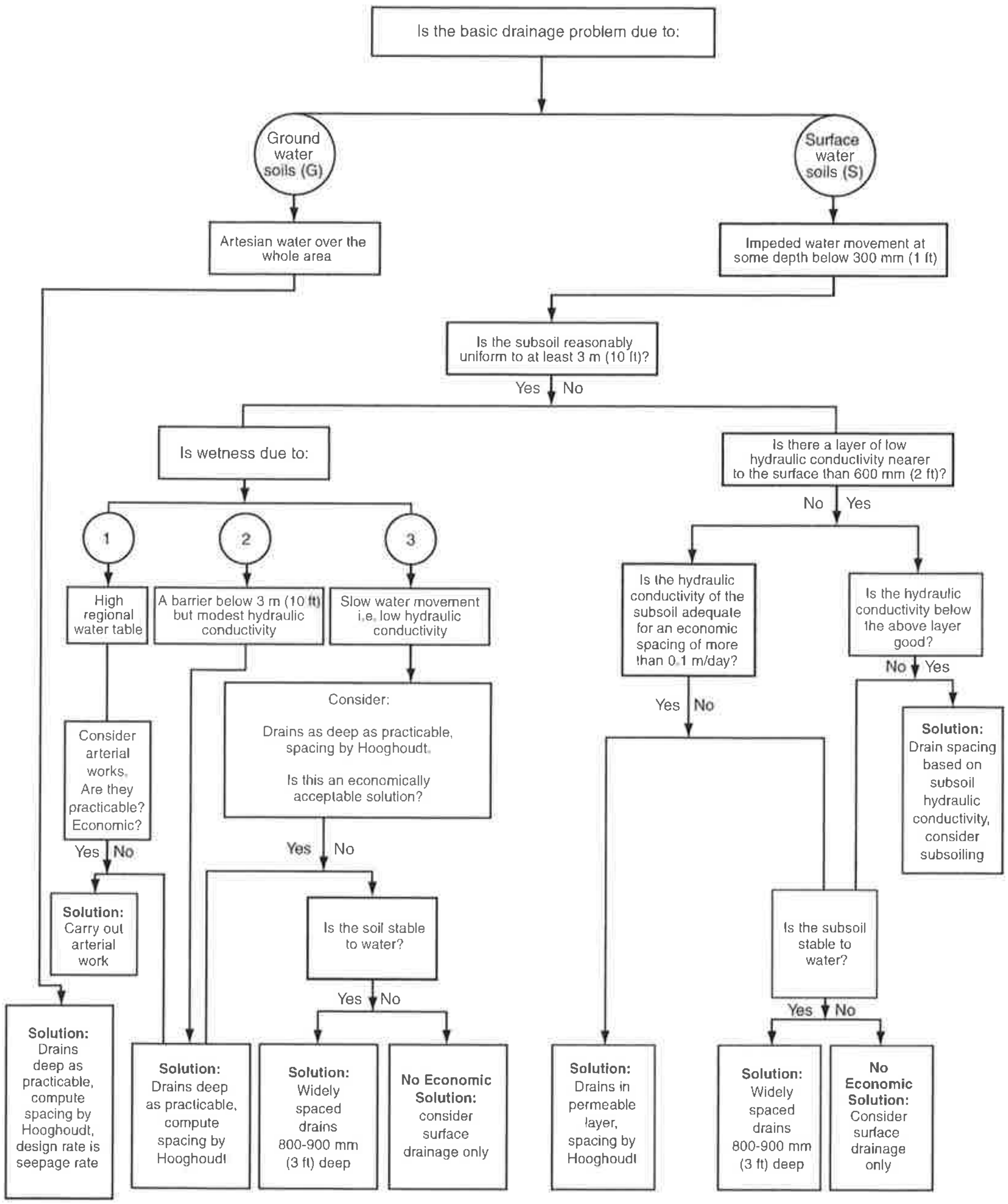


Figure B1. Calculation of Drain Spacing

The Drainage Guide gives an empirical procedure, based on long local experience, to determine drain spacing. Scientifically-based drain spacing can be determined when the required soil information can be determined. Figure B1 is a flow chart describing a procedure to follow to assess the source of the wetness problem before using the following drainage spacing equation. This steady state drain spacing formula is attributed to Hooghoudt (1940) and is presented here as it is widely accepted in practice.

Source: Hooghoudt, S.B. 1940. Bijdrage tot de kennis van enige natuurkundige grootheden van de grond. Versl. Landb. Onderz. No. 46 (14) B:515-707.

Note: see Section 2.6 Calculation of Theoretical Drain Spacing

Hooghoudt's equation states: $S^2 = (4/R)(2K_2\, d_e\, m + K_1\, m^2)$, where

- S = drain spacing, m
- K_1 = hydraulic conductivity of the layer above the drains, m/d (B2)
- K_2 = hydraulic conductivity of the layer below the drains, m/d (B2)
- d_e = equivalent depth of conducting soil below drains, or effective depth of flow (B3) dependent on depth to impermeable layer, drain spacing, and drain diameter, m.
- m = mid-spacing water table height, m
- R = drainage rate, m/day (See Section 2.10)

The saturated hydraulic conductivity (K_{sat}) is the amount of water that would move vertically through a unit area of saturated soil in unit time under unit hydraulic gradient. Since measurements are difficult to make and are available for relatively few soils, estimates of saturated hydraulic conductivity are based on soil properties. Soil properties affecting saturated hydraulic conductivity are distribution, size and shape of soil pores. In making estimates, texture is the soil characteristic that exerts the greatest control for many soils. Measure the hydraulic conductivity, K_1 and K_2, in the field. When direct measurements aren't available, estimate these values from soil texture in Figure B2.

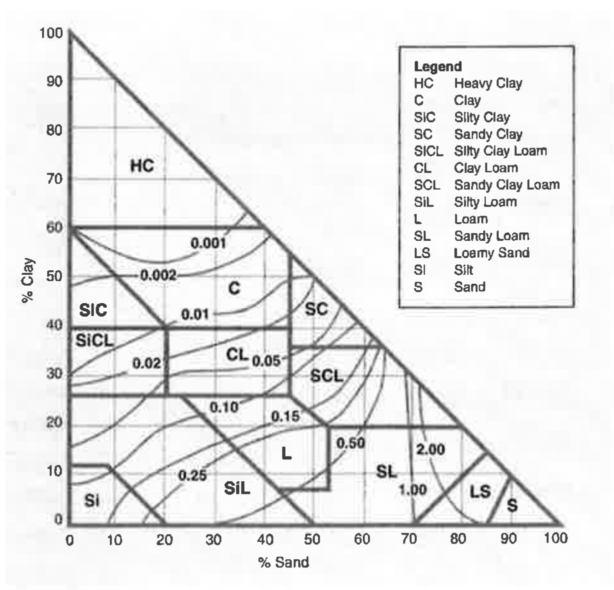
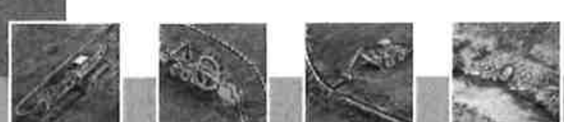


Figure B2. Estimating Hydraulic Conductivity from Soil Texture

As S affects d_e the equation is not directly solvable, and trial and error solutions must be used. However, calculations are less tedious if a spacing S is assumed and the required hydraulic conductivity, K, is calculated. Working in this way, a two layer situation can only be tackled assuming K_1 and K_2 bear some relation to one another; i.e. $K_1 = 2K_2$, $K_1 = 5K_1$, etc.



In this form the equation is:

$$K_2 = (RS^2)/(8\ d_e\ m + 4n\ m^2)$$

where n = the numerical relationship between K_1 and K_2. The equivalent depth, d_e, for a selected drain spacing and depth to impermeable layer, can be estimated from Figure B3.

In Figure B4 the drainage rate, R, has been assumed to be 0.01 m/day (cereal crop), because this has reasonable application in Ontario. Strictly, one should vary the design criteria to suit the crop and climatic conditions of the area. Present knowledge does not allow this to be done with any precision. In the calculations, the midspacing water table height between drains, m, has been chosen as 50 cm (20 in.). This may be interpreted as 50 cm (20 in.) of freeboard, or unsaturated soil, with a drain depth of 1 m (3 ft) or 30 cm (12 in.) and a drain depth of 80 cm (32 in.), or any combination. A spacing of 10 m (33 ft) has been chosen as the minimum likely to be economic for most cases. Figure B4 illustrates the way hydraulic conductivity and drain spacing are related for a number of positions of the impermeable layer. The impermeable layer is a layer having less than $^1/_{10}$ of the hydraulic conductivity of the layer above it. Note that the position of the impermeable layer is critical when it's close to drain depth, but decreases in importance as the depth of the layer increases.

Soil Drainability

It's difficult to determine whether a soil will drain rapidly enough to permit economical subsurface drainage. Pore spaces nearly full of water at field capacity don't transmit much water down through the pores to the drain lines. The soil pore air space that drainage water moves through is the total pore space minus space occupied by water held at field capacity (N at $^1/_3$ bar). This value is the drainage capacity.

Drainage capacity (%) = Total porosity (%) – porosity at field capacity.

If the drainage capacity is too low (<10%), soil water won't drain through tile drains

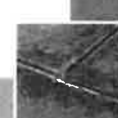
Table B1. Representative Physical Properties of Soils

Soil Texture	Bulk Density g/cc	Total Porosity % Volume	Field Capacity % Saturation	Wilting Point % Saturation
Sandy	1.65 (1.55-1.80)	38 (32-42)	39 (31-47)	17 (10-24)
Sandy loam	1.50 (1.40-1.60)	43 (40-47)	49 (38-57)	21 (15-26)
Loam	1.40 (1.35-1.50)	47 (47-51)	66 (66-82)	30 (26-34)
Clay loam	1.35 (1.30-1.40)	49 (47-51)	74 (66-82)	36 (32-40)
Silty clay	1.30 (1.25-1.35)	51 (49-53)	79 (72-86)	38 (34-42)
Clay	1.25 (1.20-1.30)	53 (51-55)	83 (76-89)	40 (37-43)

Note: Numbers in parentheses indicate normal range.

Source: Israelson, O.W., and V.E. Hansen, 1962. Irrigation principles and practices. 3rd ed., John Wiley and Sons, New York.



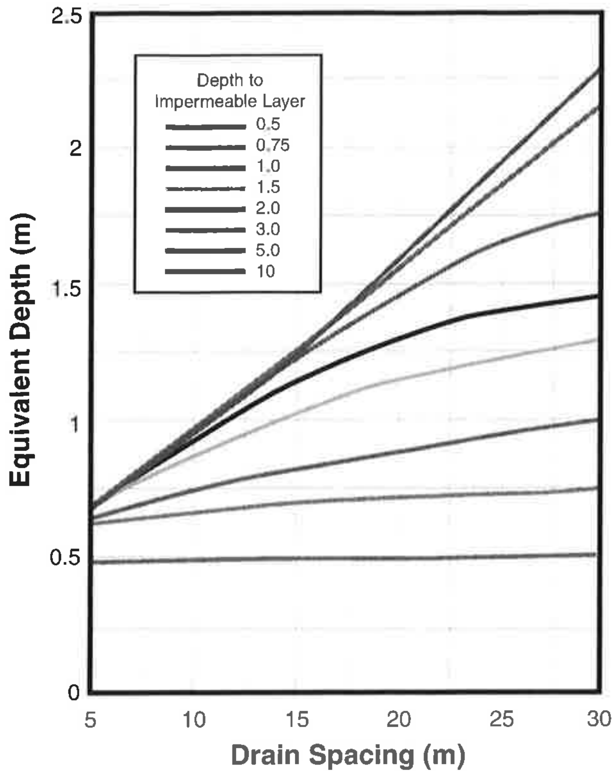


Figure B3. Estimation of Equivalent Depth for a Selected Drain Spacing (100 mm drain diameter)

Source : Labye, J. 1960. Note sur la formule de Hooghoudt. Bull. techn. du Genie rural (Min. de l'Agr), no. 49-1.

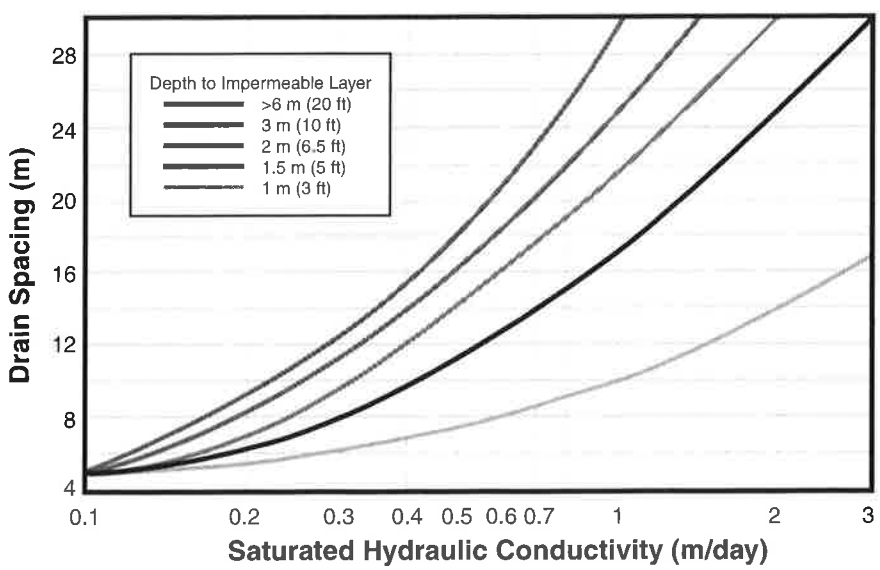


Figure B4. General Relation Between Saturated Hydraulic Conductivity and Drain Spacing




Appendix C

Additional Information

Table C1. Lateral Drain Pipe Length Required to Drain an Area

Lateral Spacing m (ft)	Length of Pipe Required * m/ha (ft/ac)
6 (20)	1,667 (2,178)
9 (30)	1,111 (1,452)
12 (40)	833 (1,089)
15 (50)	667 (871)
18 (60)	556 (726)
25 (66)	400 (660)

**Length of pipe required for mains and submains are not included in these figures.*

Table C2. Measurement Conversion Factors

Symbol	When You Know	Multiply By	To Find	Symbol
Length:				
mm	millimetres	0.039	inches	in
m	metres	3.281	feet	ft
km	kilometres	0.621	miles	mi
Area:				
m^2	square metres	10.764	square feet	ft^2
m^2	square metres	0.0001	hectares	ha
km^2	square kilometres	0.386	square miles	mi^2
ha	hectares	2.471	acres	ac
ha	hectares	10764.0	square feet	ft^2
ac	acres	43,560	square feet	ft^2
Volume:				
L	litres	0.264	gallons (US)	gal (US)
L	litres	0.220	gallons (Imp)	gal (Imp)
L	litres	0.0353	cubic feet	ft^3
L	litres	0.001	cubic metres	m^3
m^3	cubic metres	264.2	gallons (US)	gal (US)
gal (US)	gallons (US)	0.134	cubic feet	ft^3
Rate:				
L/s	litres per second	15.850	gallons per minute	gpm (US)
L/m	litres per minute	0.264	gallons per minute	gpm (US)
m^3/s	cubic metres per second	35.31	cubic feet per second	cfs
Other:				
kW	kilowatts	1.341	horsepower	hp

To convert from Imperial to Metric units divide by the number in column 3.
For example, 1.5 in. = (1.5 ÷ 0.039) = 38.1 mm.







Appendix D

Glossary

Backfilling	Placement of excavated soil in the trench after blinding has been completed.
Bedding	The earth foundation of the trench together with the select material around and over the drain, including envelope and filter material where used.
Blinding	Placement of select soil around a drain to prevent damage or misalignment when the trench is backfilled and to allow water to flow freely to the drain.
Coefficient of roughness	Factor expressing the frictional resistance to flow of a channel surface or a drain interior.
Connections	Fittings used to join two drain lines.
Continuous pipe	Extended length of pipe without perforations or unsealed joints.
Drain invert	The lowest part of the internal cross-section of a lined channel or drain pipe.
Drainage area	Area from which drainage water is collected and delivered to an outlet. Sometimes referred to as the watershed area for a particular drain.
Drainage coefficient or drainage rate	The depth of water to be removed from an area within 24 hours, in mm/day (in./day).
Drainage system	Collection of surface ditches or subsurface drains, together with structures and pumps used to collect and dispose of excess surface and subsurface water from an area.
Equivalent depth	The equivalent depth (d_e) is a function of the drain spacing, drain tube radius and depth (d) to the impermeable layer below the drain centers. It is the effective flow through the soil below the drains. Hooghoudt has suggested the use of d_e to replace the actual depth to the impermeable barrier as a means of accounting for the physical convergence of flow lines near the drain.
Gley	Gleization in poorly drained soils involves the reduction of iron into coloured mottles and concretions. Gley layers often have increased density.
Grade or gradeline	Degree of slope of a channel or natural ground.
Hydraulic conductivity	The rate at which water moves through a soil
Impermeable layer	If the permeability of the subsoil is about one-tenth that of the soil above it, the subsoil can be considered impermeable.

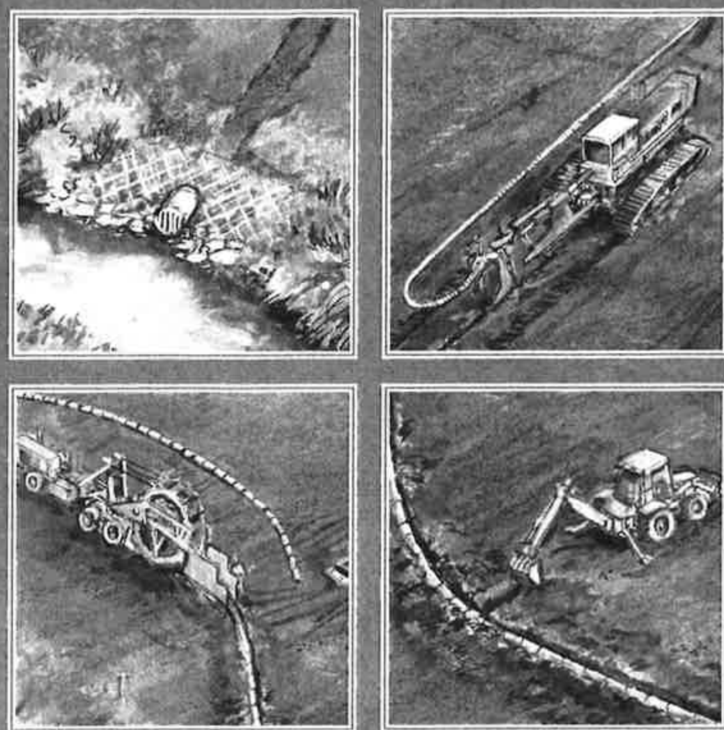



Interceptor line or drain	Surface ditch or subsurface drain, or a combination of both, designed and installed to intercept several lines to keep the number of crossings at highways and similar locations to a minimum (also called collector lines).
Junction	Point of intersection of two or more surface ditches or subsurface drains.
Land grading	The shaping of the land surface by cutting, filling and smoothing to planned grades so that each row or surface slopes to a drain without ponding.
Land smoothing	Shaping the land surface with a land plane or land leveller to eliminate minor depressions and irregularities without changing the general topography. The depth of cut in this operation is generally small and limited by the kind of equipment used. Land smoothing is also the finished operation in land grading.
Lateral drain	Secondary drain that collects excess water from a field.
Main drain	Principal drain that conducts drainage water from the lateral drains and submains to an outlet.
Pipe	Any product such as corrugated plastic drainage tubing, clay or concrete drain tile, or other type of conduit.
Pumping plant	One or more pumps, power units, and appurtenances for lifting drainage water from a collecting basin to a gravity outlet.
Submain	Branch drain off the main drain which collects discharge water from lateral drains.
Subsurface	The removal of excess water from below the soil surface by means drainage of drain tile, perforated pipe, mole channels, or other devices.
Surface drainage	The diversion or orderly removal of excess water from the surface of the land by means of improved natural or constructed channels, supplemented when necessary by sloping and grading of land surfaces to these channels.
Tile	Drain pipe made of burned clay, concrete, or similar material, in short length usually laid with open joints to collect and carry excess water from the soil.
Tubing	A flexible drain pipe that gains part of its vertical soil load-carrying capacity from lateral support of the surrounding soil.
Watershed	Total land area above a given point on a stream or waterway that contributes runoff to that point.
Water table	The upper surface of a saturated zone within the soil.







www.ontario.ca/omafra

THIS IS EXHIBIT "C" REFERRED TO IN THE AFFIDAVIT OF SIDNEY VANDER VEEN, SWORN BEFORE ME AT THE CITY OF CHATHAM, MUNICIPALITY OF CHATHAM-KENT, PROVINCE OF ONTARIO ON THIS THE 2nd DAY OF APRIL 2024 IN ACCORDANCE WITH O. REG. 431/20, ADMINISTERING OATH OR DECLARATION REMOTELY.

Lynn Kalp Digitally signed by Lynn Kalp Date: 2024.04.02 13:54:47 -04'00'

A COMMISSIONER FOR TAKING AFFIDAVITS (or as may be)

Linda Marie Kalp, a Commissioner, etc.
Province of Ontario, for the
Municipality of Chatham-Kent.
Expires August 31, 2026.

FORM 53

Courts of Justice Act

ACKNOWLEDGMENT OF EXPERT'S DUTY

(General heading)

ACKNOWLEDGMENT OF EXPERT'S DUTY

1. My name is Sidney Vander Veen *(name)*. I live at Drayton (Mapleton Township) *(city)*, in the Province *(province/state)* of Ontario *(name of province/state)*.
2. I have been engaged by or on behalf of Municipality of Chatham Kent *(name of party/parties)* to provide evidence in relation to the above-noted court proceeding.
3. I acknowledge that it is my duty to provide evidence in relation to this proceeding as follows:

   (a) to provide opinion evidence that is fair, objective and non-partisan;

   (b) to provide opinion evidence that is related only to matters that are within my area of expertise; and

   (c) to provide such additional assistance as the court may reasonably require, to determine a matter in issue.

4. I acknowledge that the duty referred to above prevails over any obligation which I may owe to any party by whom or on whose behalf I am engaged.

Date April 2, 2024

Signature

NOTE: This form must be attached to any expert report under subrules 53.03(1) or (2) and any opinion evidence provided by an expert witness on a motion or application.

THIS IS EXHIBIT "D" REFERRED TO IN THE AFFIDAVIT OF SIDNEY VANDER VEEN, SWORN BEFORE ME AT THE CITY OF CHATHAM, MUNICIPALITY OF CHATHAM-KENT, PROVINCE OF ONTARIO ON THIS THE 2nd DAY OF APRIL 2024 IN ACCORDANCE WITH O. REG. 431/20, ADMINISTERING OATH OR DECLARATION REMOTELY.

Lynn Kalp Digitally signed by Lynn Kalp Date: 2024.04.02 13:55:26 -04'00'

A COMMISSIONER FOR TAKING AFFIDAVITS (or as may be)

Linda Marie Kalp, a Commissioner, etc.
Province of Ontario, for the
Municipality of Chatham-Kent.
Expires August 31, 2026.

Profession

Professional Engineer

Education

B.A.Sc. Civil Engineering, University of Ottawa, Ottawa, ON, 1985

Civil Engineering Technology St. Lawrence College, Cornwall, ON, 1981

Professional Societies

Professional Engineers Ontario

Employment Record

Municipal Drain Lead, R.J. Burnside & Associates Limited (2019 - Present)

Drainage Program Coordinator, Ontario Ministry of Agriculture, Food & Rural Affairs (1991 – 2019)

Project Engineer, Ministry of Natural Resources (1988 – 1990)

Citizenship

Canadian

Languages

English

Sid Vander Veen, P. Eng.

A recognized authority on municipal and agricultural drainage and rural drainage issues throughout the Province of Ontario.

R.J. Burnside & Associates Limited Experience

Appointed as Drainage Engineer for Drainage Act projects by:

- Township of Adjala-Tosorontio
- Township of Amaranth
- Township of East Garafraxa
- Municipality of Grey Highlands
- Township of Guelph/Eramosa
- Township of Wainfleet

Drainage Opinions

Wrote professional drainage opinion reports for clients involved in drainage disputes.

Public Sector Experience as Provincial Employee

Provincial Administration of the Drainage Act

Guidance and direction to municipal council members and staff in the administration of the Drainage Act and to Professional Engineers in the implementation of the Act.

Program Coordinator – Agricultural Drainage Infrastructure Program

Management of the Agricultural Drainage Infrastructure Program, a $10 million annual grant program established under the authority of the Drainage Act. Specifically, this program provided grants to municipalities to offset their cost of employing drainage superintendents and to agricultural landowners to offset their share of the cost of constructing, improving, maintaining and repairing municipal drainage systems.

Lead Trainer/Facilitator for the Annual Drainage Superintendents Course

Primary instructor for the 5-day Drainage Superintendents Course since 1992. This course is mandatory training for municipal drainage superintendents.

Trainer for the Rural Municipal Drainage Courses

Instructor for the Rural Municipal Drainage Courses and the Calculating Drainage Act Assessments Courses since 1992. These courses were offered annually in 3 – 4 locations across Ontario.

Other Training

Deliver training workshops on drainage to other organizations such as the Ontario Ombudsman's Office, Ontario Hydro, the Ontario Stewardship Network, Ministry of the Environment and Energy, Ministry of Natural Resources, Ontario Federation of Agriculture, Ontario Soil and Crop Improvement Association, and individual municipalities.

Rural Ontario Municipal Association

Since 1992, drainage expert member on the Question Box Panel at the annual convention of the Rural Ontario Municipal Association.

Ontario Good Roads Association

Since 1999, drainage expert member on The Final Word Panel at the annual convention of the Ontario Good Roads Association.

Public Inquiries

Provided guidance to property owners in legal remedies to their drainage issues.

Drainage Referee

Administer and support to the Drainage Referees, the legal or procedural appeal body under the Drainage Act.

Industry Liaison:

On behalf of the Ministry of Agriculture, Food and Rural Affairs (OMAFRA), provided support to the following drainage organizations:

- Ontario Society of Professional Engineers (OSPE) Land Drainage Committee: Supported the committee's work and had an active role in the development of the annual conference program and training courses. Presented at the conference on several occasions.
- Land Improvement Contractors of Ontario: Supported the Board of Directors and assisted in the development and implementation of their annual convention. Presented at the convention on several occasions.
- Drainage Superintendents Association of Ontario: Supported the Board of Directors and assisted in the development and implementation of their annual convention. Presented at the convention on several occasions.

Interagency Cooperation:

- Chaired the interagency Drainage Act and S.28 Regulation Team, a group tasked with coordinating the implementation of the Drainage Act with regulations under the Conservation Authorities Act.
- Participated in the Drains Action Working Group, an interagency group tasked with coordinating the implementation of the Drainage with the Fisheries Act.
- Chaired an interagency group tasked with developing the Cropland Drainage Best Management Practices booklet that was published in 2011.

Program Coordinator – Tile Loan Program

Provincial administration of the Tile Loan Program established under the authority of the Tile Drainage Act. This $12 million annual program provides agricultural property owners with access to loans, through their local municipality, for installing agricultural tile drainage systems on their land.

Program Coordinator – Agricultural Drainage Licensing Program

Provincial administration of the Agricultural Tile Drainage Installation Act, including the issuance of licenses for tile drainage businesses, machines and machine operators involved in the practice of installing tile drainage on agricultural land.

Program Coordinator – Drainage in Areas Without Municipal Organization

Provincial responsibility for the delivery of drainage services in areas without municipal organization, including procurement of engineering services, property owner liaison and procurement of contractors.

Papers:

Wrote and presented various papers:

- The Drainage Engineers Conference
- The Latornell Conservation Symposium
- The Rural Ontario Municipal Association Conference
- Ontario Soil and Crop Improvement Association
- 2017 International Legislators Forum (Manitoba)

Publications:

Authored or co-authored:

- OMAFRA Publication 852 "A Guide for Engineers Working Under the Drainage Act in Ontario"
- OMAFRA Publication 859 "A Guide for Drainage Superintendents Working Under the Drainage Act in Ontario"
- OMAFRA Publication 29 "Drainage Guide for Ontario"
- Drainage e-Reference Tool: www.omafra.gov.on.ca/english/landuse/drain-eref/index.htm
- Drainage Act and Conservation Authorities Act Protocol: "Protocol for Municipalities and Conservation Authorities in Drain Maintenance and Repair Activities"
- Numerous factsheets

THIS IS EXHIBIT "E" REFERRED TO IN THE AFFIDAVIT OF SIDNEY VANDER VEEN, SWORN BEFORE ME AT THE CITY OF CHATHAM, MUNICIPALITY OF CHATHAM-KENT, PROVINCE OF ONTARIO ON THIS THE 2nd DAY OF APRIL 2024 IN ACCORDANCE WITH O. REG. 431/20, ADMINISTERING OATH OR DECLARATION REMOTELY.

Lynn Kalp Digitally signed by Lynn Kalp Date: 2024.04.02 13:56:09 -04'00'

A COMMISSIONER FOR TAKING AFFIDAVITS (or as may be)

Linda Marie Kalp, a Commissioner, etc.
Province of Ontario, for the
Municipality of Chatham-Kent.
Expires August 31, 2026.

Agricultural Land Drainage In Ontario

Ontario

FINAL REPORT OF THE SELECT COMMITTEE ON LAND DRAINAGE

TABLED IN THE LEGISLATIVE ASSEMBLY
BY
LORNE C. HENDERSON, M.P.P.
CHAIRMAN

June 1974
4th Session, 29th Legislature, 23 Elizabeth II

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CHAIRMAN'S MESSAGE

This Committee, appointed in June 1972, made an interim report to the Legislature in December 1972. Herewith is the final report wherein we have made a number of recommendations which, if implemented, we hope will make a real contribution to agricultural development in Ontario.

I should like to extend particular thanks to the Honourable William G. Davis, Q.C., Premier of Ontario, and the Honourable William A. Stewart, Minister of Agriculture and Food, for their recognition of an important matter to the people of Ontario and for their foresight in arranging for the appointment of this Committee, which, we hope, will provide some workable solutions to the problems raised.

The Committee wishes to thank the many agricultural representatives and agricultural engineers of the Ministry of Agriculture and Food, who kindly made arrangements for most of the meetings of the Committee throughout the Province. We gratefully acknowledge the assistance of the Association of Professional Engineers, the Association of Ontario Land Surveyors, the many contractors throughout the Province who appeared and made submissions, and the municipal officials, both elected and appointed, who made their views known to the Committee. We are also grateful to those whom we consulted on technical matters in Ontario, and in other jurisdictions. We greatly appreciated the valuable contribution made by the members of the public who took the time to express their views to the Committee, both in writing and by appearing at public hearings.

I should like to express my personal thanks to all the members of the Committee, each of whom displayed a great dedication to the task at hand and a keen interest in the subject under investigation.

Finally, I express the thanks of the entire Committee to the Committee staff, including the Clerk of the Committee, the Research Director, the Consulting Engineer, Counsel to the Committee, and the secretarial and administrative staff. Without their enthusiastic and effective support, the completion of this task would have been much more difficult.

Lorne C. Henderson

Lorne C. Henderson, M.P.P.
Chairman

MEMBERS

Fred A. Burr, M.P.P.
Robert G. Eaton, M.P.P.
Donald Wm. Ewen, M.P.P.
Rev. William Ferrier, M.P.P.
Maurice Hamilton, M.P.P.
Ronald K. McNeil, M.P.P.
Dr. W. J. Nuttall, M.P.P.
Donald A. Paterson, M.P.P.
John P. Spence, M.P.P.
Douglas J. Wiseman, M.P.P.

ONTARIO

LEGISLATIVE ASSEMBLY

SELECT COMMITTEE ON LAND DRAINAGE

Parliament Buildings
TORONTO, ONTARIO

CHAIRMAN
Lorne C. Henderson, M.P.P.

CLERK
David Callfas

June 1974

TO: The Honourable A. E. Reuter
Speaker of the Legislative Assembly of the Province of Ontario

Sir:

We, the undersigned members of the Committee appointed by the Legislative Assembly of the Province of Ontario on June 30, 1972, to enquire into and review the law relating to land drainage, have now the honour to submit the attached final report on land drainage.

Lorne C. Henderson
Lorne C. Henderson, Chairman

Fred A. Burr
Fred A. Burr

Robert Eaton
Robert G. Eaton

D. W. Ewen
Donald William Ewen

William Ferrier
Reverend William Ferrier

Maurice Hamilton
Maurice Hamilton

Ronald K. McNeil
Ronald K. McNeil

W. J. Nuttall
Dr. William J. Nuttall

Donald A. Paterson
Donald A. Paterson

John P. Spence
John P. Spence

Douglas Wiseman
Douglas J. Wiseman

COMMITTEE MEMBERS

L. C. Henderson, M.P.P., Lambton
Chairman

Fred A. Burr, M.P.P.
(Sandwich-Riverside)
Robert G. Eaton, M.P.P.
(Middlesex South)
Donald Wm. Ewen, M.P.P.
(Wentworth North)
Rev. William Ferrier, M.P.P.
(Cochrane-South)
Maurice Hamilton, M.P.P.
(Renfrew North)

Ronald K. McNeil, M.P.P.
(Elgin)
Dr. W. J. Nuttall, M.P.P.
(Frontenac-Addington)
Donald A. Paterson, M.P.P.
(Essex South)
John P. Spence, M.P.P.
(Kent)
Douglas J. Wiseman, M.P.P.
(Lanark)

STAFF AND ADVISORS

Clerk:
David Callfas

Secretaries:
Mrs. Doris Dunne
Miss Jane Maher
Mrs. Glenda Callfas

Legal Counsel:
Ronald Rowcliffe
Douglas Gray

Engineering Consultant:
James A. Monteith, P.Eng.

Research Director:
J. E. O'Meara

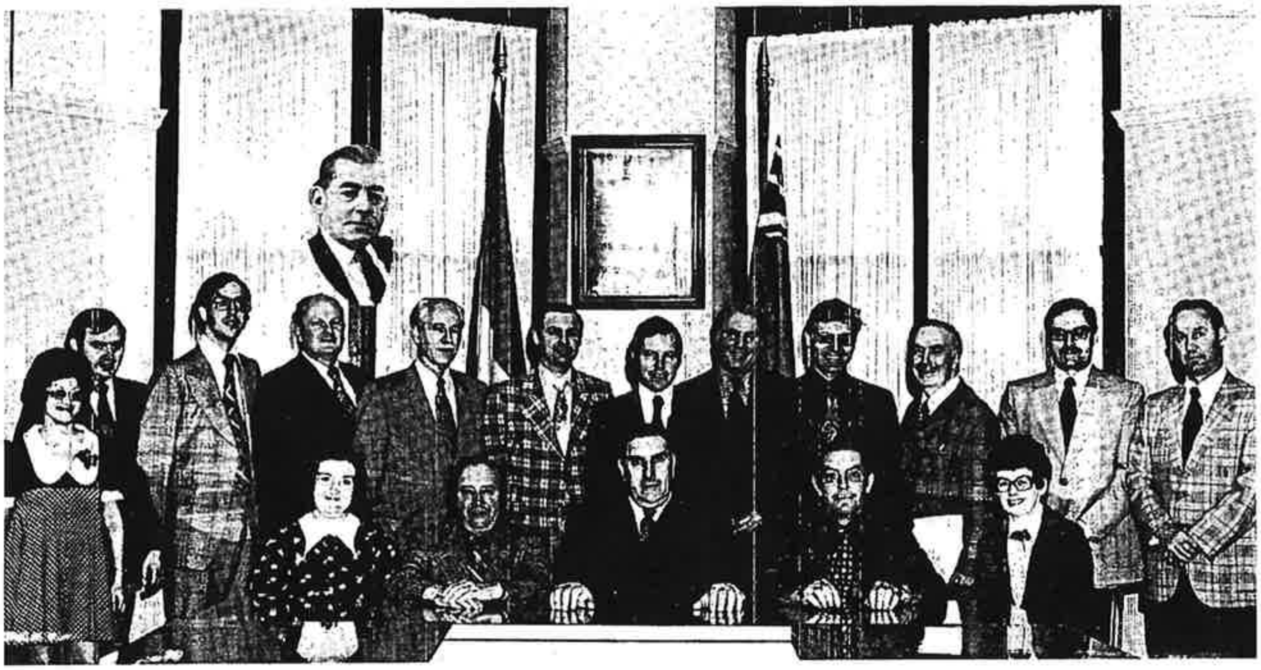
York University
Research Group:
W. C. Found
E. S. Spence
A. R. Hill

Legal Research:
Professor A. T. Weinrib

Students-At-Law:
Michael Mitchell
James Blacklock

Engineering
Research:
Todgham and Case Ltd.
Chatham, Ontario

Editorial Consultant:
L. A. Schwartz



Standing: (L to R)	Glenda Callfas, David Callfas, Douglas Gray, Donald Paterson, Fred Burr, Robert Eaton, Donald Ewen, William Nuttall, William Ferrier, Edward O'Meara, Douglas Wiseman, James Monteith
Seated: (L to R)	Jane Maher, Ronald McNeil, Lorne Henderson, Maurice Hamilton, Doris Dunne
Inset:	John Spence

TERMS OF REFERENCE

By resolution of the Legislature of Ontario a select committee was appointed on June 30, 1972 to examine, study and inquire into the following matters regarding land drainage in Ontario:

(1) The objectives of land drainage as an agricultural practice and the benefits to be derived from such practice.

(2) The associated problems of competing land use in the urban fringe and in wetlands, as influenced by land drainage projects.

(3) The problem of public interest in land use over the drainage of private lands by individuals.

(4) The prior evaluation of the benefits and costs of a drainage project.

(5) An evaluation of the petition procedure for initiating a drainage project.

(6) A review of the construction, improvement and maintenance procedures under "The Drainage Act" in achieving the objectives.

(7) A review of the appeal procedures under "The Drainage Act".

(8) A review of the financial procedures and assistance under "The Drainage Act" and other drainage programs.

(9) A study of the costs of land drainage and what influences such costs and how they may be reduced, i.e. engineering costs, etc.

(10) An evaluation of construction practices in general and erosion and weed control of drainage ditches in detail.

(11) A review of the administrative practices and methods in carrying out responsibility under "The Drainage Act".

And after due study and consideration, the Committee was directed to recommend such changes in the laws, procedures and processes as in the opinion of the Committee may be necessary and desirable.

THE WORK OF THE COMMITTEE

Upon its appointment on June 30, 1972, the Committee met in Toronto during July to plan and organize its method of procedure. At this time, the Committee appointed Mr. James Monteith, P. Eng., of the firm of Monteith-Ingram Engineering Ltd., Petrolia, Ontario, as engineering consultant. Mr. J. E. O'Meara, Associate Director of the Economics Branch of the Ministry of Agriculture and Food was assigned to act as Research Director. The Clerk of the House appointed Mr. David Callfas as clerk of the Committee. Mrs. Doris Dunne, Miss Jane Maher, and Mrs. Glenda Callfas acted as secretaries.

Mr. Ronald Rowcliffe of Sarnia acted as legal counsel during June 1973. Mr. Douglas K. Gray of Toronto was appointed legal counsel in 1974.

In August, the Committee advertised its terms of reference in the weekly and daily newspapers across the Province and invited written briefs and intentions to make oral representations. As a result the Committee received 590 briefs and letters from concerned individuals who wished to be heard. Lists of these briefs and representations are included in Appendix II.

The Committee began its travels and hearings on August 23, 1972 in the City of Kingston and since that time completed visits to 40 other locations in the Province and elsewhere to hear briefs and presentations and to make independent studies of problems and programs.

There was great interest in the rural areas on the question of land drainage as was evident from the number of briefs and presentations that were made to the Committee. All persons and organizations that wished to be heard were encouraged to come forward. The program usually consisted of a tour of the area in the morning, with hearings in the afternoon and evening. Municipal organizations and officials were heard in the afternoon, and the evening meetings were open to the general public.

Research Program

The Committee authorized three research programs as part of the study of agricultural land drainage in Ontario. The legal research was carried out by the Law School of the University of Toronto, under the direction of Professor A. T. Weinrib with the aid of two students, Michael Mitchell and James Blacklock. This research study included a review of the history of drainage law in Ontario, the preparation of a paper dealing with Ontario legislation which affects land drainage, and also a paper on federal statutes which affect land drainage in Ontario. A search was made for the written judgments of the Drainage Referee and summaries were made of these as well as those cases which had been heard by the Ontario Municipal Board.

The Committee awarded a study of benefits and costs and environmental impacts of drainage works to the Department of Geography at York University. This work was begun in January 1973 and completed on schedule on September 15, 1973. The study was under the direction of Professors W. C. Found, E. S. Spence, and A. R. Hill.

A study of engineering and construction costs was carried out by the firm of Todgham and Case Ltd., Engineering Consultants, Chatham, Ontario. Mr. H. H. Todgham, the senior partner in the firm, was responsible for the work.

Travel Program

The Committee's travels outside of Ontario included visits to Michigan, Nova Scotia, Newfoundland, Quebec, Florida, and Manitoba.

The trip to Michigan allowed the Committee members to view the latest drainage equipment in actual operation at a demonstration field day. The workings of the Drainage Commission were examined in Nova Scotia, and the Committee visited experimental plots in Newfoundland where bog areas were being drained for vegetable production.

In Quebec, the Committee had an opportunity to compare the policies and programs of a neighbouring jurisdiction and to evaluate the Ontario experience in light of the progress being made by the Quebec Department of Agriculture in providing drainage to Quebec farmers.

In Florida, the Committee was impressed with the recent legislation which gave control over water as a natural resource to one department of the state government. Similarly, the control of water and drainage in Manitoba is under the direction of a single department, and the Committee again noted with interest that this was a recent move and decision by the Province of Manitoba.

Essay Contest

During the course of its work, the Committee sponsored an essay competition among the students at the various agricultural colleges in Ontario. Nine essays were submitted on the subject "Agricultural Land Drainage — Benefits and Objectives." Cash prizes were won by Ron Sadler of the New Liskeard College of Agricultural Technology, Chas. Bauman of the Centralia College of Agricultural Technology, and Robert M. Perras of the Kemptville College of Agricultural Technology.

The Committee appreciated the interest shown by the students and hopes that the contest encouraged their interest in the important subject of land drainage.

Interim Report

In December 1972, the Chairman tabled an Interim Report of the Committee in the Legislature of Ontario. Certain recommendations were made at that time and are summarized herewith.

1. It was recommended that A.R.D.A. assistance to drainage works in the eleven eastern counties of Ontario be continued until the end of the federal-provincial rural development agreement in March 31, 1975.

2. It was recommended that demonstration drainage plots be provided in northern Ontario to help farmers of that region become aware of the advantages of drainage.

3. It was recommended that the Ministry of Agriculture and Food make loans available for tile drainage to farmers in unorganized territories and districts at the same rate and on the same terms that farmers in other areas are able to borrow under The Tile Drainage Act.

4. The Committee recommended several changes in Section 4 of The Drainage Act which concerns the requisition type of drain:

(a) That the amount required as a deposit from the requisitioning farmer be raised from $100 to $200;

(b) That the amount which could be spent on any requisition drain be raised to $7,500;

(c) That the geographical limit be deleted completely;

(d) That the engineer be required to report that, in his opinion, the drainage work proposed is not required or is impractical;

(e) That the Act be amended to permit the municipality to ask for reconsideration by the engineer and that the engineer be required to file this new report within 60 days; and

(f) That the Act be amended to make drainage works constructed under this section eligible for grants under Section 62.

SUMMARY OF RECOMMENDATIONS

AN EXAMINATION OF COSTS PART VII p.36

The Committee recommends:

1. that administrative costs related to drainage works (by-law preparation etc.) be considered part of the general administrative operation of the municipality and not be included in the direct charges assessed against a drainage works.

THE PETITION PROCEDURE PART VIII pp. 37-40

The Committee recommends:

1. that Section 3 (1) of The Drainage Act be redrafted so that a valid petition will consist of signatures representing a majority of the properties, (i.e. one signature per property to be benefited) or any number of properties representing 60 percent of the total acreage to be benefited;

2. that the phrase "area requiring drainage" in Section 3 (1) be replaced by "area to be benefited as determined by the engineer";

3. that subsection 4 of Section 3 be deleted;

4. that upon the presentation of a petition the municipal council must appoint an engineer whose duty it is to immediately confirm the validity or otherwise of the petition and define the drainage area;

5. that the Minister of Agriculture and Food may petition for the initiation of a drainage works;

6. that an environmental impact statement and a benefit/cost certificate be filed along with the engineer's report;

7. that a municipal council be permitted to require a preliminary engineering report prior to a final engineering report if in its opinion such a preliminary report is necessary for decision as to whether or not to accept the petition.

8. that the council of any local municipality be required to act on the request of one or more ratepayers to initiate preliminary studies — preliminary engineering, environmental and benefit/cost of any new proposed drainage works;

9. that the Ministry of Agriculture and Food subsidize the cost of these preliminary reports within the normal grant structure now available for construction of drainage works;

10. that the Minister of Natural Resources be permitted to appeal any new drainage proposal on environmental grounds and that the Minister of Agriculture and Food may appeal on the grounds that farmers' legitimate drainage requirements are being frustrated;

11. that the right of the road superintendent or the Minister of Transportation and Communications to initiate a drainage project be retained;

THE ENGINEER PART IX pp. 41-44

The Committee recommends:

1. that where the engineer appointed is a corporation, association or partnership such an appointee be required within 10 days of the date of appointment to notify the council of the name of the individual engineer or land surveyor who will have charge of the project;

2. that the first duty of the engineer in the case of a new drain should be to determine the area to be benefited in order to confirm the validity of the petition or to establish the requirements of such a petition where a petition has not been raised;

3. that the engineer be present at an on site meeting to hear any representations which interested parties wish to make;

4. that the engineer be required to place sufficient bench marks to permit reasonable control of elevation for future repairs or improvements;

5. that the whole of Section 8 of The Drainage Act which deals with the engineer's report be redrafted;

6. that Subsection 2 of Section 8 be amended to provide that costs of modification to a drain occasioned by a change in land use from agriculture be made at the expense of the drainage works and not charged to the road authority;

7. that Subsection 3 of Section 8 be deleted;

8. that the subjects dealt with in Subsection 4 and 5 be amalgamated into one subsection so that access bridges, farm bridges and water gates should be built and maintained by the drainage area;

9. that the engineer be permitted to grant allowances for damages to ornamental trees and fences which cannot be strictly included in the term "lands and crops";

10. that the engineer should, where it would be advantageous, be required to show assessments in the fractional part of the whole cost as well as in money;

11. that the engineer be given authority to make block type assessments in built-up areas;

12. that the engineer not be permitted to attend the Court of Revision unless specifically requested by an appellant; where such a request is not forthcoming the engineer should be required to file with the Court of Revision a statement in writing in which he gives his reasons for the appealed assessments;

THE DRAINAGE SUPERINTENDENT PART X pp. 45-46

The Committee recommends:

1. that every municipality which undertakes projects under The Drainage Act be required to engage a drainage superintendent. Two or more municipalities may jointly retain a drainage superintendent or one municipality may engage a part-time superintendent providing he is qualified;

2. that the drainage superintendent be required to report periodically on the condition of all drains within the municipality;

3. that the drainage superintendent be required to successfully complete a course of study satisfactory to the Ministry of Agriculture and Food;

4. that the salary of the drainage superintendent be borne by the general rate of the municipality and that this salary be subject to the normal grant structure available from the Ministry of Agriculture and Food.

MAINTENANCE, REPAIR AND IMPROVEMENT PART XI pp. 47-48

The Committee recommends:

1. that legislation more clearly define maintenance, repair and improvement in drainage works as outlined in part XI of this report;

2. that the functions of maintenance, repair and minor improvements continue to be undertaken without the report of an engineer;

3. that normal grants from the Ministry of Agriculture and Food be extended to maintenance, repair and minor improvements;

4. that the programs of maintenance, repair and minor improvements be permitted to be initiated by the drainage superintendent with the approval of the municipal council;

5. that major improvements be permitted to be effected by the passing of a by-law and the appointment of an engineer;

6. that in cases of major modification an environmental impact statement and benefit/cost report be filed along with the engineer's report;

7. that council be permitted to authorize as well as the environmental impact statement and benefit/cost statement a preliminary engineering study before proceeding further;

8. that normal grants be made available from the Ministry of Agriculture and Food for the cost of these preliminary studies;

9. that the procedure for processing a project which has been activated on notice of an affected owner or a road superintendent or on recommendation of a drainage superintendent be as outlined in the text;

THE APPEAL PROCEDURE PART XIII pp. 52-56

The Committee recommends:

1. that fundamental changes in the appellate system be made;

2. that the Court of Revision be retained to entertain appeals from assessments in the engineer's report;

3. the establishment of an Ontario Drainage Appeal Tribunal which would exercise all the present appellate jurisdiction of the county court judge and the referee;

4. that powers to grant mandamus, injunctions and quash by-laws and to entertain claims for damages not be given to the Ontario Drainage Appeal Tribunal but should be exercised by the ordinary courts;

5. that the Ontario Drainage Appeal Tribunal should hear appeals from allowances granted by the engineer;

6. that the jurisdiction of the Tribunal be specific;

7. that the rights of appeal to the Tribunal should be contained in one part of the Act and state each right as mentioned in part XIII of this report;

8. that an appeal to the Divisional Court be preserved;

9. that since no decision of the Drainage Tribunal should be considered absolutely final, the jurisdiction of the Divisional Court be extended to include an appeal from any decision of the Tribunal;

10. that uniform time limits be adopted for appeals which depend not on the nature of the appeal but rather on the character of the Tribunal to which the appeal is taken;

11. that in cases of appeal to the court of revision notice must be given at least 10 days before the first sitting of the court;

12. that cases of appeal to the Ontario Drainage Appeal Tribunal should be taken within 20 days after the notice of the decision or action complained of has been given;

13. that notice of appeal to the Divisional Court be given within 30 days after the date of the Tribunal's decision;

14. that the operation of the Tribunal must be expeditious, easily accessible, flexible, informal and have the necessary expertise to handle questions of an assessment, engineering or a legal nature as they arise;

15. that members of the Ontario Drainage Tribunal not be limited in number so that any number can be appointed as may be necessary as the work load increases;

16. that on an appeal to the Tribunal from the Court of Revision or on an appeal to the Tribunal by a landowner from allowances granted by the engineer, that the engineer should be required to give his evidence first;

17. that the Tribunal be given the power to govern its procedure and make rules and that such rules should be as few as possible;

18. that the Tribunal should have the power, either of its own motion or on the application of any party, to require a statement of particulars respecting the grounds for appeal;

19. that the reasons for decision of the Tribunal be required to be filed with the Ministry of Agriculture and Food as well as with the immediate parties to the appeal.

THE DRAINAGE ACT PART XV pp. 59-65

The Committee recommends:

1. that definitions of "benefit", "engineer", "drainage works", and "public utility" be redrafted as suggested in the text;

2. that the concept of "injuring liability" be deleted from the definitions in the Act and removed as a concept in the assessment responsibility of the engineer in section 16 (2);

3. that written agreements made under section 2 of the Act regarding drains constructed by mutual consent should be required to be registered in the proper registry or land titles office;

4. that section 4 (4) of the Act be rewritten to clarify that the point of commencement of the drainage works is the upstream end of the works as opposed to its point of outlet;

5. that the procedure for bringing an award ditch under the provisions of The Drainage Act be set out;

6. that authority be given to contractors engaged in the construction of drains to enter on private property and that the fine for contravention of this section of the Act be increased to $200;

7. that, where a landowner has been compensated for flooding of his land in lieu of carrying the drain to a sufficient outlet, a copy of the by-law be required to be filed in the appropriate registry or land titles office;

8. that agreements be drawn up between the Minister of Agriculture and Food for Ontario and his counterpart colleagues in the provinces of Quebec and Manitoba which would provide the necessary machinery for drains which cross provincial boundaries, and that the Act be amended to permit agreements which cover more than one project;

9. that where owners of subdivided land can mutually agree on the share each should pay of the drainage assessment then the appointment of an engineer not be required;

10. that statements or certificates of taxes or statements of tax arrears include the amounts due on municipal drainage and amounts due on borrowings under The Tile Drainage Act;

11. that the tax rolls be amended immediately after the passing of the by-law by third reading to denote the fact that a drainage assessment is pending;

12. that municipal councils give notice to the engineer that he will forfeit all claims for compensation unless his report is filed within the specified time limit, not to be less than 30 days;

13. that the municipal clerk be required to forward all the required notices and copies of reports within 20 days after the engineer's report has been filed;

14. that where all concerned, including the council and the engineer, are satisfied that modifications or amendments to an engineer's report are in order that the report need not be referred back to the engineer. Instead the report may be adopted as amended;

15. that where changes in the engineer's report regarding design and structure become apparent after the by-law has been passed, council should have the right to apply to the Ontario Drainage Appeal Tribunal for an appropriate amendment to the report;

16. that costs be eliminated by sending to neighbouring municipalities and landowners only the facts of the by-law dealing with finance and not necessarily repeating what has already been submitted in the original distribution of the engineer's report;

17. that lands normally exempt from taxation should not be exempt from assessments for drainage works, on the principle that those who benefit from the drain should be assessed and pay that assessment;

18. that where the lands within a municipality are liable for assessment the council should be able to provide that the engineer may designate the affected area or areas and set out a block assessment on these lands;

19. that sections of the Act dealing with obstruction of, or injury to, or destruction of a drainage works and the penalties therefor and the right to sue for such damages should be in one section of the Act;

20. that, if before construction has commenced, it appears that the actual cost of the drain will exceed the original estimate by 33⅓% or more, the council must obtain the approval of the assessed owners before proceeding with the work. If construction has commenced, the municipalities involved should be able to raise funds by passing amending by-laws, but within 30 days after completion of the work the engineer and the drainage superintendent should be required to file a statement containing a summary of the matters which cost more or less than the original estimate, the reasons for the increase or decrease, and a statement of how the monies were spent;

21. that fines for pollution of drains by any matter other than drainage water be a minimum of $100 in the first instance and $500 on second and subsequent offences;

22. that lands owned by the ARDA Directorate of Ontario not be considered lands owned by Ontario for the purposes of grants under The Drainage Act;

23. that no change be made in the grant structure as presently set out in section 64 of The Drainage Act;

24. that when lands which have received a grant for drainage purposes are taken out of agricultural use that the grants be repaid;

25. that any person be entitled to obtain a certificate from the Ministry of Agriculture and Food which will indicate the amount of grant which has been paid with respect to any land.

THE TILE DRAINAGE ACT PART XVI pp. 66-67

The Committee recommends:

1. that the total amount available under the Act be raised from 75% to 90% of the total cost of the works and that councils not be permitted to lend a lesser amount unless a lesser amount is applied for;

2. that money loaned under this Act be loaned at no interest;

3. that artificial barriers to land drainage, that is, roads, highways, underground installations etc. should bear the additional costs of carrying field underdrainage to a sufficient outlet. Normal subsidies should apply in these cases and these subsidies should only be available where the plan has been drawn or approved by the Ministry of Agriculture and Food;

4. that where tile drainage loans are made on farm land that within the term of the loan is converted to any use other than agriculture the balance of the loan should become immediately due and payable.

5. that repayment installments of tile drainage loans should fall due annually and on the first due date of the normal taxes for the year;

6. that the first payment should be due in the year following the date in which the loan is granted;

7. that the inspector described in The Tile Drainage Act be required to file with his certificate a sketch indicating the location and direction of the tile as laid as well as information on spacing and depth of the tile.

THE ROLE OF THE ONTARIO MINISTRY OF AGRICULTURE AND FOOD PART XVII p. 68

The Committee recommends:

1. that the Ministry of Agriculture and Food be given a greater role in the administration of The Drainage Act;

2. that a separate drainage branch within the Ministry of Agriculture and Food be organized and that drainage activity not be a section within another branch.

SPECIAL PROBLEM AREAS PART XVIII pp. 69-78

(a) Matters under Federal jurisdiction

The Committee recommends:

1. that the definition of "public utility" in The Drainage Act be amended to include "railway";

2. that the Government of Ontario negotiate with the Government of Canada with a view to amending the legislation that incorporates the Bell Telephone Company (or the Railway Act, if appropriate) to make the company's position the same as provincially controlled public utilities;

3. that appropriate amendments be made to The Drainage Act to place Indian Reserves in the same position as other lands provided that appropriate amendments to the Indian Act in conjunction therewith, are also enacted by the Parliament of Canada;

(b) Euphrasia Township Municipal Drain No. 1

4. that The Drainage Act be amended to provide that no injunction shall be issued to restrain the construction of a drain that has been authorized in accordance with The Drainage Act and is being constructed in accordance with a valid by-law of a municipal council;

5. that the Minister of Agriculture be made a party to any proceedings commenced to obtain an injunction to restrain the construction of a municipal drain and that the Minister be permitted to participate in the trial and to take any proceedings that any other party could take including appeals;

6. that to resolve the peculiar situation of the Euphrasia Municipal Drain No. 1, that the Legislature pass special legislation as discussed in the text;

(c) Qualifications of Engineers and Land Surveyors

7. that the Association of Professional Engineers and the Association of Ontario Land Surveyors initiate an effective means of determining those individuals or firms which are properly qualified to practice land drainage under The Drainage Act;

8. that the professional associations take the necessary steps to establish and define the qualifications of drainage engineers;

9. that the University of Guelph consider the feasibility of offering a full-term course in drainage engineering as one of its options to senior students;

10. that the Ministry of Agriculture and Food become the qualifying body if the professional associations involved do not develop a satisfactory system of designation which would protect all concerned;

(d) Beaver in Drainage Ditches

11. that, where in the opinion of the Drainage Superintendent, a drainage works constructed under The Drainage Act, is being damaged or rendered ineffective by the activity of beaver, he report this fact to the district office of the Ministry of Natural Resources and that the Ministry of Natural Resources be responsible for taking the necessary measures to eliminate the animal permanently from the drainage works;

(e) A Suggested Regional or County Drainage Commission

12. that where municipalities in a county or a region agree, and by by-law so authorize, a county or regional drainage commission be organized to direct and supervise and control all drainage works in the county or region, but only those in municipalities where the municipality has agreed to turn over its responsibilities;

(f) Barriers to Agricultural Drainage

13. that funds be appropriated by the Legislature into the budget of the Ministry of Agriculture and Food in sufficient amounts to provide a subsidy matching the present road subsidy to county and township road budgets to provide for the necessary crossings of county and township roads by drains constructed under The Drainage Act;

14. that an amount be provided within the budget of the Ontario Ministry of Agriculture and Food to provide for payment of assessments made against provincial highways.

WATER MANAGEMENT — A PLAN FOR THE FUTURE, PART XIX pp. 79-82

The Committee recommends:

1. that the Government of Ontario establish a task force or committee to study the future management of water in the province with one of its terms of reference, being the possibility of consolidating total water control in the province into one Ministry.

I. AGRICULTURAL LAND DRAINAGE — OBJECTIVES AND BENEFITS

Agricultural land drainage may be defined as the removal and disposal of excess water from soil in order to increase its agricultural capability. Excess water may come from normal precipitation, snow melt, overland flow or underground seepage from adjacent areas, artesian flow, flood water from channels, or water applied for special purposes. The removal of excess gravitational water from the soil can result in changes in soil properties such as greater availability of capillary water, warmer soil temperature, and improved soil aeration, all of which are beneficial to agriculture.

The knowledge that benefits derive from disposal of excess water from agricultural lands is not a new discovery. References to land drainage can be found from the second century B.C. in Egypt and Babylon. The Roman statesman Cato knew of the benefits of drainage when he said "Wherever the water stands amongst the growing corn, or in other parts of the corn fields or in the ditches or where there is anything that obstructs its passage, that should be removed, the ditches opened and the water let away."

In the third or fourth century A.D., the Romans were the authorities on drainage and their methods were practised without much improvement for more than a thousand years. In sixteenth-century England a publication appeared which held forth on "How to Drain Moores, and All Other Wet Grounds or Bogges, and Live in Dry Forever."

Although open drainage ditches were commonly used in those days, samples of underground tile still exist which can be traced back to the ancient city of Ephesus and almost to the time of Christ. Tiling and draining became commonplace in nineteenth-century England and from 1820 on there is evidence of considerable knowledge and interest in tile draining in northern New York and adjoining agricultural areas.

The principal objective of drainage is, of course, to increase yields, improve crop quality, and improve the condition of the soil. Another objective is to change wet lands now considered to be merely waste into productive agricultural acreage. A third objective is to improve conditions in wet fields so that cultivation and harvesting become more profitable.

Four essential elements are required in soil for optimal plant growth — water, heat, air, and plant food. If these elements are in proper balance in the soil, then maximum crop production obviously is feasible. Land drainage controls the amount of water in the soil and maintains it in such condition that root growth is at its deepest and does not suffer from the wet and cold. Crops need air as well as water, and so the water from the upper few feet of the soil must be removed to allow air which carries vital oxygen to reach the growing plants.

Soil temperature plays an important role in seed germination and root growth. Saturated soils largely use solar radiation to evaporate water rather than to raise soil temperature. By removing excess water, drainage enables the soil to warm up more quickly.

Plant food in the form of fertilizer is dissolved in moisture and taken up by plants. Since this activity takes place only above the water table, proper drainage of the soil is necessary to increase the availability of plant food through the roots.

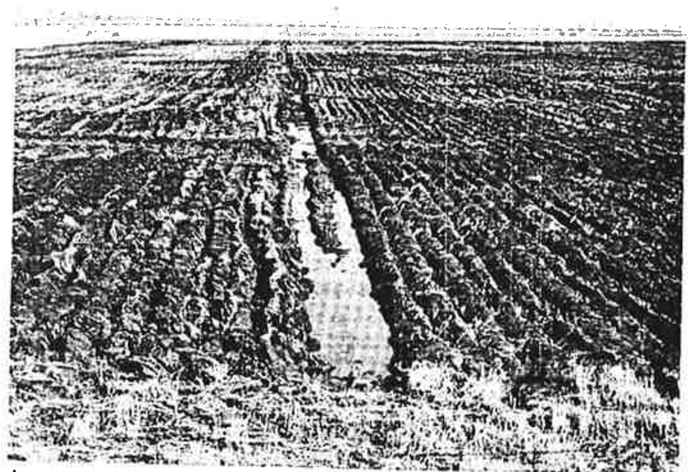
Land drainage facilitates the removal of gravitational water from the soil. Gravitational or free water forms that fraction of soil water which is in excess of the soil's moisture-holding capacity. This water normally drains downwards with the force of gravity. In areas of high water table, however, gravitational water remains on or just below the ground surface. Drainage lowers the water table and removes this excess water. Capillary water, which forms a film around each soil particle, is retained against the pull of gravity and cannot be drained off. It is capillary water that is used by plants, and removing gravitational water actually increases the amount of available capillary moisture in the soil.

Removing excess water improves soil structure because it allows increased activity by microorganisms, greater plant root development, and less shrinking and swelling action which occurs with changes in soil moisture content. The improved soil structure enables the soil to hold greater amounts of capillary water. Furthermore, lowering the water table encourages plant roots to penetrate deeper into the soil, providing access to a greater amount of capillary moisture. Increased rooting depth also enables plants to utilize nutrients from a greater volume of soil.

Benefits from land drainage have been compiled by agricultural soil scientists and may be summarized as follows: (1) earlier planting and harvesting is possible; (2) the growing season is lengthened; (3) by increasing the depth of the root zone, more available moisture and plant food is provided; (4) the soil is better ventilated; (5) soil erosion is decreased by increasing water filtration; (6) soil bacteria grow better; (7) organic salts are leached from the soil; and (8) soil temperatures are increased.

The Ontario Soil and Crop Improvement Association has for many years promoted the practice of proper land drainage. Some of the local county associations have conducted experiments and produced statistics to prove that land drainage is highly beneficial in terms of increased crop yields and better soil management. The Committee appreciated the many well-presented briefs received from county soil and crop improvement associations on the subject of land drainage.

The Canada Department of Agriculture conducts research in land drainage through the facilities of its experimental station at Harrow, Ontario and has demonstration plots in Essex and Lambton counties. The Interim Report of this Committee tabled in the Legislature on December 4, 1972, recommended that more demonstration plots be set up in northeastern and northwestern Ontario to allow farmers to see on the ground the actual benefits of land drainage.



Improperly drained cultivated land.

A good crop on well-drained land.

II. THE LAW OF DRAINAGE — PAST AND PRESENT

The Common Law

In order to gain appreciation of the complex statutory scheme which governs drainage matters in Ontario today, it is useful, indeed necessary, to have some knowledge of the basic values of the common law regarding drainage and watercourses. Most of these principles are very old, and were developed by the courts before any statutory provisions regarding drainage were enacted. It must be remembered, however, that the principles of the common law continue to be in effect unless they are specifically altered or overridden by statutory enactment — thus their continuing importance.

The common law regarding drainage may essentially be divided into two parts. First, there are the rules governing the rights and obligations of riparian landowners, in other words those whose lands are immediately adjacent to natural watercourses. The second set governs the rights and obligations of landowners which relate to surface waters.

When considering the rights of riparian owners, it should be noted that a natural watercourse has been defined by the courts as a channel with banks formed by the flowing of water and must present to the eye the unmistakable evidence of running water. 1/ The courts have held that a watercourse is established if there is a sufficient natural and constant flow of water to form and maintain a distinct and definite channel. It is not necessary that the water be continuous or from a perennial living source. It is sufficient that the water rises periodically from natural causes and reaches a plainly defined channel of a permanent character. 2/

Any landowner whose lands abut upon a natural watercourse has a right to drain his lands into that watercourse. 3/

Where a landowner with lands abutting on a natural watercourse collects the rain in ditches or in proper drains, he has the perfect right to discharge it into the watercourse. And this is so even though the result is to increase the volume of the stream and to accelerate its rate of flow. He may do so without incurring any liabilities for damages to an owner of a lower land. 4/ The lower owner must live with the possibility of increase in the flow of the stream because the upper owner has the advantages of drainage reasonably used which the stream may give him. By reasonable use is meant use up to the capacity of the banks of the stream.

1/ Re Sinclair and Sharpe (1924), 26 O.W.N. 134.
2/ Beer v. Stroud (1888), 19 O.R. 10.
3/ McGillivray v. Lochiel (1904), 8 O.L.R. 446.
4/ Ibid.

But rights also call for certain obligations. A natural watercourse from its very nature must flow from higher to lower ground, and if there is a right of the high lands to drain, then there is a corresponding obligation on the owners of the low lands to accept the flow. Subject to the limitations placed upon the upstream owners that they must use the stream reasonably, their rights to drain lands which lie within the watershed is absolute. Conversely the downstream owner is under an obligation just as firm that he will accept the disadvantages which flooding brings to his low land.

It is the duty of anyone who interferes with the course of a natural stream to see that the works which he substitutes for a channel provided by natural means are adequate to carry the water which may be brought even by extraordinary rainfall. If damages result from improperly substituted works which have been provided in place of the natural stream, then the owner is liable. 5/

The second division of common law deals with water that from time to time descends in the form of rain until it finds its way by percolation or flow to the point of commencement of some natural course. To summarize the rules in respect to surface flow and percolation it may be said that as far as owners of low land are concerned, they cannot claim the assistance of the law to prevent the natural flow of surface water from adjoining high land. However, they are not obliged to receive surface water flowing upon their lands. The low landowner may without liability protect his own lands by building structures or by filling the land to a height sufficient for protection, and the upper landowner has no complaint if flooding results. 6/

The character of water changes in law when it is collected in a man made channel and therefore, a person who collects water in an artificial channel loses any right he may have had in respect to uncollected surface water. The minute he does so makes him liable to avoid venting this collected water on the lands of another, and he must at his expense take the water to a sufficient outlet. 7/ Hence the contribution in The Drainage Act by those assessed for "outlet" where the drain is so constructed to carry water off from the lands of higher owners.

The Statute Law

Drainage statute law in Ontario goes back almost 140 years. There have been many amendments to the law

5/ McArthur v. Gillies (1881), 29 Gr. 223.
6/ Ostrom v. Sills (1898), 28 S.C.R. 485.
7/ Re Orford and Aldborough (1912), 27 O.L.R. 107.

during that period, arising in piecemeal fashion in response to particular problems. Accordingly, there now exists a system of drainage law that is extremely complex and sometimes unwieldly and is really a system of patching on a basic statute. The changes made over the years were in response to different demands from various areas in the Province, as the pace of drainage construction increased and also to demands and difficulties encountered by farmers, engineers, lawyers, and municipal councillors. It is fair to say, however, that the development of drainage law in Ontario has been a basic process with very few major reconstructions or departures from the original idea. Legislators and people involved had what they considered to be an adequate system and the amendments were brought about with a view to improving that system.

The first statute law affecting drainage in Ontario was passed in 1835. The Statute was entitled "An Act to Regulate Line Fences and Watercourses," and it set out the basic framework which we know today; i.e., that the cost of the construction was to be borne in proportion to the interests of the individual's concern. It is interesting to note that at the time of introduction this legislation was given a four-year trial period, but at the end of this trial period, the legislation was extended indefinitely.

This Act continued in force until 1859 (25 years), but in that year a new Act was passed respecting municipal institutions in Upper Canada. This Act contains the outlines of the present Drainage Act. A petition by interested landowners for construction of a drainage works was instituted; the appointment of an engineer was ordered; the passing of a by-law and the assessment of land which benefits and the permission of the council to issue debentures for payment was included as well as provisions for appeal to the County Court Judge. Interestingly, before the work was to begin, the council was required to publicize in the local press for at least a month the fact of the work and the by-law authorizing it. This is not required today.

In 1874, all previous acts were repealed and a new act was introduced entitled "An Act Respecting Ditching and Watercourses." This Act consolidated all preceding acts and the only innovation was the authority to appoint a registered Ontario Land Surveyor.

Two further pieces of legislation aided the development of drainage in Ontario. The first one established the Ontario Department of Public Works and gave it the important responsibility of constructing drainage works in swampy areas. The government was given in this way the initiative to drain certain areas without the necessity of a petition. At the same time, the government began to realize the costs of completing these drainage works and to recognize that the high cost of construction was preventing farmers from draining lands by way of a petition. In an attempt to remedy this situation, legislation was passed allocating funds to be spent on drains constructed under the Public Works Department. These moneys, however, were in the form of loans, and the lands benefited were to be charged under a difficult formula to recover the money after the drain was constructed. Thus, initiating municipalities submitted the proposed drainage schemes to the Public Works Commissioner, who then referred them to the Cabinet, which then authorized the investment of funds.

The Act was rewritten in 1871 and the Commissioner of Public Works was empowered to act on the written application of a municipal council that had received a petition of the majority of owners of land benefited by the drain. Then moneys were specifically allotted for drainage works.

The requirement for a sufficient outlet goes back to 1884, when the Act of 1871 was amended requiring that every drain be continued to a sufficient outlet. The Act held that it was lawful to construct a ditch or a drain through any number of lots until a sufficient outlet was reached.

The procedure for resolving disputes in those days was essentially a form of arbitration. It has been reported, however, that local men with a knowledge of general municipal politics were appointed as arbitrators but not necessarily because of their ability to give judicial and independent thought to the matters before them. This, of course, led to many long and bitterly contested arguments. The office of drainage referee was established in 1891, and given the powers of the arbitrators who originally sat on these cases.

In 1892, the first Commission was appointed to look into drainage laws in Ontario. Two suggestions were made to this Commission in 1892, which have some relevancy today. First, it was recommended that drainage matters should be taken out of the hands of the local municipalities and placed under the control of a board to be appointed by the Lieutenant-Governor-in-Council. Second, it was made quite clear that it was very difficult to decide which lands were benefited by the drain until the engineer had made his report. It was recommended that the engineer's report should be made and presented to the council who then would decide on the validity of the petition. There was some concern at that time about the role of the engineer, as there is today, and it was suggested that the engineer's duties be more precisely described in the Act. Many of the amendments recommended by the Commission of 80 years ago appear in today's Drainage Act, but again, were minor amendments to the existing legislation and did not really constitute a sweeping change.

The Commission of 1892 certainly did not envisage what then happened. The legislature took it upon itself to repeal certain acts then in existence and to consolidate them into a new Municipal Drainage Act, a course which had not been recommended by the Commission.

Thus, the advent of the Municipal Drainage Act in 1894 was the most important event in the evolution of the drainage statutes until the present. This Act provided for two drainage referees: one for western Ontario and one for eastern Ontario.

One of the most difficult conflicts in the development of drainage law in Ontario has been that between the need for engineering expertise and the inherent suspicion among farmers and others that the engineer's professional opinion was unnecessary, too expensive, and just as prone to error as that of the inexperienced layman. The legislation required that drainage reports must be provided by a professional engineer or an Ontario Land Surveyor. In 1903, distrust of engineers became apparent when amendments to the Act provided for any municipality to appoint two residents as drainage viewers. These viewers were to accompany and assist the engineer in all his duties. If one of the viewers and the engineer could agree in case of a dispute, that would be sufficient. What usually happened, however, was that, if both the drainage viewers disagreed with the engineer, the report was effectively thrown out. In less than 10 years, the provision for drainage viewers was removed from the Act.

Two referees had been appointed under the Act of 1894. On the death of the Western referee, however, no new appointment was made and the referee from Eastern Ontario, G. F. Henderson, Q.C., of Ottawa, carried on alone and served the whole Province. Henderson's philosophy was that the legislation was designed to get drains dug and not to write books on cases of appeal and litigation. He successfully cut down the amount of argument in formal cases before him and settled many cases by urging people to use their common sense instead of bringing formal action. In 1926, he is reported to have told the Premier that the only work he had done in the last year was to sign a few cheques. As the caseload before the referee diminished, consideration was given to dispense with the office. In 1946, amendments were introduced to allow the Ontario Municipal Board to fulfill the referee's functions.

A second Commission or Committee of the legislature was appointed in 1948, consisting of George Parry (Chairman) from Kent West, Bryan Cathcart from Lambton West, and Ross A. McEwing from Wellington North. This Committee traveled extensively throughout the Province asking for suggestions and recommendations. The amendments they suggested were aimed at closing loopholes and adding a few necessary procedures. They did not feel that any radical restructuring of the Act was necessary.

The Committee reported dissatisfaction with the work of the Ontario Municipal Board as drainage referee and recommended that a well-qualified lawyer with considerable experience in drainage should be appointed to the Municipal Board or, alternatively, that such a person be named as referee. Although this suggestion was not accepted, a drainage referee was appointed at this time and an option was given as to where disputes could be taken.

The Committee's main contribution concerned the relationship between drainage and the problems of conservation and flood control. They recommended that "in order to safeguard watersheds from the development of unwise drainage schemes, there should be some overall neutral authority with power to review drainage schemes from the standpoint of the whole watershed involved." Many of this Committee's recommendations were enacted in the following legislative session in 1949. Some of their recommendations on conservation and flood control were recognized but not exactly in the form they suggested.

In the early 1960's, drainage laws in Ontario were numerous and not entirely related to each other. In some cases they even were administered by different departments. This confusion and division of responsibility was at least partially responsible for the establishment of a Committee of the Cabinet consisting of Honourable W. Spooner, Honourable F. Cass, Honourable W. A. Stewart, Honourable C. McNaughton, and Honourable R. Connell. Their responsibility was to make recommendations on farm drainage and determine whether all aspects of farm drainage might be administered under one department. This Committee set up an Advisory Committee made up of Professor R. W. Irwin of the University of Guelph, Colonel S. W. Archibald, P.Eng., and R. D. Steele, Q.C. The Advisory Committee was not given much time to do its work, but it consolidated the Province's drainage legislation and again did so without substantial alterations.

The Advisory Committee was confronted with six Acts dealing with drainage and did what Professor Irwin called "an elaborate exercise with scissors and paste." A new Drainage Act was drawn up with the recommendation that it be administered within the Department of Municipal Affairs.

The present Drainage Act which resulted is a complex, often difficult, piece of legislation which, in its bare essence, provides for the authorization of the construction of drains by three routes: (1) private drains by agreement (Sec. 2); (2) petition (Sec. 3); (3) requisition (Sec. 4). The construction of drains upon requisition under Section 4 is rarely used. It is restricted to agricultural lands, the maximum cost of construction cannot exceed $2,500, and no grants are payable with respect to such drains.

The most common method of authorizing the construction of drains under the Act is by petition under Section 3. The majority of the owners of land in the area requiring drainage may petition the council of a municipality for the construction of drainage works. The council may appoint an engineer or Ontario Land Surveyor to make an examination of the area, and to prepare a report, including plans, specifications, estimates, and an assessment of the cost of the works against the lands to be benefited. The engineer is required to provide for the construction of bridges and culverts, and to make allowances for severance and damage. The report is considered by the council and, if appropriate, is adopted and incorporated in a provisional by-law. Any person dissatisfied with the assessment can appeal to the court of revision, which is appointed by the council, and he may appeal from the court of revision to a county court judge. An appeal may be taken from the report of the engineer directly to the referee. The referee also has general jurisdiction in drainage matters, and has power to issue a mandamus or an injunction, quash by-laws, and entertain claims for damages.

Five of the Acts were repealed, leaving, the Province with two major drainage statutes — The Drainage Act and The Tile Drainage Act. In 1972, drainage legislation was made the responsibility of the Ministry of Agriculture and Food.

One of the first acts of the present Minister of Agriculture and Food, the Honourable William A. Stewart, when these Acts were placed under the jurisdiction of his Ministry, was to recommend to Cabinet that a Select Committee of the Legislature be constituted to review the drainage law. The present Committee was established on June 30, 1972 as a result of that recommendation.

The Agricultural Tile Drainage Installation Act (S.O. 1972) as proclaimed in April, 1973, provides for the licensing of contractors, operators and their machines engaged in the installation of field tile for underdrainage of farms. Since little experience had been gained by the Ministry of Agriculture and Food, the Committee has no comment to make on the working of this relatively new piece of legislation.

Other Legislation Affecting Land Drainage in Ontario

As noted above, there are three major pieces of legislation administered by the Ministry of Agriculture and Food but the Committee's research has revealed 20 other pieces of legislation which have relevance to or impinge on the three specific drainage Acts. These Acts and their titles are listed in Appendix III. The relevance of these Acts to drainage is inconsequential in some cases. Some are inoperative or obsolete for certain reasons but some definitely present problems of conflict.

Section 33 of The Drainage Act states that an appeal lies from the Court of Revision to a County Court Judge. It then goes on to say that the provisions of the Assessment Act as to appeals to the Judge under Section 55 of that Act apply mutatis mutandis to an appeal under The Drainage Act, with the exception that the notice of appeal shall be given to the clerk of the municipality instead of to the assessment commissioner. Upon receiving this notice the clerk of the municipality then assumes the duties of the regional registrar as outlined in The Assessment Act.

The Conservation Authorities Act (R.S.O. 1970, Ch. 78), establishes authorities whose responsibility is to further conservation, restoration, development and management of natural resources. The powers of the conservation authorities are set out in Section 20 and a reading of these powers indicates that they are sufficient to allow conservation authorities to establish a scheme which might interfere with a municipal drain.

Under the Drainage Act, municipalities are required to notify conservation authorities of any drainage works proposed and the authority has the right of appeal to the drainage referee on any scheme affecting lands owned or under the jurisdiction of the authority.

The Environmental Protection Act (S.O. 1971, Ch. 86) is designed to prohibit the introduction of unauthorized contaminants in the natural environment. This Act may have some relevance when it is realized that during construction of a drain certain silting and sediment might have detrimental effects downstream. There is a possibility of conflict here in that it might be argued that under this Act, a drain could be stopped because of the introduction of a contaminant into the natural water course. However, there is some question about whether silting and sediment and other construction matter would be considered a contaminant.

The Public Transportation and Highways Improvement Act (S.O. 1971, Ch. 61), empowers the Minister of Transportation and Communications to carry out works for proper drainage of highways and any work so carried out must be done only with consent. A road superintendent under this Act has the power to commence proceedings under The Drainage Act and this is complemented by the section of The Drainage Act which allows a road superintendent to initiate a drain by notifying council.

The Local Improvement Act (R.S.O. 1970, Ch. 255). There is some question as to whether this Act has applicability to agricultural land drainage, but if the definition of a sewer in the Act can be interpreted to include a drain, then there is obviously some application. However, it is doubtful whether the word "sewer" in the Act can be so construed.

The Municipal Act (R.S.O. 1970, Ch. 284), has immediate relevance to the problems of drainage and Section 23 of this Act deals with the problems encountered when lands specially assessed under The Drainage Act become part of a new municipality, or are annexed to another municipality.

Section 293 (3) of The Municipal Act exempts any by-law passed under The Drainage Act from the provisions of subsection 1, which states that a municipal corporation cannot incur a debt, the payment of which is not provided for in the estimates of the current year unless a by-law authorizing it has been passed with the consent of the electorate.

Sections 352, 354 and 363 of The Municipal Act enable councils of municipalities to pass by-laws which may relate to drainage and water problems. The most important in this respect is Section 352 and particularly paragraph 16. This section authorizes councils of all municipalities to pass by-laws for constructing, maintaining, improving, repairing, or widening a drain, sewer or water course and for acquiring land in or adjacent to the municipality for such purposes. Before passing any by-law under this section, the Council may require an engineer's report to be made with or without a survey and the cost of this report, as well as the cost of the work itself may be levied against all the ratable property in the municipality, or in a defined area of that municipality which in the opinion of the council derives special benefits. It would thus appear from a reading of this section that any municipality in Ontario can pass a by-law to do any of the things a council can do under The Drainage Act, without the requirement of a petition. In fact, it should be noted that the council has a discretionary power as to whether or not an engineer's report is required and also a discretionary power with respect to financing.

It has been suggested in some quarters that it is doubtful that these provisions are wide enough to allow the type of drainage being constructed as is constructed under The Drainage Act since the authority of councils in this case is limited to specific purposes and no other. We believe, however, that municipalities in Ontario do have ample authority to undertake drainage schemes under The Municipal Act which are similar to those contemplated by The Drainage Act.

The only major distinction between the powers conferred under The Drainage Act to build drains under petition and the powers conferred by The Municipal Act to build drains authorized by Council without a petition, is that the former process is supported by the Province of Ontario through a grant mechanism whereas under The Municipal Act no such grants are available. Therefore the likelihood of extensive drainage works being constructed under The Municipal Act is remote.

The Municipal Act also permits municipal councils of a certain size to pass by-laws which license and regulate the operation of drainage contractors and drain layers. There is a possible conflict here between the licensing authority of the Agricultural Tile Drainage Installation Act and Section 383, subsection 3 of The Municipal Act.

The requirements of the Ontario Municipal Board Act with respect to drainage by-laws do not conflict with The Drainage Act but rather supplement and complement it. It is clear that all municipalities are required to obtain the approval of the Ontario Municipal Board before finally passing any provisional by-law authorizing the construction of a municipal drain if the cost is to be spread over a number of years or if debentures are to be issued. If that drain is to be wholly or partially financed by the issue of debentures then the validity of the debenture must be certified by the Board and is for all purposes, valid and binding upon the municipal corporation.

The Ontario Water Resources Act (S.O. 1972, Ch. 1), appears to give authority to the Ministry of the Environment to control and regulate transmission of water. A strict reading of this Act would lead to the belief that the Ministry of the Environment can build drains on the authority of the Minister.

Inlet channel and pumping installation.

III. THE EXTENT OF LAND DRAINAGE IN ONTARIO

To provide background information on both the magnitude and regional distribution of drainage activity, the Committee undertook an overview of expenditures on government assisted land drainage projects for the period of 1964-72.

Government assistance programs for the drainage of agricultural land under The Drainage Act and The Tile Drainage Act were in effect throughout the 1964-72 period. In addition to the above continuing programs, other forms of supplementary programs included special grants under A.R.D.A. and from the Ministry of Agriculture and Food.

The Drainage Act of 1962-63 (S.O. 1962-63, Ch. 39) as amended up to 1970 and as revised in 1972 (S.O. 1972, Ch. 139) provides for the payment of grants from the provincial treasury amounting to 33 1/3 percent of the cost of drainage works constructed in a county, 66 2/3 percent of the cost of the works in a territorial district or a provisional county, and up to 80 percent of the cost of drainage works constructed in a territory without municipal organization. This grant program, available throughout the 1964-72 period, applied only to agricultural lands.

The Tile Drainage Act of 1960 (R.S.O. 1960, Ch. 399) as amended up to 1970 and as revised in 1971 (S.O. 1971, Ch. 37) provides for assistance in the construction of on-farm tile drainage. Assistance under this act is in the form of provincial government purchases of debentures from municipalities to enable municipalities to lend landowners up to 75 percent of the cost of tile drainage. These loans are at low interest rates (4 percent at present) and are to be repaid over a ten-year period. This assistance for tile drainage was available throughout the period studied.

A.R.D.A. Drainage Assistance

Under the federal-provincial A.R.D.A. program, additional assistance has been made available for municipal drainage work for agricultural land. Commencing on April 1, 1966, the A.R.D.A. branch of the Ontario Department of Agriculture and Food made available a grant of 33 1/3 percent in addition to the grants under The Drainage Act for drainage works constructed in the eleven counties of eastern Ontario. On January 1, 1967, this program was extended to include all of the counties in southern Ontario. This program continued until December 31, 1968, when it was cancelled due to a lack of funds. Since January 1968, A.R.D.A. drainage grants have been available only in the eleven counties of eastern Ontario.

A special case relating to the A.R.D.A. grants for municipal drainage applies to projects in parts of nine townships (West Luther, Proton, East Luther, Arthur, Egremont, Amaranth, Melancthon, Artemesia, and Osprey) in the counties of Grey, Dufferin, and Wellington. This area was the subject of a special A.R.D.A. study in a micro-drainage area that is the source of several major river systems. This study was not completed until late in 1968. When the A.R.D.A. drainage assistance program was cancelled at the end of 1968, municipalities located within the micro-drainage study area requested an extension of the A.R.D.A. assistance based on their claim that they had not been able to fully utilize the program prior to the completion of the study. Their request was granted and A.R.D.A. grants of 33 1/3 percent of the cost of drainage works were made available in this area for projects petitioned after April 1, 1971 and for which engineers were appointed prior to March 31, 1973.

Special Agricultural Drainage Assistance

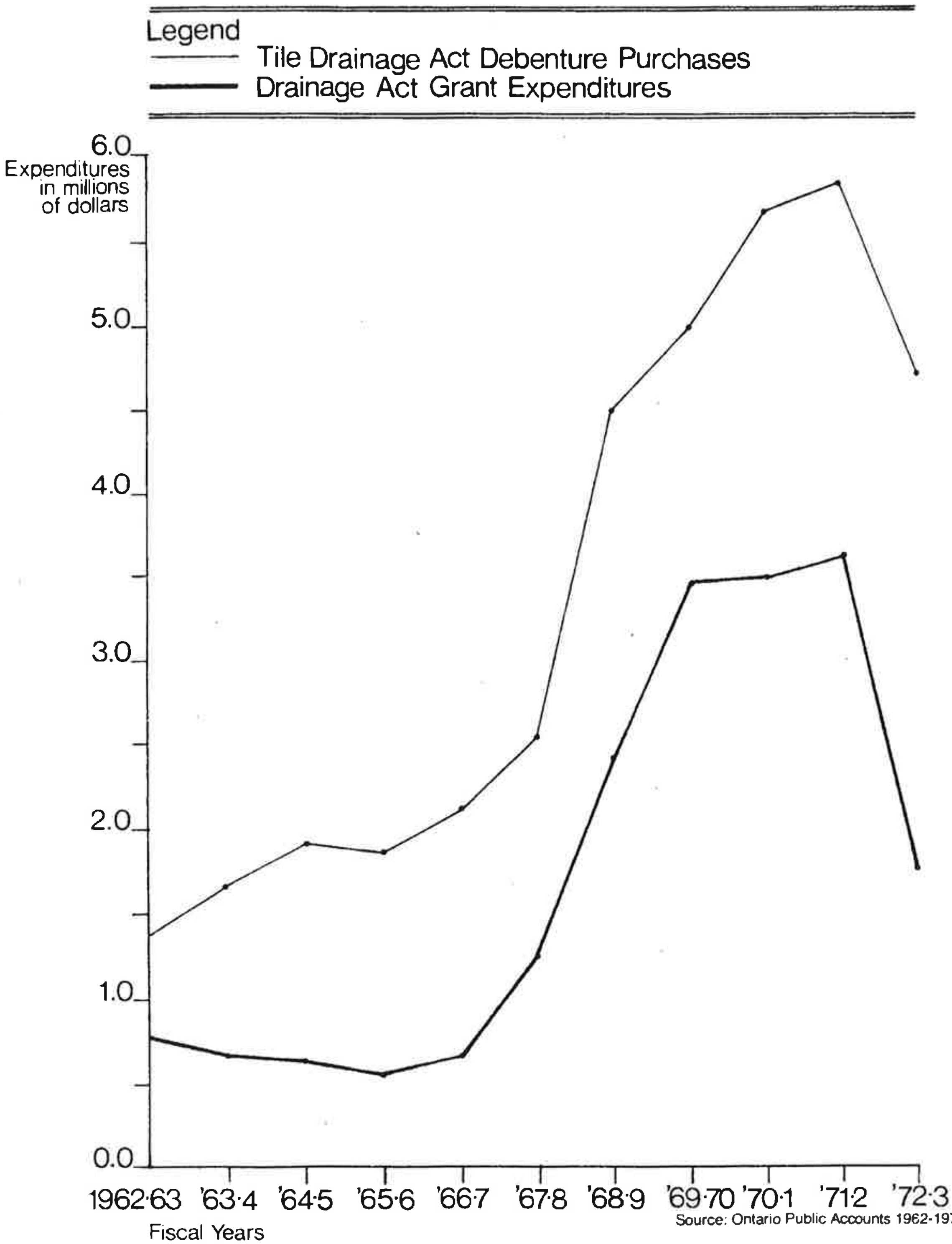
When the A.R.D.A. assistance program was cancelled at the end of 1968 for most of southern Ontario, many municipalities were in the process of initiating projects which had been petitioned by farmers expecting the A.R.D.A. grant. In June 1969, the Ontario Department of Agriculture and Food undertook to pay an additional grant of 33 1/3 percent on all drainage works petitioned prior to the termination of the A.R.D.A. program but which were constructed too late to qualify for assistance under that program. In effect, this special assistance meant that all drainage projects petitioned after April 1966 and before December 1968 were eligible for either the A.R.D.A. grant or the Special Assistance Grant of 33 1/3 percent in addition to The Drainage Act grant of 33 1/3 percent.

Capital Grants for Farm Development

In April 1967, the provincial government introduced the Capital Grants for Farm Development Program. This program provided for grants of 33 1/3 percent of the cost of drainage or permanent agricultural structures up to a maximum of $1,000 per farmer. In 1971, the rate of assistance under this program was increased to 40 percent, up to a maximum of $3,000 per farmer. Under this program, a farmer can obtain a grant towards the cost of tile drainage on his farm.

The graph in Figure 1 details the total grants paid under The Drainage Act for each year during the period 1962-72. During the first four years of the period, the expenditures decreased slightly from a total of $751,194 in 1962-63 to $567,405 in 1965-66. In 1966, the annual expenditures began to increase

Figure 1 Grant Expenditures Under The Drainage Act and Debenture Purchases Under The Tile Drainage Act, 1962-1972.



Source: Ontario Public Accounts 1962-1972 rapidly through the four-year period to 1969-70, when the total amounted to $3,493,000. This 1969-70 expenditure was maintained through the next two years before the total dropped off to $1,882,185 in 1972-73. The varying magnitudes of annual expenditures of grants under The Drainage Act can be related to the other municipal drainage assistance programs (assistance under A.R.D.A., for example), which were in effect for portions of the eleven-year period.

The relatively stable level of expenditures under The Drainage Act for the years 1962-63 to 1965-66 corresponds to a period when the only available assistance was that provided by The Drainage Act. The period of 1966-67 to 1969-70, in which grant expenditures increased sharply, corresponds to the period when the A.R.D.A. program and the provincial government's Special Drainage Assistance Program provided additional grants. The leveling-off period from 1969-70 to 1971-72 corresponds to a period when projects petitioned prior to December 1968 were still eligible for grants under the Special Drainage Assistance Program but when newly petitioned projects were only eligible for The Drainage Act grants. In the final year, 1972-73, when expenditures fell off, most of the projects constructed would have been eligible only for grants under The Drainage Act.

In summary, the graph in Figure 1 illustrates quite clearly the effect of additional assistance programs on the amount of drainage undertaken. Although there is a time lag, the initiation of the A.R.D.A. and Special Assistance programs corresponds to a period of rapid increases in expenditures. The termination of these programs corresponds to a period of leveling-off followed by reduced expenditures.

Drainage Act Expenditures by Township, 1964-72

To obtain an overview of the regional patterns of drainage expenditures, an analysis was undertaken of the annual expenditures at the township level. The period 1964-72 was selected for analysis to include the 1964-66 period during which expenditures were relatively stable, the 1966-69 period of rapid increase, and the 1969-72 period of renewed stability. Such an analysis of grant expenditures at the township level over the eight-year period would likely reveal regional trends in drainage activity.

The basic data employed in this analysis were the annual total of grants under The Drainage Act paid to each township in the Province. The initial stage of analysis involved a tabulation of these expenditures for each of the eight years. The results provided a picture of expenditure patterns but were limited in their usefulness by extreme year-to-year variations in expenditures, particularly in areas of limited drainage activity. To better summarize the pattern, average annual grant expenditures by townships in the southern part of the Province were calculated for the three-year periods of 1964-65 to 1966-67, and 1969-70 to 1971-72. The former period corresponds to the timespan prior to the rapid increases of 1967-69, while the latter period corresponds to the years of renewed stability after the increases.

The pattern of average annual drainage grants for the three-year period 1964-65 to 1966-67 for townships in the southern part of the Province indicate two major regions of activity — one in southwestern Ontario and the other in eastern Ontario, with a few smaller areas in the counties of Bruce, Grey, Dufferin, Wellington, and Simcoe. In southwestern Ontario, twelve townships received between $10,000 and $20,000 in average annual grants under The Drainage Act. Within eastern Ontario, only two townships received average annual grants over $5,000. The data also revealed a large region with no municipal drainage activity, including the area around the western end of Lake Ontario and the area east and north from Toronto.

Grant expenditures under The Drainage Act for municipalities in the northern part of the Province were summarized for the entire 1964-72 period. The municipalities receiving grants in this part of the Province are located within provisional counties or territorial districts and therefore receive grants of 66 2/3 percent of the cost of drainage. The data indicate that during the 1964-66 period only six municipalities received grants, two of which received an average annual grant of over $5,000.

The pattern of drainage activity for the three-year period 1969-70 to 1971-72 is similar to that of the 1963-67 period. It shows two major areas of activity — one in southwestern Ontario and another in eastern Ontario, with more isolated activity in the counties of Simcoe, Ontario, Victoria, and Prince Edward. Both areas of activity are larger than for the previous period, with the southwestern area being extended north and eastwards and the eastern area being extended north and west. The most significant change from the earlier period relates to the magnitude of expenditures. In southwestern Ontario, five townships received average annual grants of over $60,000 and twenty-nine other townships received average annual grants of over $30,000. In eastern Ontario, five townships received average annual grants of over $20,000. Again, a significant lack of municipal drainage activity is observed in the area around the western end of Lake Ontario and in the area to the east and north of Toronto. There was, however, some activity in isolated townships in the counties of Ontario, Victoria, and Prince Edward.

Grant expenditures in the northern part of the Province indicate only limited drainage activity during the 1969-72 period. Only eleven townships received grants during the period, one of which received an annual average grant of over $30,000 and one other above $5,000. Grants in this area represent 66 2/3 percent of the total cost of the projects.

To better understand the changes in the amount and regional patterns of grant expenditures under The Drainage Act during the 1964-72 period in the southern part of the Province, analyses were made of the percentage change in the average annual value of Drainage Act grants to townships between the period 1964-67 and 1969-72. A study also was made of the actual increase in the average annual value of municipal drainage grants to townships between the periods 1964-67 and 1969-72.

The percentage changes in the value of grants under The Drainage Act illustrate the relative changes in expenditures. Only a small number of isolated townships actually experienced a decrease in the level of expenditures and in no case were these townships that had received large grants during the 1964-67 period. Most of the townships with the highest percentage increases are associated with areas of new drainage activity which received no grants during the 1964-67 period but which did receive grants during the 1967-72 period.

These areas of new drainage activity illustrate the spread out of the two established drainage regions of southwestern and eastern Ontario. The new areas of drainage associated with southwestern Ontario form a crescent-shaped pattern that includes townships in the counties of Bruce, Grey, Wellington, Waterloo, Brant, Wentworth, and Norfolk. The new areas associated with eastern Ontario show a spread of activity west and north into townships in the counties of Grenville, Leeds, Lanark, and Renfrew and the Regional Municipality of Ottawa-Carleton. Other areas of new activity include isolated townships in the counties of Haldimand, Peel, Simcoe, Ontario, Victoria, Hastings, Prince Edward, and Lennox and Addington in the Lake Ontario area and in the areas of Nipissing and Manitoulin Island farther north. At the same time, there are many townships within the established drainage areas of southwestern and eastern Ontario that experienced large percentage increases ranging from 500 to 5,000 percent. In terms of the absolute increases in expenditures under The Drainage Act, these established areas accounted for the greatest activity.

Data on the actual increase in the average annual grant expenditures between the periods 1964-67 and 1969-72 were also tabulated and clearly show where the maximum increases in the absolute value of grants have occurred. These maximum increases are largely concentrated in the southwestern drainage area, particularly in Lambton and Middlesex counties, with less concentrations in Essex, Elgin, Huron, Bruce, and Perth counties. With only local exceptions, the magnitudes of absolute increases in the value of grants in eastern Ontario are much smaller than those in the southwest. The absolute increases in other areas of the Province are relatively insignificant compared with those in the two major areas.

It is clear that the concentration of drainage activity is in southwestern and eastern Ontario. Areas of new drainage seem to correspond to the fringes of these established areas. In terms of the absolute values of expenditures, southwestern Ontario's predominance has been well established.

Annual Tile Drainage Expenditures, 1962-72

The annual totals for provincial government purchases of debentures under The Tile Drainage Act for the period 1962-72 are shown in Figure 1. The pattern indicates a gradual increase of expenditures during the period 1962-67 when there was a more rapid increase in expenditures from 1967-70, a leveling off to 1971, and falling off in 1972. This pattern is quite similar to that described for expenditures on municipal drainage under The Drainage Act (see Figure 1), with the expenditures under The Tile Drainage Act exhibiting a slight lag behind those under The Drainage Act. This lag is easily explained in that on-farm tile drainage projects are likely to follow the installation of municipal outlet drains.

The graph of tile drainage expenditures does not exhibit the extremely sharp breaks in slope that are associated with the graph of municipal drainage expenditures. This difference can be attributed to the fact that the initiation and cancellation of the A.R.D.A. Outlet Drainage Assistance Program did not have as direct an impact on tile drainage activity as it had on municipal drainage activity. On the basis of the graph (Figure 1), it may be hypothesized that in general the tile drainage expenditure pattern for 1962-72 is closely related to the municipal drainage expenditures, with the municipal drainage activity in most cases triggering subsequent tile drainage activity. This hypothesis is further examined in the following sections which discuss regional patterns of expenditure under The Tile Drainage Act.

Tile Drainage Act Expenditures by Township, 1964-72

To provide a basis for comparing the regional patterns of expenditures under The Tile Drainage Act and The Drainage Act, an analysis was undertaken of the annual township level expenditures under The Tile Drainage Act. The period 1964-72 was selected to correspond to that considered for The Drainage Act and to include the 1967-69 period of rapid increases in tile drainage activity. The basic data employed were the annual totals for provincial government purchases of debentures under The Tile Drainage Act from each township in the Province. The initial stage of analysis involved tabulating the tile drainage expenditures for each of the eight years. A series of four summary tables were prepared to provide a basis for comparison with The Drainage Act expenditures in some areas. These four tables, which are directly comparable to those included for The Drainage Act expenditures, are of the average annual expenditures on tile drainage debentures for the three-year periods 1964-66 and 1969-71 and of percentage differences and actual increases in tile drainage debenture purchases between the two periods.

The tabulation of the average annual value of tile drainage debenture purchases by township in the southern part of the Province during the period of 1964-65 to 1966-67 reveals a pattern of major activity in southwestern Ontario. Lesser amounts of activity are shown in the counties bordering the shores of Lake Huron and southern Georgian Bay, in the Niagara Peninsula, in a bank along the north shore of Lake Ontario, and in eastern Ontario. The largest expenditures are concentrated in southwestern Ontario, particularly in the counties of Essex, Kent, and Lambton and to a lesser extent in Middlesex, Huron, Perth and Elgin.

The average annual value of tile drainage debenture purchases by township in the southern part of the Province for the period 1969-70 to 1971-72 is quite similar to that for the earlier period, but the magnitudes of expenditures are notably larger. The major centre of activity is still the southwest, particularly the counties of Huron, Perth, Lambton, Middlesex, Essex, Kent, and Elgin. There is a considerable increase in activity in eastern Ontario as well as lesser increases along the north shore of Lake Ontario and in Simcoe County.

The tile drainage debenture purchases for the municipalities in the northern part of the Province for the entire 1964-65 to 1971-72 period indicate that only fifteen municipalities took advantage of the program. And in most cases the average annual expenditures were quite small.

Two final tabulations illustrate the regional patterns of percentage and actual increases in the average annual values of tile drainage debenture purchases. The highest percentage increases are again associated with areas of new tile drainage activity. These areas include townships in the counties of Huron, Middlesex, Oxford, Norfolk, and Haldimand in the western part of southern Ontario; in the counties of Grey and Simcoe south of Georgian Bay; along the north shore of Lake Ontario; and in eastern Ontario. The greatest actual increases in tile drainage activity are concentrated in southwestern Ontario, with a small secondary concentration in eastern Ontario.

The series of four tables relating to tile drainage have emphasized *the absolute importance of the southwestern region*. Lesser amounts of tile drainage activity and new areas of activity included the Niagara Peninsula, the area south of Georgian Bay, the area along the north shore of Lake Ontario, and eastern Ontario.

Regional Overview of Drainage Activity, 1964-72

Considerable changes have occurred in the agricultural production of field crops in Ontario over the past two decades. These changes include increases in most crop yields and shifts in the magnitudes and regional distributions of acreages in various crops. For the most part, these changes have been related to the development of new crop varieties suited to local conditions and to the use of more intensive soil and crop practices.

In many areas, land drainage activity has no doubt been an important factor in the changing patterns of agricultural production. While a detailed provincial-scale analysis of the relationships of drainage activity to the changing patterns of agricultural production is not intended, an attempt is made to generalize the dominant trends on a regional basis.

By using the patterns of government expenditures under The Drainage Act and The Tile Drainage Act, it is possible to identify several loosely defined regions of drainage activity. For this discussion, the following seven zones or regions of drainage activity have been identified: Southwestern Ontario, Southwestern Ontario fringe, Southern Georgian Bay, Eastern Ontario, Niagara, North Shore Lake Ontario, and Northern Ontario.

The Southwestern Ontario region of drainage activity includes the counties of Essex, Kent, Lambton, and the western parts of Middlesex and Elgin. This area has traditionally dominated Ontario agricultural production, having the most significant increases in crop yields and the largest acreages in field crops, particularly shelled corn and soybeans. This area has been predominant in the patterns of drainage assistance expenditures for both consistently received the largest amounts of government drainage assistance over the 1964-72 period.

The second region of drainage activity, the Southwestern Ontario fringe, includes a broad bank of counties north and east of the Southwestern Ontario area and west of a line joining the southern part of Bruce County to Haldimand County. This zone is second only to the southwestern region in both agricultural production and drainage activity.

The patterns of field crop production in the fringe area are marked by recent substantial increases in shelled corn production, particularly in the southern counties of Elgin, Middlesex, Norfolk, Oxford, Brant, and Haldimand. Fodder corn is grown generally throughout the area, with wheat gaining importance particularly in Norfolk. Mixed grains are well established in the northern part of the zone in the counties of Perth, Huron, and Waterloo. While drainage activity has been prevalent in this area throughout the period, there have been major increases in expenditures in recent years.

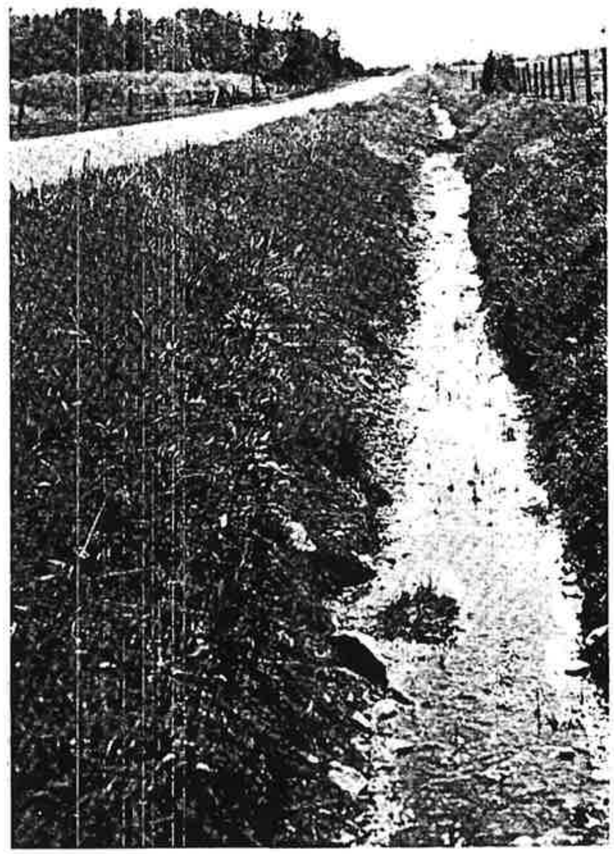
The third region of drainage activity is Southern Georgian Bay and includes the counties of Bruce, Grey, Wellington, Dufferin, and Simcoe. This area experienced a considerable amount of new drainage activity during the 1964-1972 period, the magnitudes of expenditures on drainage assistance increasing significantly. During the same period, agricultural production in this area showed a significant shift away from winter wheat and into fodder corn production. While drainage expenditures in this region are not nearly as large as in the Southwestern and fringe zones, the sustained activity requires recognition.

Eastern Ontario, the fourth region of drainage activity, includes the area east of a line through Renfrew and Frontenac Counties. There has been a dramatic increase both in municipal and tile drainage expenditures in this area during the 1964-72 period. The area has experienced an increase in the production of fodder corn, with oats and hay remaining of some importance.

The fifth and six drainage regions are Niagara and the North Shore of Lake Ontario. These zones are characterized by considerable tile drainage activity but only limited municipal drainage activity during the 1964-72 period. This may be due to the areas' topography, which has a denser network of natural watercourses that may reduce the need for municipal drainage works.

Drainage activity in Northern Ontario, the final zone, has been limited to a few local pockets including Manitoulin Island, the Lake Nipissing area, the Clay Belt areas of Timiskaming, and the Rainy River District.

Open drain under construction.



Open drain located within a road allowance.

IV. THE ENVIRONMENTAL IMPACT OF DRAINAGE WORKS

In the last decade there has been an explosion of interest in man's relationship wth his environment. Greater attention has focused on some of the environmental effects of land drainage, particularly in relation to game animals and sport fisheries. Nevertheless, there is a lack of detailed scientific data on many of the potential effects of drainage.

The effects drainage has on soil properties are obviously beneficial to agricultural crops. However, areas of excess water provide a habitat for many species of plants and animals and also play a significant role in the hydrological cycle. Drainage may therefore be damaging to these nonagricultural aspects of the environment.

Constructing drains and channeling existing streams to increase the flow of water from the land surface destroys vegetation along the excavation path. Clearance of vegetation extends for a variable distance, often 30 to 40 feet at right angles to the drain, because of passes by dredging machinery and the dumping and spreading of excavated spoil. The swath of clearance along the drain or channelized stream can be particularly damaging in woodland if removing valuable timber is involved. Drainage can result in even greater destruction of natural vegetation when permanent wetlands are converted to agricultural use.

Land drainage also affects natural vegetation by altering surface and soil water levels. Drains often are installed in permanent wetlands to facilitate the drainage of adjacent agricultural land or to allow the drain to be continued to a point where adequate outlet is provided. In these circumstances, the existing vegetation may be modified considerably. Installing a drain removes areas of surface water, thus eliminating some aquatic plants. In bog areas, drainage may lower the water table, which affects the growth of various plants specifically adapted to this type of environment.

Considerable research has been conducted by forestry scientists on the effects of drainage on hardwood swamps and forested bogs. This research suggests that drainage can be beneficial in wetland forests by increasing the growth rates of a variety of tree species. Research in northern Minnesota on the effects of drainage in forested areas has revealed average increases of 100 percent in growth rates on drained areas compared with undrained sites.

Some foresters in Ontario's Ministry of Natural Resources feel that agricultural land drainage may have a detrimental effect on woodlands. Nevertheless, the adverse effects of drainage in forested areas are not as well documented in the literature as are the beneficial effects.

Agricultural land drainage may have a variety of effects on wildlife. The most important impacts occur where various types of permanent wetlands are drained. Wetlands constitute key components of the landscape for many types of wildlife, providing cover, food resources, and breeding sites. Drainage activities may considerably influence wildlife even in areas where permanent wetlands are unaffected. In areas of intensive agriculture, open drains that have not been recently maintained contribute significantly to the total area of semi-natural vegetation. Reconstructing these drains will at least temporarily destroy the usefulness of the habitat for wildlife.

Most research on the effects of drainage on wildlife has been devoted to waterfowl and a variety of game animals because of their significance for recreation. The effect of drainage involving permanent wetlands is probably more detrimental to waterfowl than to most other types of wildlife. If the object of drainage is to convert wetland to agricultural use, the habitat is lost not only for waterfowl but also for all other types of wildlife using the area. Where wetlands are drained but not cleared for agriculture, the habitat may still be used by various types of wildlife. Removing the surface water, however, eliminates the value of the area for waterfowl and other organisms requiring an aquatic environment.

The drainage of wetlands is of major importance in its adverse effects on wildlife. In addition, the potential damage to wildlife from maintaining and reconstructing existing drains must not be overlooked. The importance of drainage ditches as wildlife habitats probably varies considerably. Ditches may be unimportant in some areas such as eastern Ontario, where there is a large variety of alternative seminatural habitats. In contrast, older drains without recent maintenance may be very significant for wildlife in the intensely farmed areas of southwestern Ontario, where alternative habitats such as woodlands and small wetlands are in short supply. In these circumstances, reconstruction or maintenance of drains will adversely affect wildlife until the vegetation cover regenerates.

Agricultural land drainage produces a variety of changes in streams and lakes. In some cases, permanent stream channels are straightened and dredged to accommodate increased flows from tile and open drains. Channelization may seriously affect sport fisheries and also alters sediment loads and various other characteristics over considerable distances downstream. Maintaining and reconstructing existing drains that are not permanent streams probably results in less direct damage to fish populations because of their absence in these areas, but alterations in sediment load and water temperature may affect fish populations at other locations in the drainage network. Installing tile drains that outlet into municipal drains also alters streams and lakes by changing nutrient loads and hydrological characteristics.

It is difficult to precisely evaluate the environmental consequences of land drainage in Ontario. The survey of seven townships undertaken by the Committee's research staff forms a very small sample for assessing the province-wide situation. The smallness of the sample, however, may be mitigated somewhat because the seven townships were chosen to give coverage to all the major regions of Ontario. In addition, the sample was biased towards an overrepresentation of areas where impacts on natural vegetation and wildlife were expected to occur.

It is difficult to adequately compare the findings in these townships with other parts of the Province, because detailed research on the environmental aspects of land drainage in Ontario is almost completely absent.

Thus, there has been a tendency to discuss the environmental impacts of land drainage in Ontario on the basis of published research from the United States. If these discussions are to be valid, there must be a strong similarity between the characteristics of land drainage projects in Ontario and elsewhere in the United States.

Considerable contrasts are apparent between the characteristics of drainage projects in certain parts of the United States and in Ontario. From the analysis of drains in seven townships and discussions with a variety of individuals involved with drainage in Ontario, it is evident that most recent drainage projects have been relatively small in size. Drains are characteristically about 2 to 3 miles long, with the land acreage involved in being between 500 and 1,500 acres. There are few examples of much more ambitious drainage schemes in Ontario (for example, the Holland Marsh), but most of these date from before the Second World War. Other circumstances being equal, small drainage projects are unlikely to have the same magnitude of environmental impact as large projects. The cumulative effect of many such schemes, however, can have serious effects.

In view of the very large increases of expenditure on both municipal and tile drainage between 1967 and 1971 in Ontario, it might be expected that extensive areas of land are being drained for the first time and converted into agricultural use. Engineers' reports for approximately 140 drains in the seven townships sampled revealed that the majority of projects involved reconstructing existing drains, although in some cases a drain was extended and new branches added. It should be pointed out that it is often difficult to judge whether a drain is new or not on the basis of existing township records. Engineers' reports frequently indicated that a drain is new when its status changes from an award drain to a petition drain. In a situation where reconstruction involves dredging an old drain that has been long neglected, the environmental consequences may differ very little from a situation where the land is first drained.

Aerial photographs from 1955 to 1971-72 were examined for the six townships sampled in southern Ontario. The disappearance of areas of permanent wetlands or woodlots as well as changes in the extent of channelized permanent streams were recorded for this 17-year period. Virtually no disappearance of permanent wetlands or woodlots was noted in West Luther and Ramsay townships, while 1 small woodlot of approximately 8 acres was cleared in Cumberland. The greatest clearance of woodland occurred in Mersea, where 27 woodlots totaling approximately 400 acres were cleared. Lesser acreages were converted to agricultural use in Ellice (120 acres) and in Brooke (100 acres). Disappearance of woodland in these townships could not be attributed solely to agricultural land drainage. Significant acreages of timber that do not require drainage are cleared in intensively farmed areas to expand the acreage of arable land. Nevertheless, approximately one half and two thirds of the woodland cleared in Mersea and Brooke, respectively, was adjacent to drains. It is therefore likely in these cases that the removal of water provided incentive to convert these acreages to intensive agricultural use.

Little increase in channelized streams was observed in any of the six townships for the period 1955 to 1971-72. In Cumberland and Brooke, a total of about 1½ miles of channel was straightened on a number of small stream sections. This channelization may have resulted from land drainage activities, though highway construction appeared to be responsible in some cases. The evidence in these six townships suggests that the loss of permanent wetlands, woodlots, and natural streams has generally been small despite the very large increase in drainage grants during the late 1960's. The greatest change has occurred in southwestern Ontario, particularly in Mersea Township, and may be explained by the high intensity of farming in this region which has provided an incentive to increase the area of agricultural land.

In eastern Ontario (Ramsay and Cumberland townships) and the Dundalk Till Plain (West Luther township), agriculture is less intensive and profitable and there is little incentive to convert wetlands and woods to agricultural use. In fact, the acreage of agricultural land has declined as marginal areas have been abandoned in recent years.

The detailed interviews concerning 37 drains in the seven townships sampled indicate some of the consequences of drainage on the local environment. No attempt was made to investigate the large-scale regional impacts of these drainage projects on stream hydrology and wildlife outside the drain area. The interview data must be interpreted with some caution, since they involve the subjective judgements of individuals with variable knowledge of the environment. The questionnaire focused primarily on small game, fur-bearing animals, and sport fisheries. Keeping these limitations in mind, the interviews suggest that *the majority of drains analyzed had no discernible effect on the nonagricultural aspects of the local landscape.* In most cases, the numbers of small game and fur bearers, together with the level of hunting and trapping, appeared to be unaffected by drain reconstruction. Most of the drains analyzed contained insignificant fish populations and did not provide any sport fishing either before or after ditching. No evidence was found of changes in well water levels that could be attributed to the effects of drainage projects on the water table.

Adverse effects were observed in a few cases. Reconstructing one drain involved the drainage of a small 12-acre marsh, resulting in the disappearance of ducks, muskrats, raccoons, and amphibians from the site. Five or six people a year hunted duck on the marsh before it was drained. Some reduction in the numbers of muskrats and ducks was noted on other drains in the period before dredging.

In the seven townships studied, it appears that *recent drainage activity has not resulted in a major loss of natural habitats and that with a few exceptions, has not caused a major reduction in small game and fur bearing animals in the vicinity of the drain.* Caution must be exercised in transferring these conclusions to the Province as a whole. Interviews with a variety of experts, however, suggest a low rate of permanent wetland loss as a result of agricultural land drainage in the past decade. In the more urbanized areas of Ontario along the Toronto-Windsor axis, the loss of permanent wetlands through urbanization and highway construction has been much more serious than the loss through agricultural land drainage.

The views expressed regarding wetlands and wildlife are also relevant to stream channelization and sport fisheries. A small proportion of recent drainage projects has had serious adverse consequences for sport fisheries. Drain construction and stream channelization have damaged trout streams in some areas. These adverse effects are particularly serious in areas where certain types of sport fishing are in short supply. In eastern Ontario, there are very few cold water stream fisheries. The detrimental effects of drainage activities on trout streams in Norfolk County are intensified because this area contains the only cold water streams within the Lake Erie drainage basin.

The effects of drainage activity on the physical hydrology of drainage basins in Ontario has been particularly difficult to evaluate. Previous research is lacking and the Committee's research staff has been unable to document such impacts in the present project. Several briefs presented to the Committee, however, indicated the potential serious impacts of extensive drainage activity on flood flows and low flows.

In recent years, the conservation authorities of Ontario have spent large sums of money on water management projects for flood control and low flow augmentation. These projects have included the construction of dams, reservoirs, and flood control channels. The designs of these projects are such that the hydrological characteristics of the basin must remain relatively stable for the program to achieve full effectiveness. Large numbers of drainage projects, particularly in water storage areas in the headwater sections of drainage basins, may considerably offset the efforts of the conservation authorities to provide flood protection and to guarantee reasonable levels of low flow. The Dundalk Till Plain in Grey, Dufferin, Wellington, and Simcoe counties is an example of a significant headwater region that has recently experienced considerable drain construction which may affect the Saugeen, Grand, and Nottawasaga rivers.

Drain maintenance practices should receive some consideration in assessing the present environmental effects of land drainage. As mentioned previously, the major portion of drainage grants in recent years involved reconstruction of existing drains. In most parts of the Province it has been general practice to allow drains to deteriorate over a period of years and then to undertake major reconstruction. This practice may be inefficient for adequately removing water from agricultural land, and it may reduce agricultural benefits and increase the long-term costs of municipal drains. Paradoxically, this practice probably has fewer adverse effects on the environment than most other methods of maintaining open drains. In the interval between reconstruction, which may vary from 6 to 8 years in areas of sandy soil (Norfolk County) to 15 to 20 years in heavy clay soils (Kent County), the drain habitat may be used by various types of wildlife and may provide some hunting and fishing.

A number of briefs to the Committee advocate changes in maintenance practices of drains. It has been suggested that streamlining municipal drains would enable more efficient maintenance. At present, several drains may empty into a common outlet, with a separate bylaw covering each drain. Each drain is usually overhauled separately and often at different times. If these drains were combined into one system under a single bylaw, the whole system could be dredged at the same time. Although this procedure might be more efficient from an agricultural viewpoint, it would result in a greater adverse impact on wildlife and fisheries because of the larger area involved. It has also been suggested that drains should have small-scale maintenance about every two years to remove silt from the drain and to clear aquatic and bank vegetation. It is claimed that this procedure would increase the efficiency of the drains and would considerably lengthen the time interval between massive drain reconstruction.

The views expressed on the environmental impacts of recent land drainage in Ontario must be regarded as tentative in the absence of comprehensive research.

SUMMARY

The bulk of drainage activity in the last decade has involved the reconstruction of existing drains rather than drainage of large new areas of land. Consequently, the overall provincial rate of disappearance of permanent wetlands as a result of agricultural land drainage has been relatively small during recent years. Wetland loss, however, has been considerably more rapid in a few areas, particularly in the counties to the north and west of Toronto.

The vast majority of drainage projects studied did not appear to be seriously detrimental to natural vegetation and wildlife within the local drain area. A minority of projects, however, did have a serious effect on the environment. Moreover, the cumulative effect of a number of drainage projects, each of which has only a minor adverse effect on the environment, may be serious in some parts of the Province. This may occur especially in areas where the remaining supplies of permanent wetlands and natural streams are at a critical level.

The impact of individual drainage projects on stream hydrology is probably very small. The cumulative effect of several municipal drains and associated tile drainage systems within a drainage basin may, however, considerably influence flood peaks and other hydrological variables, as well as water quality.

V. LAND-USE CONFLICTS RESULTING FROM DRAIN CONSTRUCTION

A major concern of the Committee and of many persons throughout the Province, as evidenced in the briefs and hearings of the Committee, is land-use conflict resulting from the construction of agricultural drains. Two kinds of conflict appeared particularly prevalent — those in wetlands and those along the interfaces between rural and urban areas.

Wetlands provide a classic case of conflict in resource utilization. To the farmer, wetlands are often a nuisance that cause delays and increase costs of farm operations. They may also be regarded as areas of potentially rich unexploited agricultural land. Both viewpoints encourage wetland drainage and conversion to cropland. At the same time, undrained wetlands fulfill a wide variety of functions that are considerably significant to the public interest. A growing awareness of the variety of wetland functions has increased the conflicts arising from agricultural drainage of Ontario's wetlands.

Several approaches were adopted in researching the problems of competing land use in wetlands. First, the various types of wetland and their major functions were documented to emphasize the full range of competing land uses that can be involved. Second, the general characteristics of competing land uses in Ontario wetlands were analyzed by means of interviews with technical personnel, engineers, agricultural representatives, and others. All the briefs submitted to the Committee and the Committee hearings were also reviewed. Finally, two drainage projects involving the most common types of wetland conflict in Ontario were examined in detail. In these cases, field surveys and interviews with landowners were carried out to assess the agricultural benefits as well as the adverse effects on wetland uses.

Wetlands vary in depth, durability, and ecological characteristics. These distinctions are important because the economic feasibility of reclaiming land depends on them. Moreover, different types of wetlands have differential significance for wildlife and a variety of other functions. In Ontario, the most common terms used to describe wetlands are marsh, swamp, and bog.

A marsh is an area that is temporarily or permanently covered with water. Trees are usually absent and the main types of vegetations are grasses, sedges, and reeds.

The term swamp has been used to loosely describe all types of wetlands, but can be defined more precisely as a wetland that supports tree vegetation. Swamps are of two types — deep and shallow. Both types support tree vegetation, but standing water persists throughout most of the summer in a deep swamp, whereas surface water is not present during the growing season in the shallow type.

The word bog is used in many different senses and sometimes includes marshes and swamps as well as true bogs. Bogs are wet areas often dominated by heath vegetation and conifers and underlain by a more or less continuous stratum of sphagnum moss.

The agricultural potential of organic soils has been recognized for many years. Draining wetlands and converting them to agricultural use has created several successful farming areas in Ontario, the most notable being the Holland Marsh, which produces millions of dollars worth of vegetables annually. However, wetland drainage has also produced agricultural failures such as the Luther Marsh in Wellington County and Tiny Marsh in Simcoe County.

In many cases, wetlands are not converted to cropland, but are drained to improve adjacent agricultural areas. Wetlands have also been drained to extract peat moss for agricultural, industrial, and home uses. This practice is currently prevalent in townships near Toronto.

Wetlands are of little importance to intensive recreation activities. Swimming, picnicking, camping, boating, and cottage living are excluded due to the unsuitability of the environment and the many mosquitoes and black flies.

Muskrat, beaver, mink, otter, and, to a considerable extent, raccoons are associated with wetlands. The majority of furs harvested in Ontario come from these animals. Several wetlands support a fur industry that is valued between 1/2 and 1 million dollars and that provides supplementary incomes for 700 persons, 20 percent of whom are farmer-trappers.

A considerable number of briefs, particularly those submitted to the Committee by nonagricultural groups, referred to wetland conflicts. However, neither the briefs nor the Committee's research made it possible to find fully documented cases of conflicts in which detailed assessments were made of the extent alternative land uses were damaged by draining wetlands for agricultural purposes.

The evidence available indicates a number of

To drain or not to drain?

Swamp as water reservoir.

wetland conflicts, although these seem to arise in only a small percentage of the total number of recent drainage projects in the Province. The extensive agricultural areas of southwestern Ontario appear to have had relatively few wetland conflicts in the last decade as would be expected for an area with a small amount of remaining wetland. However, use conflicts between waterfowl and agriculture are involved in the recent drainage of two marshes on Lake St. Clair.

Fears have been expressed regarding serious wetland conflicts on the Dundalk Till Plain in Grey, Dufferin, Wellington, and Simcoe counties. Wetlands in this region are considerably significant hydrologically since the area serves as the headwaters for the Saugeen, Grand, and Nottawasaga rivers. Several thousand acres of forest, much of it wetland, have been purchased by conservation authorities to preserve these headwater areas.

The counties to the north and west of Toronto appear to have experienced the highest rate of recent wetland disappearance in Ontario. Portions of the Stroud, Cookstown, Randall, and Adjala swamps in Simcoe County have been drained for market garden crops and sod production. Many potholes and wetlands in this region have also been drained to remove peat for commercial use.

The research staff's detailed study of seven townships and sample drains did not reveal any major example of a wetland conflict. A number of drains, particularly in West Luther, Cumberland, and Ramsay, involved small acreages of wetland but none of these areas was converted to agriculture. There was no evidence that draining the wetlands precipitated any major disputes involving competing uses.

It was therefore decided to examine two additional drainage projects that appeared to involve major conflicts. The drains were selected to represent the two categories of conflict receiving the most attention in Ontario. One drain involved a conflict between agricultural drainage and the water storage role of wetlands, while the other involved wildlife and the recreational role of wetlands. These drainage projects were investigated to present a full assessment of all costs and benefits involved and to give an indication of how adequately The Drainage Act deals with situations of competing land use.

The first drain was about 6 miles long and included 850 acres within the drainage area. The outlet for the waters from the area was in a watercourse draining through property the conservation authority had bought to preserve the natural water storage area and to develop multiple purpose forestry.

The conservation authority was concerned that the drain would have some injurious effects and made a study of the problem. The study indicated that the level of the water table would vary between 2 and 5 feet below the ground surface and that construction of the drain would lower the water table, the effect of which would extend laterally almost 200 feet. The conclusion was that this change in the water table would not cause injury to trees but that the water holding role of the land would be damaged. As a result, the authority appealed an assessment for benefit against the properties and was successful before the county court in November 1969.

The research staff's inspection of this area indicated that there had been direct damage to the woodland during the construction of the drain, probably caused by a careless contractor and lack of supervision. Nearby landowners were interviewed but little evidence was produced of effects on the environment. Some irrigation ponds had a fall in water levels. In other areas, woodlands were drier after the drain was installed.

It may be concluded that the installation of this drain had both good and bad effects. A sample survey of the farms along the drain yielded evidence that constructing the drain significantly benefited local agriculture. Improved pastures, increased crop yields, and switches to more productive crops enabled farmers to raise more beef and dairy cattle. Benefit-cost ratios for the project were all positive based on the various factors of interest rate and years of life of the drain. This drain was clearly successful from the standpoint of agricultural production. It was somewhat detrimental to the water-holding capacity of the wetland and was neither helpful nor harmful to the woodlands.

The other drainage project studied involved the channelization of a creek that extended through the middle of a swamp. Approximately 5,200 acres were included, of which 1,600 acres were in swamp and forest. The petition was made to eliminate flooding on 100 acres of agricultural land adjacent to the swamp. The swamp was forested and ideal for ducks and marsh birds. Drain construction eliminated the flooded areas and destroyed the value of the area for fowl and marsh birds. Fur bearing animals disappeared and the importance of the area for recreation declined with the disappearance of ducks. The adverse effects of the drainage on wildlife and hunting have been substantial, and any remaining use for these purposes is likely to be seriously affected by the sales of land in 10-to-25-acre lots to potential market gardeners.

Interviews with landowners in the drainage area indicate that the agricultural benefits are still quite small. The construction of the drain, however, has attracted speculators to buy the land, clear it, and offer it in small parcels to potential market gardeners. The suitability of this land for market gardening is somewhat doubtful. Inspection of the area indicated that the depth of the black muck soil varies widely, from less than 1 foot to about 3½ feet. Muck soils should really be more than 4 feet deep before the land can be regarded as having good capability for agriculture. The environmental damage to this drainage area has been considerable. Little agricultural benefit has occurred and it is questionable whether such benefits will ever materialize.

Conflicts between owners of agricultural and urban land have been referred to in many parts of the Province. Yet, as with the other conflicts, well-documented cases are difficult to find. One is led to suspect that such conflicts may be either very infrequent or rather unimportant. The research staff undertook three studies to investigate the problem: (1) an analysis of the briefs submitted to the Committee and of the Committee hearings; (2) a sample survey of urban properties along the drains that were analyzed in the seven townships; and (3) an investigation of an alleged rural-urban conflict on the periphery of the City of Niagara Falls.

Rural-urban conflicts are mentioned many times in the briefs and in the summaries of the Committee hearings. Nevertheless, cogent descriptions of specific cases are rare. There are many references to the "urban problem" or to the problem of "urban shadow," but a real understanding of the nature of the problem is left wanting. Major problems can be identified, however, by piecing together comments from a number of briefs or hearings, many of which overlap in their concern for a particular case.

When an agricultural drain passes entirely through farmland, particularly when all farmers derive direct benefit from the drain, the problem of determining how the costs of the drain are to be shared is minimized. But when a drain passes through a residential, commercial, or industrial area (to permit connection with an outlet downstream, for example) and provides no readily apparent benefit to the surrounding urban properties, the urban owners may resent having to pay an "unfair" portion of the construction costs. This problem appears to become serious if urban owners are aware that they are paying more than a minimal or token cost.

Agricultural landowners can also be dissatisfied in a situation of rural-urban cost sharing. In some cases, decisions were made to construct more costly drains through urban areas than through the main agricultural area that was deriving benefit. Closed drains may be required for urban areas, for example, while open ditches suffice elsewhere. Farmers complained under these circumstances because their assessments were high in order to subsidize costly construction to satisfy urban demands. There is clearly no smooth-functioning mechanism for determining rural-urban cost sharing.

Some reference in the hearings and briefs is made to physical damage occurring to agricultural drains when they pass through urban areas. The view is expressed that the urban population understands neither the function of the drains nor the need to keep them clear of garbage and other fill. In one recreation area, urban cottage owners were reported to have blocked a drain's outlet to the lake, apparently without realizing the effect on the drain's functioning (Cayuga hearing, July 23, 1973).

Many references were made to the detrimental effects of land speculation on the construction and maintenance of agricultural drains. It is argued that land speculators who own significant acreages in the urbanizing portions of Ontario have no real long-term interest in agriculture and thus no interest in applying for drainage grants. This can stop genuine farmers in the region from getting drains constructed or maintained. Land speculators are not the only problem. Urban dwellers, in search of weekend peace and quiet, own rural acreage for horses or beef cattle but really have little interest in drainage. One case is cited where farmers could not qualify for an A.R.D.A. drainage grant because A.R.D.A. officials felt that an insufficient quantity of "genuine" agricultural land would benefit (Cornwall hearing, August 29, 1972).

A common form of urban settlement in Ontario is the string-like distribution of houses along rural roads, normally referred to as ribbon development. Although The Planning Act has deterred this form of settlement in recent years, it is common to almost every city, town, and village in the Province. Ribbon development potentially gives rise to two problems concerning agricultural drains. One relates to the possibility of nonfarmers physically abusing drains in which they have no interest, and the other to instigating procedures to undertake drain construction. With The Drainage Act emphasizing the number of property owners rather than the acreage owned some people have argued that a majority of "urban" landowners with small (for example, 1 acre) lots can stop farmers who own the overwhelming portion of the land from petitioning for drain construction with a subsidy (Cayuga, July 23, 1973). This conflict in interest is seen as a serious threat to genuine farmers who appear to be in an unfair position.

A fairly common report in the briefs and hearings concerns the pollution of drain water from urban sources, particularly septic tanks (Sarnia hearing, January 9, 1973). It was noted that the water in drains that pass through residential or industrial areas can be observed to be polluted. The implication is that the problem would not arise without the drains to spread the pollutants. A recent study by the Ministry of the Environment documents the problems in the Township of Sandwich South (1972).

Illegal hookup to drains is closely related to the problem mentioned above. Problems have arisen where urban landowners have permitted water from either storm runoff or septic systems to flow directly into drains. This can result not only in water pollution but also in overloading drain channels. Drains cannot function properly when overloading occurs and water backs up in fields.

A special case of improper hookups occurs when urban areas as a whole (a municipal government, for example) wish to use agricultural drainage channels as an outlet so they can modify the urban channel to carry an increased load. Problems can arise if rural residents see this action as a threat to the natural status of the rural landscape. There is such a case within the City of Niagara Falls.

It may be concluded that many of the rural-urban conflict problems referred to in the briefs and hearings have a basis in fact but tend to be exaggerated or oversimplified by a lack of understanding by all parties concerned. It appears that farmers are quick to blame urban areas for having little concern for agricultural interests and that many urbanites have little understanding of the function of agricultural drains. Both urban and rural groups seem to develop unfair biases toward the other and tend to generalize rather intricate problems under the standard headings of "urban" or "rural." This situation is inevitable perhaps, but its undesirable effects can cloud the real issues and deter the fair solution of important controversies.

The seven townships and sample drains selected for detailed study were chosen to allow a good opportunity to uncover rural-urban conflicts. Care was taken to include growing towns and drains adjacent to those towns. Yet very few of the drains studied had urban properties assessed as part of the project cost, and no drain appeared to inspire any particular response — good or bad — from an urban area.

The urban properties encountered in the drain analysis were usually ribbon-type properties strung along rural roads and ranged in size from one-quarter acre to ten acres. The situations examined by the research staff failed to uncover any of the problems mentioned in the briefs to the Committee. Many of the landowners were unaware that they were located near a drain and seemed unaware that they had been assessed outlet costs. None reported any inconvenience or benefit caused by the drain. No farmers interviewed indicated any problem emanating from the urban landowners. One can only conclude that rural-urban interests in these study areas appeared to be entirely compatible.

Since the urban landowners were assessed such a small portion of the construction costs (usually only a few dollars), they were either unaware of or completely satisfied with the drain and the cost-sharing mechanism. Just as for farmers who derived no benefits from drain construction, the urban landowners who were aware of the situation appeared to accept their share of assisting those who wanted the drain construction to go ahead.

Three general conclusions concerning land-use conflicts are thus apparent:

1. Although land-use conflicts concerning wetlands and rural problems can be documented and are of real concern to responsible citizens, the Committee's research suggests that genuine conflict situations are rather rare. In the vast majority of cases, the construction of recent agricultural drains has led to no serious conflicts in land use.

2. Although problems of competing land use in the urban fringe and in wetlands have been singled out for study, it should be noted that drainage projects affecting permanent streams constitute another category of drains that involve land use conflicts and problems of public versus private interests. Several conflicts arising from the adverse effects of drains on

sport fisheries have been reported in recent years, particularly in Norfolk, Grey, and Bruce counties.

3. In areas of genuine land-use conflict, current procedures for obtaining drain construction approval have not been adequate to deal with the problem. This applies primarily to The Drainage Act but also to other acts (The Municipal Act, for example), that have some concern with drains in conflict areas.

The following sections examine three possible means of helping to resolve potential land-use conflicts.

Benefit-Cost Analysis Prior to Drain Construction. Benefit-cost analysis can provide a logical framework for evaluating a course of action, and has been used extensively in the resource management field. The general procedure is to place a precise quantitative economic value on all benefits and costs associated with a project. Decisions concerning the advisability of the project are then made on the basis of the values of the benefit-cost ratios.

Problems arise in the use of this technique in Ontario, except possibly for drainage schemes much larger than the norm or for special rural-urban drains. Many of the values associated with environmental impacts (for example, in wetlands) are intangible and cannot be measured readily in monetary terms. Some procedures are available for attaching quantitative values to the recreational role of wetlands, but this only measures the value of one of the many functions of a wetland. No practical means are currently available for measuring the economic value of the hydrological, pollution-filter, aesthetic, or other functions.

Land-Use Planning. A number of briefs presented to the Committee suggested that problems of competing land uses that involve environmental impacts could be resolved by zoning the landscape into various categories.

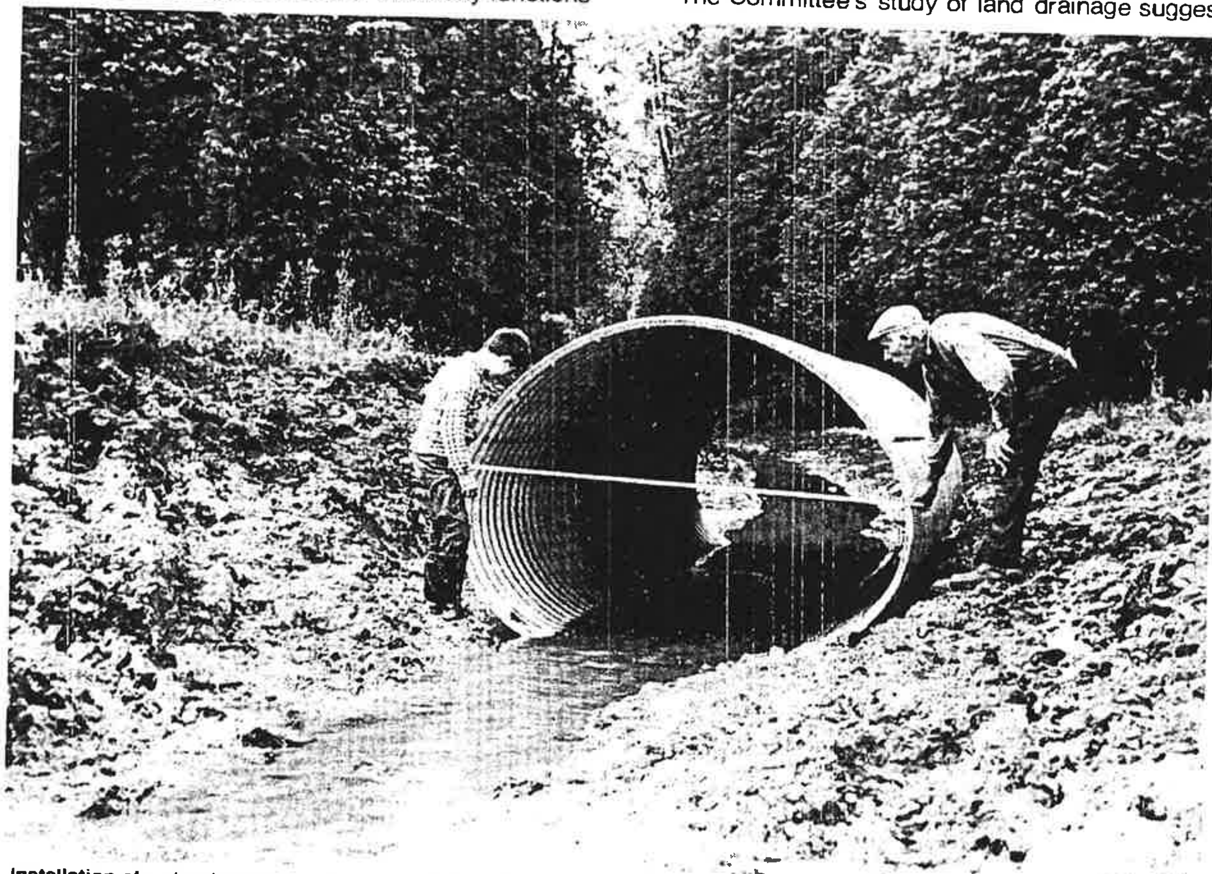
Category 1: areas where drainage should be facilitated because of high agricultural benefits and a minimum of land-use conflicts.

Category 2: areas where drainage should be prohibited because of the likelihood of environmental damage.

Category 3: areas where the situation is less clear-cut and considerable study would be required on each project before drainage could be allowed to proceed.

The type of land-use planning advocated in some cases appears to involve micro-scale zoning. For example, Category 1 would include most productive agricultural areas in the Province. Another concept suggests the use of the three types of category at a micro-scale involving the mapping of small drainage basins which could ultimately be fitted together to form a master plan for an entire major watershed.

The Committee's study of land drainage suggests



Installation of a structural-plate, pipe-arch farm bridge.

that land-use zoning on a micro-scale would not be particularly helpful in resolving conflicts. The wide variation in agricultural benefits among individual drains even within a single township indicates that it is unrealistic to identify large regions of the Province where drainage should be facilitated because of the agricultural benefits. Prohibiting drainage in certain parts of eastern Ontario would certainly prevent constructing some drains that produce considerable agricultural benefits. Conversely, automatically approving all projects in southwestern Ontario might result in the disappearance of the last remnants of wetland, which may be of major ecological importance by virtue of their very scarcity.

The detailed land-use zoning involved in the micro-scale drainage basin approach appears to be more realistic for judging the advisability of land drainage projects. The amount of work needed to evolve this type of detailed zoning, however, appears to be considerable and may only be justified in areas of intensive land drainage activity.

Formulation of Land-Use Priorities. A severe problem that is evident in almost all cases of conflict is the lack of clearly defined land-use priorities at the local or provincial levels. With respect to wetlands, for example, there are no guidelines to indicate the general amounts of wetland that should be preserved for hydrological, recreational, or aesthetic purposes. Neither all wetland needs to be preserved nor all destroyed. Determining wetland needs for hydrological purposes requires much more scientific research. Needs for recreation and other purposes presumably also require extensive surveys of current and potential users. Yet certain general guidelines could be determined which could be useful for resolving conflict situations. It might be determined, for example, that a limit should be placed on the reduction in wetland within broad regions to ensure the availability of a minimum of wetland. Obviously, general guidelines such as this would be most effective if determined through the joint cooperation of concerned governmental and other agencies. The task of formulating general rural land-use policy is not insurmountable, and should greatly assist the resolution of conflict situations.

VI. COSTS AND AGRICULTURAL BENEFITS

With the Committee's assistance and guidance, the research staff selected seven townships across Ontario for detailed study. These seven townships represented a broad variety of conditions, and a file was compiled for each containing data on physical background, settlement, agricultural production, artificial drainage, aerial photograph mosaics, and special reports.

Only drains constructed or modified during the period from 1965-66 to 1969-70 were included in the study. All drains were listed and a random sample of 4 drains was selected for each year, yielding 20 drains per township for the five-year period. These drains were mapped and 5 for each township were selected for study to ensure that a wide variety of conditions was represented. In two townships, 6 drains were examined to permit an even broader range of conditions.

Having determined the drains to be studied, the staff formally selected sample properties. About 40 properties were studied in each township, averaging 8 properties per drain. The number of property owners interviewed was sometimes less than the number of properties since individuals often owned more than one of the sample properties. Everywhere farmers were willing to arrange for long and detailed interviews. The staff was satisfied that the farmer survey proceeded successfully.

The primary objective of the interviews was to determine the benefit-cost ratios for all drains. This ratio was obtained by dividing the total cost of the drain (irrespective of subsidies) into the present value of all current and future net returns from agriculture that would not have occurred without the drain construction to yield the benefit-cost ratio. Ratios with values of less than 1.0 would indicate that the benefits are outweighed by the costs; those with values of 1.0 reflect that benefits are equaled by costs; and those with values of greater than 1.0 indicate that benefits outweighed the costs. It normally is hoped that ratio values will exceed 1.0.

The present value of current and future benefits (the numerator of the benefit-cost ratio) was calculated by determinng the average annual net increase in agricultural income and adding together the present value of all such annual net increases over the time period for which the benefits are expected. The formula for calculating the present value of the net increases in future annual income is $V = \frac{A}{(1-i)^n}$, where V = the present value of the anual net increase in future income, A = the average net increase in annual income, i = an appropriate interest or discount rate, and n = the number of years into the future of the net increase in income.

The calculations for this study were based on several assumptions:

1. Only agricultural benefits are considered; any benefits accruing to roads or other land uses are ignored.

2. The future annual incomes due to drain construction will remain the same as those reported for the present. Even though considerable yearly variation is bound to occur because of varying weather conditions and even though the increases reported to date may be abnormal, it is assumed that future increases will not differ from current ones.

3. The increases in production due to drain construction will cease at the end of the drain's life cycle (that is, when it becomes defective). For simplicity, this study assumes that the increases remain constant throughout the life of the drain until it becomes defective.

4. An appropriate range of interest rates is 6-10 per cent, and would seem to span the rates at which the government is able to borrow money.

5. An appropriate range of lifetimes for the drains is 5-20 years. Estimates of lifetimes were obtained from public reports prepared by a number of drainage engineers.

6. No secondary benefits to sectors of the economy related to agriculture are considered. For example, increased purchases of farm inputs are not counted as benefits accruing to the project.

Under these assumptions, present values and corresponding benefit-cost ratios were calculated separately for interest rates of 6, 8, and 10 per cent and for drain lifetimes of 5, 12, and 20 years. This range of values permitted a proper evaluation of any drain in the sample.

Construction costs for the sample properties on the drain were based on the actual total cost of the drain and the engineer's estimate (in the engineer's report) of the proportion of that cost that should be paid by those properties. The samples normally included three times as many benefit properties as those assessed only for outlet. So the outlet properties, which almost always report no increases in production, are underrepresented, possibly leading to unrealistically high benefit-cost ratios. On the other hand, outlet assessments on the sample properties were small and almost insignificant compared with benefit assessments. Considering this is the case and that the engineer distributes assessments under a system bearing a strong relationship to probable benefits, the cost figures and corresponding benefit-cost ratios in this study are fair and appropriate. In some cases, calculations of this type were unnecessary since the sample included all properties subject to benefit assessment.

Increases in farm income due to drain construction are sometimes difficult to distinguish from those accruing to other factors, such as changes in seed or equipment. Even though the questionnaire provided for this distinction, the data still contain many uncertainties. In calculating increased benefits, the average annual value of drainage-related increases in production was determined whether or not the increased production was actually sold. Specific data on production changes and general estimates of the percentage of net income change, which could be cross referenced with calculated changes, were obtained.

Production increases tended to result from increases in yield, changes in land use, changes in rotation systems which permitted more lucrative crops to be grown more often, or changes in animal production. Another form of change that was included in the calculation of net income changes was the value of human labour saved when less time was required for farm work. Associated with the changes in gross income were a number of changes in costs. Besides paying for the drain, several other input costs were incurred, including the cost of new equipment, fertilizer, and livestock.

A significant added cost occurred when field underdrainage was installed to take advantage of a new outlet drain. This presented a serious accounting problem, since the life of field underdrainage systems tends to be much longer than that of outlet drains. Consequently, the cost of field underdrainage was calculated on the basis of the yearly payment required to cover the total installation cost over 40 years at 6-per cent interest. The 6-per cent interest rate was chosen because it is midway between normal bank-loan rates and the special 4-per cent rate normally obtainable through The Tile Drainage Act. The 40-year period was chosen because it approximates many estimates of the effective life of field underdrainage. A shorter period such as the lifetime of the outlet drain was not chosen since this would suppose that all benefits from field drainage terminated before the end of the actual underdrain lifetime. It is recognized that farmers do pay for field underdrainage in a shorter period than 40 years, so that their annual costs would be somewhat higher than those used in this analysis. This study thus assumes higher incomes during the first few years following a project and lower incomes during later years than farmers would probably experience.

Prices and costs used in calculating increased net income were county averages for 1969-72 (from *Ontario Statistics*, Ontario Ministry of Agriculture and Food, 1969-72.) Prices for items not included in the usual publications were obtained directly from the Ministry of Agriculture and Food or from marketing boards.

The following example helps illustrate the way values for increases in income were derived. Since the completion of the drainage works, most of the farmers interviewed reported little change in production. One farmer, however, had installed new tile under 20 acres at a total cost of $3,420. The annual equivalent of this cost as calculated by the above procedure is $227. Some change in land use and yield occurred on the sample properties, but most of the change was on the newly tiled land where former pasture had been switched to grain. The difference in the market value of current over past production was calculated separately for each farm in the sample and summed to yield a net increase of $2,703, most of which occurred on the farm with the newly tiled land. Where changes in crop rotation were involved, annual production values averaged over three or four years or the length of the rotations to derive increases in the value of average gross annual production.

Increased production required increased costs in addition to the cost of field underdrainage. Culverts were installed, a granary constructed, and more fertilizer purchased. The annual value of these added costs was $392, calculated by spreading the costs over the life of each item at 6-percent interest. Thus the average annual increase in *net* income, irrespective of labour costs, is $2,703 — ($392 + $227) = $2,084. Less labour has been required following the project's completion, with farmers reporting an aggregate saving of four days. At $20.00 per day for labour, the value of the saving is calculated at $80.00. Thus, the final estimate of the average annual increase in net income is $2,084 + $80 = $2,164.

Significant differences can occur between the actual change in income experienced by farmers and the calculated estimates. If the labour saved is the farmer's own time, for example, he will gain no financial return. Also, the cost of the tile might be borne in 5 years rather than 40. The Committee's research staff believes, however, that the procedures used are essential to produce comprehensive estimates of the full benefits and costs over the life of the drains, even if the statistics differ from particular farmers' experiences in the short run. In fact, in many cases the estimated benefits closely resemble those reported by property owners.

The generally assumed agricultural benefits of draining land are evident through the study areas. Most property owners interviewed (195 out of 232) felt that drainage was beneficial, and the production data and benefit-cost ratios tend to confirm this feeling. Of those interviewed, 107 felt that outlet drainage installations had led to increases in crop yields, and 179 indicated their willingness to pay for drain maintenance whenever it is required. In addition, 122 propuniform policy and practises, and for providing common services.

The Water Act gives the Secretary of State for Environment and the Secretary of State for Wales the responsibility of securing the execution of a national policy for water conservation, water supply, sewage and sewage disposal, pollution control, and recreational use of water. The Minister of Agriculture, Fisheries and Food retains the responsibility for land drainage and salmon and fresh water fisheries. Schedule 5 of the Act has direct reference to land drainage and calls for the organization of regional land drainage committees in each regional water authority. These committees are concerned wholly with land drainage and are represented by their chairman as one of the members of the regional water authority appointed by the Minister of Agriculture, Fisheries and Food. Under these regional land drainage committees, there are to be local land drainage committees which are to be responsible for any local land drainage scheme.

Summary

Under its terms of reference, this Committee was concerned throughout its two years of study mainly with the administration of the various drainage acts in the Province of Ontario. The Committee's research quickly provided information that other jurisdictions were dealing with land drainage and water problems in a completely new and interesting manner. It is significant to note that all four of the jurisdictions in the preceding discussion had made very recent major changes in legislation to consolidate their legislation. Their thinking and philosophy regarding water problems centred on one body with one control for all aspects of water management.

The Committee is acutely aware that there still tends to be considerable fragmentation of control over water in Ontario. Appendix III to this report lists some 20 pieces of legislation in Ontario which have reference to water and water control. Water quality is the responsibility of the Ministry of the Environment. Water quantity and conservation is the responsibility of the Ministry of Natural Resources. Agricultural land drainage is the responsibility of the Ministry of Agriculture and Food. It appears to this Committee that Ontario is lagging behind the other jurisdictions it examined in the development of water resources management.

As a program for the future, **this Committee would therefore recommend,** that the Government of Ontario establish a task force or committee to study the future management of water in the Province, with one of its terms of reference being the possibility of consolidating total water control in the Province into one ministry.

The Committee was impressed with the development of such a plan in the United Kingdom and equally impressed with The Water Act of 1973, where total control of water management was given to the Secretary of State for the Environment and to the Minister of Agriculture for his segment of responsibility — namely, land drainage. This was possibly a political compromise which for some reason was deemed appropriate in the United Kingdom. This Committee does not believe that such a compromise would be necessary in Ontario and hopes that the result of the study of the proposed task force or committee would be a recommendation that would consolidate the total control of water resources in the Province in one ministry. Since water knows no political boundaries, since the quantity of water cannot be divorced from the quality of water, and since agricultural land drainage has some impact on both quantity and quality of water, these matters should be under the control of a single ministry.

Table 1 — Average Benefit-Cost Ratios in Sample Drains

Area	No. of drains	5-yr. life calculated at: 6%	8%	10%	12-yr. life calculated at: 6%	8%	10%	20-yr. life calculated at: 6%	8%	10%
S.W. Ont.										
Twp. A.	6	1.19	1.13	1.07	2.37	2.13	1.92	3.24	2.77	2.40
Twp. B.	5	1.82	1.73	1.64	3.63	3.26	2.95	4.96	4.25	3.68
N. Ont.	5	.53	.50	.47	1.05	.94	.85	1.44	1.23	1.07
E. Ont.										
Twp. A.	5	.27	.26	.25	.54	.49	.44	.74	.64	.55
Twp. B.	5	1.01	.95	.91	2.00	1.80	1.63	2.74	2.35	2.03
Fringe[a]										
Twp. A.	6	3.00	2.84	2.70	5.95	5.37	4.85	8.17	6.99	6.06
Twp. B.	5	.48	.45	.43	.95	.86	.78	1.30	1.12	.97
TOTAL	37									

[a] Fringe identifies drains in townships in the area just east of the extreme southwest counties (e.g., Middlesex, Huron, Bruce).

erty owners indicated that they would have supported the project without the government subsidy.

Beyond the general positive evidence of the impacts of drainage, considerable intertownship and interdrain variation was revealed. The highest benefit-cost ratios occur in the traditional locations of high agricultural productivity. Thus southwestern Ontario would appear to benefit significantly more than other parts of the Province. On the other hand, drains in some of the frontier drainage areas barely if at all pay for themselves. It is inappropriate, however, to assume that all drains in one region are beneficial and all those in another are not, because significant variation is evident among drains in individual townships. Measuring benefits in areas like southwestern Ontario where drainage has a long history and where most of the recent work involves reconstruction, is difficult because improvements may not only yield higher production but may also prevent future declines in production should existing drains become defective. The real benefit from regular maintenance would be the prevention of future production declines when the drain did become defective. In actuality, maintenance apparently is postponed until production problems are evident.

Northern Ontario drains (Table 1) are much more recent in construction and show great variation in benefit-cost ratios. Two of the drains have led to very small increases in income and to benefit-cost ratios so low that the construction costs will not be recovered. Two other drains have ratios with values of about 1.5 (12-year lifetime) and another has much higher ratios.

Benefit-cost ratios in eastern Ontario are generally low and only two of the drains studied are likely to pay for themselves (Table 1). Farms along two other drains in this area have experienced no benefits at all. In one area, two drains have very high ratios, even though two others will not come close to paying off unless current responses to the drains change radically.

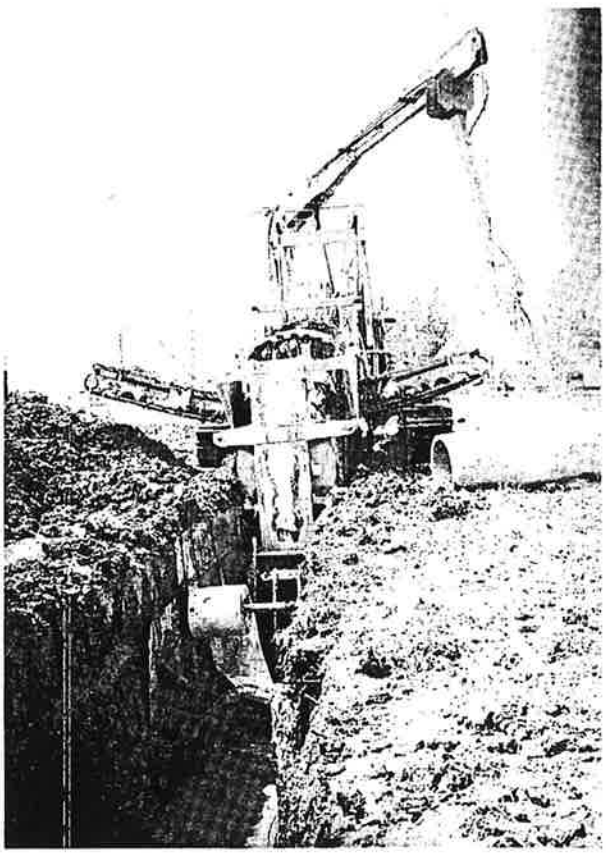
One township in the fringe area contains drains with the highest benefit-cost ratios of any studied (Table 1). Conversion of acreages from hay and small grains to corn and soybeans seems to have helped produce the highly beneficial prespective. The ratios in another township in the fringe vary considerably, ranging from three drains with little beneficial response to two others where drainage construction has obviously been a wise economic investment.

It must be emphasized again that the data used in this analysis are mostly estimates of questionable accuracy. The calculations are based on very specific and limiting assumptions that must be fully appreciated prior to interpretation. Nevertheless, it is felt that the data and the derivations are valuable and can reflect a good assessment of benefits and costs when used with caution.

On the whole, the general response in agricultural production justifies the construction of outlet drainage in the sample areas. This trend varies considerably, however, between townships and drains. Many of the sample drains, particularly in eastern and northern Ontario, have benefit-cost ratios with values below 1.0 and have been beneficial to property owners only because of government grants. Great variation in agricultural response is noted even among the properties along a single drain. A drain can quite normally have a good benefit-cost ratio because of very high responses on a small minority of farms even though the majority of properties have no increases in production.

The following sections discuss seven major factors that account for the variation among drains in benefit-cost ratios.

Good ditches make good crops.



Trenching machine installing 24" diameter tile.

1. Productivity of the Environment

The agricultural productivity of the environment varies considerably across Ontario due primarily to differences in soil and climatic conditions. Southwestern Ontario's unique combination of good soils and a long growing season gives it an environment superior to the rest of the Province. Since drainage construction costs are similar across the Province, funds invested in drainage in southwestern Ontario are bound to yield greater agricultural productivity than in other regions. Investments in eastern and northern Ontario, with their limited soil and climatic conditions, would be expected to yield lower returns. This basic relationship, which tends to accentuate the comparative advantage of "privileged" regions for capital investments, undoubtedly accounts for the general tendency of southwestern Ontario to have higher benefit-cost ratios than other parts of the Province.

On a more local scale, investment in drainage can lead to spectacular benefits if it permits switches to more lucrative land uses besides improving yields of existing ones. Such investments lead to critical changes in the productive environment which can be accompanied by very high benefit-cost ratios. In the sample areas, the highest benefit-cost ratios tended to occur where drainage permitted land to switch from hay or small grains to corn or soybeans. One township particularly contained a number of sample properties where drainage permitted this critical switch — a switch that tended to occur farther southwest several years ago.

2. Installation of Field Underdrainage

A 1972 report to A.R.D.A. concerning agricultural land drainage in eastern Ontario pointed out that when new outlet drains are installed, beneficial responses only occur on a large scale if field underdrainage is installed and attached to the outlet. This study reconfirms that conclusion. Drains with high benefit-cost ratios tend to be those where field underdrainage had been installed before or after the outlet project. Where field drainage was not installed, particularly in eastern and northern Ontario, benefit-cost ratios were unfavourable.

3. Special Hydrological Conditions

Outlet drains are often of some benefit to farms even without field underdrainage, but this is largely dependent on local hydrology. The benefits are usually very few, but under unusual circumstances outlet drainage alone can lead to benefit-cost ratios with values over 1.0. A new drain in northern Ontario, for example, prevents the flooding of fields by runoff from surrounding higher ground.

4. Local Initiative

Obviously important to the success of a drain is the initiative local farmers take to utilize its potential benefits. Such initiative might include installing field underdrainage. There was great variation in the degree of local initiative, providing an important reason for the variation in benefit-cost ratios. The most successful drains tended to be of fairly modest cost ($2,000-$4,000) and with a relatively small number of farmers having a genuine interest in the project. On the larger projects, two or three farmers commonly experienced all of the benefits, leaving the majority of landowners with no changes. This is why many of the farmers on large drains reported little benefit even though the overall benefit-cost ratios had values well in excess of 1.0.

5. Type of Project

The type of drainage project has an important influence on benefit-cost ratios. This is particularly true for maintenance projects, where the most important benefits may be unmeasurable (as in the prevention of future production decreases).

6. Quality of Engineering

The engineer who designs a drain can have a profound effect on the benefit-cost ratios. Some drains, for example, appear to be much too elaborate and costly for their intended purpose, thus lowering the benefit-cost ratios.

7. Weather Conditions Since Project

It has been pointed out that the ultimate effects of some drains could not be measured yet, since the years following construction had had abnormal weather conditions. In eastern Ontario, particularly, abnormally heavy rainfall has not permitted realization of the full beneficial effects of new drains.

It is important to note that the first six of these seven factors affecting benefit-cost ratios can be evaluated, estimated, or controlled *before any drain is constructed.* It therefore should be possible to produce fairly good estimates of the benefits to be expected from drain construction, perhaps before an engineer's report is completed and certainly with expanded versions of the reports.

But it should be clearly understood that the considerations and techniques used in calculating benefits should be the economic benefits accruing as a result of the construction of a drainage works and not the benefit as assessed by the engineer. The latter is a calculation usually pro-rated down to provide for the payment by ratepayers of the cost of the drain in proper proportion to their total benefits. In some cases, also the benefit assessment may not reflect the total benefit to be derived. Lands where improved drainage is provided, are assessed their share of the outlet costs and these could conceivably be greater than the benefit assessments.

VII. AN EXAMINATION OF DRAINAGE COSTS

The Committee authorized an engineering firm with extensive practise in land drainage to undertake a study of drainage costs. This project included an investigation of the factors influencing these costs and how they may best be controlled or possibly reduced. Existing records were examined to establish a statistical profile of past and present drainage work in Ontario with emphasis on the effect of implementing and removing grants in the last ten years. This information was obtained chiefly from the files of the consultant, which covered a period of some 60 years and was supplemented by interviews with individuals knowledgeable of drainage costs. The actual study was limited to the period between 1940 and 1972, reviewing a reasonable mixture of new drains and drains that were being repaired or improved. Although the report dealt primarily with municipal drains, the costs concerned with private drainage schemes were reviewed to some extent in that section of the consultant's report dealing with covered municipal drains.

To illustrate the changes in the costs of drainage works, three drainage cost indicators were selected:

1. Construction costs per cubic yard of earth moved;

2. Total project costs per 100 feet of drain; and

3. Total project costs per acre drained.

The cost per cubic yard included the costs of removing timber, installing culvert pipes, leveling excavated material, and all other work generally required of the drainage contractor. This did not include material costs such as culvert pipe and concrete installations. The cost per 100 feet of drain was taken to be the entire cost of the drain divided by the number of hundreds of feet in the drain on which work was carried out. The cost per acre of land drained was taken to be the entire cost of the drain divided by the number of acres within the watershed.

The cost indicators were then averaged out to produce a typical cost for each five-year period from 1940 to 1965. Further costs were calculated up to 1972, with particular emphasis on the period 1965 to 1967 when the effects of the two-thirds grants were becoming evident in the study area. The dollar costs for each indicator were then converted to a cost index (1940 = 100). The three indices are shown in Figure 2. The mean of the three cost indicators was then calculated at the end of each five-year interval and is shown as the Cost of Drainage Index on Figure 2.

The Cost of Drainage Index relates only to open drains and is based on data collected in southwestern Ontario. It was felt that if the same information were collected from a different set of drains in a different area, the numbers would have been somewhat different but the trends would be reasonably consistent over the whole Province.

Information was then gathered on the farm price indicators that represent trends in the farm economy. These are:

Farm operating expenses;

Yield per acre of principal field crops; and

Gross receipts from the sale of farm products.

Information on these indicators was obtained from *Agricultural Statistics for Ontario* and converted to an index for each indicator. These indices are shown in Figure 3 with the Cost of Drainage Index.

Three other indicators that are representative of prices and costs in Canada were examined. These were:

Consumer Price Index;

Average hourly earnings in construction in Canada; and

The Engineering News Record Cost Index.

These economic indicators are shown in Figure 4 with the Cost of Drainage Index.

Figure 2 illustrates a relatively slow rate of increase between 1940 and 1965, a sharp increase between 1965 and 1967, and a lesser but still significant rate of increase between 1967 and 1972. This is an excellent illustration of the effect on costs resulting from a major increase in the grant structure.

Figure 3 shows the relatively steady increase in the farm price indicators, which remained above the cost of drainage until the period when the A.R.D.A. grants were introduced. Since that time, the cost of drainage has increased somewhat faster than the farm price indicators.

Figure 4 indicates that the cost of drainage between 1940 and 1965 ran somewhat below the other construction indices, although the substantial gain in the Cost of Drainage Index between 1965 and 1967 was almost enough to catch up with the other indices. The Consumer Price Index did not reflect the substantial increases in the construction indices.

To evaluate drainage costs, it was appropriate to break down the chief cost components, which include materials, contractors' charges, allowances, and overhead costs. The changes in the component costs were examined from 1940 to 1973.

Materials relate to culvert pipes of either concrete or steel in the case of open drains and to agricultural tile, pipe, or precast appurtenances in the case of covered drains. The increase in material costs can best be illustrated by 4-inch clay tile which was 3 cents a foot in 1940 and about 11 to 12 cents a foot in 1972. The increase in material costs has very closely followed the rise in the Consumer Price Index. It should be noted that the present (May 1974) price for 4-inch clay tile is approximately 16 cents a foot.

In the case of open ditches, the contractor's charges generally include excavating and leveling the material, removing timber and debris, and placing and backfilling culverts. In the case of tile drains, the charges in municipal drainage activity include excavating the trench and laying the tile and generally spreading the tile and backfilling the trench. In private drainage activity, the farmer often takes care of the latter two items. Figure 2 illustrates the trends in this component. It is interesting to note that the cost per cubic yard, which is probably the least labor intensive of the drainage cost indicators, has tended to lag behind the others.

The allowances relate to damages caused by the disposal of excavated material to the land occupied for drainage purposes, to severance of land resulting from the location of the drain, and to compensation to lands adversely affected by not taking a drain to a sufficient outlet. Allowances for damages have tended to increase in relation to increased value in crop yields. Since the damage is related to the area covered, the thinner spreading of excavated material in recent years has increased the area affected, resulting in higher allowances. Allowances for lands, which are related to going land values, have exhibited a steady increase. Allowances for severance, which are related either to the value of the land severed or to the cost of a bridge or culvert which could be installed to permit access to that land, have undoubtedly tended to increase, although no pattern was established. Compensation in lieu of taking a drain to a sufficient outlet has been used rarely, so that allowances could not be correlated.

Overhead costs are composed of engineering fees, incidental to the preparation of the report, administration (clerk's fees and preparation of by-laws), and the supervision of construction. All these are labor intensive items and as such have shown a steady increase. As a percentage of the total cost of the drainage works in the area under study, the changes have not been great, with supervision and administration remaining almost constant and engineering fees tending to increase. This increase is due to greater sophistication in the drainage schemes, which tends to increase the preengineering workload. Supervision is generally carried out partly by the engineer and partly by the drainage commissioner, who may be a council member. In some cases, supervision is almost entirely carried out by the engineer, which naturally increases the cost.

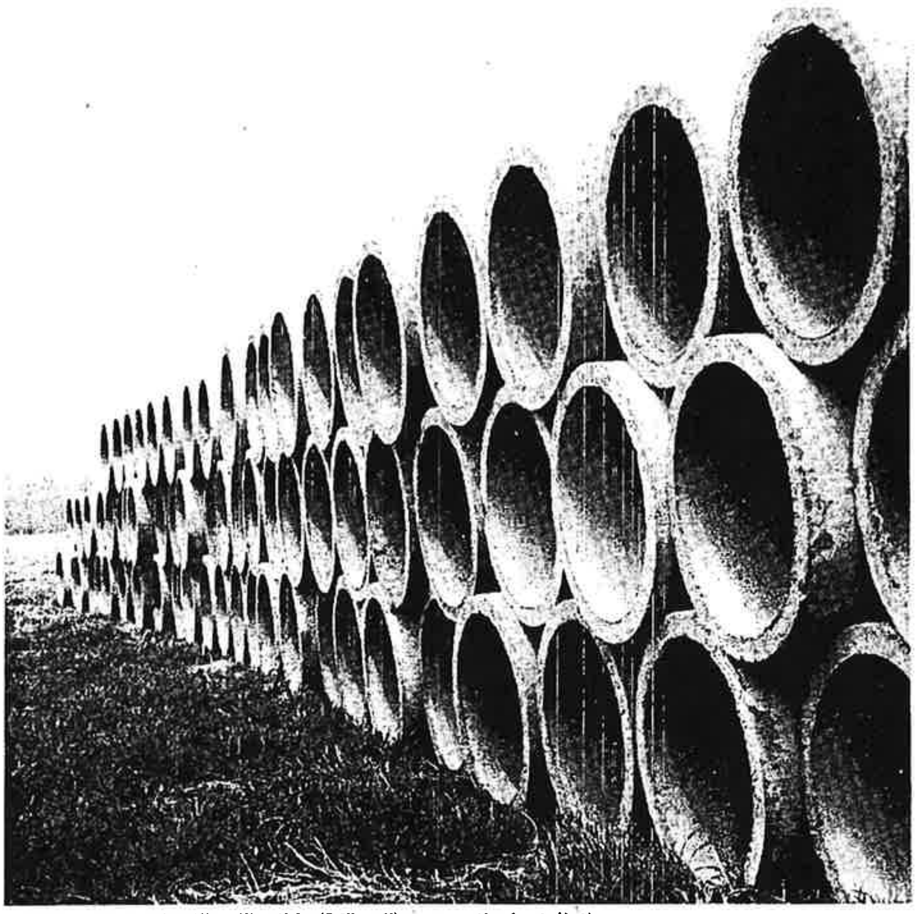
Consideration was given to the factors that influence changes in drainage costs. Materials, being manufactured items, tend to rise at about the same rate as the Consumer Price Index — a trend that may be expected to continue.

If a contractor is to continue in business, his basic charges obviously must be sufficient to cover the cost of wages for his operator and crew and to pay both the operating and capital costs of his equipment, together with something for overhead and profit. Beyond this, the amount that the contractor charges will depend on the degree of competition for work in the area. The demand for drainage work varies with the weather, the level of the farm economy, and the price of farm crops, along with the availability of grants. Increased grants lower the cost to the farmer, thus increasing the demand. However, the sharp increase in costs when the A.R.D.A. grants were available illustrates the measure to be somewhat self defeating. Although the degree to which the grants influenced drainage costs varied both by region and by type of drain, their effect was a significant factor for the Province as a whole.

There is continuing pressure to increase the allowances for damages to lands and crops. As mentioned, the tendency now is to spread excavated material to about 6 inches as opposed to 12 to 18 inches in the past. As crop yields improve and farm commodity prices increase, the crop loss will be higher. Engineers are becoming more conscious of these facts, which has been reflected in the allowances. Land allowances are generally related to the prices paid for lands by the road authorities who are acquiring land for highway purposes. Therefore any changes in county or township policies have an immediate effect on these allowances. Naturally, the changes always involve increases. The severance allowances tend to increase as time passes because of increased land values and increased bridge construction costs.

The consultant did not document any specific case where allowances were artificially excessive to help offset assessments. However, the Committee is aware of instances when pressures were put on engineers to increase allowances for this purpose. The Committee is also aware of instances where the magnitude of the allowances for damages and right of way cannot be reasonably justified. One of the problems with allowances is that decisions on damages must be made before the fact. Since the engineer cannot be sure when the work will be done, he must often assume the worst and base his allowances on the work being done at a time and in a manner such that crops are actually lost. This also applies to the allowances made for land occupation, but probably to a lesser degree.

The overhead costs, of which the largest portion is



Closed drains with tiles like this (24" x 4') are costly installations.

usually engineering, tend to increase. Engineering increases are generally related to increased wages and also to increased demands on the engineer's time for implementing more sophisticated drainage schemes which involve pipelines and other utility services that must be located and satisfactorily handled. Farm owners have become knowledgeable and require more detailed information from the engineer than in the past. The engineer is expected to attend the reading of the report in most cases. and often the court of revision. The engineering time spent on a drain today is estimated to be 50 to 60 percent greater than the time required on the same drain for basically the same work 25 years ago. Since most engineering firms base their fees on the time and related expenditures, the cost must necessarily go up.

The principal costs of administration are also labor intensive, with the cost being influenced directly by the wages and salaries paid to those people responsible for preparing the copies of the by-law and carrying out the duties of the clerk. Most municipal clerks are now full-time employees and, because the level of knowledge required is greater than in the past, salaries have risen at a somewhat greater than normal rate. However, this is sometimes offset to an extent by the office help now available to them. Printing and mailing costs have increased, and both recent revisions to The Drainage Act and requirements of the Ministry of Agriculture and Food with respect to grants have tended to increase workloads. Within the area studied, the increases in costs of administration of drainage schemes apparently have been matched by the increases in the overall costs since the percentage of these costs to the total costs has remained almost constant for the last 32 years.

The cost of supervision also depends directly on the amount of time spent and the salaries paid to those providing the services. The trend has been towards more supervision as the drainage schemes become more complex, which is entirely justifiable. Where the engineer bears the major responsibility for supervision, the costs tend to be higher than where a drainage commissioner undertakes the day-to-day supervision. The pay rates of the commissioner may be expected to be less than the engineer's. If they are higher than those of the engineer's assistants, the profit margin and the time involved in traveling to and from the job will likely offset any savings.

The type and size of drain has a profound effect on the cost of the work. Obviously, a long drain is more expensive than a short one and a drain with a large carrying capacity costs more than one with a small capacity. These factors are directly related to the size of the watershed and the amount of runoff from it. Thus the only control on this aspect of a drainage works depends on the engineer's judgment in determining the rate at which runoff must be handled. In locations such as pasture or bush, short-period flooding does not create any problems, while in places such as tobacco farms, flooding the crop for even a few hours can be disastrous.

The engineer must make the basic decision of whether to construct an open ditch or a closed drain. Small watersheds are generally best and most economically served by a covered drain. As the size of the watershed increases, however, a covered drain generally becomes a great deal more expensive than an open channel. Often, the owners involved feel the advantages of the covered drain for efficiency of operations may justify the premium that must be paid for such a system. The availability of grants frequently has a bearing on the choice of drain type as was readily apparent when A.R.D.A. grants started in 1966. When the grants ended in 1969, the number of large covered drains being installed annually dropped considerably.

The total cost of a drainage project is influenced greatly by additional work or material that is provided over and above actually excavating the channel or laying the tile. Perhaps the most notable item in this regard is bridge or culvert construction. In the early 1940's timber bridges were common and served their purpose, considering the loadings and nature of use. Today, corrugated steel and sometimes concrete structures with greatly increased loading and width requirements must be installed. For example, an 8-foot-span wooden bridge that was built in 1936 at a cost of $100 was replaced in 1969 by a corrugated steel pipe arch at a cost of $1,000. More attention is being paid to erosion control, which can be costly in many instances. Catchbasins and other covered drain appurtenances are in greater use, the cost of which has increased 5 to 6 times in the last 25 years.

The availability of grants from 1966 to 1968 also affected the number and cost of these additional items, especially bridges and culverts. The sharp rise in the indices for the cost per 100 linear feet of drain and the cost per acre drained that occurred between 1965 and 1967 (Figure 2) largely resulted from including these additional items in the drainage projects.

Changes in the pattern of owner involvement has had an influence on the cost of the drainage works. Maintenance and repairs to municipal drains were at one time often undertaken by the owners involved, thus reducing the scope and frequency of major repairs. At present, owners are either unable or disinclined to assume these reponsibilities and the cost of maintenance and repairs has increased. Traditionally, the farm owner worked side by side with the contractor when private tile systems were being installed. Because many owners now operate large holdings or have other interests, they do not have time to assist, which can only add to the out-of-pocket costs of installing tile drainage.

Special problems arise whenever a drain has to cross a road or a utility. Crossing recently paved roads must be effected by jacking or boring methods for covered drains and by similarly sophisticated means for open channels. This naturally increases costs. Similar procedures must be followed for crossing a railway. These operations generally require permits and other expenses such as increased supervision. Utilities such as gas or water lines also involve special construction procedures as well as related overhead costs. All these costs are generally borne by the authority involved, but must be considered in the overall cost of the drainage scheme.

In considering the preceding discussions, it is fairly clear that by far the great part of the increase in drainage costs is tied directly to the general increase in the Consumer Price Index and more particularly to increase in construction costs (Figure 4). A reversal of the trends in construction costs seems remote, although some things might be done to help slow the rate of increase.

Timing and combining of projects to allow volume purchasing can affect the costs of materials. In most cases, however, this would be difficult to organize, and if all material orders were moved to the winter months, seasonal discounts would simply shift to the summer.

The best way to hold down contractors' charges is to ensure a reasonable degree of competition. Because of the variety of uncontrollable factors that affect the number of drainage projects to be carried out (weather conditions and farm economics, for example), it seems almost impossible to set up a program to ensure a match between the contractors and the work. It has been suggested that municipalities purchase equipment and carry out their own drainage work, but indications in the foreseeable future are that contractors will be better able to provide this service than government. Because of the incentive aspect, it is reasonably certain that contractors will avail themselves of new developments and equipment as they become available.

Land and crop damage can be kept down if drain work is done either before the crops are planted in the spring or after they are harvested in the fall. Every effort usually is made to do this. Trucking excavated material away could be considered although trucking costs make this impractical except in the case of very high value crops. Allowances for land occupied by a drainage works must relate to current market value and will not be decreasing. One possible solution is to reduce damages and the area occupied by the drainage works by constructing covered drains. In most instances, however the additional costs involved are almost certain to offset the savings. To achieve

Figure 2

Drainage cost index for open drains

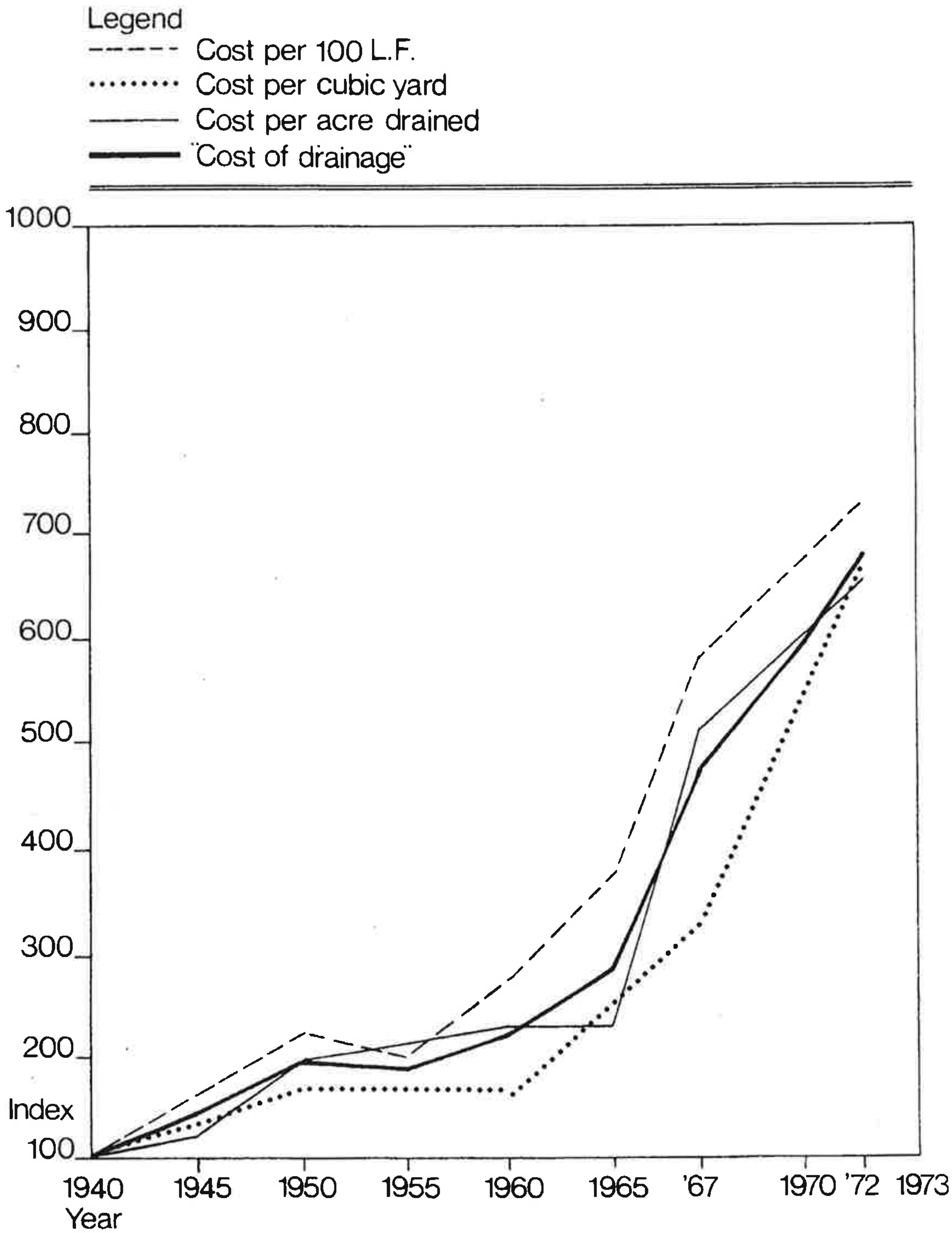


Figure 3
Farm Price Indicators

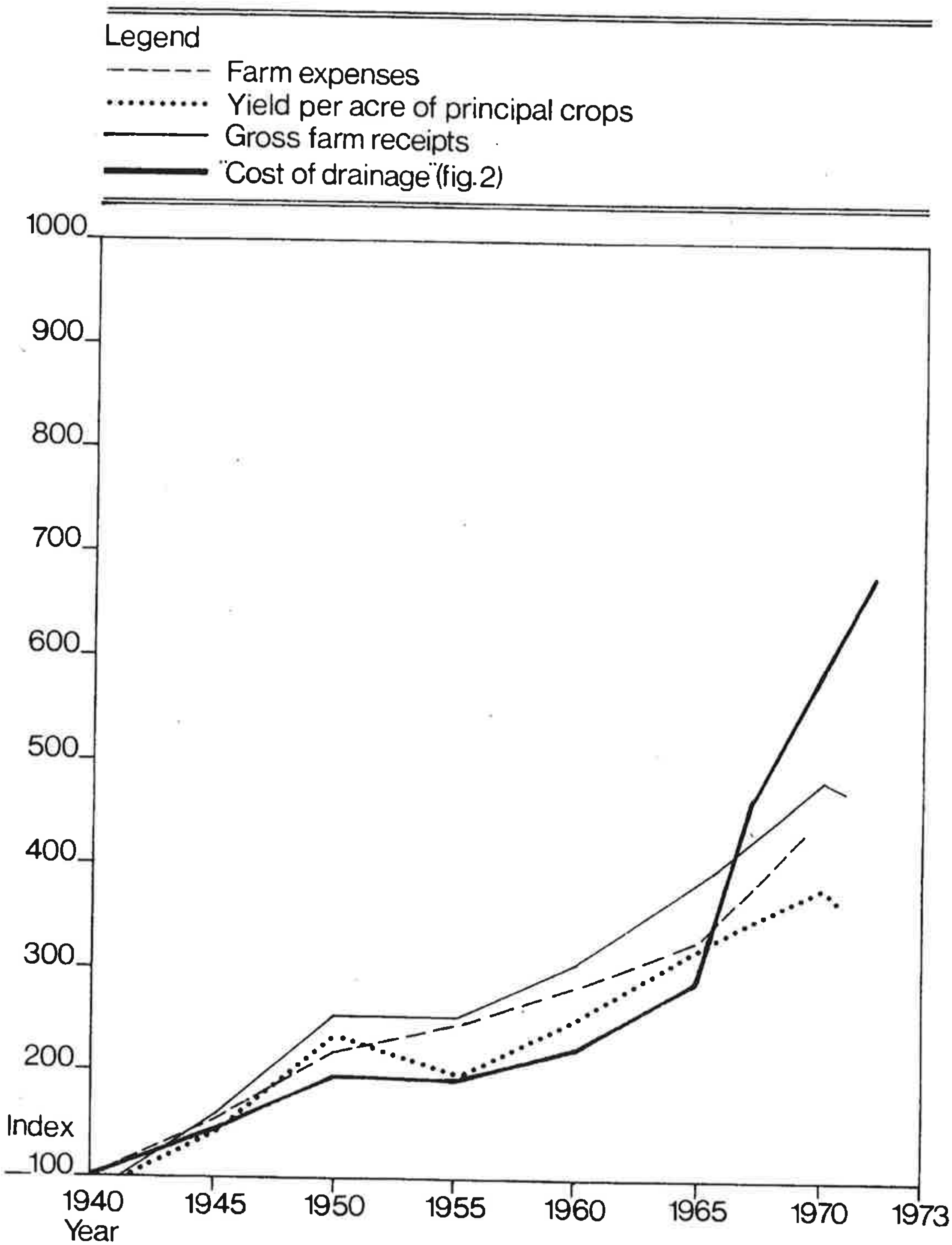
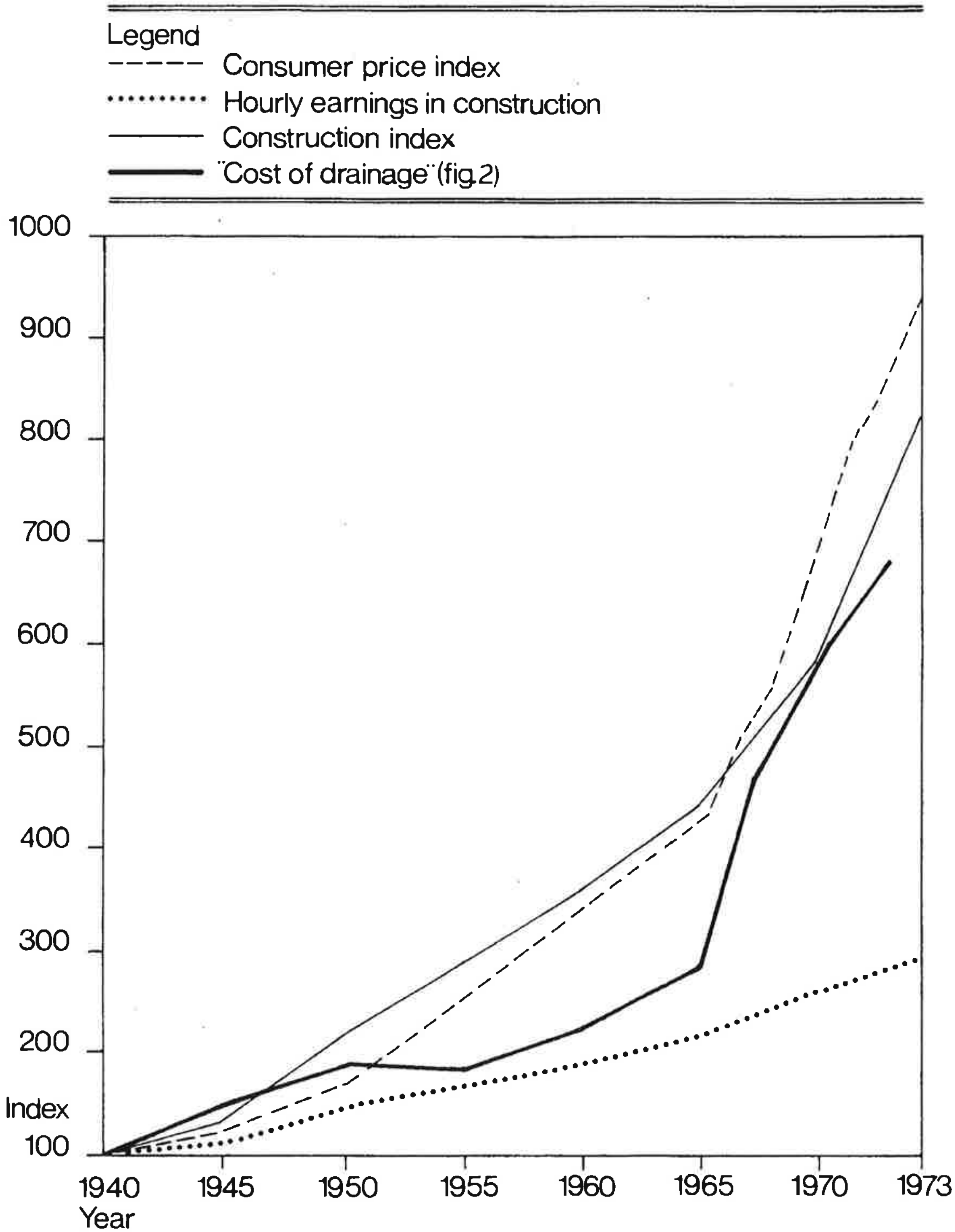


Figure 4
Economic Indicators



consistency and reductions in determining allowances where extremes occur, guidelines for the engineer's use are considered in part IX. Because engineering wage rates will not likely be reduced, it seems that the only way to effect economies in this area is to reduce the time required for preparing reports. Greater use of aerial photographs could reduce the time needed for locating new drains and determining watershed boundaries. This would effect economies in field time and to a lesser extent within the drawing office. Using the more recently developed calculating machines can effect significant time savings in computing estimates and preparing assessment schedules. Many engineers have already reduced specification preparation to a minimum by adapting a general specification for all drainage works and adding special conditions to meet the requirements of each particular project. It is doubtful if the time the engineer spends on providing information to councils and affected owners should be reduced. Based on the complaints heard by the Committee, communications between the engineer and these parties might better be increased in many instances.

It appears that the best way of holding down engineering costs is to try to make available to all engineers the most up-to-date information on methods, materials, and costs. Not only will this help hold down costs, but it should also be reflected in better engineering works. A coordinated effort by the professional associations, the University of Guelph, and the Ministry of Agriculture and Food can best attain this objective.

The administrative costs of processing drainage works could be controlled to an extent by decreasing the number of tasks that must be done. It has been suggested in many areas that the 1970 amendment to The Drainage Act which requires copies of the report (including plans and specifications), to be mailed twice to all owners who are assessed or receive allowances, is cumbersome and expensive. The Committee recommends in part XV that the plan and profile be included with the report when notice of its consideration is given. It was felt however, that only the by-law form which relates to the financial aspects as well as a clear, concise outline of the appeal procedure be forwarded to all affected parties after the provisional by-law has been adopted. The Committee also recommends elsewhere in this report that properties in urban areas not be individually assessed and this recommendation will produce considerable administration economies.

The Committee has reviewed in detail the proposition that the owners within the individual drainage areas should bear the administrative costs relating to drainage by-laws. It has been noted that administration costs for other types of services relating to specific areas, are borne out of the general funds of the township. It was also noted that the administrative staff of most rural municipalities has become full-time and the work relating to Drainage Act projects is carried out by this staff during office hours as part of their normal duties. **The Committee recommends** that the legislation be changed so that administrative expenses related to drainage works be considered part of the general administrative operation of the municipality and not be included in the direct charges assessed against a drainage works.

The key to economical and effective supervision of drainage works is a competent and conscientious drainage commissioner. Where there is a commissioner who is performing his duties in the proper manner and obtaining direction and advice from the engineer when required, it appears that the money being spent on the supervision is being used wisely. The combination of an able commissioner working in full cooperation with the engineer is considered to be the most effective arrangement possible. It is also worth noting that a commissioner who organizes and carries out maintenance and repair programs on municipal drains can effect substantial long-term savings as well as improved continuing drainage to the farmers. The Committee's recommendations concerning the drainage commissioner are included elsewhere (part X) in this report.

Long-term drainage costs would certainly be reduced by providing the most effective type and size of drain. This allows money to be well spent. Everything possible should be done to make sure the right decision is made on the kind of drain to be built, even though somewhat more money may have to be spent on additional investigation.

In conclusion, it can be seen from Figures 2, 3 and 4 that the trend of drainage costs has been upward. The trend slowed somewhat through the mid-1960's, but has been about the same as other construction costs since 1965. And until 1967, it did not differ much from the farm price indicators. The fastest increase in drainage costs seemed to coincide with the availability of A.R.D.A. grants, although the increase was also related to additional work being done on projects. Because drainage work is labor intensive, the greatest influence on drainage costs has been the rise in wages and salaries. Also, the increase in procedural requirements is not to be overlooked. It is probably safe to assume that, except for the latter point, this trend toward cost increases will continue. There does not appear to be any way to effect substantial real savings in the cost of drainage works.

Because of the great variety in Ontario topography, soil, climate, farming techniques, maintenance experience, and so on, it is impossible to generalize on the cost of maintaining drainage works. Weed and brush control techniques for open ditches are changing faster than perhaps any other aspect of drainage work. In any case, maintenance costs can best be controlled by initially ensuring proper construction of the drainage works and by following with an organized program of continuing maintenance throughout the drain's life. This can only be effectively undertaken if all those concerned with drainage activity are kept aware of innovations in methods and equipment. The Committee feels that the dissemination of this type of information should be carried out under programs of the Ontario Ministry of Agriculture and Food in cooperation with the University of Guelph.

VIII. THE PETITION PROCEDURE

A drainage work is established in Ontario in accordance with Section 3 (1) of The Drainage Act. A petition of landowners to the council of the municipality is required. To be valid, the petition must contain the signatures of a "majority in the number of owners as shown by the last revised assessment roll to be owners of lands and roads in the area requiring drainage as described in the petition." This wording immediately presents some difficulties. The tax roll usually includes husband and wife where the land or the farm is owned in joint tenancy and also includes lands owned by as many as seven or eight people. A petition once was ruled invalid because the petitioners forgot to include the required number of signatures of wives.

Another problem revolves around the phrase "the area requiring drainage." At one time, the legislation spoke of "lands to be benefited in the area described," but this was changed because it became apparent that the council, on receipt of the petition, could not determine which lands were to be benefited until they engaged an engineer and gave him this responsibility. In many cases, the municipal clerk merely computed the number of petitioners as a percentage of the total owners on the tax roll within the area described and assumed that the area was the one to be benefited. When the Act was changed to "in the area requiring drainage," it was not of any greater help because the council was still unable to decide whether or not an area required drainage unless they had personal knowledge of the area or the expert advice of an engineer. The Committee has been informed of cases where managed areas have been devised and a majority petition raised within the managed area.

There have not been many cases in the law regarding this problem. In those that could be traced, however, the referee or the court held that the engineer was beyond his authority when he reported to the council on an area greater than that described in the petition. There is one case on record where an engineer's report was rejected because it described an area which the engineer felt was a logical drainage area or basin but which was not similar to that described in the petition.

In rejecting the above engineer's report, the drainage referee said, in part:

> ". . . a petition must describe a real drainage area and it follows that there was an obligation on a council before acting on a petition to satisfy itself that a real drainage area was described in the petition . . . In my view a council must come to a conclusion as to whether or not the petition describes a real drainage area. . . ."

The problem with this judgment is that it leaves the council to decide the real drainage area, which is something it cannot do without expert advice. The Committee trusts that its recommendations in this section will solve this problem.

Another difficult problem regarding petitions is that of obtaining the required number of signatures when the area requiring drainage has several properties that may be small holdings of one or two acres. There might also be larger acreages owned by hobby farmers or city dwellers seeking a rural retreat. In such cases, it is difficult for full time farmers to raise a drainage petition because small holders or weekend hobby farmers are disinterested in drainage. The Committee was told of numerous cases where petitions failed because signatures were not easily obtained from such people. Perhaps in some cases these frustrations led to devised or managed areas as mentioned above.

The Committee was also made aware of what many briefs and submissions referred to as "the indiscriminate drainage of wetlands." Petitions raised in some drainage areas could request drain construction to the detriment of the environment or to the natural resources. The Committee agrees that construction of agricultural drains in the past had little or no regard for environmental impacts and appreciated the obvious sincerity of the conservation-minded people from agencies such as the Conservation Council, the Conservation Authorities, and the Ministry of Natural Resources who appeared before the Committee. However, the Committee's research does not support the requests for restraints on the expansion of agricultural land drainage because of the detrimental effect on the environment.

The Committee's hearings made it aware that some drains were built which did not return benefits equivalent to costs within a reasonable time. Research on this problem found that approximately 30 to 35 percent of the drains examined would not pay their way in the foreseeable future. Similarly, the A.R.D.A. Branch of the Ministry of Agriculture and Food reported in a special 1972 study on A.R.D.A.-assisted drains that about one third of the drains studied did not have positive benefit-cost ratios. The Committee believes that steps should be taken to ensure that drains return to the landowner the value he expects from the total cost of the drainage works and also that public funds invested in drainage by the governments of Ontario and Canada through A.R.D.A. yield positive returns. The proposed petition procedure accordingly gives the matter of costs and benefits major consideration.

Proposed Procedures

Recognizing the foregoing considerations, **the Committee recommends** that the present section 3 be amended in certain respects and that procedures relating to the submission of a final report, be modified so that in most cases, the problems that have been brought to the attention of the Committee can be avoided. Specifically, we recommend that section 3 (1) be redrafted so that a valid petition will consist of signatures representing a majority of the properties, (that is, one signature per property to be benefited as shown on the last revised assessment roll) or any number of properties representing 60 percent of the total acreage to be benefited. When a petition is raised and presented to council, and confirmed by an engineer, council may then proceed or not as they decide. **The Committee further recommends** that the phrase "area requiring drainage" be replaced by "area to be benefited as determined by the engineer" and that Subsection 4 be deleted since the Committee considers that a pumping installation should not be treated differently than any other type of drainage works for purposes of the initiation of a scheme. The foregoing recommendations will resolve problems relating to multiple signatures for single properties, small holdings frustrating the implementation of agricultural drains and the determination of lands to be benefited. It follows that it would be incumbent upon the engineer to determine the area to be benefited to confirm the validity of any petition before undertaking any other duties. Furthermore, before the council makes any decision as to whether or not to accept the petition, the council must appoint an engineer whose duty at this stage is to do nothing more than confirm the validity or otherwise of the petition and define the drainage area to be benefited.

With respect to difficulties encountered by full-time farmers where hobby farmers and land speculators prevent the raising of a majority petition, the Committee has noted that the present Subsection 2 provides for initiating proceedings for the drainage of a road on a petition of the interested authority and feels that the circumstances are somewhat similar. Therefore, **the Committee recommends** that an additional subsection be added whereby the Minister of Agriculture and Food, upon the application of interested parties could petition for the initiating of a drainage works.

The Committee considers that the foregoing recommendations will accommodate the great majority of drainage schemes within the Province. However, we feel that environmental impact and benefit/cost considerations cannot be ignored by any council when considering a drainage scheme. Therefore, it is recommended than an environmental impact statement and benefit/cost certificate as described later in this part be filed with the engineer's report.

The Committee also recognizes that in some instances preliminary information will be necessary prior to the authorization of a final report. This could involve environmental impact, benefit/cost calculations, or a preliminary engineering study and it is recommended that councils be permitted to authorize any or all of these elements to be furnished prior to accepting the petition. **The Committee** considers that such information in many instances, will prove of great value and **recommends** that the usual grants be made available for this purpose.

Where the council requests this preliminary information before making a decision as to whether or not to accept the petition, it is felt the balance of the costs after the grants should be the responsibility of the council.

Accordingly, **the Committee recommends** that in addition to the matters presently in section 3, the Act should provide the following:

1. When a petition of landowners is given to a municipal council for the construction of drainage works, the council must first appoint an engineer whose only duty at that stage is to define the area to be benefited and determine the validity of the petition.

2. The council may, following the engineer's validation of the petition, decide to proceed with the drainage works, at which time, the council must order the preparation of an environmental impact statement, a benefit/cost certificate and an engineer's final report.

3. In the alternative, the council may, prior to accepting the petition, decide that it wishes further information, in which case it may order the preparation of any of an environmental impact statement, a benefit/cost statement or a pre-engineering study. If, after receiving this information, the council decides to proceed, the council must order the preparation of an environmental impact statement and a benefit/cost statement if they were not obtained before. Rights of appeal will arise as outlined in Part XIII.

The successful application of these proposals depends to a great extent on the knowledgeability of the farmers and the knowledgeability and attitudes of municipal councils.

An Alternative Procedure

In some areas of the province, the Committee was made aware of disturbingly negative attitudes on the part of municipal councils wherein, based on the evidence heard, worthwhile schemes were being prevented.

Lack of information concerning the proposed projects appeared to pose the chief stumbling block along with a reticence on the part of some councils to act. With this thought in mind, **the Committee recommends** that another procedural avenue be provided, as a new section to the Act, to ensure that the information necessary is provided to all concerned as a basis for supporting or not supporting a petition for a drainage works.

The Committee recommends that any local municipality should be **required** to act on the request of one or more ratepayers to initiate a preliminary examination of any new drainage works proposed in the request. It should be understood that the persons signing this request, in so doing, guarantee the payment of the costs of such preliminary examination. **The committee recommends** that part of the cost be paid as a subsidy by the Ministry of Agriculture and Food on the same scale as the normal grant structure.

The preliminary examination should consist of three reports: (1) an environmental impact statement; (2) benefit-cost calculations; and (3) a preliminary report by the engineer giving reasonable estimates of the total cost of the proposed works and alternatives. The Committee does not anticipate that the costs of these studies will be excessive but costs will vary depending on the size of the project proposed and the area of the province in which the proposal is initiated.

An Environmental Impact Statement

It is envisaged that an environmental impact statement would be produced by a committee of three people appointed by the municipal council and consisting of a representative of the local office of the Ministry of Agriculture and Food, the Conservation Authority resources manager (or where there is no conservation authority, a representative of the Ministry of Natural Resources, or where neither of these is available, a representative of the regional office of the Ministry of the Environment), and an impartial ratepayer resident in the municipality who would act as chairman.

The Committee was impressed with the principles and procedures outlined in the Green Paper on Environmental Assessment issued in September 1973 by the Ministry of the Environment. While this paper contemplates such assessments being made on major projects such as river dams, power projects, factories, and other installations which have significant environmental effects, it has relevance to our proposals in this instance. The Green Paper indicates that an environmental assessment is intended to facilitate the identification and resolution of environmental problems at an early stage, and this is essential in proposed new drainage works.

While the Committee is not completely persuaded that agricultural drains have great environmental impact in every case, it is prepared to recognize the possibility. Accordingly, **the Committee recommends** that an environmental impact statement on every new drain proposed in Ontario be filed with the council of the municipality in which the drainage works is proposed. The Committee feels that in many cases the environmental impact committee's report to council will be merely a brief statement to the effect that the work has been completed and that the conclusion is the environmental impact is nil. The environmental impact committee would, it is expected, make a more detailed and more formal report where there are complications.

Borrowing from the guidelines laid down in the Green Paper on Environmental Assessment, **it is recommended** that the basic environmental assessment document filed with the council would contain the following elements:

1. A project description which should be a brief but comprehensive outline of the project including a statement of objectives, physical description, proposed construction methods, and operating and maintenance procedures. Alternatives should be pointed out, including the alternative of not proceeding.

2. An environmental inventory including identification of the flora and fauna, geography of the site, probable changes in land use, and other factors that might be necessary to describe the situation.

3. A prediction of the impact on the natural environment as it applies to wildlife, lands and crops, and water resources.

4. A final evaluation which would set out the consequences of the project and its alternatives, including the environmental risks involved in undertaking the project.

Benefit-Cost Considerations

The present Drainage Act makes only passing reference to benefits and costs as related to drainage projects. Section 8 (10) of the Act provides than an engineer must report to the council the fact that he found a proposed works to be not required or impractical. Any landowner affected may appeal this report to the referee. It has been suggested to the Committee that an engineer seldom reports a project to be impractical, but usually accepts his appointment as an assignment to design and lay out a drainage works.

Section 36 of the Act indicates that any owner of land affected may appeal the engineer's report to the referee on the grounds "that the benefits to be derived from the drainage works are not commensurate with the estimated cost thereof." While the landowner may appeal on the grounds of a suspected negative benefit-cost ratio, it is obvious that he is not equipped or qualified to generate the data required to demonstrate that such a negative ratio actually exists.

The Committee finds that the Act's references to costs and benefits do not adequately serve present day requirements. Therefore, **the Committee recommends** that the engineer file with the council, a certificate, over his signature and under his seal, setting out that, in his professional opinion, the benefits accruing from the work will exceed the estimated costs or vice versa as established in the preliminary or final report as the case may be. Guidance for the engineer in arriving at this opinion, is available to him from study of the material and procedures in part VI of this report.

It is expected that the engineer will consult with the staff of the local office of the Ministry of Agriculture and Food or any other logical source of information in order to obtain data on yields, crop prices, etc. necessary for the formation of his conclusion.

In order to give the council a basis for decision, the engineer's certificate should indicate the degree of plus or minus that his opinion reflects. The Committee feels that such information would be of great assistance to the council in taking a decision to proceed or not.

As mentioned in part VI, there is a possibility that because of the legal requirement for outlet assessment on lands where improved drainage only is provided or indeed where the liability only is assessed, negative benefit-cost ratios may be quite frequently found by engineers. In these cases, the Committee strongly holds the view that responsible councils will make their decision based on their knowledge of the area and local conditions, yet fully aware that such decisions are subject to appeal by disaffected ratepayers or groups.

Preliminary Engineering and Report

During the Committee's hearings, particularly in the areas where municipal drainage activity has not been great in the past, the Committee heard from many individuals who felt that their rights had not been properly respected in the petition procedure. Some reported that they had been shocked to receive the engineer's report and realize the size of the assessment that they had committed themselves to when, they, as a favour, signed a petition at the urging of a neighbour. This dissatisfaction comes about because the present Act does not provide a means by which persons unfamiliar with the implications of a drainage scheme may obtain information upon which to base their decision whether or not to support a petition. Affected owners have often not been consulted or advised of possible alternative courses of action until the final report has been actually submitted. In the opinion of the Committee, there have been too many occasions in the past, where farmers have agreed to the proposal of a new drainage works without being in possession of sufficient information. The Committee feels that the filing of a pre-engineering report would do much to remove uncertainties and doubts.

The Committee therefore proposes that this new procedural avenue would require the engineer to make a preliminary examination and report to the council that would include: (1) a sketch plan indicating the tributary area and the benefiting lands; (2) input from all concerned ratepayers, railways, utilities, road authorities, etc.; (3) an on site meeting to be called by the township clerk; (4) a description of the proposed works with alternatives set out (for example, closed or open); (5) estimates of the cost of various alternatives.

It is proposed that the three reports to the council be filed within 45 days from the time of appointment of both the engineer and the environmental impact committee with power in council, by resolution, to extend the time up to a further 60 days.

On receipt of the reports and within 30 days of the filing date, the council must call a meeting of all ratepayers assessable for benefits (including utilities and railways), members of the environmental impact committee, and the engineer who prepared the benefit/cost statement and the preliminary engineering report. Subsequent to this meeting, after everyone concerned is aware of the costs and other factors, 60 days would be allowed for raising a valid petition and filing it with the council. If no valid petition has been received at the expiration of 60 days, the clerk would then notify the original petitioners and give them a 30-day deadline to file a petition, or failing that, to have the cost to date less grants added to the tax roll against their names, thus closing the matter.

The council is then faced with three technical reports on the project along with a valid petition and must now decide whether or not to proceed. If the council decides not to proceed despite three obviously favourable reports, an appeal procedure should be provided. Should it decide to proceed despite an unfavourable environmental impact report, an appeal may be launched on behalf of the environmental interests by the Minister of Natural Resources. If the council's decision frustrates farmers in their drainage requirements, the Minister of Agriculture and Food may launch the appeal.

Where the project proceeds after appeals and after the petition is signed, the costs of the preliminary studies should form part of the cost of the drainage works as calculated by the engineer. Where the project is accepted by the council but denied on appeal, the costs of the preliminary report must be paid by the municipality out of general funds and subsidized by the Ministry of Agriculture and Food, within the normal grant structure. Where the project is denied both by council and on appeal, the preliminary costs must be paid by all the petitioners and not just those who signed the original request. In this case also, similar grants would be available from OMAF.

The Committee feels that the council must assume some responsibility and that the project becomes the council's burden when it accepts the petition. Where the council votes against a proposal, however, and the appeal upholds the council's decision, then the petitioners pay their part of the costs of the preliminary examination.

It should be understood that requests such as those from the Minister of Agriculture and Food and from the Minister of Transportation and Communications are to be treated similarly to requests from a ratepayer and that the three preliminary reports must be filed with the council. The council keeps its responsibility of making the final decision. Requests from either Ministry are not to be construed as mandatory on the council to carry out the complete proposal and construct the works.

IX. THE ENGINEER

The Present Function of the Engineer

The engineer performs one of the most important functions under the present Drainage Act, with his appointment being a pre-condition to many of the projects that can be undertaken under The Act. The engineer's function has been described as semi-judicial in nature since he determines many matters which directly affect the rights of individuals. It is inaccurate perhaps to describe the engineer as an employee of the municipal council or of anyone else. His appointment and duties are specifically prescribed in The Act, and the method of carrying out those duties is not to be dictated by any other agency.

The definition of engineer in The Drainage Act includes a surveyor registered under The Surveyors Act. Therefore, an Ontario land surveyor can be appointed under The Drainage Act. For convenience, however, the Committee will refer to the engineer as the person appointed to perform the statutory duties imposed on him. The Committee has recommended elsewhere in this report (part XV) that the definition of engineer be amended to include corporations and partnerships of engineers and Ontario land surveyors.

There are several sections of The Act under which the engineer's appointment can be made. Under Section 19, an engineer can be appointed to apportion the assessment charged against a parcel of land where that parcel is divided by a change of ownership. An engineer can be appointed under Section 51 to vary an assessment on the grounds of changed circumstances. Under Section 52 (2), an engineer is appointed where the Province of Ontario or any municipality or suburban road commission relocates a drainage works that is on or adjacent to a road. An engineer is appointed under Section 4 when drainage works are to be constructed on requisition. The most important sections under which the engineer is appointed are 3, 49, and 53 where, respectively, drainage works are constructed on petition, drains are to be maintained or repaired, and drains are to be improved.

The duties of the engineer are contained in Sections 3, 4, 6, 7, 8, 9, 10, 13, 14, 15, 16, 17, and 18, the most important of which is Section 8. In essence, the engineer is required to make an examination of the area, and to prepare a report including plans, specifications, cost estimates of the drainage works, and an assessment against the lands and roads in the area requiring drainage. He has the power to enter upon any land during the course of his examination. Under Section 8, he is required to specify the structures necessary for the works, such as bridges and culverts, and he must allow compensation to owners of land for certain matters such as damage to crops, severance, private drains, rights of way, and the impracticability of taking a drain to a sufficient outlet.

In determining the assessment to be imposed on the lands and roads to be benefited by the drainage works, the engineer is required to show the approximate number of acres affected by the drainage works in each parcel. He must assess for benefit, outlet liability, and injuring liability, and he must separately list the lands in each municipality that are assessed. Within six months after his appointment, the engineer must prepare a formal report and file it with the clerk of the initiating municipality. The engineer's greatest contact and possible conflict with the general public arises from his determination of the appropriate assessments on particular parcels of land and the allowances he must grant for such matters as severance, damage, and rights of way.

Difficulties with the Present System

In general, the Committee is satisfied that the present system works with reasonable efficiency and that the present functions of the engineer should be retained. The engineer is the most qualified person to plan the nature and structure of drainage works in a detailed way. Assessments and allowances are so intertwined with the works themselves that the engineer should continue to be responsible for determining them.

The Committee received a large number of criticisms and complaints that related more to the manner in which the engineer's functions are preformed than to whether or not the engineer is the appropriate person to perform them. Aside from the occasional complaint of incompetence, the major criticisms were aimed at the engineers' reports and concerned lack of detail, difficulty of understanding, failure to set out project objectives, insufficient specifications, lack of clarity in financial details including estimates, assessments, and allowances, and lack of communication between the engineer and the parties affected by his report. Although some of these criticisms are justified, the committee feels that most of them arise from a lack of communication and from the notable lack of uniformity to date in the way engineers conduct their examinations and prepare their reports. Furthermore, there has been insufficient direction given to engineers by public agencies and professional associations.

Criticisms were also directed at the Court of Revision where, on assessment appeals, the engineer's assessment is often accepted by Court members who are usually the same municipal councillors who adopted the engineer's report. Many feel that if the engineer is present at the Court of Revision, the landowner has little chance of successfully challenging the assessment.

Proposals

As already mentioned, the Committee believes that the basic system presently in effect should be continued. However, the Committee feels the system can be made more effective if two basic principles are borne in mind. First, there should be a greater degree of communication between the engineer and all affected parties, including landowners, public utilities, road authorities, municipal councils, conservation authorities, and government agencies. Second, measures should be taken to ensure much more uniformity in the way engineers' reports are prepared and assessments and allowances are calculated. The Committee's recommendations in this part of the report are intended to advance these basic objectives.

The Committee recommended elsewhere in this report (part VIII) that all affected parties in the construction of a new drain should be given notice of the proceedings at each stage. Notice will be given before work begins on either the preliminary studies where authorized or on the preparation of the final report. In every case where new construction or major improvements are anticipated, an on site meeting will be held to allow all concerned the opportunity of making representations. The Committee hopes that these provisions will effectively increase awareness of the conduct of the project and the engineer's role in it and that they will decrease the unfamiliarity with the engineer's function that has, to date, produced some dissatisfaction.

The Committee believes it is of paramount importance to develop guidelines and uniform procedures if the construction of drainage works throughout the Province is to be maintained at a consistently high level. The Committee does not intend to tie the engineer's hands in exercising his professional judgement, but some direction nevertheless is needed. Some of the Committee's recommendations will involve amendments to the legislation, others will simply attempt to assist the engineer in his duties, and still others will relate to efforts that government agencies and professional organizations will have to make at a later date.

The Committee recommends as follows:

1. The engineer has been defined in part XV of this report. Where the engineer appointed is a corporation, association, or partnership, **the Committee recommends** that the corporation, association, or partnership should be required within 10 days of the date of appointment to notify the council of the name of the individual engineer or land surveyor who will have charge of the project and who is thereby authorized to sign the necessary documents such as the report, completion certificate, etc.

2. **The Committee recommends** that the first duty of the engineer in the case of new construction should be to determine the area to be benefited in order to confirm the validity of a petition or to establish the requirements of such a petition where the petition has not yet been raised. In so doing, he must obtain some basic information from the petitioners or initiators of the scheme as to their expectations of the drainage works and the nature of the works required.

3. After the clerk has notified all affected parties in the area to be benefited and other persons required to be notified, **the Committee recommends** that an on-site meeting be held at which the engineer will hear any representations that interested parties wish to make. Where preliminary studies have been authorized, the engineer could make his preliminary examination at the time of the meeting. Where a final report has been authorized, the detailed survey of the drain could be commenced in conjunction with the on-site meeting.

4. In the course of all drainage surveys, **it is recommended** that the engineer be required to place sufficient bench marks to permit reasonable control of elevations for future repairs or improvements. Such bench marks should not be more than one mile apart, and in any case should be available at every road crossing or other logical means of access to the drainage works, exclusive of farmers' lanes, and at each end of shorter drainage projects.

5. The whole of Section 8 of The Drainage Act should be redrafted, since it is presently somewhat confusing and illogical in sequence. **The Committee also recommends** some specific amendments to Section 8. The Committee's attention was drawn to instances where it was unjust to force a public road authority to bear the excess cost of a culvert modification occasioned by a change in land use from agriculture. For example, culverts may not be of sufficient size if parking lots and paved streets and urbanization have increased the rate of run-off. In such instances, required changes should be charged to the drainage works rather than to the road authority. Bearing in mind that the Committee has recommended that public road authorities are to be treated the same as utilities, Subsection 2 of Section 8 should be amended accordingly. Subsection 3 of Section 8 should be deleted entirely. The items covered in Subsections 4 and 5 are related and should be dealt with in one subsection under the revised statute so that the access bridges, farm bridges, and water gates thus dealt with should be built and maintained by the drainage area. Concerning allowances, **the Committee recommends** that the engineer be permitted to grant allowances for matters not strictly within the expression "lands and crops," such as ornamental bushes, lawns, trees, and fences.

6. Where it would be advantageous, the engineer should be required to show assessments in the fractional part of the whole cost as well as in money.

7. **The Committee recommends** that the engineer be given the authority to make block-type

assessments in built-up areas as opposed to the present system of individual assessments on each parcel of land. This would require the engineer to differentiate only between streets eligible for Ministry of Transportation and Communications grants and urban land. He would be required to delineate the areas assessable to the scheme, and the drainage assessment would then be collected by means of a charge against the ratable property within the area to be assessed. This alleviates the necessity of individual treatment and effects a considerable saving in both time and administrative costs.

The Committee recognizes that this recommendation would involve a different approach to the notification of the parties involved and it suggests some form of advertisement such as is used in certain other statutes. The Committee notes that the council presently may, within limitations, absorb small assessments in the general rate of the municipality. The Committee suggests that the council might be given the alternative of either notifying affected parties within the area being assessed or absorbing the assessment in the general rate.

Impressive evidence of the need for a change in assessment procedures for urban areas was presented and, considering the rate of urbanization in the Province, the Committee strongly recommends that appropriate amendments be made to remove the necessity of individual assessments in built-up areas.

8. The engineer should not be permitted to attend the Court of Revision unless his presence is specifically requested by an appellant. If no such request is forthcoming, the engineer should be required to file with the Court of Revision a written statement that gives his reasons for the appealed assessments. A copy of such statement should be forwarded to the appellant prior to the hearing. In appellate proceedings after the Court of Revision, the engineer should make himself available to and co-operate with the municipal council in preparing the appeal.

Suggestions for Improved Procedures by the Engineer

1. The Committee feels that the pre-engineering report should not provide more than an outline of the drainage problems, a discussion of a proposed solution with alternatives, and approximate cost estimates relating thereto. Included with the submission of a pre-engineering report, there should be a sketch plan of the tributary area, the lands to be benefited and the approximate location of the proposed drainage works. The Committee recognizes that more detailed work or supplementary information may be required in some instances to provide council or the affected owners a proper basis for decision. The engineer must therefore be allowed some latitude while at the same time maintaining communication with the council and the affected parties.

The engineer will be preparing his benefit-cost statement either at the time the pre-engineering study is being prepared or in conjunction with the preparation of the final engineering report. The details of this statement are outlined in part VI of this report.

2. The engineer should attend the municipal council meeting at which the preliminary studies are considered. The engineer can be of invaluable assistance to the council and to interested parties who attend the meeting in explaining his preliminary report and its ramifications.

3. Where a final report has been authorized, the engineer should undertake his field study to obtain the information needed for preparing his report. This field study would include staking and the taking of levels along the course of the work, obtaining details as to channel dimensions, watershed limits, individual parcels of land, and the effect the drainage works will have on those parcels. On completing the field survey and investigation, the engineer should undertake his final design and prepare any required plans, profiles, and detail drawings, as well as the specifications. He must also determine allowances to be granted, estimate the total cost of the drainage works, and prepare assessment schedules.

While the Committee does not wish to lay down firm guidelines as to how assessments and allowances should be prepared, it does note that there is probably less uniformity in the preparation of these matters than in any other aspect of the engineer's report. The engineer must **at least** be fully familiar with the definitions of benefit and outlet liability as redefined in this report. It should be noted that benefit as used for assessment purposes is not the same as the economic benefit related to benefit-cost considerations, although a proportional relationship often exists. This is one aspect that should be co-ordinated between the Association of Professional Engineers, the Association of Ontario Land Surveyors, the Ministry of Agriculture and Food, and the University of Guelph. If these agencies cannot work out such guidelines through co-operative effort, the Committee feels that only the Ministry of Agriculture and Food can do so effectively.

4. The Committee has noted instances in the Province where the design of a particular drainage works has been inappropriate to the needs of the area requiring drainage. Again, the appropriate professional associations and government agencies must work together to provide design and specification guidelines. If the necessary steps are not taken by these bodies, the government itself may be required to act.

5. In both his preliminary and final reports, the engineer must obtain sufficient pertinent information relating to title drain outlets, access culverts, gas and oil pipelines, water and hydro services, buried cables, roads, and railways. The engineer should make every effort to communicate with and co-operate with the agencies responsible for such matters.

6. In preparing his report the engineer should endeavour to explicitly state the problems requiring a solution, the alternatives considered, and his reasons

for adopting the proposed solution. Although details will vary depending on the size and nature of the project, the engineer nevertheless should cover these matters in some way. The engineer's report should provide separate schedules of assessments and allowances for each branch of the drain and composite schedules of assessments and allowances for the drain as a whole. Furthermore, the amount of land assessed in each branch should be stipulated in the schedules.

7. For drain improvements, the engineer should bear in mind that he cannot simply prorate the assessments which were used for the original drain construction. He must reassess on the basis of the work presently being undertaken and in light of present circumstances.

8. In addition to attending the meeting at which the preliminary report is considered, the engineer should, where circumstances warrant, attend the meeting at which the final report is considered. In general, the engineer should attempt to make himself available to affected owners to discuss and explain the various facets of the proposed scheme.

X. THE DRAINAGE SUPERINTENDENT

Under the present Drainage Act, the council of a local municipality may appoint one or more commissioners to assist the engineer and to supervise the maintenance of any drainage works. The council may require commissioners to report annually on the state of repairs of all drainage works. The commissioner has the same powers to enter land as the engineer. Under Section 55 of the Act, the commissioner has the power to require a person responsible for an obstruction in the drain to remove it.

The Committee believes that the appointment of an officer who reports to the municipal council and is responsible for supervising the construction and maintenance of all drains within the municipality is most worthwhile and should be continued. However, the present Act is deficient in that it does not clearly specify the duties of this officer and makes no mention of any particular qualifications or training he should have. Furthermore, the appointment of such an officer is not mandatory, and many municipalities have not made such appointments.

The Committee therefore recommends that every municipality which undertakes projects under The Drainage Act be required to engage a "Drainage Superintendent." The Committee feels that, while perhaps it is only a matter of preference, the change in name would serve to distinguish this official from the commissioners appointed under the present Section 59 to operate and maintain pumping schemes. In the Committee's opinion, the latter commissioners still would be necessary, although their status would be secondary to the drainage superintendent. The Committee recognizes that some municipalities may find it difficult to justify a full-time superintendent. It would be possible, however, for two or more municipalities to jointly retain a superintendent or for a municipality to engage a part-time superintendent who is capable of becoming qualified.

Duties of the Superintendent

While the duties of the drainage superintendent must necessarily be somewhat general, they can be divided into two major areas of responsibility:

1. The implementation of new construction of or major improvements to the drainage works; and

2. Maintenance, repairs, and minor improvements to the drainage works.

The implementation of new construction and improvements would necessarily be carried out in co-operation with the engineer. The superintendent's duties should include making arrangements for tenders, evaluating the contractors' bids, and submitting recommendations to the council, as well as providing on-site supervision of the construction operations including the authorization of progress payments where applicable. These functions would be carried out while maintaining sufficient liaison with the engineer so that the engineer will be in a position to properly sign certificates of completion for making final payment to the contractor and suppliers and for Ministry of Agriculture grants. The superintendent should be given sufficient latitude to make reasonable minor changes in the specifications where field conditions or common sense dictate, provided that such changes do not affect the capacity or effectiveness of the drainage works. He should also be required to maintain liaison with all property owners affected by the construction of or improvement to the drainage works.

It is anticipated that the superintendent would systematically organize and implement programs to maintain and undertake repairs to all the municipal drains under his jurisdiction. In the case of improvements made without the necessity of an engineer's report the drainage superintendent should provide guidance to the council as to the advisability of such a step in addition to subsequently arranging for and supervising the work.

Since the Committee recommends (part XI) that the functions of maintenance, repair, and minor improvements be undertaken within budgetary limitations established by the Ministry of Agriculture and Food, it would be the drainage superintendent's duty to make the necessary submissions to the Ministry so that the proposals could be reviewed and budgets established for grant purposes.

The Committee recommends that the drainage superintendent be required to report to the municipal council periodically on the condition of all drains within the municipality. It would be necessary for the superintendent to maintain contact with landowners as to the condition of local drains, particularly in municipalities where there is a great deal of drainage activity and where it would be impossible for the superintendent to physically inspect all drains.

Qualifications and Training

The superintendent must be capable of interpreting plans, profiles, and other related documents such as the engineer's report and the specifications. He should have a working knowledge of the engineer's level and should be able to set and check grades in the field. He should have some knowledge of financial matters so that he will be able to control costing; that is, he should be able to maintain running totals on expenditures and summarize costs upon completion. He should have or be capable of assimilating a general knowledge of basic drain design, erosion control, and in some cases pumping operations. The Committee feels that these are the minimum qualifications for a competent drainage superintendent.

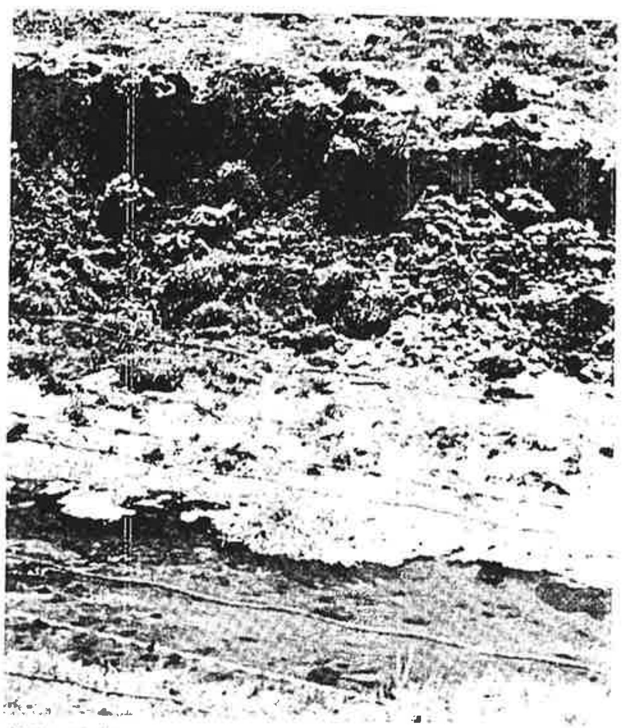
The present Act makes no mention of any particular qualifications and does not require any particular course of study to acquire them.

The Committee therefore recommends that the proposed drainage superintendent be required to successfully complete a course of study satisfactory to the Ministry of Agriculture and Food. The Ministry of Agriculture and Food and the University of Guelph should jointly establish a program to develop a suitable course with an examination to initially qualify the superintendents. The Ministry and University should also undertake a continuing program of education in which all drainage superintendents would be required to participate so that they may be kept fully aware of improving techniques, materials, and equipment.

Local municipalities should be required to arrange for the superintendent's attendance and financing at such courses. Expenses incurred for this purpose should be eligible for grants from the Ministry of Agriculture and Food.

Compensation

The Committee has carefully considered the proposition that there is a similarity between a township drainage superintendent and a road superintendent. The road superintendent supervises maintenance and construction programs relating to the roads system throughout the township. The Committee has noted that such road construction projects often benefit only specific areas of a municipality and that the road superintendent's duties involve the implementation of these projects. Similarly the drainage superintendent's responsibilities benefit specific areas in a municipality. Therefore, **the Committee recommends** that the drainage superintendent's salary be borne by the general rate of the municipality. While this could be considered a burden on residential sections of a municipality, it was noted that there are officials in most rural-urban municipalities who are paid out of the general rate of the township while basically providing service only for the urban areas. Since the basic functions of the drainage superintendent are intended to properly implement and prolong the useful life of municipal drains, **the Committee also recommends** that the salary of the superintendent be subject to the normal grant structure and available from the Ministry of Agriculture and Food.



Bank erosion on an open drain — a job for the Drainage Superintendent.

Inlet erosion and improperly leveled spoil bank.

XI. MAINTENANCE, REPAIR, AND IMPROVEMENT

The treatment of drains after they have been originally constructed was the subject of much discussion both at the Committee's public hearings and in its subsequent deliberations. In introducing the topic, it would seem appropriate to first define the terms the Committee agreed upon during its study of this area. These can then be amplified by discussing their functions in the operation of a drainage works. This discussion also involves the procedural aspects of implementing the various operations by a municipality. The Committee adopted the following definitions to differentiate between the objectives and the means by which these objectives should be achieved:

1. Maintenance: means the preservation of a drainage works;
2. Repair: means the restoration of a drainage works to its original condition;
3. Improvement: means the reconstruction of or adding to a drainage works so as to increase the effectiveness of the system.

Maintenance and repair are implemented at present under Section 49 of the Act and are considered synonymous to all intents and purposes. The Committee does not consider this sameness to be entirely true of the objectives, and the two functions will be treated separately in this discussion. An analogy might be drawn between the maintenance of a car, which is generally considered to involve oil changes, lubrication, etc., and the repair of a car, which might mean rebuilding a motor due either to lack of maintenance or to its age. In other words, the Committee viewed maintenance as taking steps to avoid the need for repair work. For the most part, this concept limits maintenance of drainage works to vegetation-control undertaken as a preventative measure where this was not provided for originally.

Maintenance procedures, then, generally involve operations that are intended to retard or prevent the growth of vegetation harmful to a drainage works and to remove such growth or other debris before the drainage works can be adversely affected. These operations could also include planting appropriate types of vegetation on channel banks or in natural runs above tile drains to stabilize the soil conditions and inhibit erosion. As a preventative measure, erosion protection by the use of riprap, piping, or other structural means might be regarded as maintenance under certain circumstances. However, these operations would be better considered as part of drain construction.

Repairs are steps that must be taken to restore a drainage works to its original condition when it has deteriorated to the extent that the system is not operating effectively. The need for repairs can be attributed to faulty design, poor construction methods, lack of proper maintenance, or the age of the drainage works. Some types of drainage works eventually break down and become ineffective even with regular maintenance. Repairs involve removing sediment and other debris that has washed into the open channel or tile drain due to erosion or that has built up over the years and also repairing washouts and erosion on these drains. In the case of pumping installations, repairs can be mechanical in nature or can relate to erosion in the area of the pumphouse or in the dyking system. In short, repair work is intended to make a drainage installation comparable to that originally installed and is the appropriate treatment to be undertaken when the original installation is still adequate for the needs of the drainage area.

The nature and degree of improvements to a drainage system are almost unlimited. At present, Section 52 of The Drainage Act provides a means by which minor improvements may be undertaken without an engineer's report. Such improvements usually involve deepening an open channel or part thereof to provide a proper outlet for surface or subsurface installations constructed subsequent to the municipal drain. Another logical application is extending the drainage works downstream from the original termination where it proves beneficial to the system.

Improvements that require an engineer's services are presently done under Section 53 and generally relate to substantial enlargements of open and covered drains or increased capacity, improved controls, or major modifications to a pumping system.

The Committee deliberated at length on the foregoing objectives, the means of obtaining these objectives, and also by whom and how they would be implemented. At present, maintenance, repair, and minor improvements can be undertaken without an engineer's report and **the Committee recommends** that this be continued. **The Committee also recommends** that Ministry of Agriculture and Food grants be extended with certain limitations to these activities. Briefly, these limitations would involve budgetary restraints imposed by the Ministry in the case of maintenance and repair, which as now would be dealt with as one function. In addition to the Ministry budgetary restraints, the minor improvements could not exceed prescribed financial limits (see part XV, Section 52). uld not be made available where a municipality has not engaged a qualified drainage superintendent.

The Committee decided that the drainage superintendent could initiate these programs with the approval of the council. Programs would be based on the superintendent's recommendations, complaints by affected parties, and other input received by the council. The Committee also felt that the recommended limitations on these minor improvements were sufficient, and alleviated the requirement for any avenue of appeal by affected parties on their assessments. The Committee did recognize and has recommended accordingly the need for a means similar to that provided by the present Section 51, whereby a new assessment could be obtained from an engineer where the situation warrants.

Major improvements requiring an engineer's services must be effected by passing a by-law similar to that required for the initial construction of a drain. Since the need for drainage has already been established in these cases, the Committee did not consider that a majority petition of the benefiting properties should be required. However, considering the changing requirements and objectives which often dictate major modifications to a scheme, **the Committee recommends** that environmental impact and benefit-cost statements be filed with the engineer's final report. Also similar to the case of initiating a new scheme, the Committee recognizes the need in certain instances for preliminary information before proceeding with a final report. **The Committee therefore recommends** that the council be permitted to authorize that any or all of the following elements be included in the preliminary information: environmental impact statement, benefit-cost statement, a preliminary engineering study, and that grants be made available for the costs incurred.

The Committee has evolved a procedure that is intended to permit these projects to proceed expeditiously while at the same time insuring that all affected parties have ample opportunity to provide input relating to their specific requirements. The following step-by-step outline is the procedure the Committee recommends for processing a project which has either been activated on the notice of an affected owner (including the road superintendent), or by the recommendation of the drainage superintendent.

1. The clerk of the township council notifies all affected parties including the Ministry of Agriculture and Food that work on a drainage scheme is contemplated. A period of 20 days is allowed for these parties to make submissions to the council with respect to the drainage works.

2. At the next regular meeting of council following expiration of the 20 days, the council engages an engineer with instructions either to obtain preliminary information or to proceed with a final report. Any preliminary information developed is intended only for the use of the council in its decision on the advisability to proceed. The decision of the council at this stage is subject to appeal by any affected party.

3. In the case of a decision to proceed, the engineer prepares and submits his final report on the drainage works. At this time, the clerk must notify the affected parties of the filing of the report and must place the consideration of the report on the agenda for the next council meeting, providing a minimum of 10 days notice.

4. Council considers the report and, if it is adopted, all procedures thereon shall conform with those set out elsewhere in this report (part XV).

XII. CONSTRUCTION PRACTICES

The drainage construction practices that have evolved over the years have been dependent to a great extent on the technological advances in equipment and materials. Private farm drainage systems that are intended to remove surface water only are constructed as open ditches, varying from plowed furrows to channels that are excavated by draglines, backhoes, or bulldozer-type equipment. Open channel drains are also used in private construction as outlets for underdrains.

Underdrainage has been provided almost exclusively by clay tile, although perforated plastic pipe has become widely used more recently. The standard tile size is presently 4 inches and may be spaced from 20 to 100 feet apart in flat lands. In rolling country, the tile lines often follow the low water runs and usually pass beneath the low spots in the field. Main or header tile are often used instead of ditch-type collectors and discharge into municipal outlet drains or natural watercourses.

The majority of the installations for municipal drains are open channels. At present these channels generally have a minimum bottom width of 3 feet and vary in depth depending on the objectives. A channel conducting surface water only is not likely to be as deep as one conducting subdrainage. The side slopes vary from 1 foot horizontal to 1 foot vertical in heavy soils to as much as 4 feet horizontal to 1 foot vertical in certain lighter soils. A minimum of 1½ feet horizontal to 1 foot vertical has been widely adopted. Although flatter slopes would be desirable in light soils, farmers are somewhat reluctant to give up the amount of land necessary for a completely stable slope situation. Thus many channels are constructed steeper than the optimum with the result that frequent repairs are necessary and erosion often occurs.

In the early years, many of the open municipal drains were dug with teams of horses pulling hand-operated scrapers. By the later 1920s, these had been mostly replaced with drag lines, which is the equipment still being used today. The earth excavated from the channel is deposited on adjoining land and is subsequently spread and levelled with a bulldozer usually to depths between 6 and 24 inches depending on location and circumstances. In recent years, the tendency in cropped lands has been to the shallower depths. Leveling excavated material is delayed where possible until the crops have been harvested from the adjoining land and the scheduling is undertaken as much as is practicable to avoid crop loss.

Brush and small trees can usually be pulled out by the dragline, with chain saws removing larger timber and bulldozers assisting in stump removal. The timber debris is left for the owner's disposal or is piled and burned by the contractor. Pipe sections for culvert installations are usually supplied by the commissioner and placed and backfilled by the contractor.

Side-mounted back hoes have been developed in recent years for working on open drains. These can be driven along the drain bank while the side mounting allows work in the ditch beside the vehicle. While having certain advantages with respect to bucket control, this equipment does not have the versatility a dragline offers. New open channel construction on a large scale is sometimes suited towards the use of road scrapers, although this is not general.

Where rock and unstable soils such as muck are encountered special treatment is necessary. Weathered rock may often be removed by the use of a backhoe or bulldozer, however, solid rock must generally be removed by explosives. Unstable solids encountered in swamp and bogs usually require the use of timer mats to support the excavating equipment. In some instances excavation can only be effectively carried out during the winter with the assistance of frost. This type of work must sometimes be undertaken in more than one stage by partially excavating the channel in the first pass in order to dry out and stabilize the immediate area and then making subsequent passes until the channel dimensions are achieved.

Erosion control is an important consideration both in the design and the construction of open channels, particularly where the drainage works is to be located in lighter soil. Erosion can result from a variety of reasons including surface flow off adjoining lands and flow from tributary ditches or tile drains. The presence of a water-bearing layer below the ground surface through which ground water flows undermines and causes erosion of this layer and subsequent bank failure. Erosion can also be caused by flow with the channel where excessive velocity creates problems at turns and in the bottom and results in bank failure. Obstacles and debris in open channels can contribute to erosion by deflecting the flow into the channel banks.

Where erosion can be anticipated, it is best treated during the original construction of the drain. There are instances, however, where spot treatment is possible at a lesser cost than undertaking preventive measure over a large area. Erosion from surface flow off adjoining lands is generally treated by ensuring that the flow enters the channel at places where it can be properly protected by rubble, pipe entries, or other suitable means, and this treatment usually involves some form of dyking. Erosion at the entries of tributary ditches or tile drains, or a combination of both, is of a localized nature and as such can be effectively treated. Protective walls of stone or some form of riprap may be used for channel entries where the erosion is not severe with a more sophisticated form being used where the situation warrants.

Tile outlets are usually protected by the installation of a rigid pipe that is sufficient in length to carry the water out into the ditch and that extends sufficiently into the bank for stability. This means can also be used for a great variety of open ditch discharge points. Where tile and open channels coincide, the entry works must be designed to handle both elements of flow and often requires careful design.

The erosion problem related to subsurface flow is very difficult to control except by some form of intercepting tile. This is usually very expensive and can only be justified where serious and progressive erosive conditions exist. Ditch-bottom erosion caused by excessive velocities of flow in a channel is also often expensive to effectively control. Reducing the gradients is the only control and can be done with weirs or check dams at invervals along the drain. These can be constructed from such materials as gabions, timber, or concrete and may involve sophisticated drop structures that require considerable design skill to contain the flow and absorb the energy generated by the water. Rubble or similar protection can be used effectively at sharp turns to control erosive effects. In some cases, the judicious use of vegetation can inhibit many types of erosion.

The stability and longevity of an open channel can be greatly improved if the bottom of the channel can be kept dry. There was a period during and before the 1930s when many drains were constructed with a tile sunk in the bottom of an open channel. These installations removed the moisture from the bottom of the drains greatly reducing maintenance costs and providing a better conductor for surface flow. Since the tile in these drain bottoms generally lacked adequate capacity for present day subdrainage, most of these installations have since been improved as open channels.

To a limited degree, equally effective channels that are deep enough to conduct subdrainage flow have been constructed with a small tile drain installed below the ditch bottom and taken to a sufficient outlet to keep the ditch bottom dry. Such an arrangement can be incorporated best either in a new channel or in a major enlargement to an existing channel, providing the relative elevations are favorable. The earth excavation can be carried out in two stages in these cases. First, the upper part of the channel can be constructed to a depth and width that is suitable for installing the small tile with a conventional trencher. Then the balance of the channel can be completed.

Some reference should be made to the ways vegetation can be controlled or removed from open channels. Newer and better chemicals and application methods are being developed every year. Chemical control, however, involves problems of potential damage to adjacent crops and possible water pollution. Effective chemical sprays have been developed for cattails and approved for use by the Ministry of the Environment. There are also effective chemicals for use on willows and other forms of brush. Newly developed equipment and techniques have greatly reduced the dangers of spray drifting to adjacent areas. Accessibility is a matter of some importance, and drains that are located along roadsides are by far more convenient to treat with sprays.

Equipment has recently been introduced on the market in Ontario that incorporates a mowing bucket mounted on a sideboom vehicle. Experience with mowing machines is limited at present and the practicability of this type of equipment has not been proven.

Although chemicals and techniques for vegetation control are available and in use, there are not many townships with organized programs in operation. It is hoped that the recommendations included in this report will encourage these types of programs.

Construction methods are much the same for both municipal and private covered drains. The contractor generally distributes the tile or pipe for the scheme along the course of the run for municipal drains, whereas the farmer often does this job for private installations. The contractor then uses a tiling machine to excavate the trench along the desired route and to suitable grades. Clay or concrete tile sections are placed into the trench either manually or with a sideboom or other mechanical means. The tile are then blinded with top soil (or sod where practical) to hold them in place and protect them from stones in the balance of the backfill. The excavated material is then put back into the trench by a grader, bulldozer, or some form or equipment specially designed for the task. Tiling machines are available that undertake all these functions in one operation. Where tile drains are installed in sandy or otherwise unstable soil, it is good practice to wrap the joints with fiberglas sheeting, which allows water to pass through but filters out sand to a considerable extent. Plastic tiles can be wrapped with sheeting in the manufacturing plant. Polyethylene underlay is often used for stability in this type of soil.

A relatively new type of machine is being used to install plastic pipe tile. Instead of excavating a trench, placing the tile, and backfilling it, this new machine plows in the tile in a manner similar to that used for a telephone cable. Laser beam equipment is used to control grades. This method is most often used in the smaller sizes for private installations and requires special treatment where large stones are encountered. The Committee received complaints that sometimes contractors did not go back and treat such locations with resulting defects in the work. Tile drain inspectors expressed concern about this problem and also about the lack of an effective way to check grades for this type of construction. Manufacturers' representatives indicated to the Committee that research was being undertaken on a recording device that would indicate on paper what was happening below the ground as the work proceeded.

The current methods for installing tile drains seem to be working reasonably well. Technological advances in equipment and materials are being implemented which have improved construction and installation techniques at a fairly rapid pace. Licencing tile drainage contractors has improved the quality of the work, and manufacturers are developing quality standards for their various products.

XIII. THE APPEAL PROCEDURE

The Present System

Under The Drainage Act, appellate jurisdiction is exercised by three tribunals: the Court of Revision, the County Court judge, and the Referee.

The Court of Revision is established under Section 30 of the Act and consists of three or five members appointed by the council of the municipality. Under Section 31, the Court of Revision hears appeals by landowners from the engineer's assessment of their lands following adoption of the engineer's report by provisional by-law. The Court of Revision also hears appeals under Section 51 following reassessment of land arising from changed circumstances.

The County Court judge hears appeals under Section 33 from decisions of the Court of Revision and against the omission, neglect, or refusal of the Court of Revision to hear or decide an appeal. The judge's decision is final. The judge can also hear an appeal from the owner following the apportionment of an assessment which results after the subdivision of a parcel of land if the assessment is greater than $200. Under Section 23, the judge has power to review the engineer's account on the application of the council of the municipality.

Under the Act, the Referee exercises broad jurisdiction, both appellate and original. He hears appeals on a wide variety of matters, some of which may be originated in his office that are not by way of appeal from some other tribunal. The office of the Referee is established under Section 66 of the Act, and he has all the powers of a Supreme Court judge under Section 67. His jurisdiction is not set out in any one part of the Act, but rather his catalogue of powers is scattered throughout a number of sections. The Referee's most important jurisdiction is found in Section 36 of the Act, under which a landowner or a public utility can appeal from the engineer's report on any of the following grounds:

1. That the engineer's report does not comply with the requirements of The Drainage Act;

2. That the benefits to be derived from the drainage work are not commensurate with the estimated cost thereof; and

3. That the drainage work should be modified on grounds to be stated.

Under Section 37, an appeal can be taken from the engineer's report where the report is to the effect that the drainage work is not required or is impractical or cannot be constructed under Sections 3 or 4 of the Act. The decision of the Referee under Section 37 is final. Under Section 35, a conservation authority may appeal from the engineer's report on the ground that the works will injuriously affect a scheme undertaken by the conservation authority. The council of a municipality other than the initiating municipality can appeal from the engineer's report on a variety of grounds contained in Section 38 (2). Under Section 50, any such municipality can also appeal from a provisional by-law authorizing repairs, enacted by the initiating municipality. The appeal can be made on the ground that the amount assessed against the lands and roads in the municipality is excessive, or that the work provided in the by-law is unnecessary, or that the drainage works has never been completed through the fault or neglect of the municipality whose duty it was to do the work. Under Section 51, the council of a municipality liable for contribution to a drainage works may apply to the Referee on the ground of changed circumstances for permission to procure an engineer's report to vary the assessment. Any municipality served with a copy of the engineer's report obtained under this procedure may appeal to the Referee from the engineer's findings as to the portion of the cost of the drainage works for which the municipality is liable. Under Section 23 (4), the Referee can entertain an appeal from a County Court judge's decision on a review of the engineer's account if the account exceeds $500.

Under Section 61, there are similar rights of appeal to the Referee on an abandonment of a drainage works. Sections 48 and 53 confer rights of appeal on a reassessment where insufficient funds have been provided for and appeal upon a reconstruction.

In addition to the strictly appellate jurisdiction conferred on the Referee, he is given some rather broad powers of a general nature that are usually exercised by ordinary courts in other cases. Under Section 67, the Referee may grant an injunction (an order restraining someone from doing something) or a mandamus (an order requiring someone to do something) in any matter before him. Section 76 of the Act provides that a court or judge before which an action is brought may order the action to be transferred to the Referee. Section 73 appears to confer the broadest powers on the Referee. It provides:

> Subject to Section 76, applications to set aside, declare void or otherwise directly or indirectly to attack the validity of any petition, report of an engineer, resolution of a Council, provisional by-law or by-law relating to a

drainage works, as well as all proceedings to determine claims and disputes arising in respect of anything done or required to be done under this Act or consequent thereon, or by reason of negligence, or for a mandamus or injunction, **shall be made to and shall be heard and tried by the Referee,** who shall give his decision and his reasons therefor.

The jurisdiction of the Referee to quash a by-law is reinforced by Section 44, which provides that if an application to quash is not made to the Referee within three months after the passage of the by-law, the by-law is valid and binding according to its terms.

Notwithstanding the apparently all-encompassing nature of Section 73, the Committee is aware of the decision of the Referee in *City of Niagara Falls vs. The Township of Niagara* (June 1966). In this instance, the Referee decided that Section 73 does not of itself confer the right to apply to quash a provisional by-law, but that it is only a catalogue of matters in which the Referee has jurisdiction. If that is indeed the case, then the purpose of Section 73 is unclear and only adds confusion to the Act.

The Referee decided 57 cases from 1966 to 1973. A summary of some of the more important decisions of the Referee is contained in Appendix IV. The procedure to be followed in proceedings before the Referee is governed by Ontario Regulation 227. Needless to say, the procedure is complex and would be difficult to follow without a lawyer's assistance.

Section 83 of the Act provides a further right of appeal from a decision of the Referee, except as otherwise provided in the Act. One instance in which there is no appeal concerns a decision of the Referee under Section 37, where an appeal has been taken to the Referee from the engineer's report that the drainage work is not required or is impractical or cannot be constructed under Sections 3 or 4, in which case the Referee's decision is final. Under Section 83, the appeal from the Referee's decision is expressed to be to the Court of Appeal. By Section 17 of the Judicature Act, however, the appeal is now taken to the Divisional Court. The Divisional Court is a division of and is composed of the judges of the High Court of Justice (a branch of the Supreme Court of Ontario). It sits continuously in panels of three in Toronto and from time to time in London, Ottawa, Sudbury, Sault Ste. Marie, and Thunder Bay.

A New Appellate Procedure

While the present system has by and large served the public well for many years, the Committee believes that some fundamental changes in the appellate system are now necessary. The Act as presently drafted apears to have been written by and for members of the legal profession rather than for those whom it is designed to serve. A proposed appellant must attempt to determine the appropriate appellate forum and the grounds of appeal permitted to that forum. And if his appeal is to the Referee, he must attempt to comply with the procedural requirements of Ontario Regulation 227, the existence of which he is unlikely to be aware. It is improbable that anyone could process an appeal to the Referee without a solicitor's assistance. Furthermore, it can take a good deal of time to dispose of such an appeal.

While many assessment appeals to the County Court judge are taken without legal assistance, they contain all the trappings of the Court system, which the Committee feels are unnecessary and inappropriate in such matters. During its deliberations the Committee received a large number of complaints that the proceedings on appeals to the County judge appeared to be weighted against the appellant who is not represented by counsel. The appellant finds himself in a completely unfamiliar environment and often finds the township solicitor and the engineer against him. The proceedings are conducted by a judge who expects the appellant to give technical reasons as to why his assessment is erroneous and to cross-examine the engineer on his evidence.

The Committee intends no criticism of the many County Court judges who faithfully attempt to carry out their duties under the Act and who, in the great majority of cases, do so in a fair and impartial manner according to law. Nor does the Committee intend any criticism of the present incumbent of the office of Drainage Referee, whose knowledge of drainage law and procedure is well known and who has served this Province well for many years. However, the Committee's basic premise is that the appeal procedure should be expedient, simple, easy to understand, and as informal as possible while maintaining fundamental justice and fairness. While the County Court judge and the Referee provide justice and fairness, they do not necessarily provide speed, simplicity, ease of understanding, or informality. The Committee believes that the latter factors require the institution of a completely new appellate system, which is outlined below and recommended for adoption.

Court of Revision

The Committee recommends that the Court of Revision be retained to entertain appeals from assessments determined by the engineer in his report. The Committee believes that it is desirable to retain a tribunal whose members are familiar with the local conditions prevailing within the particular area under consideration when the only consideration is the amount of money an individual is to be assessed for a proposed drainage works. Agricultural land owners are familiar with the Court of Revision and most persons expressed satisfaction with its operation to the Committee.

Ontario Drainage Appeal Tribunal

For the reasons outlined above, **the Committee recommends** the establishment of an Ontario Drainage Appeal Tribunal. The proposed composition and procedures of the Tribunal will be discussed later in this section. The jurisdiction that the Tribunal should exercise is discussed below.

In general, the Tribunal should exercise all of the present appellate jurisdiction of the County Court judge and the Referee. The Committee has already made reference to the general jurisdiction of the Referee (which appears to be conferred by Sections 67, 73, and 76 of the present Act) to entertain claims for damages, grant mandamus and an injunction, and to quash by-laws. It is not appropriate that such jurisdiction be exercised by a provincially appointed administrative tribunal, and **the Committee recommends** that no reference to such matters be made in the amended statute. Those powers should be exercised by the ordinary courts.

Curiously enough, there does not appear to be any power conferred on any appellate tribunal under the present Act to entertain appeals from allowances granted by the engineer under Section 8. Notwithstandng this oversight, the Committee has been advised that some Courts of Revision and County Court judges have entertained appeals from allowances. It is not known, however, whether any challenge was made to the jurisdiction of those bodies to entertain such appeals. **The Committee recommends** that the redrafted statute provide for appeals from allowances to the Ontario Drainage Appeal Tribunal.

The Committee has already discussed (part VIII) its proposals for a modified petition procedure and the rights of appeal that will flow from such procedure. The Committee has recommended that in some cases any number of landowners should be able to initiate a request for preliminary studies prior to a formal petition. It is contemplated that in all cases an environmental assessment, and a benefit-cost analysis will be obtained, and in some cases a preengineering report. In those cases in which a preengineering report is obtained, 60 days will then be allowed for a valid petition to be raised and the local council will then decide whether the project should proceed. Certain rights or appeal will arise at the time that decision is made and others will arise when the engineer makes his final report.

In cases in which a valid petition is raised without the necessity of a preengineering report, a benefit-cost report and an environmental impact statement will be filed with Council at the same time as the engineer's final report. Council will make a decision as to whether or not to adopt the report, and all rights of appeal will arise at that time.

The Tribunal's jurisdiction should be specific and should be contained in one part of the Act to avoid confusion. For clarity, the rights of appeal to the Tribunal should be to entertain any of the following:

1. An appeal from any decision of a Court of Revision;

2. An appeal from the apportionment of an assessment following the division of a parcel of land where the assessment is greater than $200 (see Section 19 of the present Act);

3. A review of the engineer's account (see Section 23 of the present Act);

4. An appeal on environmental grounds by the Minister of Natural Resources from a decision of the municipal council to proceed or not to proceed with the drainage works;

5. An appeal by the Minister of Agriculture and Food from a decision of the municipal council to proceed or not to proceed with the drainage works;

6. An appeal by a landowner in the area benefiting from the proposal as defined by the engineer from the decision of the municipal council to proceed or not to proceed with the drainage works;

7. An appeal by any landowner within the drainage area or by the Minister of Agriculture and Food from the engineer's final report on the grounds that the report does not comply with the requirements of The Drainage Act or that the works should be modified on grounds to be stated (see the present Act, Section 36);

8. An appeal by a conservation authority from the engineer's final report on the ground that the drainage works will injuriously affect a scheme undertaken by the authority (see Section 35 of the present Act);

9. An appeal from the engineer's final report by a municipal council other than the initiating municipality on the grounds presently contained in Section 38 (2) of the Act;

10. An appeal from a provisional by-law respecting repairs to a drainage works by a council of a municipality other than the initiating municipality on the grounds presently contained in Section 50 (1);

11. An appeal by a municipal council from the engineer's report on a variation of assessments for maintenance as to the portion of the cost of the drainage works for which the Municipality is liable (see Section 51 (3) of the Act);

12. Appeals on abandonment of a drainage works (see present Section 61 of the Act);

13. An appeal by a landowner or the Minister of Agriculture and Food from the allowances provided by the engineer's final report under Section 8 of the Act;

14. Appeals on improvement or reconstruction of a drainage works;

15. An appeal by a landowner from the refusal by a municipality to lend funds for tile drainage purposes pursuant to Section 3 of The Tile Drainage Act;

16. An application by a municipal council at any time to modify a drainage works on grounds to be stated;

17. Appeals under Section 48 of the Act.

In cases where a preengineering report is obtained, the Committee has provided for certain appeals after the preliminary decision of a council to proceed with the drainage works, as it is preferable to determine such matters at that stage rather than incur the expense of a complete engineer's report and then determine such matters. In cases where a preengineering report is not obtained, and a project is proceeded with on the strength of a petition, a benefit-cost analysis and an environmental impact statement, the rights of appeal under items 4, 5, and 6 above will arise when the council decides whether or not to adopt the engineer's report.

Divisional Court

The Report of the Royal Commission Inquiry into Civil Rights stated that: "A right of appeal from a decision affecting civil rights is the best known insurance against the arbitrary exercise of power." While not suggesting that the Ontario Drainage Appeal Tribunal would exercise its power arbitrarily, the Committee nevertheless agrees with the general principle. Thus **the Committee recommends** that an appeal to the Divisional Court (a division of the Hight Court of Justice) be preserved. The jurisdiction of the Divisional Court, however, should be extended to include an appeal from any decision of the Tribunal. No decision of the Tribunal should be absolutely final. While the Committee anticipates that appeals to the Divisional Court would be rare, an avenue of appeal should be provided to preserve the rights of all parties concerned and to ensure that important questions can be determined by an appellate court.

Time Limits

The Committee has noted that the times limited for the taking of particular appeals under the present Drainage Act are many and varied. For example, a notice of appeal to the Court of Revision under Section 31 shall be given "at least ten days before the first sitting of the Court"; an appeal from the engineer's report under Section 36 shall be made "within thirty days after the mailing of the copy of the provisional by-law"; an appeal from a negative report of the engineer under Section 37 shall be made "within 21 days from the mailing of the notice . . . "; and an appeal by the council of a municipality under Section 38 shall be made "within six weeks after the report is sent to the Clerk."

The Committee recommends that uniform time limits be adopted for appealing which depend not on the nature of the appeal but rather on the character of the tribunal to which the appeal is taken. **The Committee recommends** that cases of appeal to the Court of Revision must be made at least ten days before the first sitting of the Court provided that, as now, the time can be extended in special circumstances. Cases of appeal to the Ontario Drainage Appeal Tribunal should be taken within twenty days after notice of the decision or action complained of has been given. A notice of appeal to the Divisional Court should be given within thirty days after the date of the Tribunal's decision. Both the Tribunal and the Divisional Court should be able to extend the time for appealing in special circumstances.

Composition and Procedures of the Tribunal

The character and procedures of the Tribunal established by legislation are of equal importance to the right of appeal. It is often of greater importance to the appellant to have access to an appellate body that is flexible enough to hear his case quickly, that is a reasonable distance from his residence, and that has a degree of informality so he will not feel completely overwhelmed by a procedure unfamiliar to him but that will nevertheless guarantee him a fair hearing. The Committee realizes that many of these matters cannot be provided for adequately in the legislation, but it nevertheless wishes to make some observations that will guide and assist those who will ultimately operate and administer the Tribunal.

The Committee considers the following general principles to be of prime importance in the operation of the Tribunal:

1. It must be expeditious and easily accessible;

2. It must be flexible as it will hear appeals throughout the Province;

3. It must be reasonably informal but nevertheless guarantee a fair hearing;

4. It must have the expertise to handle questions of an assessment, engineering, or legal nature as they arise.

The Tribunal should be established under the Act and should have the jurisdiction that has already been discussed. The members should be appointed by the Lieutenant-Governor-in-Council. **The Committee recommends** that the legislation not contain a maximum number of members that can be appointed as it may be necessary to appoint more from time to time as the workload increases.

It is impossible to predict at this time the number of cases that the Tribunal will hear annually. The Drainage Referee heard only 57 cases from 1966 to 1973, but other cases might have been taken to the Referee had it not been for the expense, time, and complications involved. The Committee has been unable to determine the number of assessment appeals in drainage matters taken to County Court judges. It should be borne in mind that the Tribunal's jurisdiction will be slightly broader than that of the County Court judge and the Referee and that more appeals may result. A sufficient number of members should be appointed in various parts of the Province to ensure that an appellant will be able to have his appeal heard as expeditiously as possible. The members need not be full time and their services can be utilized as required.

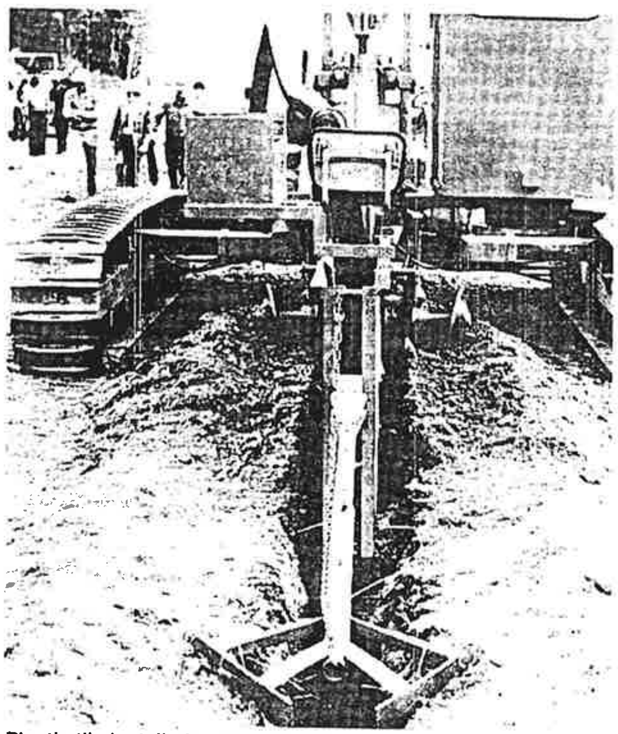
The chairmen of the Land Compensation Board and the Assessment Review Court appeared before the Committee during its deliberations to outline the operations of their Tribunals. The Committee is grateful to those gentlemen for taking the time to appear and for giving it an insight into the workings of two tribunals which currently operate under Ontario legislation.

The Committee was advised by the Chairman of the Assessment Review Court that that Court is presently composed of 350 members, that it disposed of 170,000 assessment appeals in 1973. The Committee was provided with a copy of a manual that had been prepared for the use of the Assessment Review Court members. The manual, which outlines the proceedings of the Court, is too lengthy to reproduce in this Report, but it is sufficient to say that its tenor stresses a degree of informality but requires a fair hearing in all respects. A Court member is encouraged to ask questions of both the assessor and the appellant, particularly where the appellant is not represented by a solicitor and has not properly presented his case. Of course, the Assessment Review Court is subject to the Statutory Powers Procedure Act (as would be the Ontario Drainage Appeal Tribunal) and must follow the minimum rules of procedure as set out in that Act.

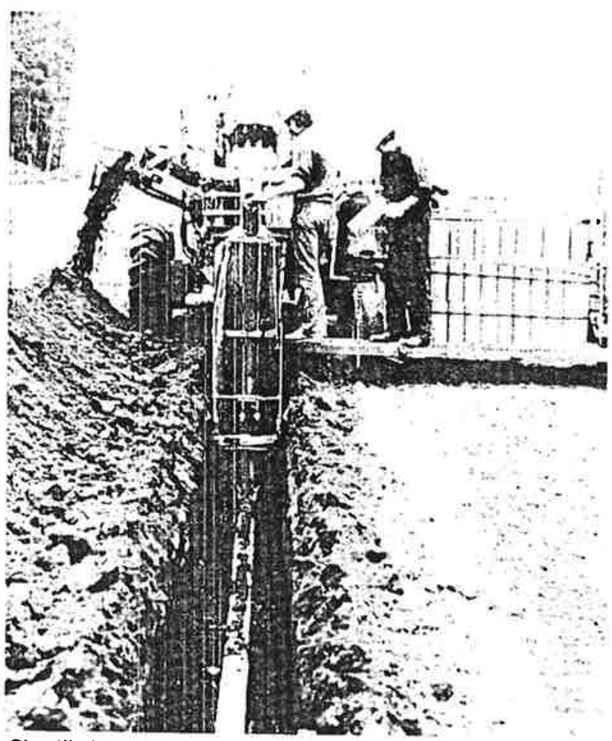
The Chairman of the Assessment Review Court pointed out that under Section 52 (7) of the Assessment Act, where value is a ground for complaint, the assessor must give his evidence first on the ground that he has knowledge of all the factors that compelled him to arrive at the value in question. In agreement with this principle, **the Committee recommends** that on an appeal from the Court of Revision or on an appeal to the Tribunal directly by a landowner from allowances granted by the engineer under Section 8, the engineer should be required to give evidence first.

With the approval of the Lieutenant-Governor-in-Council the Tribunal should be given power to make rules to govern its own procedure. However, **the Committee recommends** that such rules should be as few and as simple as possible. Since it is likely that many appellants will not be represented by solicitors, the appellant should be required to do a minimum of paperwork. It should be stated in the statute itself that the report or decision appealed from should inform the appellant of the time required to appeal, of where the notice of appeal should be sent, and of what it should contain. Preferably, a form of notice of appeal should be appended to the report or decision. The appeal should not be defeated merely because the grounds of appeal are not stated as accurately as they might be. The Committee realizes, however, that it is unfair to expect a respondent to prepare a response to the appeal and to proceed to the hearing if the grounds stated are so vague that they do not set out a clear basis for complaint. This would particularly be the case where an appeal is taken on some technical aspect of the engineer's report. **The Committee therefore recommends** that the Tribunal should have the power either of its own motion or on the application of any party to require a statement of particulars of the grounds of appeal. However, this power should not be used as a tool of oppression or for the purpose of delay.

Decisions of the Tribunal should be required to be filed with the Ministry of Agriculture and Food as well as the immediate parties to the appeal. Where written reasons are given, the Ministry should make every effort to make them available to interested persons on request. The Committee feels that the periodic publication of an index to decisions of the Tribunal would be of great assistance in making the public aware of the policies of the Tribunal.



Plastic tile installation by trenching.



Clay tile installation by trenching.

XIV. FINANCIAL ASSISTANCE

The policy of financial assistance to municipalities for drain construction has been in effect for a long time and recognizes the continuing need to bring potentially productive agricultural land into full production. During the immediate post-war period, legislation entitled The Provincial Aid to Drainage Act authorized the government to assist municipal drainage schemes by assuming 20 percent of the cost if the total cost exceeded $10,000. In 1948, the Report of the Select Committee on Farm Drainage noted that the limitation of grants under this Act to those works costing over $10,000 was a bar to some drainage schemes. That Committee recommended that the work would be expedited and more encouragement given if the minimum cost for grant eligibility were reduced from $10,000 to $5,000 and if the grant were increased from 20 to 30 percent. The eligibility limitation on the drain size was reduced as a result of this recommendation from $10,000 to $5,000, but the grant was left at 20 percent.

In 1950, a Select Committee on Conservation reported that "It appears that there is a real need for greater provincial assistance that would accelerate soundly conceived drainage projects not only in the east and the north but on any lands where the agricultural potential is relatively high. Provincial assistance must of necessity be more generous in the territorial districts and in the areas lacking any municipal organization than in the well-settled and highly developed sections of Ontario." They therefore recommended that provincial subsidies on drainage works be raised to 33⅓ percent in the counties, 66⅔ percent in the territorial districts or provisional counties, and up to 80 percent in the unorganized areas. These recommendations were accepted and taken into legislation, forming the present grant structure under The Drainage Act, Section 64(2) and 65 (2).

Aid to farmers who wanted to underdrain their fields was first made available in 1878. The legislation at that time allowed a municipal council to issue debentures for not less than $2,000 and not more than $10,000 for the purpose of lending money to farmers to install tile drains. The amount to be loaned to any individual farmer was not to exceed 75 percent of the total estimated cost of the work and no sum would be loaned which would require a greater taxation rate than 3 cents per dollar on the value of the lot proposed to be drained. In 1885, the municipal council could issue debentures under The Tile Drainage Act to a maximum of $10,000 at any one time. In 1887, the interest rate on loans made under this Act was reduced from 5 to 4 percent. At the same time, a top limit of $350,000 was set for total purchase of tile drainage debentures by the Province. In 1914, the interest rate under The Tile Drainage Act was changed from 4 to 5 percent and municipalities' borrowing limits were raised from $10,000 to $40,000. The total amount which could be borrowed by an individual remained at $1,000. Further amendments were made 9 years later, increasing the limit on municipal borrowing to $200,000 and the maximum level of provincial expenditures to $2,000,000. The maximum to be loaned to any individual was raised to $2,000 for each 100 acres in 1920, and the provision that the amount to be loaned to any individual was not to exceed 75 percent of the total cost of the work was added in 1928. Also, in 1928, the maximum allowable amount of provincial debenture purchases under The Act was raised to $3,000,000.

The rate of interest under The Tile Drainage Act was reduced again from 5 to 4 percent in 1937 and was further reduced to 3 percent in 1943. The Select Committee on Farm Drainage in 1948 recommended that the maximum amount which could be borrowed by an individual be raised to $3,000 per 100 acres. This recommendation was accepted and the necessary amendments to The Tile Drainage Act were enacted in 1949.

During the 1960's, a number of changes in The Tile Drainage Act affected the amount municipalities were permitted to borrow and also the total amount the provincial government could invest and the terms of the loan between the municipality and the farmers. The Act of 1971 made it clear that there was no longer to be a maximum amount which any municipality could borrow except that the municipality could not issue more than one debenture each month. This debenture, however, could combine amounts to be loaned by the municipality for any number of drainage works. The amount of each debenture issued could not exceed either the amount of the loans for which the debenture was issued or 75 percent of the total cost of the drainage work. The interest rate on debentures was to be set from time to time by the Cabinet rather than by legislation. The limit on the total amount of money that could be invested in tile drainage debentures by the provincial government was also removed. The total amount loaned to any one farmer was not to exceed either the amount applied for or 75 percent of the total cost of the works.

Municipalities and farmers in Ontario have been quick to take advantage of the available grants and favorable interest rates to provide themselves with improved land drainage. The chart in Figure 1 indicates that annual debenture purchases under The Tile Drainage Act increased from $1,400,000 in 1962 to a high of \$6,000,000 in 1971-72. With the recent increases in the market value of cash grains, total purchases of tile drainage debentures by the Province were reported to be over \$8,000,000 in the fiscal year 1973-74.

Amounts granted under The Drainage Act have exhibited a similar pattern although not quite as abrupt as the debenture purchases (Figure 1). The total amount was about \$750,000 in 1962, followed by a falling off in the amount until the grant expenditures started to climb in 1966-67. The amount reached a peak of \$3,500,000 in 1971-72 but was followed by a sharp drop in drainage activity, with grant expenditures amounting to less than \$2,000,000 in 1972-73.

The Committee received requests during its deliberations that grants under The Drainage Act and amounts available under The Tile Drainage Act should be increased so that additional agricultural land could be properly drained. The Committee's recommendations with regard to future financial assistance under both these Acts is contained in parts XV and XVI of this report.

XV. THE DRAINAGE ACT, R.S.O. 1970, CHAPTER 136

Problems

As outlined in the part (II) of this report dealing with the history and development of drainage law, the present Act is the result of five separate pieces of legislation being amalgamated by a special advisory committee in 1961-62. While that committee did a commendable job of consolidating drainage legislation into one statute, a comprehensive reading of the Act reveals that many inconsistencies and illogical sequences make it very difficult to understand not only for laymen but even, in some cases, for the lawyers and professional engineers involved.

The engineer in The Drainage Act is important because he is appointed under the Act's authority. Because he makes judgments and decisions that have considerable impact on ratepayers and others, the Drainage Referee has described him as semijudicial in his duties. In reading this Act, it is difficult to discern clearly and concisely the engineer's duties and functions. For example, Section 8 of the Act almost wholly deals with what the engineer shall include in his report. There are ten subsections to Section 8, with all except Subsection 3 using the phrase "the engineer in his report." Subsection 3 deals with the powers given to a local municipality for assuming by by-law, as a charge on the funds of the municpality, the whole or such part of the cost of construction, improvement, and maintenance of bridges and culverts rendered necessary by a drainage works which crosses any public road within the municipality.

A close reading of the Act reveals other small peculiarities. For example, there is reference to lateral drains in Sections 17 and 62 (2), but nowhere does the Act define lateral drains. Yet the engineer is given specific instructions to indicate the assessment of the cost of lateral drains in his report. Practising engineers have reported to the Committee that their view is that lateral drains are considered to be drains which begin and end in one parcel of property and that since these drains serve only one parcel, they are not entitled to grants and are therefore excluded under Section 62 (2).

Section 7 (1) of the Act permits a municipality to have the engineer make one report with respect to two or more petitions in adjoining areas, and Subsection 2 refers to the engineer appointed. It is really not clear whether the engineer appointed in Subsection 2 is the engineer referred to in Subsection 1. Again, practising engineers have reported to the Committee that they understand Subsection 2 to mean the engineer appointed under Section 3 of the Act and not the engineer appointed under Section 7 (1).

The Committee puzzled over the wording of Section 51 (4) which refers to "any owner of land and any ratepayer in a municipality in which roads are assessed." The Committee concluded that this phrase means that any ratepayer, even though living miles from the drain, may appeal from the assessment. It is difficult to know how any ratepayer in the municipality receives notice of such an assessment unless he is actually involved in the drain. It is the Committee's feeling that the council itself should be protecting the interests of other ratepayers in cases like this. In any case, the road superintendent should be the advocate for ratepayers in this regard and it is really not necessary for the Act to make the distinction.

The preceding discussion includes only a few of the examples of what is puzzling and illogical in the present Drainage Act, leading the Committee to believe that a concerted effort be made to construct the Act so that it reads clearly and logically from beginning to end.

During its study of this legislation, the Committee was made aware of an address to the Institute of Public Administration of Canada by Martin L. Friedland, Dean of the Faculty of Law of the University of Toronto, in February 1974. Dean Friedland made a statement with which the Committee is in total agreement: "The state has an obligation to ensure that its laws are available in understandable fashion to laymen." The Drainage Act by its very nature, deals with the rights and properties of citizens. Dean Friedland also says that "citizens should be able easily to ascertain their rights and obligations." The Committee's view is that The Drainage Act in its present form does not allow citizens easy access to the determination of their rights and obligations. A farmer who becomes involved with The Drainage Act at present must consult a lawyer to determine the totality of his rights and obligations. Dean Friedland does not agree with this situation and goes on further to say that "it is surely in principle wrong to have the law in such a form that only lawyers can find and interpret it."

This Committee wishes to draw to the attention of the authorities concerned that it is fervently hoped the finished product of rewriting The Drainage Act will be presented in a logical, lucid, and clear manner so that ordinary citizens, engineers, and township councillors can use the Act efficiently with little or no difficulty and with a minimum of costly and time-consuming litigation before the courts.

Recommended Amendments

While the Committee has dealt with proposed major changes in legislation in preceding parts of this report, **the following are recommended as amendments to certain sections of the Act:**

Definitions

1. Benefit should be defined to mean the increased worth to any lands, roads, buildings, or other structures from the construction, improvement, repair, or maintenance of a drainage works such as will result in a higher market value or increased crop production or improved appearance or better control of surface or subsurface water or any other advantages relating to the betterment of the properties, whether or not they are similar in nature to those listed.

2. The present Act defines an engineer as one registered as such under the Professional Engineers Act or a surveyor registered under The Surveyors Act. In light of present day practise, where many engineers and surveyors are working in registered partnerships or in limited companies, it is incumbent that the definition be changed to provide for such practise. It is recalled that a case was successfully appealed to the Drainage Referee when a municipality appointed a corporation rather than an individual engineer. The Referee, hewing strictly to the legal definition, held that this appointment was invalid. **Therefore the Committee recommends** that the definition of an engineer be as follows: Engineer shall mean an engineer registered as a professional engineer under The Professional Engineers Act or a surveyor registered as an Ontario land surveyor under The Surveyors Act or a partnership, association, or corporation which holds a certificate of authorization under either of these Acts, providing that in the case of a partnership, association, or corporation, the person responsible for the undertaking is registered as a professional engineer or an Ontario land surveyor.

3. Drainage works should be defined as an installation constructed by any means involving the improvement of a stream, creek, watercourse, and includes installations necessary to control the water table or level on any lands or to regulate the level of the waters of a reservoir, lake, or pond and includes a dam, embankment, wall, pumping installation, protective works, or any combination thereof.

4. The Committee has decided that the definition of public utility should be extended in the Act to include railways and public roads under the jurisdiction of any municipality or the Province of Ontario. The reasoning and justification for this decision is contained in the part of this report dealing with all types of barriers to drainage construction.

5. The concept of injuring liability has been rendered obsolete over the years, since practising engineers have usually assessed this type of liability, if there were any, along with their assessment of outlet liability. The Committee accepts this as a proper practise and **recommends** that injuring liability be deleted from the definitions in the Act and removed as a concept in the engineer's assessment reponsibilities (Section 16 (2)).

SECTION 2. This section provides for mutual agreement drains whereby two farmers who desire to construct or improve a drainage works and are willing to pay the cost thereof enter into agreement. The section provides for the details which shall be covered in the agreement. It also provides that this agreement may be filed with the clerk of the local municipality or a copy may be registered in the proper registry or land titles office. While the Committee agrees that this is an admirable part of the Act and is an arrangement that should be available to farmers entering into such agreements, the Committee still feels that the permissive nature of the section nullifies its usefulness. The Act does not require that any agreement be entered into and goes on to say that, if an agreement is entered into, it does not necessarily have to be filed with the clerk or registered in the registry office.

The Committee recommends that, to avoid difficulties which have been reported in hearings and elsewhere, a copy of the agreement should be required to be registered in the proper registry or land titles office, where there is a mutual written agreement entered into by two or more owners of land regarding the construction or improvement of a drainage works. The Committee feels that requiring such registration will protect future purchasers from buying land where an agreement exists without their knowledge.

SECTION 4 (4). Some confusion has been reported as to the meaning of the phrase "the point of commencement of the drainage works." Subsection 4 is concerned with the assessment of land adjacent to the drainage works, and the Committee would point out that in the context of the whole subsection, the only reasonable interpretation of the phase is that it means the upstream end of the works rather than its point of outlet.

SECTION 4 (9). Award ditches under the former Ditches and Watercourses Act must be maintained by the municipality in accordance with the award until such time as the ditch is brought under the provisions of The Drainage Act. The procedure for such tranformation should be made clear.

SECTION 6. Authority is given for the engineer to enter upon private property in the performance of his duties. The Committee notes the lack of uniformity in Subsection 1, which refers to "the engineer and his assistant," and Subsection 2, which refers to "the engineer or any of his assistants." It is suggested that the second phrase be applicable to the whole section.

While agreeing that such authority and right must be given to the engineer under the Act, the Committee is agreed that, in carrying out his duties and using this authority, the engineer should be restricted to the extent that he should not enter any property until the owner is notified by the clerk that survey work may be anticipated on his property.

The Committee notes that the engineer and his staff are given this right and authority and that the drainage superintendent is given similar authority. It was drawn to the Committee's attention, however, that contractors engaged in constructing a drain have sometimes been refused entry. **The Committee recommends** that this obvious omission be corrected.

The Committee also recommends that the fine should be increased to $200 from the amount stipulated in Subsection 2 of Section 6.

SECTION 7. Comprehension and interpretation difficulties arise in this section because of poor drafting and wording. It has already been noted that there is some question whether the phrase "the engineer appointed" in Subsection 2 refers to the engineer in Subsection 1 or whether it refers to the engineer appointed by council as a result or petition in Section 3. Again, the Committee is not clear as to why Subsections 3 and 4 are contained in Section 7 when they obviously deal completely with matters not pertinent to Subsections 1 and 2.

SECTION 8 (9). While most of Section 8 is dealt with elsewhere in this report, the Committee wishes to make some particular observations about Subsection 9, which permits an engineer to compensate an owner of low-lying land in lieu of taking a drain to a sufficient outlet. The Committee feels this principle should be continued but is concerned that an unsuspecting buyer could purchase lands in the dry season without being aware that a drain has been specifically constructed so that the lands will flood and that the present owner has been appropriately compensated. Accordingly, **the Committee recommends** that where a person has been compensated in lieu of the drain being taken to a sufficient outlet, a copy of the by-law be required to be filed in the appropriate registry or land titles office. A registrable description of the property affected must also be filed in such cases.

SECTION 11. This section deals with interprovincial drainage works from Ontario into adjoining provinces or vice-versa. Neither the Ministry of Agriculture and Food nor the Committee is aware of any agreement which exists under this section. During the Committee's hearings and in reviewing the submissions, no comment was made on this subject by any group or municipality. Late in its deliberations, however, the Committee did receive a delegation from eastern Ontario, where there was a problem with a drain which had been constructed in the Province of Quebec and which, in order to fulfill its proper function, should have been continued into the Province of Ontario. The delegation wanted to know the proper procedure for accomplishing this.

The Committee recommends that a situation like this should be resolved by using the procedure outlined in Section 11. However, the agreement should not cover only one specific drainage works. It should be rather a blanket agreement by which the two governments set out the procedures and responsibilties of each government in cases where drains cross provincial boundaries. Thus subsequent drains of this type could be dealt with by the administering officials rather than by drawing up ministerial agreements for each case. The Section should be amended to permit such blanket agreements.

SECTION 12. The Committee is agreed that the drainage commissioner should be given a greater role in the construction and maintenance of drainage works. Accordingly, part X of this report deals fully with this subject.

SECTION 19. This section deals with the problem of changing assessments when the land has been subsequently divided into different parcels. While the Committee was not really concerned with the provisions of Section 19 in this regard, it was felt the requirement that an engineer should be involved was perhaps unnecessary in some cases. **The Committee agreed to recommend** that where the owners can mutually agree on the amount they should pay after the land is subdivided, an engineer should not be required, providing the township revenues are not thereby reduced in any way.

In discussing this section, the Committee was made aware of the possibility of future buyers being unaware of drainage taxes when purchasing land. The forms presently used as tax certificates that lawyers obtain when involved in conveyancing of property are not required to and do not as a rule show the drainage taxes arising from construction of a municipal drain or the tile drainage debentures registered against the property. These taxes are discernible to a buyer only if it is quite evident to him and to his lawyer that drainage taxes are likely in that particular area.

Section 526 of The Municipal Act (R.S.O. 1970, Ch. 284) provides for the issuance of a tax certificate by the collector, but no form is provided or details set out. Section 549 of the same Act provides for the issuance of a certificate of tax arrears and a form of certificate is provided. Neither case allows for drainage taxes or tile debentures.

The Committee recommends very strongly that for the buyer's protection, statements or certificates of taxes or statements of tax arrears set out all the charges due on the property, including amounts due on municipal drainage and amounts due on borrowings under The Tile Drainage Act. The Township of Enniskillen in Lambton County provides a certificate to prospective purchasers on a form which the Committee agrees is quite adequate for this purpose. The items tabulated on the form include:

1. Township and County rate
2. Education
3. Fire Protection
4. Municipal Drainage
5. Dog Tax
6. Water Rates
7. Lights
8. Telephone

9. Tile Drainage Loan (maturity)
10. Miscellaneous
11. Total Current Taxes

The Committee believes that such a statement would comply effectively with the recommendation above.

It also has been brought to the Committee's attention that the period from the time of the third reading of the by-law to the time the amount payable by a land-owner for drain construction costs is actually placed on the tax roll could extend up to two years. During this time, a prospective buyer might purchase a property without knowing that a drainage assessment is pending. To remove this hazard, **the Committee recommends** that the tax rolls be amended immediately after the by-law is passed by third reading, to indicate the fact that a drainage assessment is pending.

SECTION 20 (1) In the interest of brevity and clarity, the Committee feels Subsection 1 should be written into two subsections since two situations are involved. One situation is where an owner of land subsequently connects with a drainage works, and the other is where the nature and extent of the use of the drainage works is substantially altered. The Committee feels that it would be simpler and easier to read if these two subjects were dealt with in two separate subsections rather than in one complicated subsection as now.

SECTION 22. This section deals with the matter of filing the engineer's report with council and places a six-month time limit for such filing after the date of the engineer's appointment or within such time as may be extended by council. It has been reported that this provision is not always adhered to. Because of his work load, the engineer in some cases is not always able to produce his reports and surveys in the six-month time period allotted, and there is usually tacit understanding between the engineer and the council as to when the report will be filed. It also has been reported that councils do not always make formal extensions of the time limit as required under this section. The Committee considered amending the section to conform with reality but felt these limits would continue to be necessary in some areas of the Province. The Committee therefore concluded that no change was required.

However, the Committee feels that Subsection 2 is not strong enough for its purpose and suggests a clause be added indicating that the engineer should be given notice that he will forfeit all claims for compensation unless the report is filed within a specified time limit, not to be less than 30 days.

SECTION 24. This section requires some amendment in the interests of clarity, but no major change is required. Subsection 1 requires the council of the initiating municipality, if it intends to proceed with the work, to forward a copy of the engineer's report to the clerk of every other municipality in which lands or roads are assessed for the works and to conservation authorities, railways, public utilities, and the Minister of Lands and Forests where land under his jurisdiction is affected. The reference to the Minister of Lands and Forests should be replaced by the Minister of Natural Resources in every case and the Minister of Agriculture and Food should be added. The phrase "if it intends to proceed with the drainage works" only adds confusion, since the council normally would not have even considered the report at the time copies are sent out. The subsection should therefore be amended to simply provide that the clerk shall send copies of the report to those agencies listed. The agencies should also be notified of the date on which the report will be considered by council.

Subsections 2, 3, and 4 provide that affected parties shall be sent notices which contain information such as the assessment and the date on which the report will be considered. Subsection 5 also requires that a copy of the report shall be forwarded with each notice. It has been suggested that this procedure can be expensive and that it provides some duplication. However, the Committee feels that affected persons should be entitled to a copy of the full report so that there will be no misunderstanding of what is involved. **The Committee therefore recommends** no change in this respect.

Subsection 6 provides that the date of the council meeting at which the report will be considered shall be not less than 10 days after the required notices are mailed. It has been drawn to the Committee's attention, however, that the consideration of some reports has been unduly delayed because the notices and copies of reports have not been sent out for months. **The Committee therefore recommends** that the clerk be required to forward all the required notices and copies of reports within 20 days after the engineer's report has been filed and that Subsection 6 be retained in its present form.

The Committee received complaints concerning difficulty in notifying large corporations. Notices have been sent to head offices in distant locations without provoking any reply. The engineer will now be required to be in touch with major corporations and utilities at the time he is preparing his preliminary or final report, and this problem should be alleviated. The clerk should simply send the notice to the head office of the corporation unless otherwise notified in writing. If the corporation does not wish to take advantage of its right to make representations, the council ought not to be concerned.

SECTIONS 25 AND 26. These sections deal partly with a petition under the present Act. The Committee feels that the modified petition procedure suggested in this report will clarify some of the problems that became evident in considering these sections, especially Section 26. The problems revolve around the withdrawal of petitioners' signatures and the penalty clause in Section 26 (2). The Committee feels that the modified petition procedure will to some extent remove the possibility of last-minute withdrawals and that the penalty is unjustified and should be deleted.

SECTION 28. Council is given the right to refer the report back to the engineer for reconsideration if it appears there may be errors in his report. A referral back is normally time consuming and costly, and the Committee wishes to make two recommendations to improve this situation.

Errors by the engineer in calculating costs and allowances can sometimes be resolved at the time the report is considered. Information frequently is presented at that time which can reasonably dictate modification of the proposals. To expedite projects in cases where all present, including the council and the engineer, are satisfied that the modifications or amendments are proper, **the Committee recommends** that the report need not be referred back to the engineer. Instead, **the Committee recommends** that it be adopted "as amended" and that the engineer file an amended report clearly outlining the changes that would be included when forwarding the by-law. This will ensure that all concerned are aware of any changes made at the report's adoption which would be subject to appeal.

A second situation arises when the necessity for changing the engineer's report regarding the design and structure of the work becomes apparent after the by-law has been finally passed. In such cases, the council should have the right to apply to the Ontario Drainage Appeal Tribunal at any time for an appropriate amendment to the report. (See Appeal Procedure, part XIII of this report.)

SECTION 29. The possibiliy of additional duplication appears in sending copies of the provisional by-law to other municipalities. The Committee feels that there is room in this procedure for eliminating costs and therefore **recommends** that only the facts of the by-law dealing with finance, etc. be sent to neighbouring municipalities and landowners, without necessarily repeating what has already been submitted through the original distribution of the engineer's report in Section 24(5).

SECTION 41. This is a long complicated section which covers many items that are not all related. This section should be split after Subsection 3.

The Committee feels the marginal notes which refer to a "special assessment" that is not mentioned in the body of the Act tend to confuse readers and persons involved in administering the Act. It should be made clear, perhaps, that drainage assessments are special assessments, and then it would be proper to so designate them. Subsections 2 and 3 do not speak of special assessments whereas the marginal notes do.

Subsection 2 deals with the responsibility of each local muncipality to pay the assessed amounts to the intiating muncipality. The Committee points out that there are instances where an adjoining municipality might be permitted to pay the amount assessed in a lump sum and charge this amount to its general funds rather than calculate and pay a large number of very small assessments. The Act should provide for this possibility and allow the decision to be made by the council of the muncipality concerned.

The Committee recommends a change in thinking in the present Subsection 4 of Section 41, starting with a change in the $25 figure in this subsection to $50 having regard for present day values. This subsection provides that where assessments are levied on small parcels of land within the municipality's limits, the local council may provide that the assessments shall be paid out of the municipality's general funds. As a general principle **the Committee recommends** that where lands within a muncipality are liable for assessment, the council may provide further that the engineer may designate in his report the affected area or areas and set out a block assessment on these lands and assessments on streets and roads. Such block assessment shall then be recovered by a levy against the ratable property in the designated area, and the assessment on streets and roads shall be recovered by a levy on the general rate of the municipality. If this recommendation is adopted, there would necessarily be changes in the section of the Act that deals with issuing notices regarding drains.

Subsection 6 provides complications in both interpretation and application. The phrase "specially assessed" is used in this subsection and again it is not clear what is special about this assessment. This subsection makes it clear that when lands normally exempt from taxation are assessed for drainage purposes, the assessments must be paid by the municipality imposing them, except where they are imposed on land occupied by churches or institutions of learning or lands owned by a school board. In the latter cases, the assessments are paid by the owners of the land. During their construction, many drains pass through lands exempt from taxation (for example, military installations, airports, provincial parks, lands owned by the county or township, etc.).

The Committee feels that this subsection is somewhat unfair to the township imposing the assessments. The Committee believes the principle should be that those who benefit from a drain should be assessed and pay that assessment regardless of their tax status. It is recognized that this principle is difficult to enforce on lands owned by Canada, but it is the Committee's belief that where a drainage assessment is made against lands owned by a county (for example, a county forest), the assessment should be accepted by and paid for by the county.

SECTION 44. Under the present provisions of Section 44, an application to quash the by-law must be made to the Referee within three months after its passage. Otherwise the by-law shall be deemed to be valid and binding. The intent of the section is obvious: those who wish to attack the by-law's validity should have a reasonable opportunity to do so, but the council should be able to rely on the by-law after a reasonable time has passed. However, since the Committee has recommended that the Office of Referee be abolished, the reference to the Referee in this section should be removed so that applications to quash will be made to the ordinary courts.

SECTION 45. A municipality is given the right in this section to sue for damages to a drainage works. Section 7 (4) provides for the conviction and fine of anyone destroying bench marks or levels. Section 58 also provides for penalties to anyone who obstructs or injures or destroys a drainage works. Section 55 sets out the council's or drainage commissioner's authority in removing obstructions from drainage works. Rather than have these provisions scattered through various sections of the Act, it appears to the Committee that they should be brought together properly and dealt with under one heading — possibly damage or obstruction to drainage.

SECTION 48. This section is important in that it deals with raising funds when the engineer's estimate is too low. Where insufficient funds have been provided and the works are within one municipality, the council may simply pass an amending by-law and issue new debentures (Subsection 1). However, where the works are in two or more municipalities, an engineer must be appointed to examine the works and make a report with an estimate of the cost of completion (Subsection 2). The council of any municipality may appeal to the Referee as to the improper expenditure or illegal application of the money. It should be noted that this section applies only to projects which have been completed or commenced.

The Committee is of the view that some basic changes in this section should be made. If, before construction has commenced, it appears that the actual cost of the drain will exceed the original estimate by 33⅓ percent or more, **the Committee recommends** that Council must obtain the approval of a majority of the owners of properties within the drainage area, or owners of 60 percent of the acreage within the drainage area, before proceeding with the work. Subsection 2 should be amended to remove the requirement that an engineer must be appointed where two or more municipalities are involved. It should simply be provided that the initiating municipality may pass amending by-laws to raise additional funds, and other municipalities involved shall forthwith pass amending by-laws to raise their portions of the increased cost.

The Committee also recommends that, within 30 days after completion of any drainage works, the engineer and the drainage superintendent should be required to file a statement with the council which contains a summary of the matters which cost more or less than the original estimate, the reasons for the increase or decrease, and statement of how the monies were spent. The clerk should be required to forward a copy of the statement to the other municipalities involved, if any, every ratepayer on the drain, and the Minister of Agriculture and Food.

SECTION 51. This section provides that the council of a municipality liable to contribute to the maintenance of a drainage works may apply to the Referee for permission to appoint an engineer to make a report varying the assessment for maintenance on the ground of changed circumstances. If all the lands are within one municipality, the Referee's permission is not necessary. The Committee feels the principle of the section is sound, but **recommends** that the provision providing for an application to the Referee be repealed so that it is no longer necessary to gain the permission of some other body to secure an engineer's report. Of course, the normal appeal procedure would apply.

SECTION 52. Where a drainage works is to be repaired or improved without the report of an engineer but on the recommendation of the Drainage Superintendent, the financial limitations **the committee recommends** should be 20 percent of the original cost or $2000 whichever is the greater.

SECTION 60. This section prohibits pollution of drains by any liquid material or substance other than drainage water. It was represented to the Committee that the new technology in sewage disposal should permit the discharge of effluent into a drainage works, but the Committee feels that the requirements in Subsection 1 of Section 60 are sufficient. If manufacturers of this type of new technology are able to obtain the necessary approvals, as are at present required, they should proceed through the townships for the necessary by-laws as set out in Subsection 1. The Committee feels strongly about this section and **recommends** that the fines on summary conviction should be a minimum of $100 in the first instance and $500 on second and subsequent offences.

SECTION 62. It recently has been determined for the purpose of this section that farms owned by the A.R.D.A. Directorate of Ontario are "lands owned by . . . Ontario" and therefore that drainage assistance grants may not be made as provided for in this section. In calculating the amount of grant to be paid, the assessments against lands owned by Ontario (including A.R.D.A.-owned farms) are deducted.

These assessments, however, are paid in full by the Municipal Subsidies Branch of the Ministry of Treasury, Economics and Intergovernmental Affairs on behalf of A.R.D.A. similar to assessments on provincial highways, institutions, or installations owned by the Province.

This results in a peculiar situation. A farmer who leases and works a farm owned by A.R.D.A. has the drainage assessment against this land paid in full, while a farmer on his own land must pay at least ⅓ of the drainage assessment in the eleven eastern counties of Ontario and ⅔ of the assessment in the rest of the Province.

While it is recognized that A.R.D.A. regards these assessments as capital improvements and that the assessments are added to the price to be paid when and if the farmer exercises his option to buy, it is still an immediate benefit available to one group of farmers and not to others.

The Committee recommends that this anomaly be removed by making it clear that lands owned by A.R.D.A. are not to be considered as lands owned by Ontario for the purpose of calculating drainage grants.

SECTION 64. The Committee is aware from its research on costs and from the Ontario Farm Drainage Association's brief that the availability of 66⅔ percent grants on drainage works led to a volume of construction that was difficult to cope with and also led to increased costs and the quick exhaustion of available funds. This caused problems in the drainage industry for contractors, manufacturers, and suppliers. Nevertheless, the quality of the drainage works constructed during this period was high, and the Committee is confident that much of the additional grant money was well spent. Because of this reaction to increased grants, the Committee does not agree that the grant structure as provided in this section should be increased as was requested in several briefs and submissions. Therefore, **the Committee recommends** no change in grant structure as outlined in Section 64 (2).

Such grants are made only in respect of assessments made upon lands used for agricultural purposes (Section 62 (2)). The Committee agrees that this principle should be continued and further **recommends** that when such lands are taken out of agricultural use, the grants made with respect to such lands should be repaid. The Committee feels such repayment should be made by the person responsible for changing the use of the lands. However, a prospective purchaser of property should be entitled to ascertain the extent of the grants made with respect to the property so that he can take the amount of those grants into account when negotiating a purchase price. Accordingly, **the Committee recommends** that any person, upon paying a nominal fee, be entitled to obtain from the Ministry of Agriculture and Food a certificate which discloses the amount of the grant that has been paid.

XVI. THE TILE DRAINAGE ACT, S.O. 1972, Ch. 37

The Tile Drainage Act enables the council of a municipality to pass a by-law authorizing the borrowing of money from the Treasurer of Ontario for the purpose of lending the money for the construction of drainage works on agricultural land. When this by-law is passed, owners of such agricultural lands may make application to the council to borrow money for such a purpose. The approval of this application is at the council's discretion and its decision is final. The council is required to give written notice of the decision to the applicant.

The Act provides for an inspector who oversees the work and files an inspection and completion certificate with the clerk. Upon receipt of this certificate, council issues a debenture payable to the Treasurer of Ontario for the funds to be loaned. The Treasurer of Ontario is then authorized to purchase, acquire, and hold the debentures issued under the authority of the Act. The council then lends the money to the applicant in sums of $100 or multiples thereof for a term of 10 years at a rate of interest determined by the Lieutenant-Governor-in-Council. The amount loaned to any one applicant, however, shall not exceed either the amount applied for or 75 per cent of the total cost of the drainage work for which the loan is made.

The loan is repaid over a period of 10 years at a special equal annual rate sufficient to discharge the principal and interest. The repayment shall be deemed as taxes and the provisions of The Municipal Act apply insofar as they have reference to collection and recovery of taxes and proceedings that may be taken in case of default.

In the course of the Committee's deliberations, little or no criticism was directed at the provisions of The Tile Drainage Act and there were only one or two occasions when the Committee was requested to increase the level of assistance provided.

Research done for the Committee makes it clear that positive benefit-cost ratios in almost every instance result from tiling adjacent lands into the municipal drain. The Committee feels very strongly that municipal drains should only be built when farmers are prepared to tile their lands almost immediately and take full advantage of the improved outlet. The benefit-cost studies conducted by the Committee's research staff indicate that even one farmer tiling 20 acres into a newly constructed drain will place that drain in a highly positive benefit-cost ratio.

To further encourage the drainage of agricultural land by individual farmers, **the Committee recommends** major changes in the procedures of The Tile Drainage Act. It should be mandatory on all councils which have by-laws passed under this Act to lend the total amount provided for in the Act or at least the amount applied for. Some instances were reported to the Committee where councils cut the amount to be loaned to as low as $80 per acre when the current costs of tiling land were $180 per acre. In this situation, a farmer is forced to borrow the additional $100 per acre somewhere else at higher rates of interest, which seems to nullify the purposes of this Act.

The Committee recommends that the total amount available under the Act be raised from 70 to 90 per cent of the total cost of the work and that councils not be permitted to lend a lesser amount unless a lesser amount is applied for.

The Committee feels that the provisions of Subsection 3 of Section 3 should continue and that, when the approval of any application is denied, a written notice of this denial be given to the applicant with reasons therefor. The applicant should then be permitted the right to appeal this decision to the new appeal tribunal outlined in part XIII of this report.

Section 5 (4) of The Tile Drainage Act indicates that interest rates on debentures issued under this Act shall be determined from time to time by the Lieutenant-Governor-in-Council. **The Committee recommends** that hereafter money be loaned under this Act with no interest rate applicable. The Committee was unanimous that the interest rate be reduced from the present 4 per cent. A minority favoured a rate of 2 per cent, but the majority agreed to recommend that the interest rate be eliminated entirely.

This may seem to be extremely generous at first glance. Calculated in terms of what it costs farmers to borrow money, however, it is estimated that lending 90 per cent of the cost of the installation at no interest represents a subsidy of 32 per cent. The present formula of 75 per cent of the loan at 4 per cent interest represents a subsidy of 16 per cent. Thus the Committee's recommendation raises the assistance under the Tile Drainage Act to approximately the same level as the assistance given under The Drainage Act, which is 33⅓ per cent in organized counties.

In making these recommendations, the Committee is acutely aware of the provision in Section 8 of The Tile Drainage Act which says the council "shall levy and collect . . . over and above all other rates a special annual rate" and also of the fact that these rates are deemed to be taxes and as such a first charge on the property. The authority for collection and recovery of taxes is subject to proceedings under The Municipal Act in case of default.

In line with the Committee's thinking that artificial barriers to land drainage (that is, roads, highways, underground installations, etc.) should bear the additional costs of carrying field under-drainage to a sufficient outlet, **the Committee recommends** that such installations be required to permit crossings of adequate size at the expense of the road authority or installation involved. Normal subsidies should apply in the case of roads or highways. These subsidies should only be available where the plan of field under-drainage has been drawn or approved by the Ministry of Agriculture and Food.

One other caution should be added to this Act. Following the precedent set in the Farm Tax Rebate program, **the Committee recommends** that where tile drainage loans are made on farm land that, within the term of the loan, is converted to any use other than agriculture, the balance of the loan will become immediately due and payable.

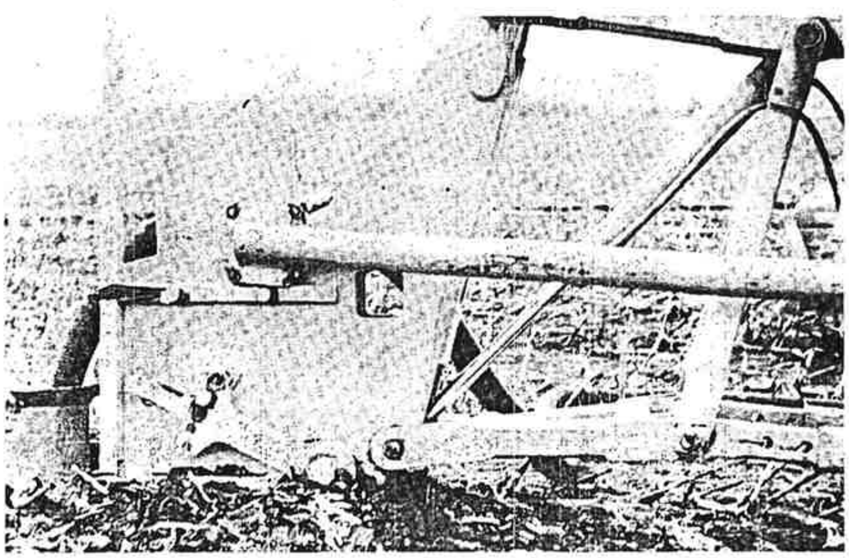
It was pointed out to the Committee in hearings that some municipalities are requiring tile drainage loans to be repaid in quarterly or half-yearly installments along with the normal taxes. **The Committee recommends** that repayment installments of tile drainage loans should fall due annually and on the final due date of the normal taxes for the year. The first payment should be due in the year following the date the loan is granted. Another requirement appears to be needed for the protection of prospective buyers. It has been recommended elsewhere that tax certificates include the fact of the existence of an unpaid tile drainage loan. But while this protects the buyer it gives him no indication of the location of the tile.

The Committee therefore recommends that the inspector provided for in Section 4 of The Tile Drainage Act be required to file with his inspection certificate a sketch indicating the location and direction of the tile as laid as well as information on spacing and depth of the tile.

The Committee was surprised to learn from councillors and others that municipal officials still believed that borrowings under The Tile Drainage Act impaired the borrowing capacity of the municipality. This is not so. It was the case previous to 1970, but was changed in 1971.

Councillors also expressed some fear of lending money to inefficient farmers or to farmers already in debt beyond their capacity. The Committee wishes to reiterate, however, that these loans are a first charge on the property and collectable before any other debts. The Committee also feels that it is quite unfair to the applicant to decide his credit worthiness based on rumors and common gossip. The application form for such a loan requires no disclosure of net worth and it is difficult for a council to refuse an applicant for a tile drainage loan on the basis of incomplete or inaccurate information.

The committee is quite aware that this new program as herein recommended might mean severe pressure on clay and plastic tile manufacturers as well as on contractors and agricultural engineers. The Committee is confident, however, that these pressures will be met and that increases in tiled acreage and food production will be the final result.



Plow-type equipment for plastic tile.

XVII. THE ROLE OF THE ONTARIO MINISTRY OF AGRICULTURE AND FOOD

In The Drainage Act, the Ministry of Agriculture and Food is the administering agency and is mentioned in those sections dealing with the grants that are made under The Act. The Minister is also mentioned in connection with drains that extend into Manitoba or Quebec, or vice versa. Other than that, the Minister has no power or authority under this Act. True, the section dealing with grants is permissive and makes it possible for the Minister to refuse to pay the grants if he so wishes. The Act is silent, however, as to grounds for denying a grant application and is also silent with regard to any appeal that a municipality may have if such a grant is denied.

The Committee would like to give the Ministry of Agriculture and Food a greater role in the administration of The Drainage Act. To some extent this greater role has already been undertaken by the Ministry's Drainage Co-ordinator who is in the peculiar position of consulting, advising, and guiding farmers and municipal officials on problems and procedures under the present Drainage Act, but none of these activities have been defined in The Act. The Act neither mentions the Drainage Co-ordinator as such nor does it specify that the Minister may delegate his authority under The Act to a public servant.

The estimates of the Ministry of Agriculture and Food for the fiscal year 1974-75 include the expenditure of $3,000,000 in drainage grants and $5,400,000 in the purchase of tile drainage debentures. The present administration of the three drainage acts involves four full-time public servants and one part-time and is estimated at roughly $150,000. It appears to the Committee that the administration of the duties and responsibilities of the three drainage acts should be given to a separate branch within the Ministry of Agriculture and Food and not be allowed to remain a section within the Agricultural and Horticultural Societies Branch.

The Committee has already recommended grants or subsidies for the proper maintenance, repair, and minor improvements of drainage works. Upon its acceptance, this recommendation will result in a greater budget and more administrative responsibility.

The Committee has also recommended that the Minister be given the authority to initiate drainage works where he believes these works are necessary and also authority to appeal decisions of municipal councils for or against a drain and to appeal from allowances granted by the engineer.

The present Drainage Co-ordinator has already made a commendable start in carrying out his role and has begun to closely observe the details and data furnished him from engineers' reports. With no authority and no jurisdiction, however, the Drainage Co-ordinator has found it difficult to be certain that his data and statistics are complete, since he cannot require municipalities or engineers to provide him with necessary information.

In accordance with the Committee's recommendations, the Ministry will receive copies of all preliminary reports, final engineers' reports, and The Drainage Tribunal decisions. Useful data can be extracted from these reports for the benefit of the whole industry and continued monitoring of costs of materials, labor, and allowances can be carried out. Decisions of the Tribunal can be summarized and distributed for the benefit of all concerned.

The Committee has recommended that drainage superintendents be qualified in each municipality carrying out works under The Drainage Act and that the responsibility for qualifying these superintendents should rest with the Ministry of Agriculture and Food. The courses to qualify these people will undoubtedly be the responsibility of the University of Guelph and the Extension Branch of the Ministry, but the final qualification and certification should remain the responsibility of the recommended Drainage Branch.

In making these recommendations, the Committee is aware that this will be the first time the provincial authority is being inserted to a greater degree in development and promotion of drainage works. While some groups may feel this to be an unwarranted intrusion, it has become apparent to the Committee after talking with hundreds of interested farmers and municipal officials and elected representatives that there is a great desire for one single source of guidance and counsel. There is also a desire for a real measure of co-ordination, and the Committee believes that the recommendations outlined above will provide a measure of support from the provincial government over and above the actual continuing financial assistance. The support, counsel, and guidance received from the present Drainage Co-ordinator and staff is very much appreciated by those seeking help with drainage matters. **The Committee feels it has a responsibility to recommend** that these duties be defined and supported in the legislation which the new Drainage Branch will administer.

XVIII. SPECIAL PROBLEM AREAS

(A) MATTERS UNDER FEDERAL JURISDICTION

Pursuant to Section 92 (10) of the British North America Act, works and undertakings which extend beyond the borders of one province fall under exclusive federal jurisdiction and as such are not under the control of the provincial legislatures except as may be specifically provided in federal legislation. Included in such works and undertakings are inter-provincial railways, pipelines, and the works and undertakings of the Bell Telephone Company of Canada. Accordingly, such matters are not subject to provincial legislation (including the Drainage Act) except where federal legislation specifically makes such provincial legislation applicable.

Section 91 (24) of the British North America Act provides that "Indians and lands reserved for the Indians" are under exclusive federal control. Provincial laws accordingly have no application to Indian reserves except where federal legislation provides otherwise.

This part of the report examines the ramifications of these principles on the applicability of provincial drainage laws to inter-provincial railways, pipelines, the Bell Telephone Company of Canada, and Indian reserves.

Inter-Provincial Railways

Inter-provincial railways such as the Canadian National Railways and the Canadian Pacific Railway are governed by the Federal Railway Act, Sections 208, 209, and 210, of which deal with drainage matters. In essence, Section 208 provides that in the construction of new railways, the railway company shall ensure that a sufficient outlet is provided "so that the then natural, artificial, or existing drainage, or water supply, of the lands shall not be obstructed or impeded by the railway".

Section 209 provides that where any municipality or landowner desires to obtain means of drainage through, along, upon, across or under a railway, such municipality or landowner may apply to the Canadian Transport Commission for approval of such drainage. The Commission may order the terms and conditions upon which such drainage may be effected.

Section 210 provides that, in the alternative, proceedings may be taken in accordance with any legislation of a province through which a railway runs, relating to drainage matters provided that the railway company has the option of constructing the portion of the drain required upon or under the railway. Before any proceedings are taken under Section 210, the character of the works or the specifications or plans must first be submitted to and approved by the Canadian Transport Commission, except that the Commission has provided by Order E-10 certain specifications and conditions that, if followed, remove the necessity for a formal application to the Commission for approval. As well as standard specifications, the Order provides for obtaining the railway company's consent, the appointment of an inspector by the company, and the supervision of construction by the inspector.

It is clear from these provisions that inter-provincial railways are essentially in the same position as any other landowner. In fact, it has become almost universal for engineers to assess railways for the entire increase in cost of constructing a drainage works through a railway. This practise coincides with the Committee's view that artificial barriers to drainage programs such as highways, public utilities, and railways should indeed bear the entire increase in the cost of constructing drainage works through such areas. Accordingly, **the Committee recommends** that this practise should be formally embodied in The Drainage Act and that the definition of public utility in the Act should be amended to include a railway.

The present provisions of The Railway Act generally present no particular problems to the effective working of drainage legislation in Ontario. However, the Committee received some complaints from municipal clerks that, in many cases, when notices and copies of reports were forwarded to head offices of railway companies, either no reply was received or a reply was received after several months. Furthermore, engineers have experienced difficulties in obtaining co-operation from railway companies to approve specifications for the construction of drainage works through railways and in arranging times for inspection. On the other hand, some railway companies suggested to the Committee that the time permitted under The Drainage Act is not sufficient for the company to adequately consider any notice or report it receives. The Committee believes that such problems are likely due to the adequacy or otherwise of internal communication lines within the particular railway companies. Local municipal clerks and engineers should not be concerned with how speedily the appropriate railway officials become aware of drainage problems once the company has been notified under the Act. Officials of the Canadian Transport Commissioner have assured the Committee that the Commission, as a regulatory agency having general supervisory jurisdiction over raillways, will make every effort to ensure that railways co-operate with municipal councils and engineers in the construction of drainage works through railways. As a last resort, a formal application may be made to the Commission for approval of the crossing pursuant to the engineer's report.

Under the new petition procedure, the railway companies will be notified of the proceedings at the earliest opportunity, and the timing problems they have experienced should be alleviated.

Any notice to a railway company should be forwarded to its head office unless the company has notified the municipal clerk in writing that notices should be sent to some other address.

Pipelines

Pipelines that cross provincial boundaries fall under the jurisdiction of the National Energy Board, which is constituted under the National Energy Board Act. The Act provides that the Board may, upon such terms and conditions as it considers proper, direct a pipeline company to divert or relocate its pipeline if the Board believes that the diversion or relocation is necessary to prevent or remove an interference with a drainage system. The Board may direct by whom and to whom the costs of the diversion or relocation shall be paid. Section 77 of the Act provides that no drainage system shall, except by leave of the Board, be carried across, along, upon, or under any pipeline and that the Board may permit such crossings upon such terms and conditions as it considers proper. It is clear from these provisions that the matter of crossing a pipeline by a drainage works is completely within the National Energy Board's jurisdiction, which includes the power to determine the cost of such crossings and by whom it shall be paid.

While it is impossible to accurately predict how that jurisdiction will be exercised, some guidance can be obtained from the decision of the National Energy Board in *Re Inter-Provincial Pipeline Company* (May 30, 1967). In this case, the company made application for leave to carry portions of its pipeline across certain highways and utilities. During the hearing, questions arose as to the proposed pipeline's effect on municipal and private drainage systems. In its reasons for decision, the Board had occasion to say:

> "The Board is, of course, convinced of the necessity for adequate drainage for agricultural land and the desirability of there being as little interference as possible with such drainage, as one aspect of the broader principle that where the public interest requires the construction of a utility such as a pipeline across private lands and other utilities, the presence of the pipeline thereafter should interfere as little as reasonably possible with the use, enjoyment, and development of the lands affected by it."

In particular, the Board stated its policy to require pipelines to be laid at such a depth that future drainage systems could be installed conveniently. Furthermore, if the pipeline is not located at a depth sufficient to permit efficient tile drainage, the pipeline company should, at its own expense, make those alterations necessary to permit such drainage.

One of the submissions made at the hearing was that the Board recommend to the Government of Canada that the National Energy Board Act be amended so that pipelines which are being constructed or operated under Federal Charter will be brought within provincial drainage law similar to the position of inter-provincial railways. To this submission, the Board said:

> "While this proposal engages the sympathy of the Board, it can not entice its support. The Board would consider it undesirable that companies under Federal jurisdiction should be subjected to present or future enactments of any or every Province by means of legislative reference. The Board would however see merit in amendment of the National Energy Board Act to incorporate in it, in general terms, such protections for municipal and private drainage systems as have been offered by Inter-Provincial in this proceeding."

Under the present statute, however, such matters are not specified in the Act, but remain within the discretion of the National Energy Board.

The present policy of the Board appears to favor protecting private and municipal drainage systems. Consequently, the Committee sees no need to make any particular recommendation with respect to this matter at present. The Committee is pleased that the Board has developed the positive policy towards land drainage that it presently observes and hopes that this enlightened policy will continue.

The Bell Telephone Company of Canada

The Bell Telephone Company of Canada historically has taken the position that the provinces have no legal right to subject the Company to their legislation. In general, it would appear that this position is correct in law. 1/ Consequently, the provisions of The Drainage Act applicable to public utilities, particularly Section 21 which requires payment by a public utility, do not apply to the Bell Telephone Company.

However, in some instances the Company has deviated from the strict legal position and has relocated its cables at its own cost when the widening of highways or the construction of new drainage systems necessitated doing so. The Company continues to take the position that doing such work at its own expense is by the grace of the Company and that it cannot be legally required to do so.

1/ See *City of Toronto vs. Bell Telephone Company* (1905) A.C. 52; *Commission du Salaire Minimum vs. The Bell Telephone Company of Canada* (1966) S.C.R. 767.

Notwithstanding the assertion of the Bell Telephone Company that it cannot legally be required to pay the cost of relocating its lines, the Committee is aware of Section 318 (9) of the Federal Railway Act, which provides:

> "Where a municipality or landowner desires to obtain means of drainage or the right to lay water pipes or other pipes, temporarily or permanently, through, along, on, across, or under any telegraph or telephone line within the legislative authority of the Parliament of Canada or any lands forming part of or used in connection with such telegraph or telephone line, the Commission (Canadian Transport Commission), may, upon the application of the municipality or landowner, permit the construction of the drainage or the laying the pipes upon such terms and conditions as the Commission may consider proper."•

The ambit of this subsection is not entirely clear, particularly as to whether the Canadian Transport Commission's power to impose "terms and conditions" includes the power to require the Telephone Company to pay relocation costs. The Committee has been advised by the Commission that there has never been an application made under this subsection, so that no authoritative interpretation has ever been given. In a particularly difficult case, however, a municipality or a group of municipalities may consider it appropriate to apply to the Commission for a ruling under this subsection.

The general policy of the Telephone Company with respect to drainage matters was set out in a letter (March 12, 1973) to the Chairman of the Committee from the Assistant Chief Engineer of Bell Canada. He stated:

> "The first policy has to do with ditching operations carried out under the provisions of the Ontario Drainage Act. It is now our policy to waive compensation for plant rearrangements necessitated by the more frequently encountered crossing conflicts unless the costs are substantial or the project is primarily for road improvements.
>
> This is obviously not a general waiver of compensation. There may be a few cases where the proposed locations for a drain may longitudinally conflict with our cable in a legally consented location or on easement. There may also be instances where physical obstacles or right of way problems complicate relocation and add significantly to the costs involved. If under these circumstances and following consultation with the drainage engineer and/or contractor, abnormally high costs to Bell cannot be avoided, we must reserve the right to bill all or a portion of the costs.
>
> "However, based on our past experience and the manner in which we plan to administer this policy, we anticipate that 80 to 90 percent of the cable/drain conflicts will not result in a billing. This anticipated reduction in the cases billed will depend on close co-operation between the drainage people and Bell personnel in terms of advance notice and planning. We are prepared to extend such co-operation.
>
> The second new policy concerns cable/tile crossing conflicts where private tile drainage systems are installed by individual farm property owners to improve the productivity of their land. Under this new policy we will locate, physically expose, and raise or lower our cable to the extent necessary to permit the farm property owner to proceed with this installation at no additional expense to him. Again, we will require advance notice to avoid delays."

Under Section 21 of The Drainage Act, public utilities under provincial control are required to pay all of the increase in cost necessitated by a drain crossing a public utility. It is apparent that the Bell Telephone Company will not voluntarily place itself in the same position as such utilities, but will reserve the right to pay less than the full cost in some circumstances. Believing that this situation should be corrected, **the Committee recommends** that the Government of Ontario negotiate with the Government of Canada with a view to amending the legislation that incorporates the Bell Telephone Company (or the Railway Act, if appropriate) to make the Company's position the same as provincially controlled public utilities.

Indian Reserves

Indian reserves fall completely within the legislative jurisdiction of the Parliament of Canada and provincial legislation has no application thereto. Thus drainage systems cannot be constructed through Indian reserves and in some instances have simply been constructed up to reserve borders and left there. In the meantime, Indians have not had the agricultural benefits to be derived from land drainage.

Under Section 81 (f) of the Indian Act, a band council is empowered to make by-laws respecting "the construction and maintenance of water courses, roads, bridges, ditches, fences and other local works." However, an Indian band is not permitted to expend band funds unless the Governor in Council has declared that the band has reached an advanced stage of development, and unless an appropriate by-law has been made by the band and approved by the Minister of Indian and Northern Affairs. Alternatively, the Governor in Council may declare under Section 69 of the Indian Act that a band may control, manage, and expend its revenue monies.

Under The Conservation Authorities Act, the definition of a muncipality includes a band under the Indian Act that is permitted to control, manage, and expend its revenue monies under Section 69 of that Act. Consequently, it is possible for an Indian band to become a member of a conservation authority and to contribute to the authority's expenses. If an Indian band refused to so contribute, however, it is unlikely that any proceedings could be taken to enforce such contribution.

It has been suggested that an Indian band could be placed in the same position as a municipality or a landowner under The Drainage Act by enacting appropriate definitions similar to that contained in The Conservation Authorities Act. It has been further submitted that if individual Indians object to drains crossing their lands, the band council can enact an appropriate by-law under Section 81 (f) of the Indian Act. It is suggested that the funds to be paid by the Indians would be paid by the Government of Canada or by the band directly following appropriate approval under Section 69 of the Indian Act or under a by-law approved by the Minister of Indian and Northern Affairs.

The Committee has received submissions from Indian representatives requesting that the Indians be permitted to have the benefits of agricultural land drainage and the appropriate subsidies therefor and that The Drainage Act be amended accordingly. The Committee fully agrees with these submissions. However, The Drainage Act is a two-way street, so to speak, in that it confers certain benefits and imposes certain obligations at the same time. The major obligations are that an indivudal landowner must, for the common good, permit a drain to flow through his lands if the majority of his neighbours consider it necessary and that he must contribute financially to the drain. Under the present provisions of the Indian Act, there is no way to enforce either of these obligations if a particular band council does not wish to permit a drain to flow through a reserve or does not wish to or cannot contribute to it financially.

As mentioned, the Committee fully agrees with the principle that Indians should be entitled to the benefits of agricultural land drainage and the appropriate subsidies. However, the Committee feels just as strongly that Indians should be placed in the same position in law as other landowners insofar as their obligations are concerned. Accordingly, **the Committee recommends** that appropriate amendments be made to The Drainage Act to place Indian reserves in the same position as other lands, provided that appropriate amendments to the Indian Act in conjunction therewith are also enacted by the Parliament of Canada. **The Committee recommends** that the Government of Ontario enter into negotiations with the Government of Canada accordingly.

Summary

1. No change should be made in the present law respecting inter-provincial railways, except that railways should be included within the definition of "public utility."

2. Considering the present policy of the National Energy Board, no change need be made in the present law respecting pipelines that cross provincial boundaries.

3. The Government of Ontario should negotiate with the Government of Canada with a view to amending the legislation that incorporates the Bell Telephone Company of Canada (or the Federal Railway Act, if appropriate) to make the Bell Telephone Company's position the same as provincially controlled public utilities.

4. Appropriate amendments should be made to the Drainage Act to place Indian reserves in the same position as other lands insofar as drainage is concerned, provided that appropriate amendments to the Indian Act in conjunction therewith are enacted by the Parliament of Canada to place Indians in the same position as other landowners insofar as their obligations are concerned.

(B) EUPHRASIA TOWNSHIP MUNICIPAL DRAIN NO. 1

During 1971, a group of landowners petitioned the Council of Euphrasia Township in Grey County for the construction of a drain persuant to Section 3 of The Drainage Act. The construction of the drain was eventually halted by an injunction issued by the County Court of Grey County. The saga of this drain presents problems which the Committee believes are fundamental to the effective workings of The Drainage Act, and the Committee accordingly has examined this particular situation in some detail.

Background

During Spring 1971, six landowners petitioned the Muncipal Council for the construction of a drain. On June 7, 1971, the Municipal Council appointed an engineer pursuant to Section 3 of the Act. The engineer's report was received by the Council on August 5, 1971 and was considered on August 28. The report was adopted on September 19, 1971, a Court of Revision was held on October 12 and closed October 15. The by-law was given third reading on October 15, 1971.

The North Grey Conservation Authority had been notified of the petition on May 6, 1971.

Following receipt of the engineer's report, several persons filed notice with the Township Clerk in August and September that they intended to make application to the Referee to have the by-law quashed. However, no application was ever made and construction on the project started in October 1972.

Up to this point, it appears that the drain had been properly authorized under the provisions of The Drainage Act and that all necessary procedural steps had been taken. All time limits for appeal had passed with no formal opposition being raised except for a few appeals to the Court of Revision, which had been dismissed. However, opposition to the drain had been building by those who opposed it primarily on the grounds that they did not want to contribute financially to a drain from which they would derive little or no benefit. This opposition increased following the release of a report prepared by two officials of the Conservation Authorities Branch of the Ministry of Natural Resources. The report suggested that there could be some detrimental environmental impact following the drain construction. The report had been prepared at the specific request of the Resources Manager of the North Grey Conservation Authority. He had vigorously opposed the construction of the drain and subsequently made an affidavit in support of an injunction to stop the drain.

A few days after construction had begun, several landowners in the area obtained an interim ex parte injunction from the local County Court judge against the Township of Euphrasia that restrained the Township from proceeding with the drain construction for a period of one week. Such ex parte injunctions are obtained as an emergency measure without the defendant being heard or even notified that such an injunction is being sought. On the expiry of that injunction, a hearing was held at which the Township was represented by counsel and during which the plaintiffs requested an order continuing the injunction until trial of the action. On October 13, 1972, the judge continued the injunction in the following somewhat curious terms:

> "Order to go continuing injunction on terms to be agreed upon between counsel or if no agreement as I shall then provide."

The purpose of such an interlocutory injunction is to maintain the parties in status quo until the action can be tried and the rights of the parties finally determined.

Since the interlocutory injunction was granted, a municipal election was held and the composition of the Council changed. The present Municipal Council's position is that it will make no attempt to have the interlocutory injunction set aside and will take no steps to force the plaintiffs to proceed to trial. This is perfectly acceptable to the plaintiffs who essentially have achieved the result they desired without the necessity of proceeding to the trial of the action. What was intended to be a temporary injunction until trial has become in affect a permanent one. In the meantime, the petitioners who originally requested the drain cnstruction have no status to take any part in the injunction proceedings and have no means of redress.

The Committee is aware that, in all but the most exceptional cases, it is improper to comment about a case that is presently before the courts on the sound principle that any such comments might prejudice the ultimate outcome. In this case, however, no proceedings have been taken since October 13, 1972, and for all practical purposes the final result has been achieved. Furthermore, in a case like this, where fundamental questions are posed as to the workability of The Drainage Act and as to the appropriateness of legal procedures available to frustrate the Act, the Committee feels that it is proper and indeed necessary for it (appointed by the legislature of Ontario which, after all, bears ultimate responsibility for all the laws of this Province) to express its views. Accordingly, the Committee shall do so.

Comments

The case of the Euphrasia drain presents in stark perspective many of the general problems that the Committee hopes will be ultimately solved by the recommendations in this report. It represents a situation in which the existing procedures of The Drainage Act were inadequate to resolve the conflict between those who petitioned for the drainage of their agricultural lands and those who opposed it on environmental grounds and on the grounds that it would cause undue damage to their lands. It also presents the narrower problem of how this particular conflict ought to be ultimately resolved.

In general, the main cause of the dispute seems to be that the opponents of the drain did not become aware of its implications until the engineer's report had been prepared. They did not take advantage of their right to appeal to the Referee or they were not aware of the procedures to follow in order to appeal. Presuming for the moment that the environmental objections to the drain are legitimate, such objections did not become apparent until after the time for appealing had expired. There was no requirement, of course, that any environmental impact study be obtained. The Committee cannot help but note that, although the Resources Manager of the North Grey Conservation Authority became actively involved as an individual in the injunction proceedings, the Conservation Authority itself did not see fit to appeal the engineer's report to the Referee as it had a right to do.

The Committee hopes that cases of this nature need not arise in the future if the recommendations in this report are implemented. All parties affected by a drain will be notified at an early stage of the proceedings that a drain is being proposed. In many cases, preliminary studies will be obtained that include an environmental impact study. Clear rights of appeal will be provided to all parties following consideration of the preliminary studies and following adoption of the engineer's final report. All parties will be advised of the procedures to be followed. If these recommendations are adopted, problems such as those arising in the Euphrasia case should be resolved at an early stage.

The Committee believes that the new procedures contemplated will adequately protect the rights of everyone affected by the proposed construction of a drain. **The Committee therefore recommends** that the Act be amended to provide that no injunction shall be issued to restrain the construction of a drain that has been authorized in accordance with The Drainage

Act and that is being constructed in accordance with a valid by-law of a municipal council.

The Committee realizes that an injunction may be appropriate in some cases if, for example, a drain is constructed other than in accordance with the Act or in a location other than that authorized by the by-law. However, the Committee feels that, after an interlocutory injunction has been granted, a municipal council should not be allowed (as in the Euphrasia case) to be inactive to the prejudice of landowners who are detrimentally affected by the injunction. Accordingly, **the Committee recommends** that the Minister of Agriculture be made a party to any proceedings commenced to obtain an injunction to restrain the construction of a municipal drain and that the Minister be permitted to participate in the trial and to take any proceedings that any other party could take, including appeals.

The particular problem raised with respect to the Township of Euphrasia Municipal Drain No. 1 remains to be considered. The drain proponents have been deprived of drainage of their lands because of a conflict with other landowners in the area, primarily on environmental grounds. The merits of that conflict have been finally resolved because of an artificial stagnation of the proceedings. The Committee has concluded that this problem can be resolved only by the unusual, but not unknown, step of a special act of the legislature. The question is how to frame such a statute so that the dispute can be resolved fairly. It must be remembered that the project had reached the stage of complete approval, that construction had actually begun, and that the arguments advanced during the injunction proceedings were presented at a very late date indeed.

The Committee conceives the viable alternatives in a special Act to be as follows:

1. Provide that the Minister of Agriculture shall be deemed to be a party to the original action and shall be entitled to participate in all proceedings in the action henceforth. Further provide that if the action is not taken to trial within six months after the date the special act comes into force, the action shall be deemed to be dismissed. Further provide that no other action shall be commenced to restrain the construction of this particular drain, other than the action which resulted in the granting of the interlocutory injunction. Further provide that if the action is ultimately dismissed, the municipal council shall proceed to construct the drain in accordance with the engineer's report following a new majority petition.

2. Provide that the action for the injunction shall be deemed to be dismissed, that no further injunction can be obtained to restrain the construction of the drain authorized in accordance with The Drainage Act, and that notwithstanding any interlocutory injunction granted to date, new proceedings can be commenced by the landowners desiring drainage in accordance with the new procedures of The Drainage Act as amended.

While both of these alternatives are attractive in certain respects, the Committee believes that the first alternative is preferable. The second alternative might be considered unfair because it completely alters the procedures under which this drain was authorized and challenged. Furthermore, if the second alternative is adopted, additional cost will be incurred in obtaining preliminary studies and a new engineer's report. Adopting the first alternative will simply ensure that the legal claim put forward on behalf of the plaintiffs will be pressed to its utlimate conclusion within a reasonable period of time. Since it is essential in the interests of justice that both sides of the argument be presented to the Court, it is hoped that the Ministry of Agriculture will defend the action as a friend of the Court, if the municipal council does not wish to do so.

The Committee feels this matter requires immediate implementation and suggests that the special act be introduced and enacted at the earliest opportunity as the matter has now been delayed since October 1972.

(C) QUALIFICATIONS OF ENGINEERS AND LAND SURVEYORS

During its public hearings, the Committee became concerned about the performance of the duties imposed on individual engineers and Ontario land surveyors practising under the Act. Criticisms ranged from charges of incompetence to a lack of clarity and detail in report documents. Wide variations were found with respect to allowances under Section 8 and to assessment procedures. In some instances, the Committee was made aware of faulty design and received complaints concerning both underdesign and overdesign. The Committee feels that municipal councils appointing an engineer under The Drainage Act should have the assurance that the appointee is competent to carry out the assignment.

Informal discussions were held with representatives of the Association of Professional Engineers and the Association of Ontario Land Surveyors concerning a means of qualifying persons practising in land drainage. The Committee also consulted the staff of the Ministry of Agriculture and Food, who are involved to a degree with all municipal drainage projects and accordingly with all drainage consultants. The information presented by the Ministry tended to confirm some of the criticisms received from the public.

As a result of considerable deliberation and debate, **the Committee recommends the following:**

1. The Association of Professional Engineers and the Association of Ontario Land Surveyors, either individually or collectively, should initiate an effective means of determining those individuals or firms that are properly qualified to practise land drainage under this Act. This will not be an easy task since there are no formal university courses available in this field and competence in the past has been obtained only through what might be termed an apprenticeship

system. However, the Committee feels that this duty lies within the responsibility of the professional associations and **recommends** that they take the necessary steps to establish and define the qualifications of drainage engineers and land surveyors.

2. The Committee considers this problem to be very important and feels some satisfactory solution must be found, particularly since provincial grants are involved and ample evidence exists that these monies have been used unwisely and improperly in some instances. **The Committee therefore recommends** that the Ministry of Agriculture and Food become the qualifying body if the professional associations involved do not develop a satisfactory system of designation that will protect all concerned.

(D) GREAT LAKES WATER LEVELS

During the early months of 1973 and while involved in its continuing study of drainage, the Committee became aware of the exceptionally high water levels of the Great Lakes which were having serious effects in Essex, Kent, and Lambton counties. Some study was given to the causes of the increase in water levels and consultations were had with officials of the Ontario Ministry of the Environment. The Committee's concern was to determine the amount of water that might be deposited by agricultural land drainage schemes into the Great Lakes. The conclusion was that the amount was minimal and that agricultural drainage works were not reponsible for the disastrous consequences resulting from the high levels. In some areas, however, the reverse was true in that the high levels of lake water were backing up the drains to the extent that they were not functioning efficiently.

As a result, the Chairman of the Committee appeared before a sitting of the International Joint Commission in Toronto on January 25, 1973. In his submission, the Chairman expressed the opinion that climatic conditions were the controlling factor in the cyclical fall and rise of the Great Lakes levels. The Chairman called on the International Joint Commission to expedite its study of a plan that will maintain lake waters at a proper level and expressed the hope that senior governments will take the necessary steps to carry out the work associated with the required controls.

(E) BEAVER IN DRAINAGE DITCHES

Early in its travels through eastern and northern Ontario, the Committee was made forcefully aware of the damage and obstruction to drainage works that can be caused by beaver colonies. The Drainage Act makes provision for the removal of obstacles to proper drainage and provides penalties for those who deliberately obstruct or damage a drainage works. Naturally, the present Act makes no mention of the problem of beaver. The Committee believes, however, that measures should be taken to prevent these natural obstructions to costly drains from being permitted to continue.

The Minister of Natural Resources has long been concerned with both the welfare of this popular animal and the obvious damage that it can do when it becomes plentiful in certain areas of the Province. The Ministry is thus in a difficult position; although it is unable to accept the complete elimination of this species from agricultural areas, it recognizes that somehow the damage should and must be controlled. The Ministry has permitted trapping these animals and has encouraged farmers and others to have the animals removed by trappers. While trapping is a proper, humane, and sometimes profitable way of removing these animals from certain areas, the Committee is not convinced that it is the complete answer. Trappers do not necessarily "trap out," but usually leave a seed pair to ensure a supply of animals for the next season's trapping. This practise just continues the depredations the animals can create in drainage ditches.

The Ministry of Natural Resources' position is that the responsibility of removing these animals when they become a nuisance rests with the landowner and that the Ministry merely gives advice to landowners as to methods of removal.

The Committee is acutely aware of the millions of dollars being spent annually by farmers and municipalities and the Government of Ontario in the construction of drainage works under The Drainage Act. The Committee is concerned that these dollars are being wasted in some areas of eastern and northern Ontario because of the activites of nuisance beaver. The Committee has already recommended that the drainage superintendent be given certain additional powers with regard to his duties in maintaining drains in proper condition. In the case of nuisance beaver, the Committee feels that the drainage superintendent also be given special authority in this area.

The Committee therefore recommends that where, in the opinion of the drainage superintendent, a drainage works constructed under The Drainage Act is being damaged or rendered ineffective by the activity of beaver, the superintendent report this fact to the district office of the Ministry of Natural Resources and that the Ministry be responsible for taking the necessary measures to permanently eliminate the animal from the drainage works.

(F) LAKESHORE EROSION

The problem of gully erosion on the lakeshores of southern Ontario was drawn to the Committee's attention when it visited areas of Elgin, Huron, and Bruce counties. Damage to lakeshores is greatest when the lake levels are high, but it even continues to a lesser degree when levels are normal. Some of this normal damage from erosion no doubt results from the cumulative effect of the area's agricultural drains, which tend to seek an outlet directly in the lake or in tributaries leading to the lake.

The Report of the Select Committee on Conservation in 1950 indicated that "losses through shore erosion today have reached a point where they can no longer be considered the responsibility of the individual person whose land is affected but rather a problem to be considered jointly by the federal and provincial governments and the municipality concerned." That Committee recommended that studies of lake currents and studies of the construction of protective works should be commenced to prevent the losses, which were obviously becoming serious.

It is impossible to measure the effect that neighbouring agricultural areas have on the lakeshore by reason of drainage works constructed under The Drainage Act. There must be some effect, however, and authorities involved should be aware that excessive drainage can be detrimental and that the cumulative affects of drainage can increase the gully erosion along the shorelines.

Other factors also make their contribution to erosion problems. The Committee feels that urbanization, with its growth of paved areas in shopping centres, driveways, and highways, has a much greater effect on lakeshore gully erosion than the water that might be brought down by drainage works.

The Committee has recommended that enviromental impact statements should be prepared prior to new drain construction. It is hoped that in preparing such statements for drains that are eventually going to take water to the lakes, the environmental impact committee (proposed in part VIII of this report) would take this erosion problem into consideration and have some comments made regarding the possible effect of the drain on increased shoreline erosion.

(G) A SUGGESTED REGIONAL OR COUNTY DRAINAGE COMMISSION

It has already been recommended that one or more municipalities may appoint a single qualified drainage superintendent to look after all the drain work in the municipalities concerned. Arising from this, the Committee also felt that some counties or regions quite possibly might need and desire all the drainage works in the area to be administered by one body and by one or more drainage superintendents as required. It was suggested that the county or region should appoint and pay for a drainage commission that would carry out all functions of a municipal council under The Drainage Act. The authority of this drainage commission would extend to those drains in townships where the townships had voted by by-law to turn over their responsibility to the county or regional body.

Some counties have already considered this possibility and have indicated their interest by filing resolutions with the Committee. It is quite possible in already established regions that agricultural land drainage receives little or no attention because of the predominance of urban interests and urban elected representatives. **The Committee therefore recommends** that, where municipalities in a county or a region agree and so authorize by by-law a county or regional drainage commission be organized to direct, supervise, and control all drainage works in those municipalities that have agreed to turn over their responsibilities to the commission.

(H) BARRIERS TO AGRICULTURAL LAND DRAINAGE

Water naturally flows down grade with the force of gravity, and is diverted from such natural flow when barriers such as furrows and dykes are placed in its obvious path. Drainage works are built to carry this flow to a proper outlet in open channels or in underground tiles, but these works must also observe the requirements of gravitational flow.

In constructing drainage works, conflicts inevitably arise with other structures and works, including railways, provincial highways, county and township roads, Ontario Hydro lines, and underground installations such as pipelines and telephone and telegraph cables.

The Committee has definitely concluded that all such works are artificial barriers to both natural and constructed drainage. Because they are barriers and because they are artificial, the Committee contends that the increase in cost occasioned in building the drainage works by the very existence of the barrier must be assumed by the artificial barrier, whatever it may be.

Precedent is to be found in the Railway Act, Revised Statutes of Canada, 1970. Section 208 of the Act clearly outlines the responsibility of railways to make and maintain suitable water pipe, flumes, ditches, and drains along each side of, across, and under the railway in order to connect with the ditches, drains, and watercourses that were on the land through which the railway runs so as to afford a sufficient outlet. The Act states that the natural, artificial, or existing drainage or water supply of the land "shall not be obstructed or impeded by the railway." Thus, the precedence as between railways and agricultural drainage is clearly set out.

Section 210 of the Canada Railway Act also provides that wherever an act of a provincial legislature makes possible proceedings by any municipality or landowner for any drainage work across the property of any other landowner, then similar proceedings may be taken at the option of the municipality or landowner for drainage works across the lands of the railway company. If proceedings are taken with respect to a railway under this section, the provincial drainage laws apply to railway company lands to the same extent the laws apply to any other landowner. This section also provides that the costs of the drain across or through the railway be borne by the company and in all cases shall be based on the increase of the cost of such work caused by the construction and operation of the railway.

Almost the same precedent applies in the case of pipelines. In 1967, the National Energy Board held a hearing in London, Ontario to discuss the application of Interprovincial Pipelines Ltd. to take their line across the lands of southwestern Ontario and to determine the line's relationship to the numerous agricultural drains with which it was going to interfere or impede. The company stated at the hearing that it was prepared to lay its pipe so that it would not interfere with any existing municipal drain or any planned municipal drain of which it had knowledge. Where an existing line interfered with a municipal drain, the company agreed to lower its existing lines so that it would not interfere.

At this hearing, the Province of Ontario supported the concept of making federal pipelines subject to provincial drainage laws in much the same manner as outlined for railways.

The National Energy Board Act subsequently was amended and Sections 37 and 77 set out the precedent that pipelines must give way to drainage works where the two conflict. The National Energy Board recently issued an order to Dome NGL Pipelines Ltd. on the building of a pipeline across Kent County. This order requires the pipeline company, at its own expense, to take any necessary steps to ensure that its facilities do not interfere either with any existing, future, planned, or unplanned municipal drainage systems or with any existing or future private drainage systems. This order seems to set out the fact that the drains take precedence where pipelines interfere with drains.

Conflicts arising from roads of all levels and standards that cross agricultural drains and vice versa are not as clearly resolved. The Drainage Act regards roads as any other landowner and the engineer assesses them as such in his report. A road is assessed the increase in cost that occurs because its existence prevents the drain from having free right of passage. Drainage engineers accept the theory that a road is an artificial barrier to the progress of the drain, and when they design a drain through or across a road they assess to the road the additional costs required by the road's being there. Although this is an accepted practise among drainage engineers, there is no clear authority in the Act permitting such an assessment.

The opposing contention is that if a municipal drain is being dug through a road and there is no discernible benefit to the road from this new drainage works, the road should not be assessed.

The Committee believes that a road is an artificial barrier to the natural flow and drainage of the land and that excess coss therefore should be assessed against the road. In the light of the precedents established with railways and pipelines, the Committee feels its views can be substantiated. The preeminence of land drainage over all forms of barriers is accepted.

Road authorities should not be regarded as landowners but rather as any other public utility, and provision should be made in the provincial budget for payment of crossing costs. This suggestion was made to the Committee in some briefs and submissions. If this were done, township and county road budgets would be relieved of having to meet disastrously large assessments that are a detriment to local maintenance and road building programs.

At present, provincial highways are assessed the cost of passing the drain through the highway and this assessment is turned over to the Municipal Subsidies Branch of the Ministry of Treasury, Economics and Intergovernmental Affairs. This Branch then pays, on behalf of the Ministry of Transportation and Communications, the assessment as set out by the engineer. Where assessments are made against county and township roads, the costs are paid out of the county or township road budgets, which are subsidized (up to 80 per cent in some cases) by the Ministry of Transportation and Communications.

These subsidies are really a form of provincial aid for upgrading and maintaining county and township roads and are not intended to finance drain crossings. The Committee agrees with this view and believes that it is really unfair to have these budgets and subsidies reduced by drainage assessments being debited to the county or township road budgets. One costly road crossing in a small township quite possibly could severely cripple the road superintendent's plans for the rest of the year.

The Committee therefore recommends that the Legislature appropriate funds into the budget of the Ontario Ministry of Agriculture and Food in sufficient amounts to cover the present subsidy to county and township road budgets for necessary crossings of county and township roads by drains constructed under The Drainage Act. In addition, an amount should be provided within the budget of the Ministry of Agriculture and Food to provide for the payment of assessments made against provincial highways and the Ministry of Transportation and Communications. All payments on behalf of provincial, county, and township road crossings should be paid out of the funds, and with the approval of the Ministry of Agriculture and Food.

In tabling this report in June 1974, the Committee wishes to draw to the attention of the Legislature that it believes this recommendation urgently needs almost immediate implementation. This would require that special procedures be undertaken and special authority be given the Ministry of Agriculture and Food to immediately begin payment of these subsidies. The Committee is informed that there is presently in the Province a sense of confusion and disturbance among the municipalities as to the disposition of their road budgets for 1974-75. The Committee, believes that immediate attention to this recommendation would clarify, in the minds of municipal officials the extent of their programs for the rest of this year.

(I) RIVER FLOODING

During its travels, the Committee was made aware of two areas in northern Ontario where river flooding caused damage to bordering agricultural lands and seriously delayed farmers' spring operations. It was evident from discussions with local municipal officials and farmers that the cost of works for effective flood control would be expensive and was beyond the financial capability of the municipalities and landowners involved. While river flooding as such was not within the Committee's terms of reference, the matter was still brought to its attention, and it feels some comment is necessary on the solution to the problem.

The Committee believes that such river flooding as was brought to its attention in northern Ontario is the responsibility of the Ministry of Natural Resources through the Conservation Authorities Branch. The two areas involved are not now within the jurisdiction of a conservation authority, making it difficult to solve their problem until a conservation authority is organized in the areas where the flooding occurs. Still, the Committee feels that this is the only practical solution to an obviously troublesome situation.

The chronic flooding along the South Nation River in eastern Ontario was also drawn to the Committee's attention. There is a conservation authority on the South Nation River and the Committee feels it is this authority's responsibility to take care of the flooding problems. It is possible that corrective measures on the South Nation River may well be beyond the financial capabilities of both authority and the municipalities. If this is so, the Committee feels that, since the area is so extensive, an approach to the Government of Ontario would evoke some support. Perhaps a joint provincial-municipal agreement could be arranged and the necessary works constructed by the conservation authority. Such an agreement was devised some years ago but rejected by the local municipalities.

XIX. WATER MANAGEMENT — A PLAN FOR THE FUTURE

The Committee was impressed with the submissions received from the Committee of Chairmen of the Conservation Authorities of Ontario and from the Grand River Conservation Authority. The central theme of these briefs revolved around the theory and practise of water management. Both briefs deplored the fragmentation of control over water as a resource in Ontario and suggested that the conservation authorities were being hampered in their responsibilities as watershed managers when they had little or no control or input into the planning of agricultural drainage.

The numerous pieces of legislation on the Ontario statute books that seem to conflict with The Drainage Act have already been mentioned but this compilation also indicates an overlapping of jurisdiction and confusion among authorities as to where jurisdiction lies. One conservation authority indicated to the Committee that in its opinion the position could be held that a conservation authority must issue a permit before any drainage works could be constructed. As a solution to the conflicts, the Chairmen of the Conservation Authorities recommended that, since drainage is only one aspect of water management, it must logically be viewed as part of the total water management program in a watershed. The Chairmen's brief contended that, in order to bring drainage into the total watershed management program, the plan outlined in the brief was to be implemented by the Conservation Authorities of Ontario in co-operation with the Ministry of Agriculture and Food, the Ministry of Natural Resources, the Ministry of the Environment, and the local municipalities. The Committee is grateful to the Chairmen of the Conservation Authorities for having brought these basic concepts to its attention.

Florida

The idea of total watershed management that includes land drainage was not forgotten and was again forcibly brought to the Committee's attention when it visited the State of Florida in 1973.

Florida had recently passed legislation entitled The Florida Water Resources Act, 1972, in which the following policy was declared: (1) waters in the State are among its basic resources and such waters have not heretofore been conserved or fully controlled to realize their full beneficial use; (2) it is further declared to be the policy of the Legislature to provide for the management of water and related land resources.

The Act then discusses provisions for promoting conservation and utilization of water and for the development and regulation of dams, reservoirs, and other works to provide water storage, to handle flood, erosion, and drainage damage, to preserve natural resources, to promote recreation, and to maintain the navigability of river and harbour waters.

The legislation also recognized that Florida's water resources problems would vary from region to region both in magnitude and complexity. The Legislature therefore intended to vest in the Department of Natural Resources the power or responsibility to accomplish the conservation, protection, management, and control of the State's waters with sufficient flexibility and discretion to accomplish these ends through delegating appropriate powers to the various water management districts. The legislation gives to the Department of Natural Resources the responsibility of developing a water-use plan for the integrated and coordinated use and development of Florida's waters.

Another section of the legislation created and divided the whole State into five water management districts, two of which were already in existence before the legislation was passed. The Act specifically stated that it was the intent of the Legislature that all territory in the State should be included in water management districts.

The Committee met with senior officials of the Department of Natural Resources who explained the workings of the new Act and the new ground they were breaking to bring the State's total water resources under the management and control of one department of government. The Committee also met with Representative Jack Shreve, a member of the Florida Legislature who had been responsible for developing the bill and taking it through the Legislature. Mr. Shreve described to the Committee the complicated procedure by which legislation is drafted and processed through the Florida Legislature. Although the procedure was long and arduous, he was grateful to the many officials, institutions, and agencies that agreed with his thesis that water management should be controlled by one government agency and not be allowed to proliferate and continue under the auspices of innumerable agencies and bodies.

Nebraska

The Committee was informed through discussions with federal officials in Washington, D.C. that a move similar to Florida's had been undertaken by the State of Nebraska. There is now a Natural Resources Commission in Nebraska which develops and controls all programs dealing with soil and water conservation, watershed protection, overall planning, flood plain management, etc.

This Commission was established as a result of a study by a predecessor Commission that had been ordered by the Legislature to prepare a water plan involving the whole State.

In directing that such a plan be developed, the Legislature recognized that the State's economy depended primarily on its soil and water resources. Therefore, the study's primary objective was to ensure that these resources be wisely developed for the maximum benefit of the citizens of Nebraska. Since the development of Nebraska's natural resources had seemed fragmented, the study recommended that the units of local government which were responsible for resource development should be modified, combined, improved, and empowered to meet present and future needs. Part of the study which developed the State water plan recommended steps to the Legislature that were necessary to overcome the obstacles to resource development arising from cumbersome and outdated local organizational arrangements. It is interesting to note that both Florida and Nebraska have come to the perhaps painful recognition that their present organizations and structures are inadequate to meet modern needs.

It was found that Nebraska had fourteen different types of special purpose districts with responsibility in water and land resource development. This resulted from the patchwork development of legislation over the years dealing with such matters as irrigation, drainage, flood control, ground-water conservation, and mosquito control. The Commission carrying out this study was confused by the number of local districts and had great difficulty determining their location and number. It was estimated, however, that at least 500 of these special purpose districts were organized in Nebraska, with almost 100 in one county sometimes. This tabulation was made in January 1969. The study also pointed out the many defects of this fragmented organization of water management districts. Many of them were too small and did not have adequate financial capability and many overlapped, with an obvious lack of responsibility in many cases.

The final report to the Legislature of Nebraska outlined the alternative courses of action, with the main recommendation being that the single purpose districts be made into multipurpose districts. This required the State Legislature to eliminate the enabling legislation and replace it by legislation with a multipurpose base. Accordingly, it was recommended that there be natural resource districts authorized to carry out and sponsor all known programs for resource development. The study pointed out that these districts could be established on the basis of either river basins or common problems. Some consideration was given to setting up the districts on the basis of river basins, but it was decided to delineate the districts in which most or all residents had a common interest. Because the latter was more easily determined, it was recommended in the study.

The main recommendation was that the State of Nebraska should enact legislation to create natural resource districts whose objectives should be to carry out water and land resource development on the local level. The major areas of concern were flood control, drainage, recreation, water supply, irrigation, pollution control, wildlife preservation, watershed protection, forestry and range management, flood plain zoning, and soil conservation.

The second recommendation was that the legislation should consolidate all of the State's existing soil and water districts—rural water districts, drainage districts, reclamation districts, and irrigation districts. It recommended a State Commission that would have responsibilities related to the 15 or 20 local natural resource districts.

This Committee feels that there obviously is much to be learned in the co-ordination and management of water resources by studying the experiences of Florida and Nebraska.

Manitoba

Closer to home, the Committee discovered that the Province of Manitoba had taken steps along similar lines. For many years, water control and conservation in Manitoba had been the responsibility of the Department of Agriculture and Conservation, but in 1972, this responsibility was transferred to the Department of Mines, Resources and Environmental Management.

A clear definition and division of authority now exists between the Province and the municipalities with regard to the vast system of drains and floodways which had previously been the responsibility of many municipalities throughout Manitoba. A similarity to Nebraska's background may be noted here in that fragmented municipal laws were leading to confusion and a multiplication of responsibilities. One of the first things Manitoba did to clear up the confusion was to develop a provincial waterways policy. As a result, the natural watershed areas in the Province were outlined and their boundaries established. Waterways were then designated and classified through the application of certain criteria. Drains and waterways of a specified order were then declared to be a provincial responsibility, and thus the first steps were taken to clear up the confusion. Other drains of other orders were the responsibility of the municipalities or of district organizations.

The Committee visited Manitoba in September 1973 and spent three useful days studying the program there. The Committee also visited the first of the conservation districts that had been established under the legislation. The Committee was favourably impressed not only with the structure of the administering Department and the Water Resources Branch but also with the overall nature of the philosophy as expressed by the officials it met.

Certainly it is clear that in water resources development in Manitoba, every possible area is controlled and administered by one agency and one department. These include flood control, drainage, water for agriculture, irrigation, ground-water control, water power, municipal water supply, and water resources involving recreation, fish and wildlife.

Manitoba's Watershed Conservation Districts Act has a concept of total watershed management and is the basis for a co-ordinated, long-range, co-operative approach to water control and to resources management in general. The whole problem is treated by considering the watershed as a single entity rather than as a series of individual or artificial segments. The watershed is regarded as a community of people and the resources that support them, and the health and welfare of this community depends on good management of the watershed.

The Act has been on Manitoba's statute books for some time, but just now is coming into more general and wide-spread use. The objective of the Act is "to promote the conservation and control of the water resources within the district and for that purpose, to study, undertake and put into effect, operate and maintain a scheme in respect of a district for the purposes of conserving, controlling, developing, protecting, restoring and using — (a) the water resources within or available to the district; and (b) the land, forest, wildlife and recreation resources within the district as may be necessary or incidental to the achievement of these aims and objectives."

The Committee met with officials of the Whitemud Watershed Conservation District, which covers an area of 2,400 square miles on the east side of Riding Mountain. This district has been formed and is managed by local people and is supported by the necessary technical staff from the Province.

The Committee was impressed with the presence and co-operation of many technical people and the interdisciplinary nature of the technology available such as from engineers, biologists, and agriculturists. If watershed management is to be fully effective, obviously many people must be actively involved. Technical and professional people must be concerned with the effects their proposals have on the entire well-being of the watershed. They must be conscious of the affected interests; they must be visionary and must accept people of other disciplines in planning all aspects of good water management. The only goal must be to make the project work. The engineer must be conscious of the related work of the biologist, the soils expert, the wildlife manager, and the forester. All must be jointly involved in making decisions and policies and in implementing them. Municipal councillors, the individual landowners, and provincial politicians must also be involved.

After looking at Manitoba's legislation and programs, it was obvious to the Committee that this Province had a worthwhile program for the co-ordination and rational development of water resource management.

The United Kingdom

In the United Kingdom, The Water Act of 1973 outlines a national policy for water. This Act is the result of many years of studying the need for reorganizing water and sewage services and was the culmination of many years of studying the problem of overlapping local organization and the proliferation of boards, agencies, and councils. For years, there had been a Central Advisory Water Committee, which was commissioned in September 1969 to consider how the functions relating to water conservation, water resources management, water supply, sewage disposal, and pollution prevention that were being exercised by river authorities, public water undertakings, and sewer and sewage disposal authorities could best be organized and to make recommendations. Their report was tabled in April 1971 and includes an inventory of the various types of bodies associated with water management. The report argued for overall planning. The conflicts of interest which hinder such planning were examined and a plan was set out for necessary co-ordination in the future. The Committee recommended a national water authority and emphasized a certain urgency in ensuring adequate water supply.

While land drainage as such was not within the Advisory Committee's terms of reference, it was obvious that land drainage would be affected by any proposals the Committee made. The Committee therefore noted in its report that the impact of its proposals on land drainage must be given due weight.

The Committee's major recommendation was that there be a national water authority and that there be a number of regional water authorities. As a result of this study, The Water Act of 1973 was passed and received Royal Assent in July 1973, representing a radical restructuring of the management of water services in England and Wales.

It was expected that the proposals under The Water Act would come into effect on April 1, 1974, when new local authorities would come into existence and the smaller authorities would disappear.

The Act finally decided on nine regional water authorities in England and one in Wales to be responsible for water and sewage functions formerly carried out by more than 1,500 separate local authorities. The new authorities are responsible for water resources and supply, sewage, and sewage disposal, pollution prevention, land drainage and flood protection, fisheries, recreation and the amenities of the use of their water space, and some cases of navigation.

It is reported that these authorities will employ 75,000 people and have an annual revenue of about 350 million pounds and an investment budget of 300 million pounds annually.

At the national level, there is to be a National Water Council consisting of the chairmen of the ten water authorities, an overall chairman, and other appointees of the government. The main duty of the National Water Council will be to advise the government on national water policy and to provide the regional water authorities with a forum for discussing common problems, for developing and disseminating uniform policy and practises, and for providing common services.

The Water Act gives the Secretary of State for Environment and the Secretary of State for Wales the responsibility of securing the execution of a national policy for water conservation, water supply, sewage and sewage disposal, pollution control, and recreational use of water. The Minister of Agriculture, Fisheries and Food retains the responsibility for land drainage and salmon and fresh water fisheries. Schedule 5 of the Act has direct reference to land drainage and calls for the organization of regional land drainage committees in each regional water authority. These committees are concerned wholly with land drainage and are represented by their chairman as one of the members of the regional water authority appointed by the Minister of Agriculture, Fisheries and Food. Under these regional land drainage committees, there are to be local land drainage committees which are to be responsible for any local land drainage scheme.

Summary

Under its terms of reference, this Committee was concerned throughout its two years of study mainly with the administration of the various drainage acts in the Province of Ontario. The Committee's research quickly provided information that other jurisdictions were dealing with land drainage and water problems in a completely new and interesting manner. It is significant to note that all four of the jurisdictions in the preceding discussion had made very recent major changes in legislation to consolidate their legislation. Their thinking and philosophy regarding water problems centred on one body with one control for all aspects of water management.

The Committee is acutely aware that there still tends to be considerable fragmentation of control over water in Ontario. Appendix III to this report lists some 20 pieces of legislation in Ontario which have reference to water and water control. Water quality is the responsibility of the Ministry of the Environment. Water quantity and conservation is the responsibility of the Ministry of Natural Resources. Agricultural land drainage is the responsibility of the Ministry of Agriculture and Food. It appears to this Committee that Ontario is lagging behind the other jurisdictions it examined in the development of water resources management.

As a program for the future, **this Committee would therefore recommend,** that the Government of Ontario establish a task force or committee to study the future management of water in the Province, with one of its terms of reference being the possibility of consolidating total water control in the Province into one ministry.

The Committee was impressed with the development of such a plan in the United Kingdom and equally impressed with The Water Act of 1973, where total control of water management was given to the Secretary of State for the Environment and to the Minister of Agriculture for his segment of responsibility — namely, land drainage. This was possibly a political compromise which for some reason was deemed appropriate in the United Kingdom. This Committee does not believe that such a compromise would be necessary in Ontario and hopes that the result of the study of the proposed task force or committee would be a recommendation that would consolidate the total control of water resources in the Province in one ministry. Since water knows no political boundaries, since the quantity of water cannot be divorced from the quality of water, and since agricultural land drainage has some impact on both quantity and quality of water, these matters should be under the control of a single ministry.

CORPORATION OF THE MUNICIPALITY OF CHATHAM-KENT
Applicant

-and-

COURT FILE NO. CV-23-00001165-0000 (Chatham)

CANADIAN PACIFIC RAILWAY COMPANY

Respondent

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PROCEEDING COMMENCED AT
CHATHAM, ONTARIO

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