



A Guide for Engineers

working under the

DRAINAGE ACT IN ONTARIO

Publication 852





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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
MTCSS - Ministry of Tourism, Culture and Sport
MTO - Ministry of Transportation
OMAFRA - Ontario Ministry of Agriculture, Food and Rural Affairs

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

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

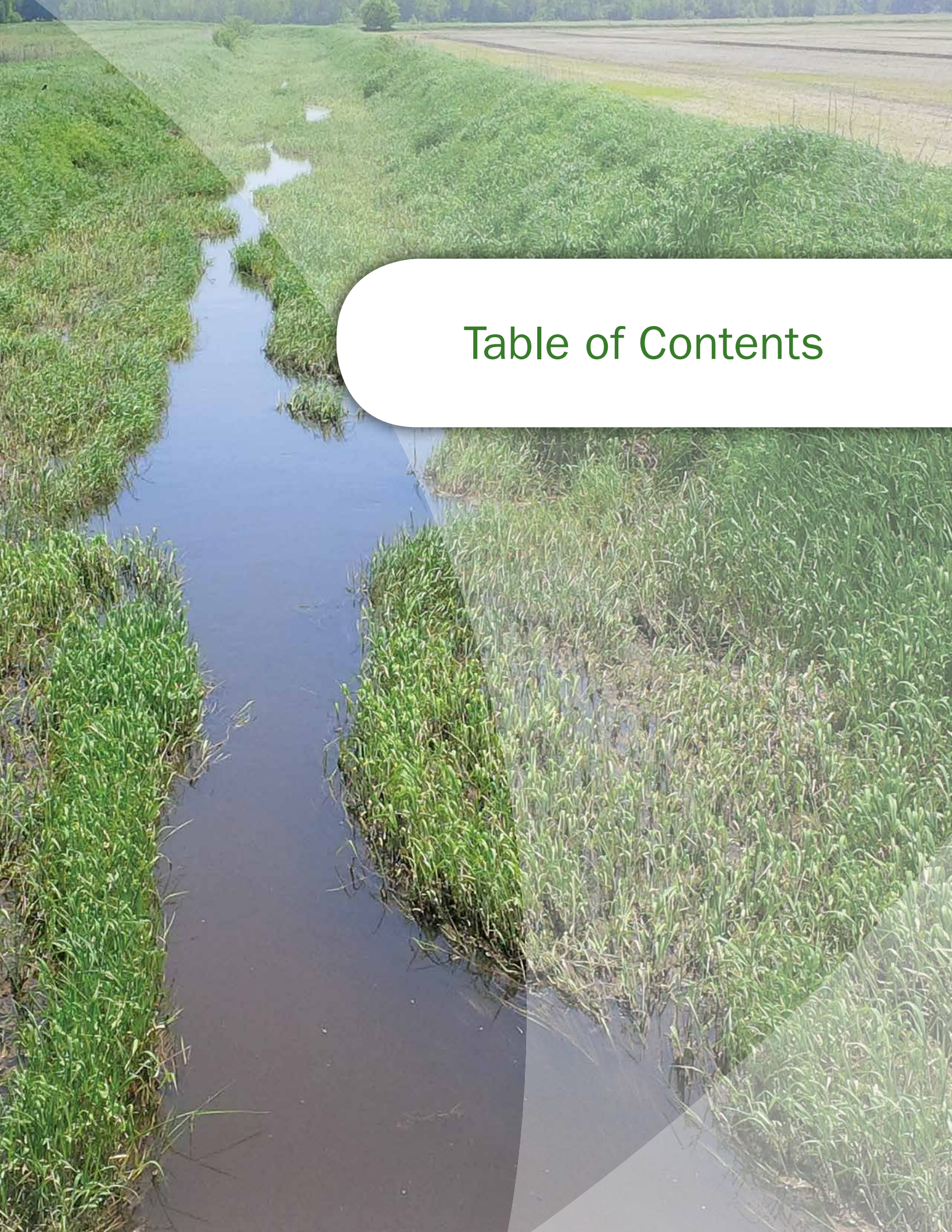


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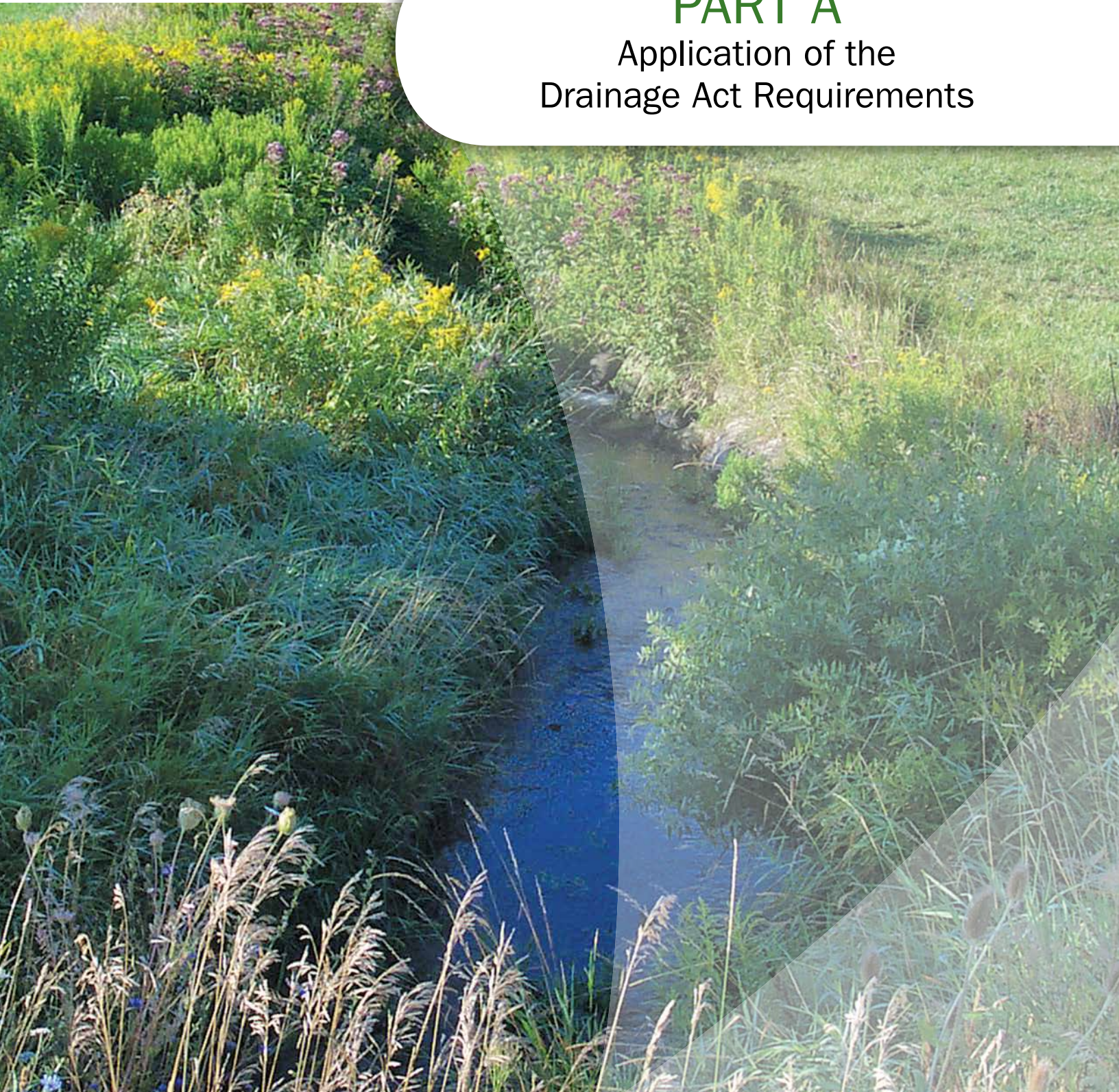
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PART A

Application of the Drainage Act Requirements



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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)

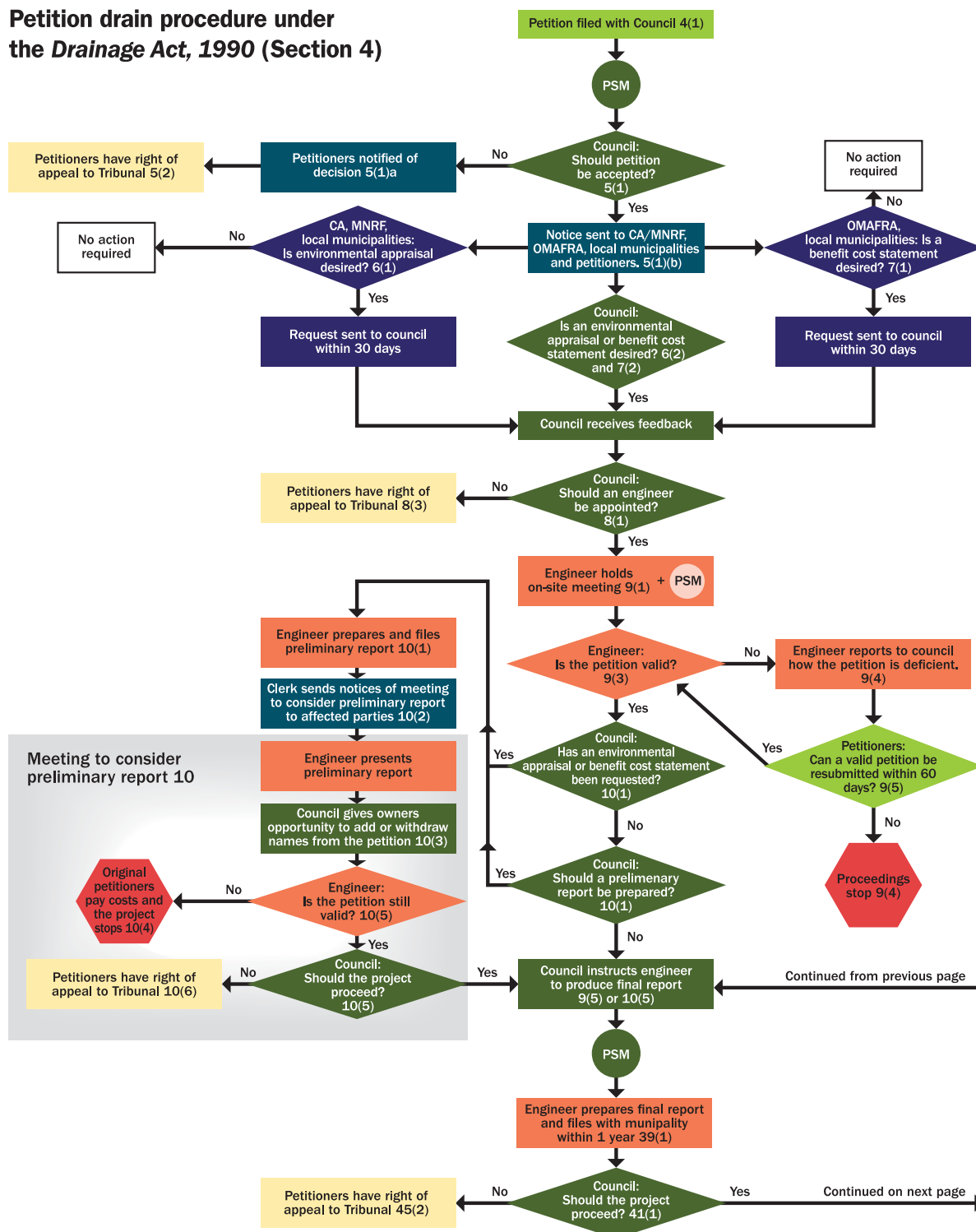


Figure A1–2. *Drainage Act, 1990* process, responsibilities and requirements under Section 4.

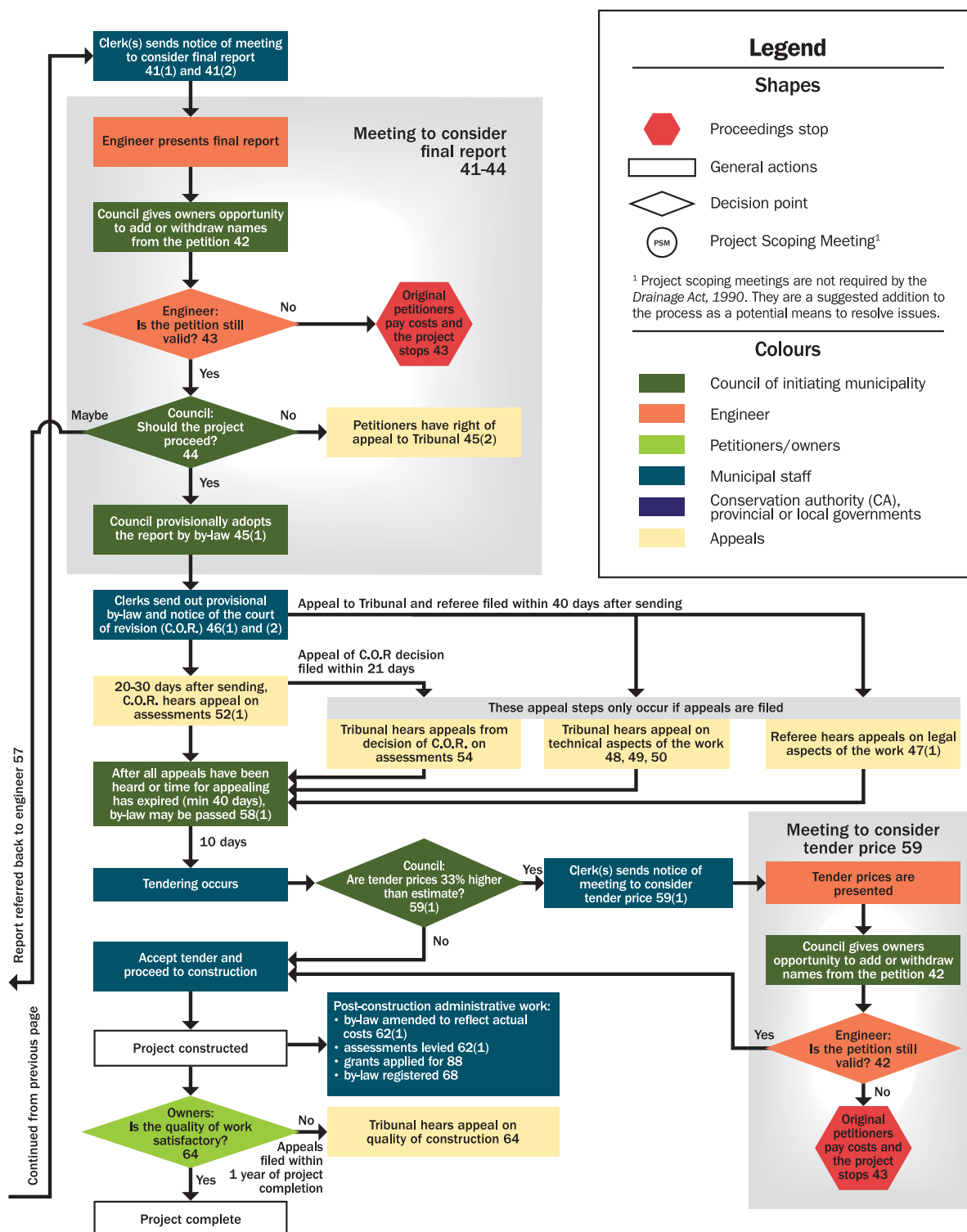


Figure A1–2. Drainage Act, 1990 process, responsibilities and requirements under Section 4.

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

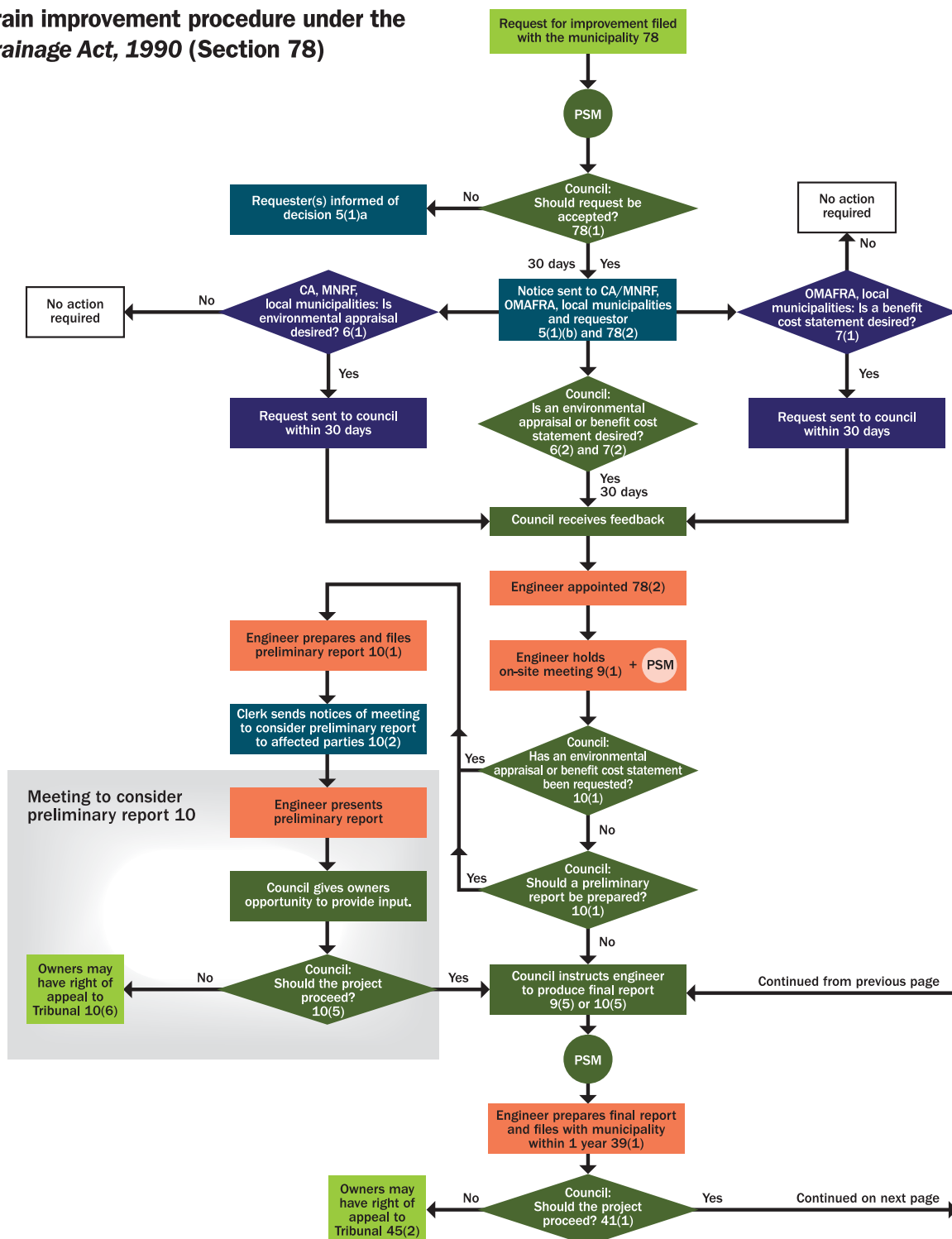


Figure A1–3. Drainage Act, 1990 process, responsibilities and requirements under Section 78.

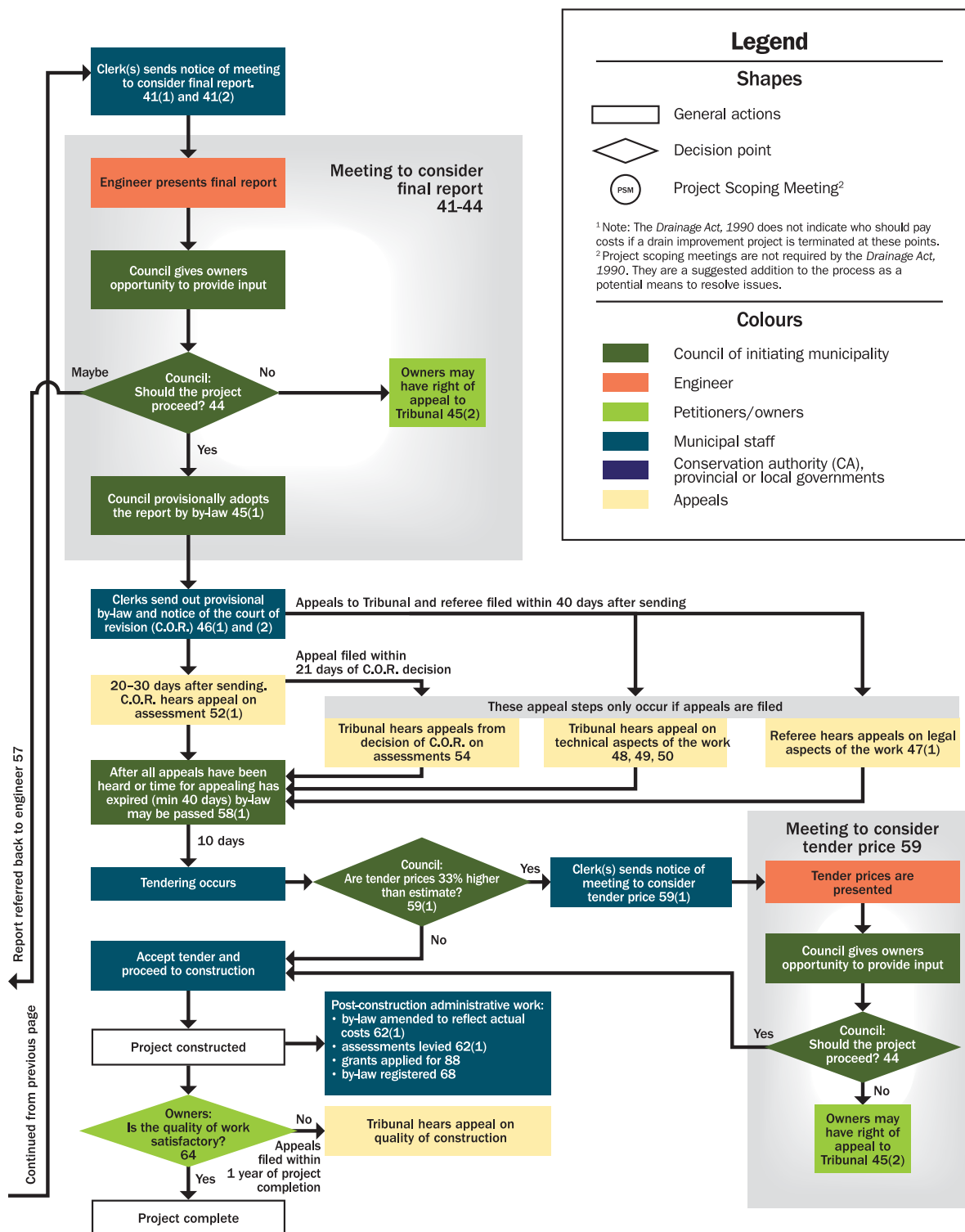


Figure A1–3. Drainage Act, 1990 process, responsibilities and requirements under Section 78.

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.



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)

N $\frac{1}{2}$ 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) <u>Smith</u>	(First Name) <u>John</u>	Telephone Number <u>519-555-1214</u> ext.
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Address	
Road/Street Number <u>14138</u>	Road/Street Name <u>Concession 5 Road</u>

Location of Project			
Lot <u>1-3</u>	Concession <u>5</u>	Municipality <u>North Township</u>	Former Municipality (if applicable) <u>—</u>

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, 20 15

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	0123-456-789-0000-0100
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 N$\frac{1}{2}$ 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)	Signature	
Farmer, Ima	Ima Farmer	
Name of Corporation	I have the authority to bind the Corporation.	
Fantastic Farms Inc.	Date (yyyy/mm/dd)	
Position Title	2015/07/18	
President		
☐ 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. <i>Drainage Act</i>, 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. <i>Drainage Act</i>, 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. <i>Drainage Act</i>, 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. <i>Drainage Act</i>, 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 <i>Drainage Act, R.S.O. 1990, c. D.17, subs. 78(1)</i>					
To: The Council of the Corporation of the <u>Township</u> of <u>North</u>					
Re: <u>Fake Municipal Drain</u> (Name of Drain)					
In accordance with section 78(1) of the <i>Drainage Act</i>, 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): ☒ 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: <u>Requesting the relocation of a 300 m section of the ditch municipal drain.</u>					
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.					
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 5px;"> Property Description <u>N 1/2 Lot 3, Concession 5</u> </td> <td style="width: 50%; padding: 5px;"> Parcel Roll Number <u>0123-456-789-00000-0000</u> </td> </tr> <tr> <td style="width: 50%; padding: 5px;"> Ward or Geographic Township <u>North Township</u> </td> <td></td> </tr> </table>		Property Description <u>N 1/2 Lot 3, Concession 5</u>	Parcel Roll Number <u>0123-456-789-00000-0000</u>	Ward or Geographic Township <u>North Township</u>	
Property Description <u>N 1/2 Lot 3, Concession 5</u>	Parcel Roll Number <u>0123-456-789-00000-0000</u>				
Ward or Geographic Township <u>North Township</u>					
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) <i>Farmer, Ima</i>			
Name of Corporation <i>Fantastic Farms Inc.</i>		Position Title <i>President</i>	
Signature <i>Ima Farmer</i> I have the authority to bind the Corporation.		Date (yyyy/mm/dd) <i>2013/07/14</i>	
Enter the mailing address and primary contact information of property owner below:			
Last Name <i>Farmer</i>		First Name <i>Ima</i>	Middle Initial <i>—</i>
Mailing Address			
Unit Number <i>—</i>	Street/Road Number <i>3254</i>	Street/Road Name <i>Fake Sideroad</i>	PO Box <i>R.R.#1</i>
City/Town <i>Anywhere</i>		Province <i>Ontario</i>	Postal Code <i>NON-ONO</i>
Telephone Number <i>555-555-5555</i>	Cell Phone Number (Optional) <i>—</i>	Email Address (Optional) <i>ima.farmer@nosupplier.ca</i>	
To be completed by recipient municipality:			
Notice filed this _____ day of _____ 20 _____			
Name of Clerk (Last Name, First Name)		Signature of Clerk	



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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 ($C = B/A \times 100\%$).

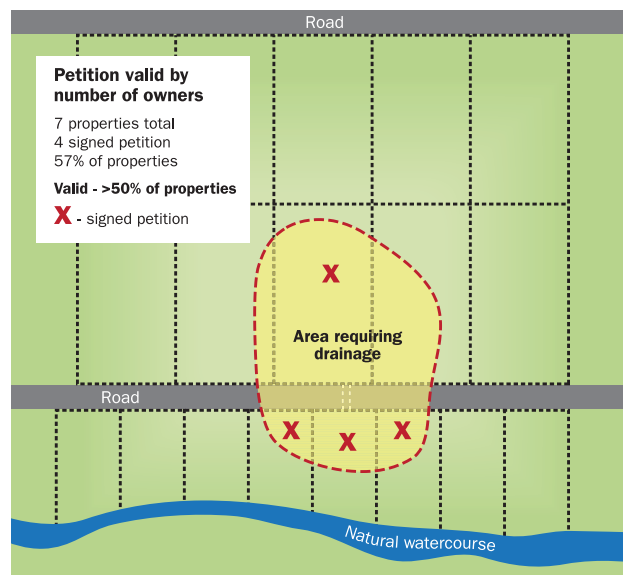


Figure A4–4. Determining the validity of a petition by percentage of owners.

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 ($C = B/A \times 100\%$).

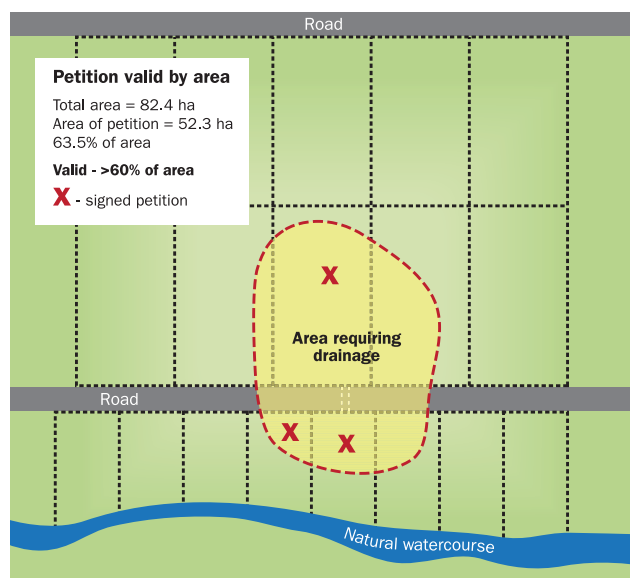


Figure A4-5. Determining the validity of a petition by percentage of area.

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

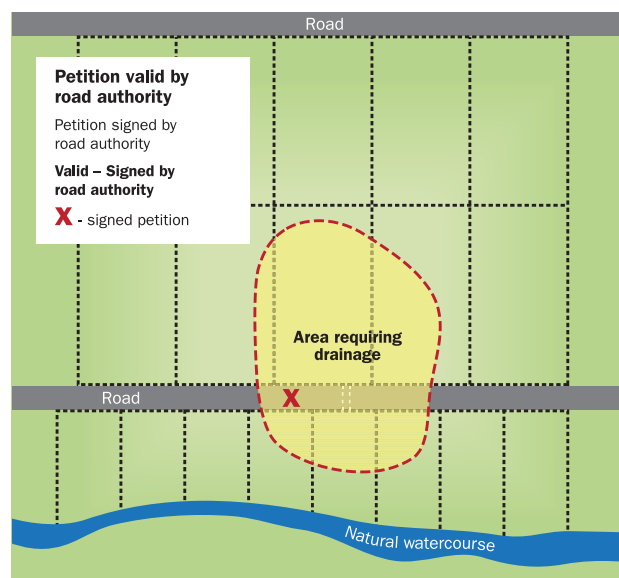


Figure A4-6. Determining the validity of a petition by road authority.

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

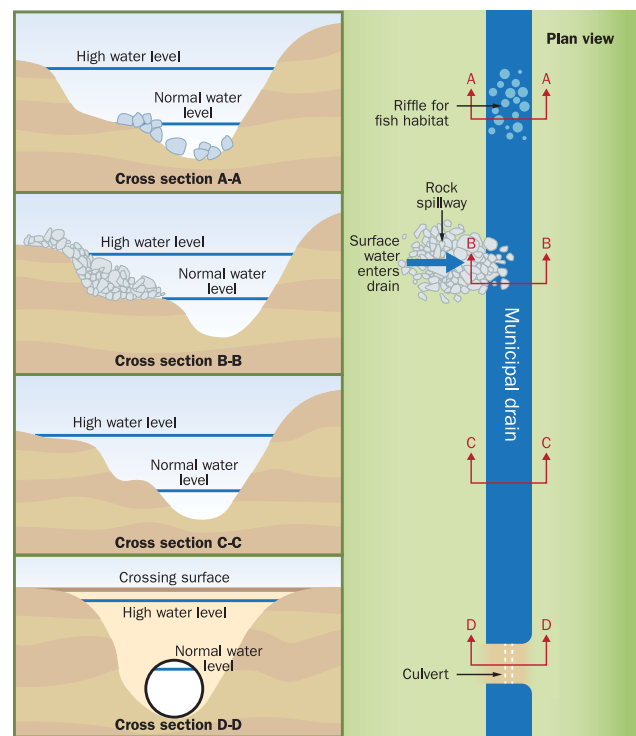


Figure A6–5. Plan view and four cross-sections of a surveyed watercourse.

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.



- 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)

7.2 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

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.

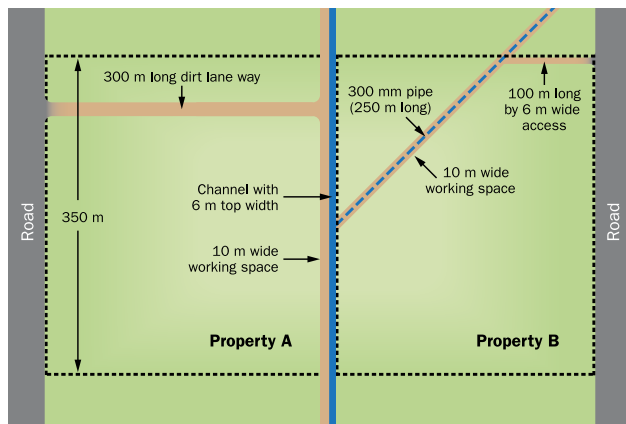


Figure A8-1. Land and right-of-way allowances.

Solution for Property A

Property A is entitled to:

- an allowance for land permanently taken
- an allowance for land used periodically for an access right-of-way
- 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:

$$350 \text{ m} \times 6 \text{ m} \times \$36,000/\text{ha} / 10,000 \text{ m}^2/\text{ha} = \$7,560$$

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:

$$\text{Future Value (FV)} = \$0.5/\text{m} \times 300 \text{ m} = \$150$$

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:

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

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

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

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

$$\text{Allowance} = \$270$$

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.

$$350 \text{ m} \times 10 \text{ m} \times \$1,704/\text{ha} / 10,000\text{m}^2/\text{ha}$$

= \$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.

$$\begin{aligned}\text{Allowance} &= 1.8 \times \$596 \\ &= \$1,073\end{aligned}$$

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:

$$\text{FV} = \$1,704/\text{ha} \times 100 \text{ m} \times 6 \text{ m} / 10,000 \text{ m}^2/\text{ha} = \$102$$

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:

$$\begin{aligned}\text{Allowance (present value)} &= \sum \frac{1}{(1+i)^n} \times \text{FV} \\ \text{Allowance} &= \left(\frac{1}{(1+0.04)^{25}} + \frac{1}{(1+0.04)^{50}} \right) \times \$102\end{aligned}$$

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

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

$$\text{Allowance} = \$53$$

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.

$$250 \text{ m} \times 10 \text{ m} \times \$1,704/\text{ha} / 10,000\text{m}^2/\text{ha}$$

$$= \$426 \text{ is considered the future value paid to the property owner}$$

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

$$\begin{aligned} \text{Allowance} &= 0.52 \times \$426 \\ &= \$222 \end{aligned}$$

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:

$$\text{crop damage (\$)} = \text{crop value (\$/ha)} \times \text{area affected (ha)} \times \text{thickness factor} \times \text{duration factor} \times \text{quality factor}$$

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

$$\begin{aligned}
 &= \$1,704/\text{ha} \times (350 \text{ m} \times 10 \text{ m})/10,000 \text{ m}^2/\text{ha} \times \\
 &1.5 \times 3 \times 1.0 \\
 &= \$2,684
 \end{aligned}$$

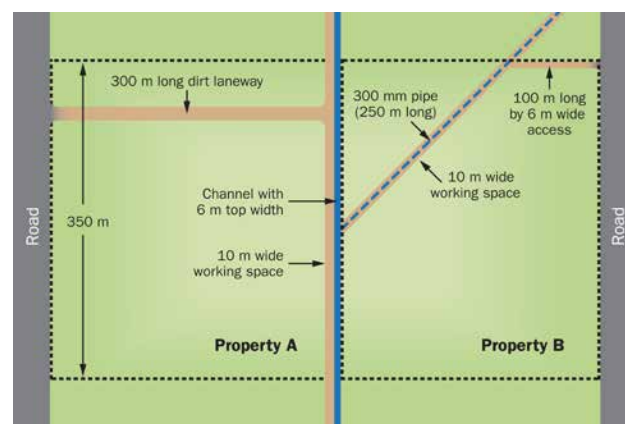


Figure A8–3. Crop damage allowances.

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.).

$$\begin{aligned}
 \text{Allowances for crop damage (\$)} &= \$0.50/\text{m} \times 300 \text{ m} \\
 &= \$150
 \end{aligned}$$

Solution for Property B

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

$$\begin{aligned}
 \text{Allowances for crop damage (\$)} &= \text{crop value (\$/ha)} \times \text{area affected (ha)} \times \text{thickness factor} \times \text{duration factor} \times \text{quality factor} \\
 &= \$1,704/\text{ha} \times (250 \text{ m} \times 3 \text{ m})/10,000 \text{ m}^2/\text{ha} \times \\
 &1.0 \times 3.0 \times 1.0 \\
 &= \$383
 \end{aligned}$$

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:

$$= \$1,704/\text{ha} \times (250 \text{ m} \times 7 \text{ m})/10,000 \text{ m}^2/\text{ha} \times 1.0 \times 1.0 \times 1.0$$

$$= \$298$$

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:

$$= \$1,704/\text{ha} \times (100 \text{ m} \times 6 \text{ m})/10,000 \text{ m}^2/\text{ha} \times 1.0 \times 2.0 \times 1.0$$

$$= \$204$$

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.

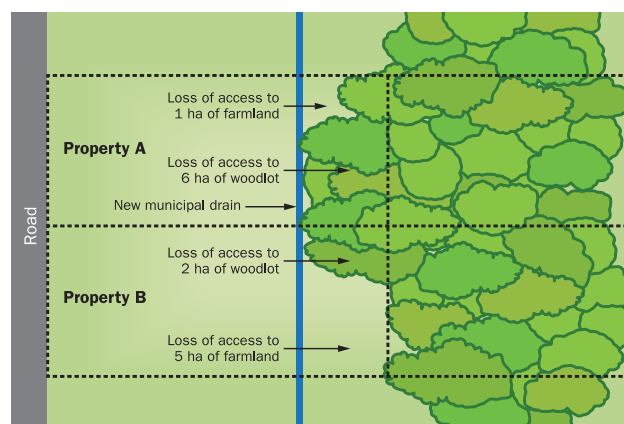


Figure A8-4. Loss of access allowance.

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).

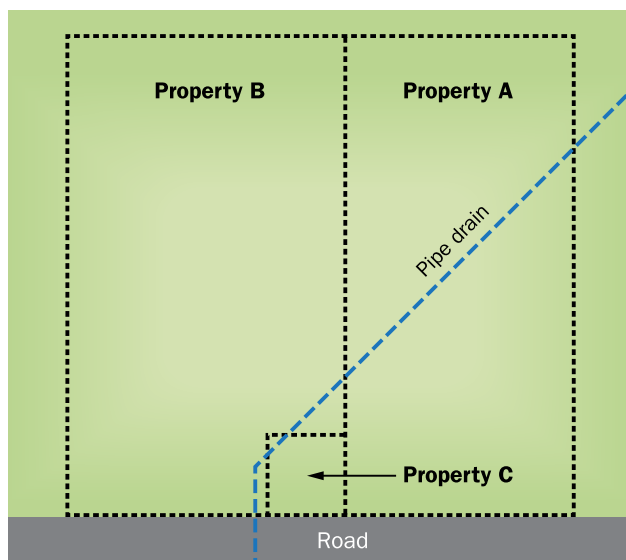


Figure A9–1. Benefit value calculations.

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:

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

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

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

$$\text{Average Annual Benefit Value} = \$250/\text{yr}$$

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:

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

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

$$\text{Benefit Value} = (21.5) \times \$250$$

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

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 $\$10/\text{m} \times 200 \text{ m} = \$2,000$.

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 ($300 \text{ m} \times \$15/\text{m}$).

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 ($\$6,000/\text{ha} - \$3,000/\text{ha} = \$3,000/\text{ha}$).

The benefit value for the property is $\$3,000/\text{ha} \times 15 \text{ ha} = \$45,000$.

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.

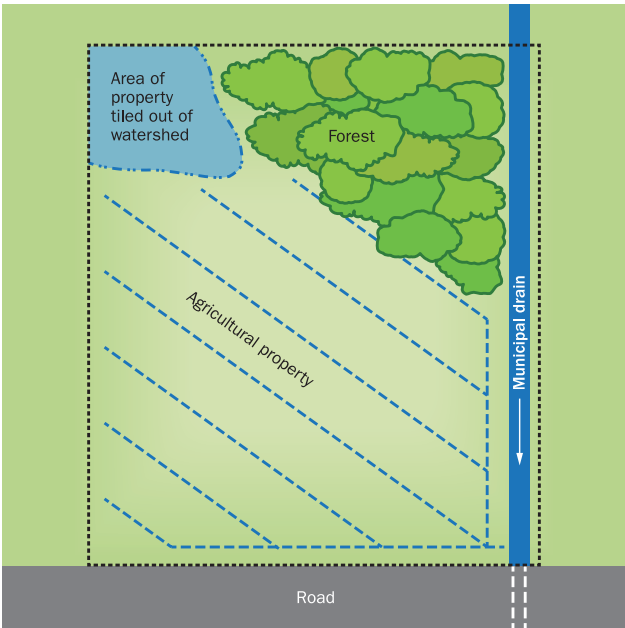


Figure A9–2. Equivalent area calculation.

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).

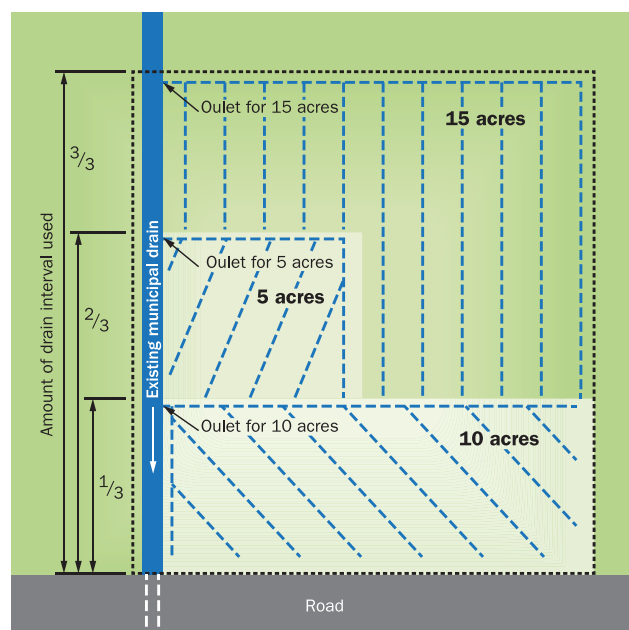


Figure A9–3. Equivalent length calculation.

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 $21.66/30 \text{ ha} = 0.72$.

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).

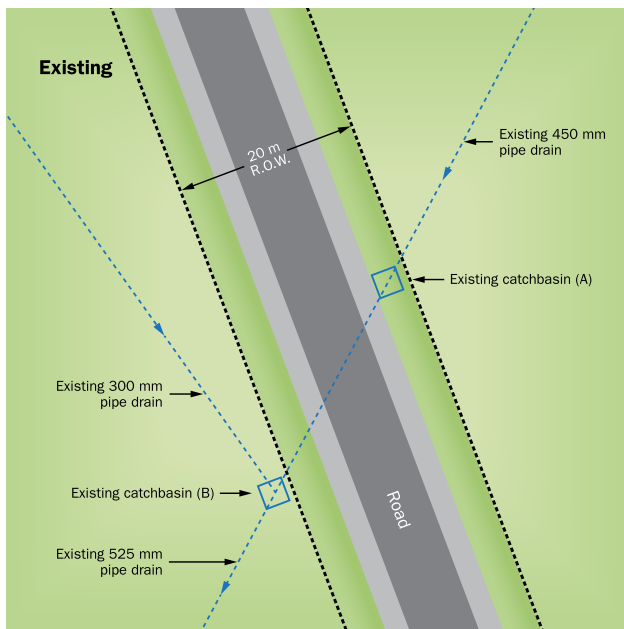


Figure A9-7. Existing conditions.

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).

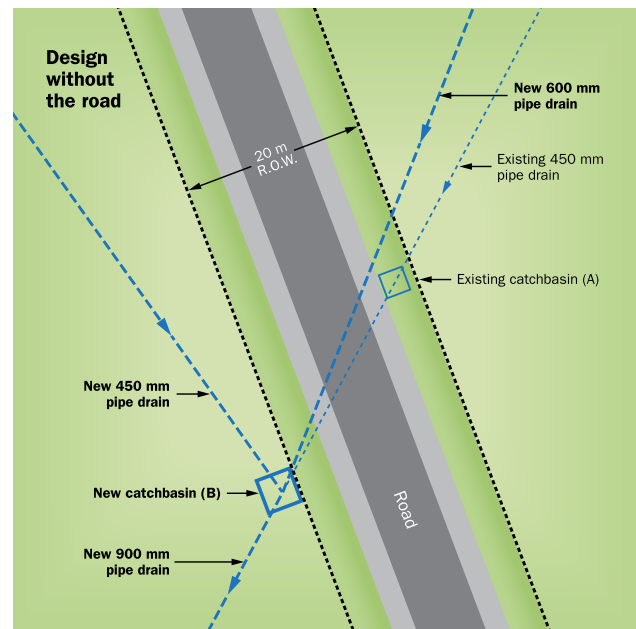


Figure A9-8. Design without the road.

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).

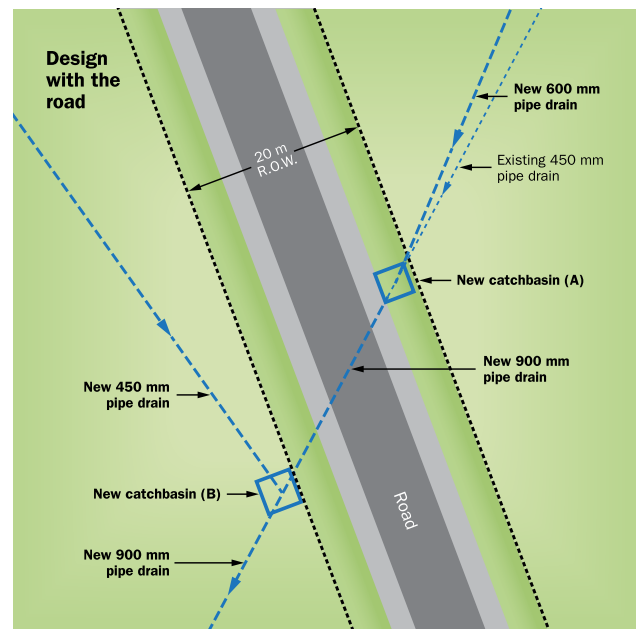


Figure A9-9. Design with the road.

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 Administra- tive 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.

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).

DID YOU KNOW?

Built-up area is defined in Section 1 of the *Drainage Act, 1990*.



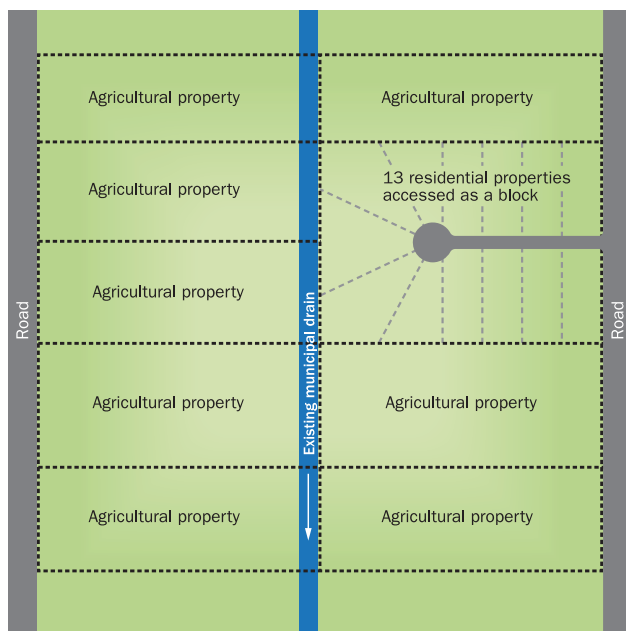


Figure A9-10. A plan showing a block or built-up area.

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 rationale for the assessment must be defensible 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

$$\text{Benefit Assessment} = \frac{BV}{\sum BV} \times IB$$

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.

$\frac{BV}{\sum BV}$ 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).

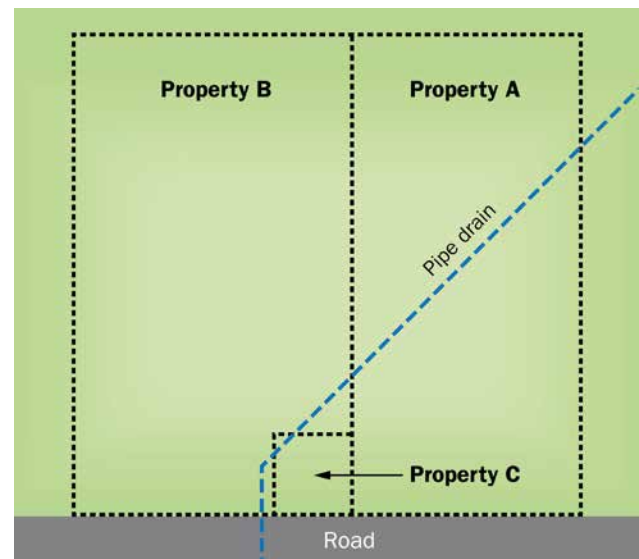


Figure A9–11. Proportioning benefit.

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 $20\% \times \$50,000 = \$10,000$
- the interval outlet liability is $80\% \times \$50,000 = \$40,000$

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 (ΣBV)

Property A

- Estimated Benefit Value = \$56,875

$$\text{Benefit Assessment} = \frac{BV}{\Sigma BV} \times IB$$

- Benefit Assessment = $\$56,875 / \$132,694 \times \$10,000$
 $= 0.429 \times \$10,000$
 $= \$4,290$

Property B

- Estimated Benefit Value = \$64,532

$$\text{Benefit Assessment} = \frac{BV}{\Sigma BV} \times IB$$

- Benefit Assessment = $\$64,532 / \$132,694 \times \$10,000$
 $= 0.486 \times \$10,000$
 $= \$4,860$

Property C

- Estimated benefit value = \$11,287

$$\text{Benefit Assessment} = \frac{BV}{\Sigma BV} \times IB$$

- Benefit assessment = $\$11,287 / \$132,694 \times \$10,000$
 $= 0.085 \times \$10,000$
 $= \$850$

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-EEEE							
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-EEEE-FFFF represents:

- AA - County or Municipal District
- BB - Municipality
- CCC - Ward
- DDD - Area Subcenterisation
- EEEEE - Street Subcenterisation
- 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.

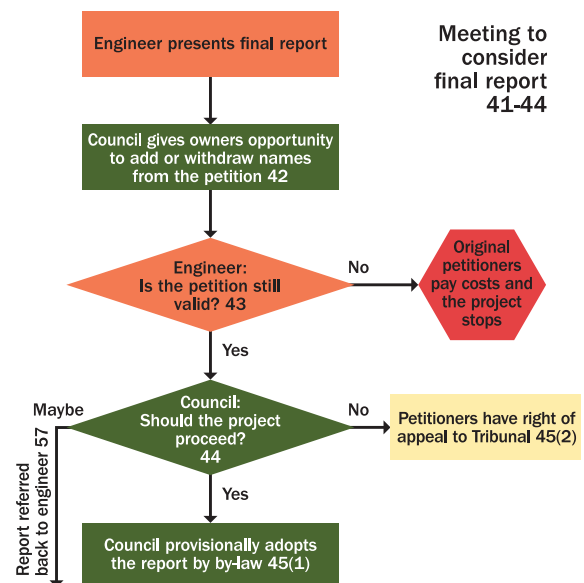


Figure A10–1. Section 4 process for the meeting to consider the report.

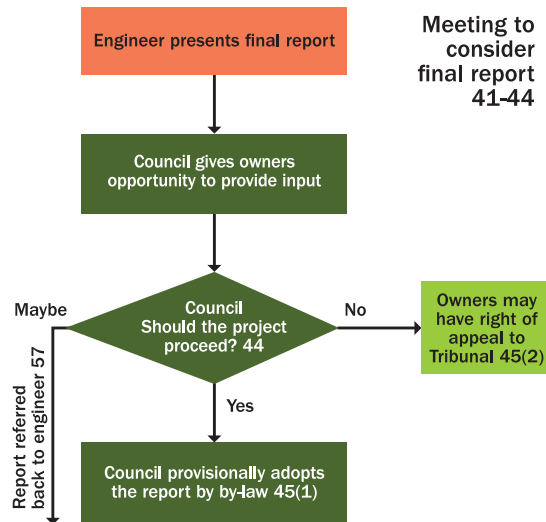


Figure A10–2. Section 78 process for the meeting to consider the report.

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))

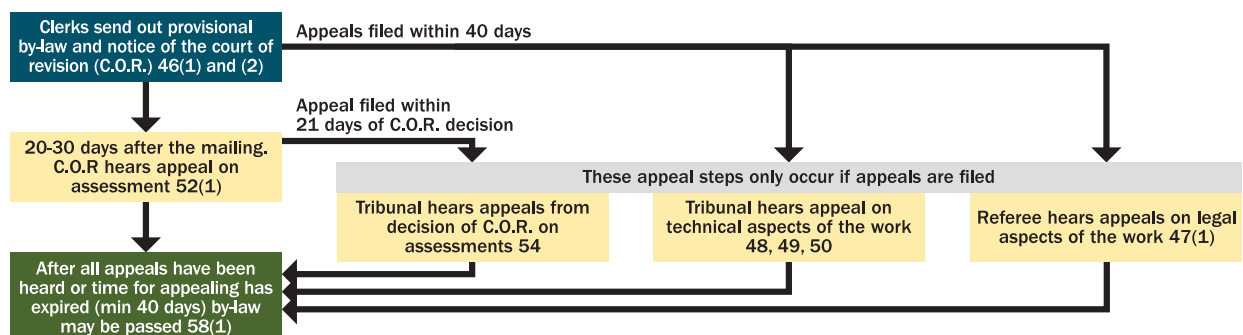


Figure A10–3. Appeals process.

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/onafrat search "McLean Drain"](http://www.canlii.org/en/on/onafrat/search/McLean%20Drain)). 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).

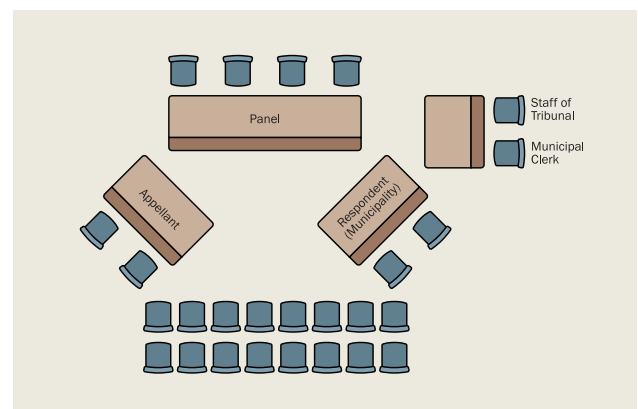


Figure A11–1. Tribunal room layout.

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 C0de

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

 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.

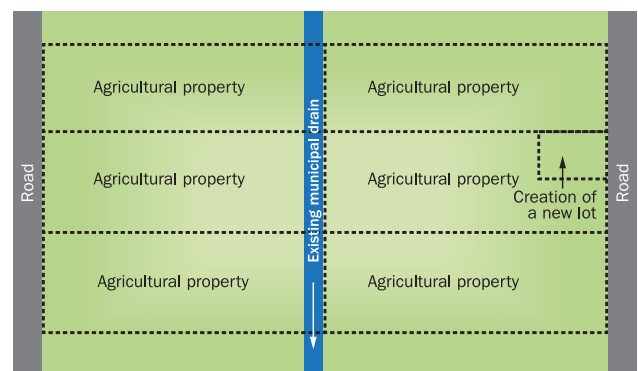


Figure A13–1. A proposed severance.

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.

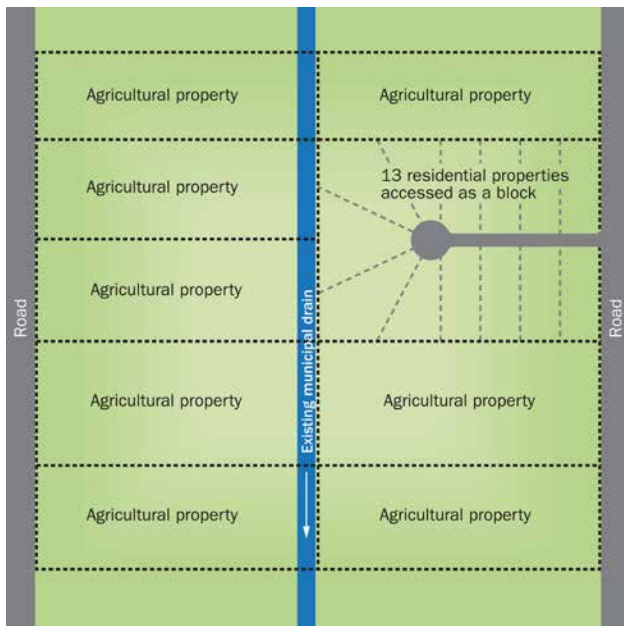


Figure A13–2. Agricultural properties converted into a subdivision.



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.

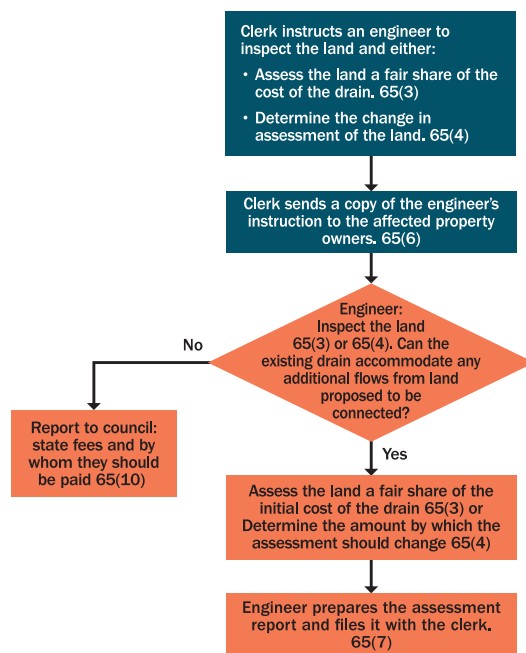


Figure A13–4. A decision tree of the process the engineer follows for reports on the impact of connections.

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).

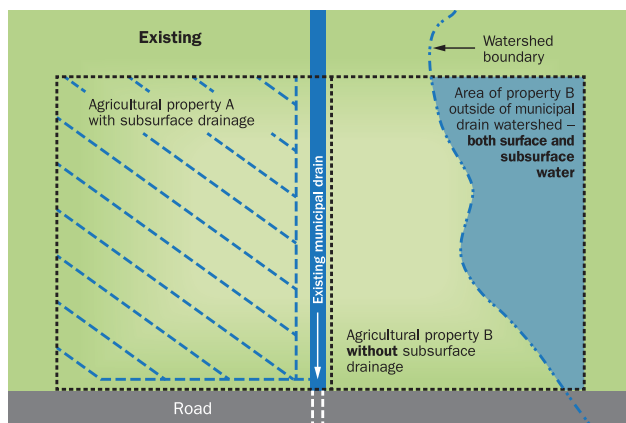


Figure A13–5. Water flow in the existing watershed.

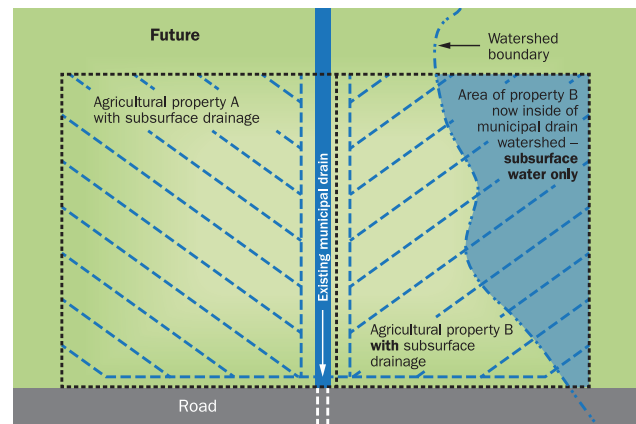


Figure A13–6. Change in water flow in the future watershed.

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.

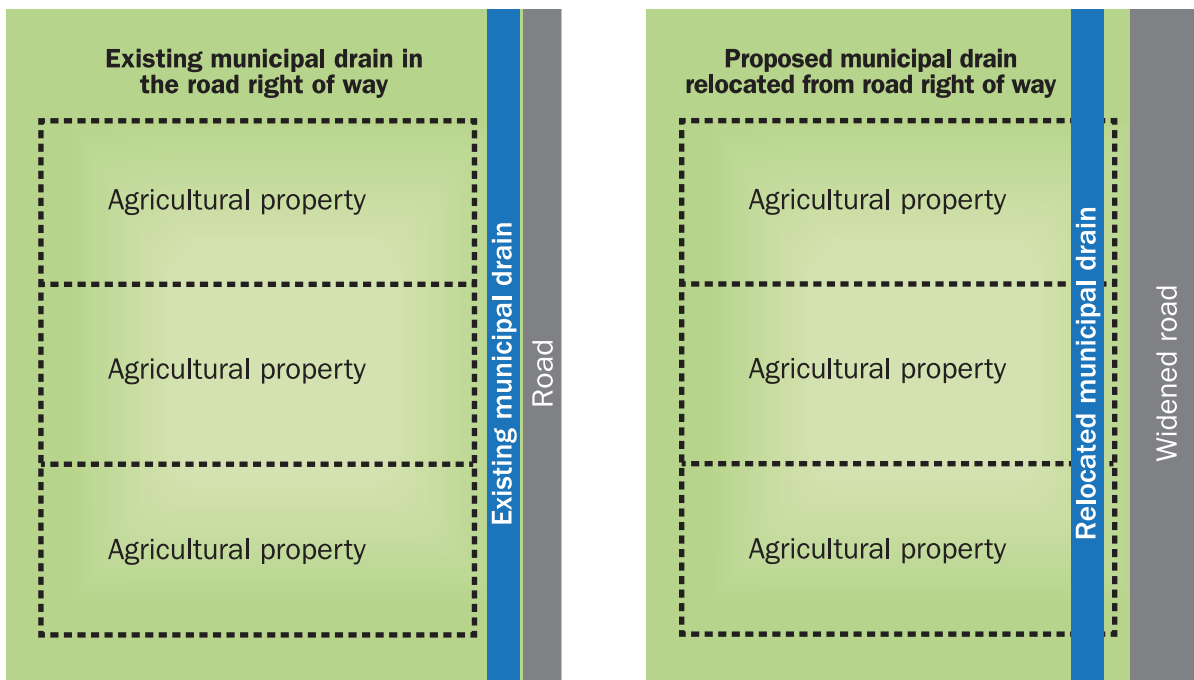


Figure A13–7. An existing municipal drain located in a road right-of-way (left), with a proposed relocation from the road right-of-way (right).

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

LUSBY DRAIN CULVERTS 2014			
MUNICIPALITY OF LAMBTON SHORES			
Drainage Superintendent:	No.	REVISIONS	DATE
AL LITTLE			
519-243-1400			
Drawn By: RL	Field Book	JOB No.	Drawing No.
Date: SEPT. 15, 2014	G.P.S.	214151	1 of 2
T-04			
SPRIET ASSOCIATES LIMITED			
LONDON CONSULTING ENGINEERS			
155 YORK STREET - LONDON (519) 872-4100 - NEA 148			

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 4th 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 4th Line.

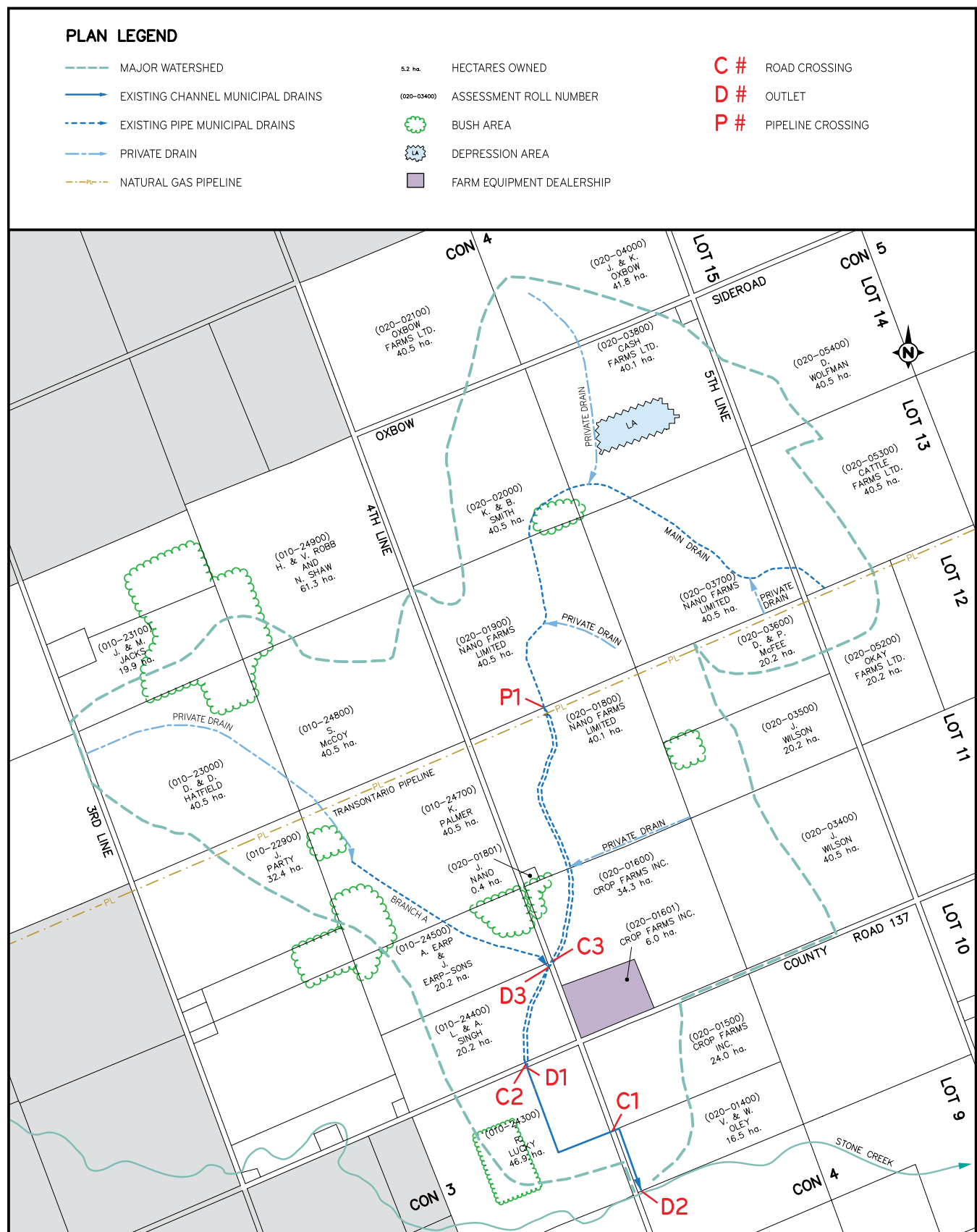


Figure A15-1. Initial conditions of the watershed.

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.

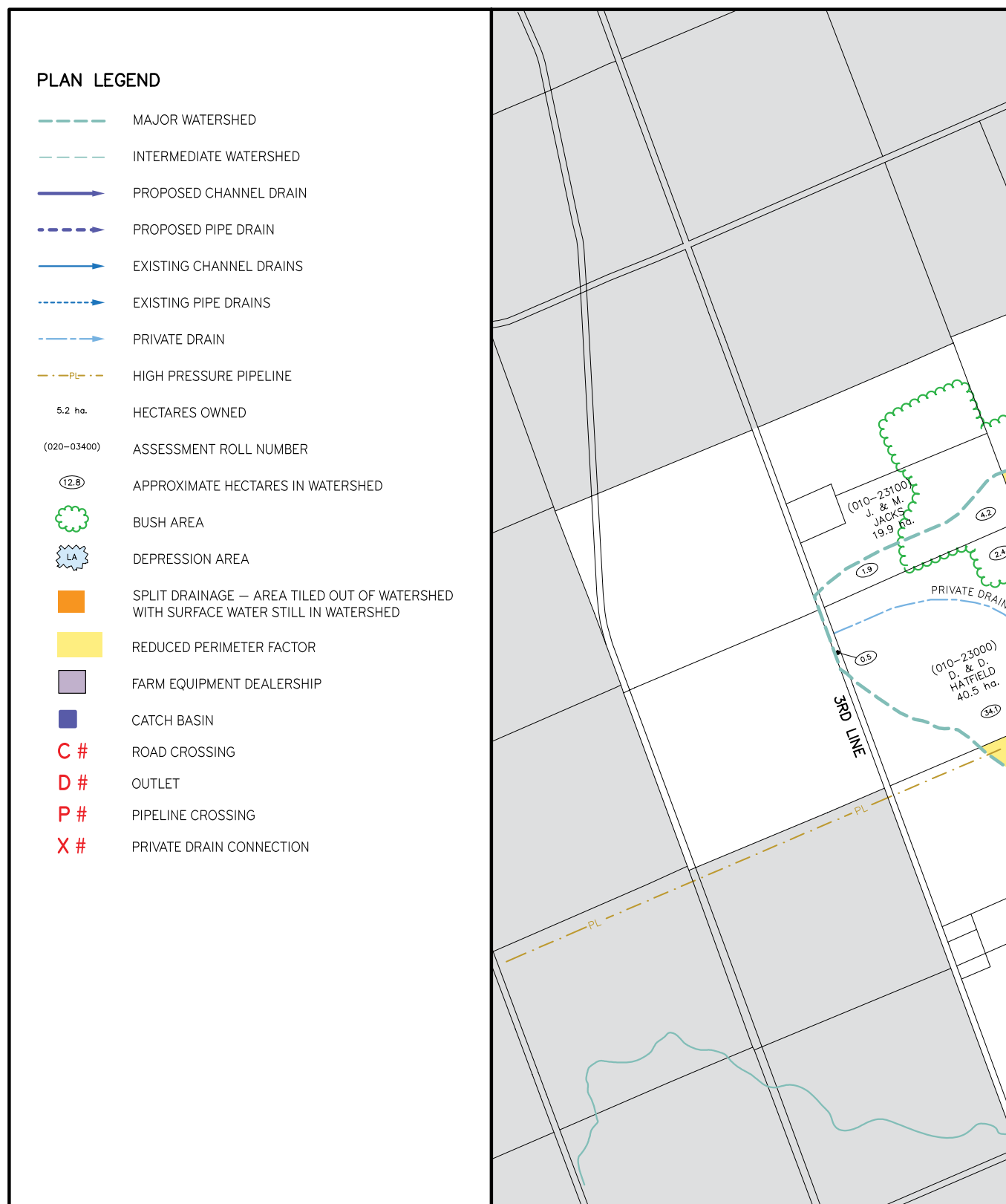
An investigation of the 45-year-old pipe identified no problems except that the TransOntario pipeline crossing gradient was found to be quite flat. The property owners in the watershed upstream of the pipeline suggested that the existing drain upstream of the pipeline did not require any improvements.

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.



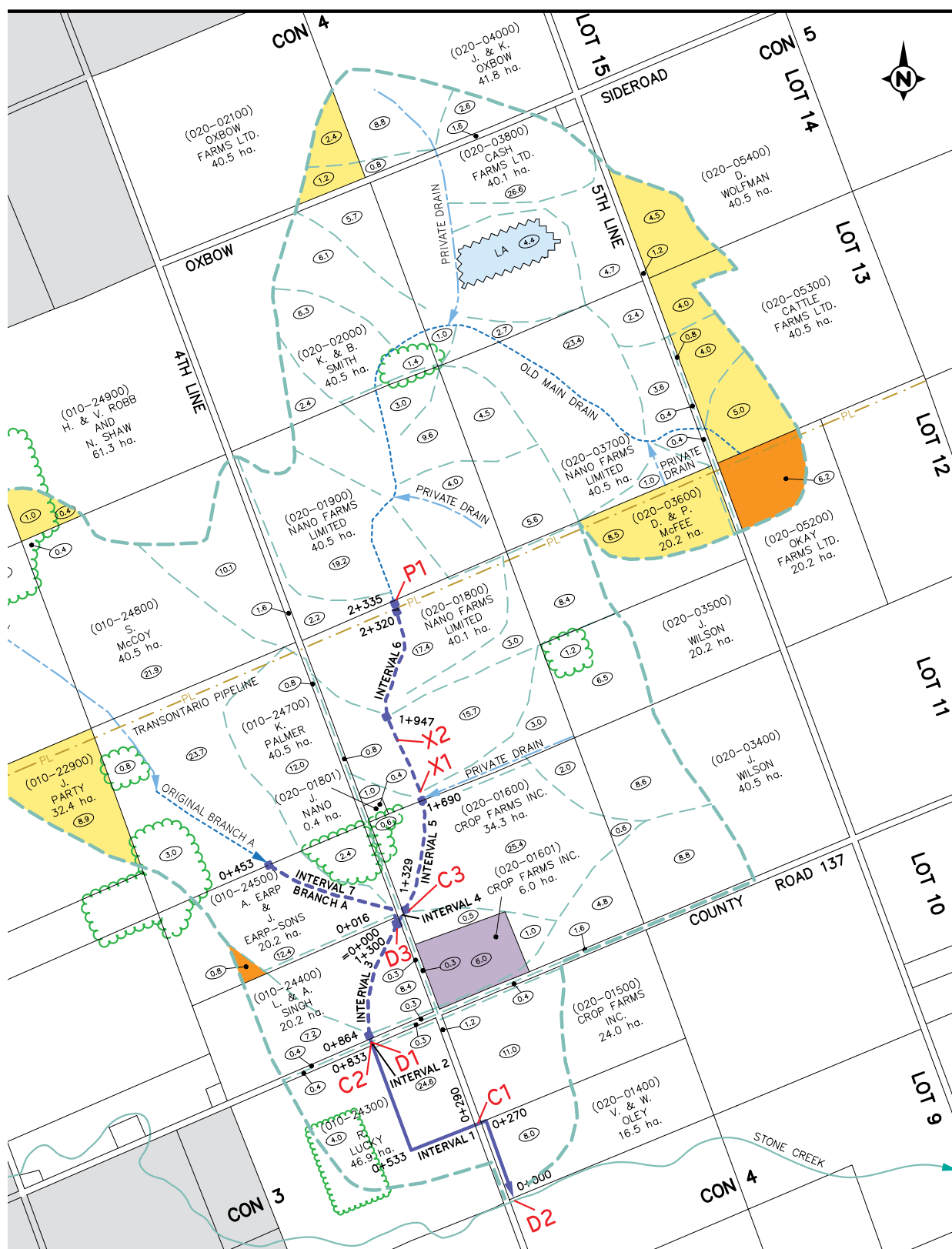


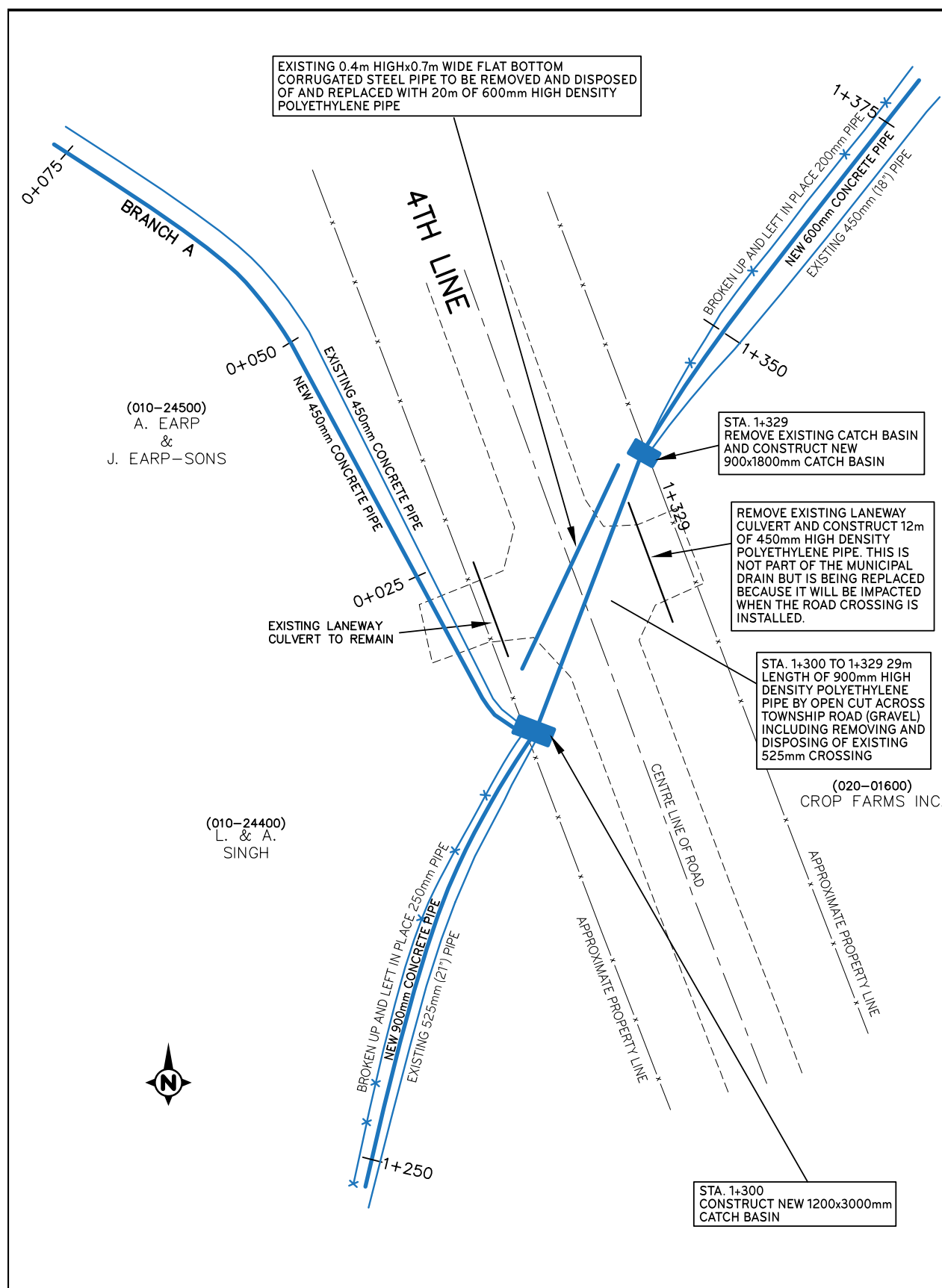
Figure A15-2. Proposed drainage system.

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					-
3 rd Line - Twp of North					-
4 th Line - Twp of North					-
Special Assessments to 4 th Line					-
5 th Line - Twp of North					-
Oxbow Sideroad - Twp of North					-
Total Assessments on Roads:					-
TOTAL:					-

In Watershed (Ha)	TOTAL WATERSHED						
	Agricultural (Ha) EAAF=1.0	Bush Area (Ha) EAAF=0.5	Residential (Ha) EAAF=1.5	Commercial (Ha) EAAF=2.0	Depression Area (Ha) EAAF=0.2	Split Drainage (Ha) EAAF=0.5	Total Adjusted (Ha) $\Sigma \text{Area} \times \text{EAAF}$
8.9	8.9	-	-	-	-	-	8.9
36.5	34.1	2.4	-	-	-	-	35.3
6.1	1.9	4.2	-	-	-	-	4.0
28.6	24.6	4.0	-	-	-	-	26.6
-	-	-	-	-	-	-	-
15.6	15.6	-	-	-	-	-	15.6
15.6	12.4	2.4	-	-	-	0.8	14.0
39.5	35.7	3.8	-	-	-	-	37.6
32.4	32.0	0.4	-	-	-	-	32.2
1.4	0.4	1.0	-	-	-	-	0.9
8.0	8.0	-	-	-	-	-	8.0
11.0	11.0	-	-	-	-	-	11.0
34.3	33.7	0.6	-	-	-	-	34.0
6.0	-	-	-	6.0	-	-	12.0
40.1	40.1	-	-	-	-	-	40.1
-	-	-	-	-	-	-	-
0.4	-	-	0.4	-	-	-	0.6
38.0	38.0	-	-	-	-	-	38.0
21.9	20.5	1.4	-	-	-	-	21.2
3.6	3.6	-	-	-	-	-	3.6
18.0	18.0	-	-	-	-	-	18.0
7.7	6.5	1.2	-	-	-	-	7.1
16.9	16.9	-	-	-	-	-	16.9
40.5	40.5	-	-	-	-	-	40.5
39.4	35.0	-	-	-	4.4	-	35.9
12.2	12.2	-	-	-	-	-	12.2
6.2	-	-	-	-	-	6.2	3.1
13.0	13.0	-	-	-	-	-	13.0
4.5	4.5	-	-	-	-	-	4.5
-	-	-	-	-	-	-	-
506.3	467.1	21.4	0.4	6.0	4.4	7.0	494.8
	2-Lane Gravel - EAAF =1.5			2-Lane Asphalt - EAAF = 2.0			
3.4	-	-	-	-	3.4	-	6.8
-	-	-	-	-	-	-	-
0.5	-	0.5	-	-	-	-	0.8
5.0	-	-	-	-	5.0	-	10
-	-	-	-	-	-	-	-
2.8	-	-	-	-	2.8	-	5.6
1.6	-	1.6	-	-	-	-	2.4
13.3	-	2.1	-	-	11.2	-	25.6
519.6	-	-	-	-	-	-	520.4

Table A15–3. continued.

FPCTR (Yes / No)	Conc.	Lot	Roll No. (12-58-010)	Owner	In Interval (Ha)	Agricultural (Ha)
						EAAF=1.0
Yes	3	Pt W½ 12	-010-22900	J. Party	8.9	8.9
Yes	3	W½ 13	-010-23000	D. & D. Hatfield	36.5	34.1
Yes	3	Pt SW¼	-010-23100	J. & M. Jacks	6.1	1.9
Yes	3	Pt 10	-010-24300	R. Lucky	28.6	24.6
Yes	Special Benefit to Lucky				-	-
Yes	3	SE¼ 11	-010-24400	L. & A. Singh	15.6	15.6
Yes	3	NE¼ 11	-010-24500	A. Earp & J. Earp-Sons	15.6	12.4
Yes	3	E½ 12	-010-24700	K. Palmer	39.5	35.7
Yes	3	E½ 13	-010-24800	S. McCoy	32.4	32.0
Yes	3	E½ 14	-010-24900	H. & V. Robb & N. Shaw	1.4	0.4
Yes	4	SW¼ 10	-020-01400	V. & W. Oley	8.0	8.0
Yes	4	NW¼ 10	-020-01500	Crop Farms Inc.	11.0	11.0
Yes	4	Pt W½ 11	-020-01600	Crop Farms Inc.	34.3	33.7
No	4	Pt W½ 11	-020-01601	Crop Farms Inc.	6.0	-
Yes	4	Pt W½ 12	-020-01800	Nano Farms Limited	40.1	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	38.0	38.0
Yes	4	W½ 14	-020-02000	K. & B. Smith	21.9	20.5
Yes	4	W½ 15	-020-02100	Oxbow Farms Ltd.	3.6	3.6
Yes	4	E½ 11	-020-03400	J. Wilson	18.0	18.0
Yes	4	SE¼ 12	-020-03500	J. Wilson	7.7	6.5
Yes	4	NE¼ 12	-020-03600	D. & P. McFee	16.9	16.9
Yes	4	E½ 13	-020-03700	Nano Farms Limited	40.5	40.5
Yes	4	Pt E½ 14	-020-03800	Cash Farms Ltd.	39.4	35.0
Yes	4	E½ 15	-020-04000	J. & K. Oxbow	12.2	12.2
Yes	5	Pt W½ 12	-020-05200	Okay Farms Ltd.	6.2	-
Yes	5	W½ 13	-020-05300	Cattle Farms Ltd.	13.0	13.0
Yes	5	W½ 14	-020-05400	D. Wolfman	4.5	4.5
No	3 to 5	Pt 12	Special Assessment TransOntario Pipeline		-	-
Total Assessments on Lands:					506.3	467.1
County Road 137 - County of South					3.4	-
Special Assessments to County Road 137					-	-
3 rd Line - Twp of North					0.5	-
4 th Line - Twp of North					5.0	-
Special Assessments to 4 th Line					-	-
5 th Line - Twp of North					2.8	-
Oxbow Sideroad - Twp of North					1.6	-
Total Assessments on Roads:					13.3	-
TOTAL:					519.6	-

MAIN DRAIN (INTERVAL 1)							
Bush Area (Ha) EAAF=0.5	Residential (Ha) EAAF=1.5	Commercial (Ha) EAAF=2.0	Depression Area (Ha) EAAF=0.2	Split Drainage (Ha) EAAF=0.5	Perimeter Factor (PF) (from Table A15-2)	Equivalent Length Factor (ELF)	Total Adjusted (Ha) (Σ Area x EAAF) x PF x ELF
-	-	-	-	-	0.8	1.0	7.1
2.4	-	-	-	-	1.0	1.0	35.3
4.2	-	-	-	-	1.0	1.0	4.0
4.0	-	-	-	-	1.0	0.5	13.3
-	-	-	-	-	-	-	-
-	-	-	-	-	1.0	1.0	15.6
2.4	-	-	-	0.8	1.0	1.0	14.0
3.8	-	-	-	-	1.0	1.0	37.6
0.4	-	-	-	-	1.0	1.0	32.2
1.0	-	-	-	-	0.4	1.0	0.4
-	-	-	-	-	1.0	0.2	1.6
-	-	-	-	-	1.0	0.2	2.2
0.6	-	-	-	-	1.0	1.0	34.0
-	-	6.0	-	-	1.0	1.0	12.0
-	-	-	-	-	1.0	1.0	40.1
-	-	-	-	-	-	-	-
-	0.4	-	-	-	1.0	1.0	0.6
-	-	-	-	-	1.0	1.0	38.0
1.4	-	-	-	-	1.0	1.0	21.2
-	-	-	-	-	0.4	1.0	1.4
-	-	-	-	-	1.0	1.0	18.0
1.2	-	-	-	-	1.0	1.0	7.1
-	-	-	-	-	0.67	1.0	11.3
-	-	-	-	-	1.0	1.0	40.5
-	-	-	4.4	-	1.0	1.0	35.9
-	-	-	-	-	1.0	1.0	12.2
-	-	-	-	6.2	1.0	1.0	3.1
-	-	-	-	-	0.8	1.0	10.4
-	-	-	-	-	0.33	1.0	1.5
-	-	-	-	-	-	-	-
21.4	0.4	6.0	4.4	7.0	-	-	450.6
2-Lane Gravel - EAAF=1.5		2-Lane Asphalt - EAAF = 2.0					
-	-	-	3.4	-	1.0	1.0	6.8
-	-	-	-	-	-	-	-
0.5	-	-	-	-	1.0	1.0	0.8
-	-	-	5.0	-	1.0	0.75	7.5
-	-	-	-	-	-	-	-
-	-	-	2.8	-	1.0	1.0	5.6
1.6	-	-	-	-	1.0	1.0	2.4
2.1	-	-	11.2	-	-	-	23.1
-	-	-	-	-	-	-	473.7

Table A15–3. continued.

FPCTR (Yes / No)	Conc.	Lot	Roll No. (12-58-010)	Owner	In Interval (Ha)	
						Agricultural (Ha) EAAF=1.0
Yes	3	Pt W½ 12	-010-22900	J. Party	8.9	8.9
Yes	3	W½ 13	-010-23000	D. & D. Hatfield	36.5	34.1
Yes	3	Pt SW¼	-010-23100	J. & M. Jacks	6.1	1.9
Yes	3	Pt 10	-010-24300	R. Lucky	-	-
Yes	Special Benefit to Lucky				-	-
Yes	3	SE¼ 11	-010-24400	L. & A. Singh	15.6	15.6
Yes	3	NE¼ 11	-010-24500	A. Earp & J. Earp-Sons	15.6	12.4
Yes	3	E½ 12	-010-24700	K. Palmer	39.5	35.7
Yes	3	E½ 13	-010-24800	S. McCoy	32.4	32.0
Yes	3	E½ 14	-010-24900	H. & V. Robb & N. Shaw	1.4	0.4
Yes	4	SW¼ 10	-020-01400	V. & W. Oley	-	-
Yes	4	NW¼ 10	-020-01500	Crop Farms Inc.	-	-
Yes	4	Pt W½ 11	-020-01600	Crop Farms Inc.	34.3	33.7
No	4	Pt W½ 11	-020-01601	Crop Farms Inc.	6.0	-
Yes	4	Pt W½ 12	-020-01800	Nano Farms Limited	40.1	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	38.0	38.0
Yes	4	W½ 14	-020-02000	K. & B. Smith	21.9	20.5
Yes	4	W½ 15	-020-02100	Oxbow Farms Ltd.	3.6	3.6
Yes	4	E½ 11	-020-03400	J. Wilson	18.0	18.0
Yes	4	SE¼ 12	-020-03500	J. Wilson	7.7	6.5
Yes	4	NE¼ 12	-020-03600	D. & P. McFee	16.9	16.9
Yes	4	E½ 13	-020-03700	Nano Farms Limited	40.5	40.5
Yes	4	Pt E½ 14	-020-03800	Cash Farms Ltd.	39.4	35.0
Yes	4	E½ 15	-020-04000	J. & K. Oxbow	12.2	12.2
Yes	5	Pt W½ 12	-020-05200	Okay Farms Ltd.	6.2	-
Yes	5	W½ 13	-020-05300	Cattle Farms Ltd.	13.0	13.0
Yes	5	W½ 14	-020-05400	D. Wolfman	4.5	4.5
No	3 to 5	Pt 12	Special Assessment TransOntario Pipeline		-	-
Total Assessments on Lands:					458.7	423.5
					-	
County Road 137 - County of South					2.3	-
Special Assessments to County Road 137					-	-
3 rd Line - Twp of North					0.5	-
4 th Line - Twp of North					3.8	-
Special Assessments to 4 th Line					-	-
5 th Line - Twp of North					2.8	-
Oxbow Sideroad - Twp of North					1.6	-
Total Assessments on Roads:					11.0	-
TOTAL:					469.7	-

MAIN DRAIN (INTERVAL 2)							
Bush Area (Ha) EAAF=0.5	Residential (Ha) EAAF=1.5	Commercial (Ha) EAAF=2.0	Depression Area (Ha) EAAF=0.2	Split Drainage (Ha) EAAF=0.5	Perimeter Factor (PF) (from Table A15-2)	Equivalent Length Factor (ELF)	Total Adjusted (Ha) ($\Sigma \text{Area} \times \text{EAAF}$) $\times \text{PF} \times \text{ELF}$
-	-	-	-	-	0.8	1.0	7.1
2.4	-	-	-	-	1.0	1.0	35.3
4.2	-	-	-	-	1.0	1.0	4.0
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	1.0	1.0	15.6
2.4	-	-	-	0.8	1.0	1.0	14.0
3.8	-	-	-	-	1.0	1.0	37.6
0.4	-	-	-	-	1.0	1.0	32.2
1.0	-	-	-	-	0.4	1.0	0.4
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
0.6	-	-	-	-	1.0	1.0	34.0
-	-	6.0	-	-	1.0	1.0	12.0
-	-	-	-	-	1.0	1.0	40.1
-	-	-	-	-	-	-	-
-	0.4	-	-	-	1.0	1.0	0.6
-	-	-	-	-	1.0	1.0	38.0
1.4	-	-	-	-	1.0	1.0	21.2
-	-	-	-	-	0.4	1.0	1.4
-	-	-	-	-	1.0	1.0	18.0
1.2	-	-	-	-	1.0	1.0	7.1
-	-	-	-	-	0.67	1.0	11.3
-	-	-	-	-	1.0	1.0	40.5
-	-	-	4.4	-	1.0	1.0	35.9
-	-	-	-	-	1.0	1.0	12.2
-	-	-	-	6.2	1.0	1.0	3.1
-	-	-	-	-	0.8	1.0	10.4
-	-	-	-	-	0.33	1.0	1.5
-	-	-	-	-	-	-	-
17.4	0.4	6.0	4.4	7.0	-	-	433.5
2-Lane Gravel - EAAF =1.5		2-Lane Asphalt - EAAF = 2.0					
-	-	-	2.3	-	1.0	1.0	4.6
-	-	-	-	-	-	-	-
0.5	-	-	-	-	1.0	1.0	0.8
-	-	-	3.8	-	1.0	1.0	7.6
-	-	-	-	-	-	-	-
-	-	-	2.8	-	1.0	1.0	5.6
1.6	-	-	-	-	1.0	1.0	2.4
2.1	-	-	8.9	-	-	-	21.0
-	-	-	-	-	-	-	454.5

Table A15–3. continued.

FPCTR (Yes / No)	Conc.	Lot	Roll No. (12-58-010)	Owner	In Interval (Ha)	
						Agricultural (Ha) EAAF=1.0
Yes	3	Pt W½ 12	-010-22900	J. Party	8.9	8.9
Yes	3	W½ 13	-010-23000	D. & D. Hatfield	36.5	34.1
Yes	3	Pt SW¼	-010-23100	J. & M. Jacks	6.1	1.9
Yes	3	Pt 10	-010-24300	R. Lucky	-	-
Yes	Special Benefit to Lucky				-	-
Yes	3	SE¼ 11	-010-24400	L. & A. Singh	7.4	7.4
Yes	3	NE¼ 11	-010-24500	A. Earp & J. Earp-Sons	14.8	12.4
Yes	3	E½ 12	-010-24700	K. Palmer	39.5	35.7
Yes	3	E½ 13	-010-24800	S. McCoy	32.4	32.0
Yes	3	E½ 14	-010-24900	H. & V. Robb & N. Shaw	1.4	0.4
Yes	4	SW¼ 10	-020-01400	V. & W. Oley	-	-
Yes	4	NW¼ 10	-020-01500	Crop Farms Inc.	-	-
Yes	4	Pt W½ 11	-020-01600	Crop Farms Inc.	29.5	28.9
No	4	Pt W½ 11	-020-01601	Crop Farms Inc.	6.0	-
Yes	4	Pt W½ 12	-020-01800	Nano Farms Limited	40.1	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	38.0	38.0
Yes	4	W½ 14	-020-02000	K. & B. Smith	21.9	20.5
Yes	4	W½ 15	-020-02100	Oxbow Farms Ltd.	3.6	3.6
Yes	4	E½ 11	-020-03400	J. Wilson	9.2	9.2
Yes	4	SE¼ 12	-020-03500	J. Wilson	7.7	6.5
Yes	4	NE¼ 12	-020-03600	D. & P. McFee	16.9	16.9
Yes	4	E½ 13	-020-03700	Nano Farms Limited	40.5	40.5
Yes	4	Pt E½ 14	-020-03800	Cash Farms Ltd.	39.4	35.0
Yes	4	E½ 15	-020-04000	J. & K. Oxbow	12.2	12.2
Yes	5	Pt W½ 12	-020-05200	Okay Farms Ltd.	6.2	-
Yes	5	W½ 13	-020-05300	Cattle Farms Ltd.	13.0	13.0
Yes	5	W½ 14	-020-05400	D. Wolfman	4.5	4.5
No	3 to 5	Pt 12	Special Assessment TransOntario Pipeline		-	-
Total Assessments on Lands:					436.1	401.7
					-	
County Road 137 - County of South					-	-
Special Assessments to County Road 137					-	-
3 rd Line - Twp of North					0.5	-
4 th Line - Twp of North					3.8	-
Special Assessments to 4 th Line					-	-
5 th Line - Twp of North					2.8	-
Oxbow Sideroad - Twp of North					1.6	-
Total Assessments on Roads:					8.7	-
TOTAL:					444.8	-

MAIN DRAIN (INTERVAL 3)							
Bush Area (Ha) EAAF=0.5	Residential (Ha) EAAF=1.5	Commercial (Ha) EAAF=2.0	Depression Area (Ha) EAAF=0.2	Split Drainage (Ha) EAAF=0.5	Perimeter Factor (PF) (from Table A15-2)	Equivalent Length Factor (ELF)	Total Adjusted (Ha) (ΣArea x EAAF) x PF x ELF
-	-	-	-	-	0.8	1.0	7.1
2.4	-	-	-	-	1.0	1.0	35.3
4.2	-	-	-	-	1.0	1.0	4.0
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	1.0	0.75	5.6
2.4	-	-	-	-	1.0	1.0	13.6
3.8	-	-	-	-	1.0	1.0	37.6
0.4	-	-	-	-	1.0	1.0	32.2
1.0	-	-	-	-	0.4	1.0	0.4
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
0.6	-	-	-	-	1.0	1.0	29.2
-	-	6.0	-	-	1.0	1.0	12.0
-	-	-	-	-	1.0	1.0	40.1
-	-	-	-	-	-	-	-
-	0.4	-	-	-	1.0	1.0	0.6
-	-	-	-	-	1.0	1.0	38.0
1.4	-	-	-	-	1.0	1.0	21.2
-	-	-	-	-	0.4	1.0	1.4
-	-	-	-	-	1.0	1.0	9.2
1.2	-	-	-	-	1.0	1.0	7.1
-	-	-	-	-	0.67	1.0	11.3
-	-	-	-	-	1.0	1.0	40.5
-	-	-	4.4	-	1.0	1.0	35.9
-	-	-	-	-	1.0	1.0	12.2
-	-	-	-	6.2	1.0	1.0	3.1
-	-	-	-	-	0.8	1.0	10.4
-	-	-	-	-	0.33	1.0	1.5
-	-	-	-	-	-	-	-
17.4	0.4	6.0	4.4	6.2	-	-	409.5
2-Lane Gravel - EAAF=1.5		2-Lane Asphalt - EAAF = 2.0					
-	-	-	-	-		-	-
-	-	-	-	-	-	-	-
0.5	-	-	-	-	1.0	1.0	0.8
-	-	-	3.8	-	1.0	1.0	7.6
-	-	-	-	-	-	-	-
-	-	-	2.8	-	1.0	1.0	5.6
1.6	-	-	-	-	1.0	1.0	2.4
2.1	-	-	6.6	-	-	-	16.4
-	-	-	-	-	-	-	425.9

Table A15–3. continued.

FPCTR (Yes / No)	Conc.	Lot	Roll No. (12-58-010)	Owner	In Interval (Ha)	
						Agricultural (Ha) EAAF=1.0
Yes	3	Pt W½ 12	-010-22900	J. Party	-	-
Yes	3	W½ 13	-010-23000	D. & D. Hatfield	-	-
Yes	3	Pt SW¼	-010-23100	J. & M. Jacks	-	-
Yes	3	Pt 10	-010-24300	R. Lucky	-	-
Yes	Special Benefit to Lucky				-	-
Yes	3	SE¼ 11	-010-24400	L. & A. Singh	-	-
Yes	3	NE¼ 11	-010-24500	A. Earp & J. Earp-Sons	-	-
Yes	3	E½ 12	-010-24700	K. Palmer	-	-
Yes	3	E½ 13	-010-24800	S. McCoy	10.1	10.1
Yes	3	E½ 14	-010-24900	H. & V. Robb & N. Shaw	-	-
Yes	4	SW¼ 10	-020-01400	V. & W. Oley	-	-
Yes	4	NW¼ 10	-020-01500	Crop Farms Inc.	-	-
Yes	4	Pt W½ 11	-020-01600	Crop Farms Inc.	29.5	28.9
No	4	Pt W½ 11	-020-01601	Crop Farms Inc.	6.0	-
Yes	4	Pt W½ 12	-020-01800	Nano Farms Limited	40.1	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	38.0	38.0
Yes	4	W½ 14	-020-02000	K. & B. Smith	21.9	20.5
Yes	4	W½ 15	-020-02100	Oxbow Farms Ltd.	3.6	3.6
Yes	4	E½ 11	-020-03400	J. Wilson	9.2	9.2
Yes	4	SE¼ 12	-020-03500	J. Wilson	7.7	6.5
Yes	4	NE¼ 12	-020-03600	D. & P. McFee	16.9	16.9
Yes	4	E½ 13	-020-03700	Nano Farms Limited	40.5	40.5
Yes	4	Pt E½ 14	-020-03800	Cash Farms Ltd.	39.4	35.0
Yes	4	E½ 15	-020-04000	J. & K. Oxbow	12.2	12.2
Yes	5	Pt W½ 12	-020-05200	Okay Farms Ltd.	6.2	-
Yes	5	W½ 13	-020-05300	Cattle Farms Ltd.	13.0	13.0
Yes	5	W½ 14	-020-05400	D. Wolfman	4.5	4.5
No	3 to 5	Pt 12	Special Assessment TransOntario Pipeline		-	-
Total Assessments on Lands:					299.2	279.0
County Road 137 - County of South					-	-
Special Assessments to County Road 137					-	-
3 rd Line - Twp of North					-	-
4 th Line - Twp of North					2.7	-
Special Assessments to 4 th Line					-	-
5 th Line - Twp of North					2.8	-
Oxbow Sideroad - Twp of North					1.6	-
Total Assessments on Roads:					7.1	-
TOTAL:					306.3	-

MAIN DRAIN (INTERVAL 4)							
Bush Area (Ha) EAAF=0.5	Residential (Ha) EAAF=1.5	Commercial (Ha) EAAF=2.0	Depression Area (Ha) EAAF=0.2	Split Drainage (Ha) EAAF=0.5	Perimeter Factor (PF) (from Table A15-2)	Equivalent Length Factor (ELF)	Total Adjusted (Ha) $\Sigma \text{Area} \times \text{EAAF}$ $\times \text{PF} \times \text{ELF}$
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	1.0	1.0	10.1
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
0.6	-	-	-	-	1.0	1.0	29.2
-	-	6.0	-	-	1.0	1.0	12.0
-	-	-	-	-	1.0	1.0	40.1
-	-	-	-	-	-	-	-
-	0.4	-	-	-	1.0	1.0	0.6
-	-	-	-	-	1.0	1.0	38.0
1.4	-	-	-	-	1.0	1.0	21.2
-	-	-	-	-	0.4	1.0	1.4
-	-	-	-	-	1.0	1.0	9.2
1.2	-	-	-	-	1.0	1.0	7.1
-	-	-	-	-	0.67	1.0	11.3
-	-	-	-	-	1.0	1.0	40.5
-	-	-	4.4	-	1.0	1.0	35.9
-	-	-	-	-	1.0	1.0	12.2
-	-	-	-	6.2	1.0	1.0	3.1
-	-	-	-	-	0.8	1.0	10.4
-	-	-	-	-	0.33	1.0	1.5
-	-	-	-	-	-	-	-
3.2	0.4	6.0	4.4	6.2	-	-	283.8
2-Lane Gravel - EAAF=1.5		2-Lane Asphalt - EAAF = 2.0					
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	2.7	-	1.0	0.75	4.1
-	-	-	-	-	-	-	-
-	-	-	2.8	-	1.0	1.0	5.6
-	-	-	-	-	1.0	1.0	2.4
1.6	-	-	5.5	-	-	-	12.1
-	-	-	-	-	-	-	295.9

Table A15–3. continued.

FPCTR (Yes / No)	Conc.	Lot	Roll No. (12-58-010)	Owner	In Interval (Ha)	
						Agricultural (Ha) EAAF=1.0
Yes	3	Pt W½ 12	-010-22900	J. Party	-	-
Yes	3	W½ 13	-010-23000	D. & D. Hatfield	-	-
Yes	3	Pt SW¼	-010-23100	J. & M. Jacks	-	-
Yes	3	Pt 10	-010-24300	R. Lucky	-	-
Yes	Special Benefit to Lucky				-	-
Yes	3	SE¼ 11	-010-24400	L. & A. Singh	-	-
Yes	3	NE¼ 11	-010-24500	A. Earp & J. Earp-Sons	-	-
Yes	3	E½ 12	-010-24700	K. Palmer	-	-
Yes	3	E½ 13	-010-24800	S. McCoy	10.1	10.1
Yes	3	E½ 14	-010-24900	H. & V. Robb & N. Shaw	-	-
Yes	4	SW¼ 10	-020-01400	V. & W. Oley	-	-
Yes	4	NW¼ 10	-020-01500	Crop Farms Inc.	-	-
Yes	4	Pt W½ 11	-020-01600	Crop Farms Inc.	28.0	27.4
No	4	Pt W½ 11	-020-01601	Crop Farms Inc.	-	-
Yes	4	Pt W½ 12	-020-01800	Nano Farms Limited	40.1	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	38.0	38.0
Yes	4	W½ 14	-020-02000	K. & B. Smith	21.9	20.5
Yes	4	W½ 15	-020-02100	Oxbow Farms Ltd.	3.6	3.6
Yes	4	E½ 11	-020-03400	J. Wilson	9.2	9.2
Yes	4	SE¼ 12	-020-03500	J. Wilson	7.7	6.5
Yes	4	NE¼ 12	-020-03600	D. & P. McFee	16.9	16.9
Yes	4	E½ 13	-020-03700	Nano Farms Limited	40.5	40.5
Yes	4	Pt E½ 14	-020-03800	Cash Farms Ltd.	39.4	35.0
Yes	4	E½ 15	-020-04000	J. & K. Oxbow	12.2	12.2
Yes	5	Pt W½ 12	-020-05200	Okay Farms Ltd.	6.2	-
Yes	5	W½ 13	-020-05300	Cattle Farms Ltd.	13.0	13.0
Yes	5	W½ 14	-020-05400	D. Wolfman	4.5	4.5
No	3 to 5	Pt 12	Special Assessment TransOntario Pipeline		-	-
Total Assessments on Lands:					291.7	277.5
County Road 137 - County of South					-	-
Special Assessments to County Road 137					-	-
3 rd Line - Twp of North					-	-
4 th Line - Twp of North					1.6	-
Special Assessments to 4 th Line					-	-
5 th Line - Twp of North					2.8	-
Oxbow Sideroad - Twp of North					1.6	-
Total Assessments on Roads:					6.0	-
TOTAL:					297.7	-

MAIN DRAIN (INTERVAL 5)							
Bush Area (Ha) EAAF=0.5	Residential (Ha) EAAF=1.5	Commercial (Ha) EAAF=2.0	Depression Area (Ha) EAAF=0.2	Split Drainage (Ha) EAAF=0.5	Perimeter Factor (PF) (from Table A15-2)	Equivalent Length Factor (ELF)	Total Adjusted (Ha) ($\Sigma \text{Area} \times \text{EAAF}$) $\times \text{PF} \times \text{ELF}$
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	1.0	1.0	10.1
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
0.6	-	-	-	-	1.0	0.5	13.9
-	-	-	-	-	1.0	-	-
-	-	-	-	-	1.0	1.0	40.1
-	-	-	-	-	-	-	-
-	0.4	-	-	-	1.0	1.0	0.6
-	-	-	-	-	1.0	1.0	38.0
1.4	-	-	-	-	1.0	1.0	21.2
-	-	-	-	-	0.4	1.0	1.4
-	-	-	-	-	1.0	1.0	9.2
1.2	-	-	-	-	1.0	1.0	7.1
-	-	-	-	-	0.67	1.0	11.3
-	-	-	-	-	1.0	1.0	40.5
-	-	-	4.4	-	1.0	1.0	35.9
-	-	-	-	-	1.0	1.0	12.2
-	-	-	-	6.2	1.0	1.0	3.1
-	-	-	-	-	0.8	1.0	10.4
-	-	-	-	-	0.33	1.0	1.5
-	-	-	-	-	-	-	-
3.2	0.4	-	4.4	6.2	-	-	256.5
2-Lane Gravel - EAAF =1.5		2-Lane Asphalt - EAAF = 2.0					
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	1.6	-	1.0	1.0	3.2
-	-	-	-	-	-	-	-
-	-	-	2.8	-	1.0	1.0	5.6
1.6	-	-	-	-	1.0	1.0	2.4
1.6	-	-	4.4	-	-	-	11.2
-	-	-	-	-	-	-	267.7

Table A15–3. continued.

FPCTR (Yes / No)	Conc.	Lot	Roll No. (12-58-010)	Owner	In Interval (Ha)	
						Agricultural (Ha) EAAF=1.0
Yes	3	Pt W½ 12	-010-22900	J. Party	-	-
Yes	3	W½ 13	-010-23000	D. & D. Hatfield	-	-
Yes	3	Pt SW¼	-010-23100	J. & M. Jacks	-	-
Yes	3	Pt 10	-010-24300	R. Lucky	-	-
Yes	Special Benefit to Lucky				-	-
Yes	3	SE¼ 11	-010-24400	L. & A. Singh	-	-
Yes	3	NE¼ 11	-010-24500	A. Earp & J. Earp-Sons	-	-
Yes	3	E½ 12	-010-24700	K. Palmer	-	-
Yes	3	E½ 13	-010-24800	S. McCoy	10.1	10.1
Yes	3	E½ 14	-010-24900	H. & V. Robb & N. Shaw	-	-
Yes	4	SW¼ 10	-020-01400	V. & W. Oley	-	-
Yes	4	NW¼ 10	-020-01500	Crop Farms Inc.	-	-
Yes	4	Pt W½ 11	-020-01600	Crop Farms Inc.	-	-
No	4	Pt W½ 11	-020-01601	Crop Farms Inc.	-	-
Yes	4	Pt W½ 12	-020-01800	Nano Farms Limited	20.4	20.4
Yes	Special Benefit to Nano Farms				-	-
No	4	Pt W½ 12	-	J. Nano	-	-
Yes	4	W½ 13	-020-01900	Nano Farms Limited	38.0	38.0
Yes	4	W½ 14	-020-02000	K. & B. Smith	21.9	20.5
Yes	4	W½ 15	-020-02100	Oxbow Farms Ltd.	3.6	3.6
Yes	4	E½ 11	-020-03400	J. Wilson	-	-
Yes	4	SE¼ 12	-020-03500	J. Wilson	-	-
Yes	4	NE¼ 12	-020-03600	D. & P. McFee	16.9	16.9
Yes	4	E½ 13	-020-03700	Nano Farms Limited	40.5	40.5
Yes	4	Pt E½ 14	-020-03800	Cash Farms Ltd.	39.4	35.0
Yes	4	E½ 15	-020-04000	J. & K. Oxbow	12.2	12.2
Yes	5	Pt W½ 12	-020-05200	Okay Farms Ltd.	6.2	-
Yes	5	W½ 13	-020-05300	Cattle Farms Ltd.	13.0	13.0
Yes	5	W½ 14	-020-05400	D. Wolfman	4.5	4.5
No	3 to 5	Pt 12	Special Assessment TransOntario Pipeline		-	-
Total Assessments on Lands:					226.7	214.7
County Road 137 - County of South					-	-
Special Assessments to County Road 137					-	-
3 rd Line - Twp of North					-	-
4 th Line - Twp of North					1.6	-
Special Assessments to 4 th Line					-	-
5 th Line - Twp of North					2.8	-
Oxbow Sideroad - Twp of North					1.6	-
Total Assessments on Roads:					6.0	-
TOTAL:					232.7	-

MAIN DRAIN (INTERVAL 6)							
Bush Area (Ha) EAAF=0.5	Residential (Ha) EAAF=1.5	Commercial (Ha) EAAF=2.0	Depression Area (Ha) EAAF=0.2	Split Drainage (Ha) EAAF=0.5	Perimeter Factor (PF) (from Table A15-2)	Equivalent Length Factor (ELF)	Total Adjusted (Ha) (Σ Area x EAAF) x PF x ELF
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	1.0	0.3	3.0
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	1.0	0.3	6.1
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	1.0	1.0	38.0
1.4	-	-	-	-	1.0	1.0	21.2
-	-	-	-	-	0.4	1.0	1.4
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	0.67	1.0	11.3
-	-	-	-	-	1.0	1.0	40.5
-	-	-	4.4	-	1.0	1.0	35.9
-	-	-	-	-	1.0	1.0	12.2
-	-	-	-	6.2	1.0	1.0	3.1
-	-	-	-	-	0.8	1.0	10.4
-	-	-	-	-	0.33	1.0	1.5
-	-	-	-	-	-	-	-
1.4	-	-	4.4	6.2	-	-	184.6
2-Lane Gravel - EAAF =1.5		2-Lane Asphalt - EAAF = 2.0					
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	1.6	-	1.0	0.3	1.0
-	-	-	-	-	-	-	-
-	-	-	2.8	-	1.0	1.0	5.6
1.6	-	-	-	-	1.0	1.0	2.4
1.6	-	-	4.4	-	-	-	9.0
-	-	-	-	-	-	-	193.6

Table A15–3. continued.

FPCTR (Yes / No)	Conc.	Lot	Roll No. (12-58-010)	Owner	In Interval (Ha)	
						Agricultural (Ha) EAAF=1.0
Yes	3	Pt W½ 12	-010-22900	J. Party	8.9	8.9
Yes	3	W½ 13	-010-23000	D. & D. Hatfield	36.5	34.1
Yes	3	Pt SW¼	-010-23100	J. & M. Jacks	6.1	1.9
Yes	3	Pt 10	-010-24300	R. Lucky	-	-
Yes	Special Benefit to Lucky				-	-
Yes	3	SE¼ 11	-010-24400	L. & A. Singh	-	-
Yes	3	NE¼ 11	-010-24500	A. Earp & J. Earp-Sons	12.4	12.4
Yes	3	E½ 12	-010-24700	K. Palmer	27.5	23.7
Yes	3	E½ 13	-010-24800	S. McCoy	22.3	21.9
Yes	3	E½ 14	-010-24900	H. & V. Robb & N. Shaw	1.4	0.4
Yes	4	SW¼ 10	-020-01400	V. & W. Oley	-	-
Yes	4	NW¼ 10	-020-01500	Crop Farms Inc.	-	-
Yes	4	Pt W½ 11	-020-01600	Crop Farms Inc.	-	-
No	4	Pt W½ 11	-020-01601	Crop Farms Inc.	-	-
Yes	4	Pt W½ 12	-020-01800	Nano Farms Limited	-	-
Yes	Special Benefit to Nano Farms				-	-
No	4	Pt W½ 12	-	J. Nano	-	-
Yes	4	W½ 13	-020-01900	Nano Farms Limited	-	-
Yes	4	W½ 14	-020-02000	K. & B. Smith	-	-
Yes	4	W½ 15	-020-02100	Oxbow Farms Ltd.	-	-
Yes	4	E½ 11	-020-03400	J. Wilson	-	-
Yes	4	SE¼ 12	-020-03500	J. Wilson	-	-
Yes	4	NE¼ 12	-020-03600	D. & P McFee	-	-
Yes	4	E½ 13	-020-03700	Nano Farms Limited	-	-
Yes	4	Pt E½ 14	-020-03800	Cash Farms Ltd.	-	-
Yes	4	E½ 15	-020-04000	J. & K. Oxbow	-	-
Yes	5	Pt W½ 12	-020-05200	Okay Farms Ltd.	-	-
Yes	5	W½ 13	-020-05300	Cattle Farms Ltd.	-	-
Yes	5	W½ 14	-020-05400	D. Wolfman	-	-
No	3 to 5	Pt 12	Special Assessment TransOntario Pipeline		-	-
Total Assessments on Lands:					115.1	103.3
County Road 137 - County of South					-	-
Special Assessments to County Road 137					-	-
3 rd Line - Twp of North					0.5	-
4 th Line - Twp of North					-	-
Special Assessments to 4 th Line					-	-
5 th Line - Twp of North					-	-
Oxbow Sideroad - Twp of North					-	-
Total Assessments on Roads:					0.5	-
TOTAL:					115.6	-

[illegible]

After determining the Total Adjusted Area, complete the hydrology, hydraulics and drain design (Part B).

Step 2b: Calculate Allowances

Calculate the allowances (Sections 29–33) for each property in each interval (Part A, Chapter 8). The detailed calculations are not shown; however, a summary table is provided in Table A15–4. The Section 29 allowance for land taken is based on a value of \$36,000/ha. The Section 30 allowance for crop damage is based on a value of \$1,704/ha.

Table A15–4. Allowances

Interval	Station to Station	Roll No. (12-58-010)	Owner	Section 29 Allowance (\$ (A))	Section 30 Allowance (\$ (B))	Total Allowance (\$ (A+B))
MAIN DRAIN						
1	0+000 to 0+270	-020-01400	V. & W. Oley	2,550	825	3,375
1	0+290 to 0+833	-010-24300	R. Lucky	5,750	4,375	10,125
Subtotal Interval 1						13,500
3	0+864 to 1+300	-010-24400	L. & A. Singh	1,000	2,380	3,380
5	1+329 to 1+690	-020-01600	Crop Farms Inc.	750	1,840	2,590
5	1+690 to 1+947	-020-01800	Nano Farms Limited	525	1,235	1,760
Subtotal Interval 5						4,350
6	1+947 to 2+335	-020-01800	Nano Farms Limited	700	1,725	2,425
6	2+335	-020-01900	Nano Farms Limited	-	100	100
Subtotal Interval 6						2,525
MAIN DRAIN TOTAL (C= ΣSubtotal of Intervals):				11,275	12,480	23,755
BRANCH A						
7	0+000 to 0+016	-010-24400	L. & A. Singh	50	75	125
7	0+016 to 0+453	-010-24500	A. Earp & J. Earp-Sons	1,350	2,125	3,475
7	0+453	-010-24700	K. Palmer	-	100	100
BRANCH A TOTAL (D):				1,400	2,300	3,700
TOTAL ALLOWANCES (C+D):				12,675	14,780	27,455

Step 2c: Estimate Other Costs

Estimate the amount of the construction, engineering, eligible municipal administration and contingency costs that are assigned to each interval (Part A, Chapter 9.2).

Table A15–5 provides detailed construction costs by line item to assist with future tendering. They are associated with a particular property to make it possible to assign special benefit or special assessment.

Table A15–5. Detailed Construction Costs

Interval 1				
From Station	To Station	Roll No. (12-58-010)	Owner	Distance (m)
0+000	0+100	-020-01400	V. & W. Oley	100
0+100	0+270	-020-01400	V. & W. Oley	170
0+105	-	-020-01400	V. & W. Oley	-
0+135	-	-020-01400	V. & W. Oley	-
0+260	0+265	-020-01400	V. & W. Oley	5
0+265	0+270	-020-01400	V. & W. Oley	5
0+270	0+290	-	4 th Line	20
0+290	0+833	-010-24300	R. Lucky	543
0+290	0+810	-010-24300	R. Lucky	520
0+530	0+540	-010-24300	R. Lucky	10
0+750	-	-010-24300	R. Lucky	-
0+790	0+800	-010-24300	R. Lucky	10
0+292, 0+535 & 0+680	-010-24300	-010-24300	R. Lucky	
0+295		-010-24300	R. Lucky	
0+810	0+833	-010-24300	R. Lucky	23

Construction Costs**Allowances (Refer to Table A15-4) (D)****Engineering & Eligible Municipal Administrative Costs****Net HST ($F=[C+E]*0.0176$)****Total Interval Cost ($C+D+E+F$)**

Interval 1 continued				
Work	Unit	Quantity (A)	Price (\$) (B)	Total (\$) (A*B)
Remove 2 bar areas only (10 m total length). No other work.	L.S.	1	500	500
Widen and deepen existing channel with adjacent levelling and bank seeding. Separately strip and replace topsoils.	m	170	10	1,700
Construct temporary straw bale sediment trap.	each	1	500	500
Remove and dispose of existing 8 m of 1,200 mm CSP and construct new access culvert with 12 m of 2,400 mm CSP with 1 m embedment, 20 m ² riprap protection (10 m ² at each end) and granular in embedment.	L.S.	1	12,000	12,000
Construct timber crib wall for habitat enhancement.	L.S.	1	2,000	2,000
Riprap on filter on bank	m ²	25	40	1,000
Remove and dispose of existing 1,500 mm CSP and supply and install 15 m of 2,400 mm CSP with granular bedding, native backfill and granular surface and with 5m of ditch widening and deepening and including disposal and restoration. Pipe to be embedded 500 mm below design grade and Granular B to be placed in embedded portion. Place 20 m ² of riprap on filter (10 m ² each end).	L.S.	1	16,000	16,000
Power brush channel and on top of bank. Chips to be spread in area of levelling. Brush/trees to remain on south bank from Sta. 290 to 530.	m ²	5,200	1.20	6,240
Widen and deepen existing channel with adjacent levelling and bank seeding. Separately strip and replace topsoils.	m	520	15	7,800
Place riprap on filter on bank.	m ²	30	40	1,200
Remove and dispose of existing 9 m of 1,200 mm CSP and construct new 15m length of 2,000 mm CSP farm culvert with 12 m ² riprap on filter (6 m ² at each end) and laneway restoration. Use 300 mm earth embedment.	L.S.	1	12,000	12,000
Place riprap on filter on bank at surface water entry.	m ²	30	40	1,200
Place riprap on filter at existing tile outlets.	m ²	15	40	600
Construct temporary straw bale sediment trap.	each	1	500	500
Construct stilling pool area with 200 m ³ excavation and off site disposal, 200 m ² of riprap on filter and bank seeding (1.2 m depth of water).	L.S.	1	10,000	10,000
Subtotal Construction				73,240
Lump sum contingency allowance (approximately 10%)				7,330
Total Construction (C)				80,570
				13,500
Engineering for Report and Processing				18,000
Construction Supervision and Finalization				15,000
Eligible Municipal Administrative Costs (approximately 3% of Construction and Engineering)				3,400
Total Engineering and Eligible Municipal Administrative Costs (E)				36,400
Net HST (1.76%) on Construction, Engineering and Eligible Municipal Administrative Costs				2,059
				132,529

Table A15–5. Detailed Construction Costs continued

Interval 2				
From Station	To Station	Roll No. (12-58-010)	Owner	Distance (m)
0+833	0+864		County Road 137	31
0+864			County Road 137	-
			County Road 137	75

Construction Costs

Allowances (Refer to Table A15-4) (D)

Engineering & Eligible Municipal Administrative Costs

Net HST ($F=[C+E]*0.0176$)

Total Interval Cost (C+D+E+F)

Interval 3				
From Station	To Station	Roll No. (12-58-010)	Owner	Distance (m)
0+864	1+300	-010-24400	L. & A. Singh	436

Construction Costs

Allowances (Refer to Table A15-4) (D)

Engineering & Eligible Municipal Administrative Costs

Net HST ($F=[C+E]*0.0176$)

Total Interval Cost (C+D+E+F)

Interval 2 continued				
Work	Unit	Quantity (A)	Price (\$ (B)	Total (\$) (A*B)
2 runs of 31 m lengths of 750 mm HDPE (by open cut) with rodent gates and with 50 m ² of riprap at outlet including removing or sealing old pipe	L.S.	1.	20,000	20,000
Remove existing CBs and construct 2 new 900 x 1,200 mm CB's.	each	2	2,500	5,000
75 m of north road ditch cleanout with hauling of spoil	m	75	30	2,250
Subtotal Construction				27,250
Lump sum contingency allowance (approximately 10%)				2,750
Total Construction (C)				30,000
				0
Engineering for Report and Processing				6,000
Construction Supervision and Finalization				5,500
Eligible Municipal Administrative Costs (approximately 3% of Construction and Engineering)				1,445
Total Engineering and Eligible Municipal Administrative Costs (E)				12,945
Net HST (1.76%) on Construction, Engineering and Eligible Municipal Administrative Costs				756
				43,701

Interval 3 continued				
Work	Unit	Quantity (A)	Price (\$) (B)	Total (\$) (A*B)
900 mm concrete drain tile including paralleling existing 525 mm tile and break up of old 250 mm tile	m	436	150.00	65,400
Subtotal Construction				65,400
Lump sum contingency allowance (approximately 10%)				6,600
Total Construction (C)				72,000
				3,380
Engineering for Report and Processing				15,000
Construction Supervision and Finalization				12,000
Eligible Municipal Administrative Costs (approximately 3% of Construction and Engineering)				3,000
Total Engineering and Eligible Municipal Administrative Costs (E)				30,000
Net HST (1.76%) on Construction, Engineering and Eligible Municipal Administrative Costs				1,795
				107,175

Table A15–5. Detailed Construction Costs continued

Interval 4				
From Station	To Station	Roll No. (12-58-010)	Owner	Distance (m)
1+300			4 th Line	-
1+300	1+329		4 th Line	29
1+329			4 th Line	-
1+329			4 th Line	-
1+329			4 th Line	-

Construction Costs

Allowances (Refer to Table A15-4) (D)

Engineering & Eligible Municipal Administrative Costs

Net HST ($F=[C+E]*0.0176$)

Total Interval Cost (C+D+E+F)

Interval 5				
From Station	To Station	Roll No. (12-58-010)	Owner	Distance (m)
1+329	1+690	-020-01600	Crop Farms Inc.	361
1+690		-020-01600	Crop Farms Inc.	-
1+690	1+938	-020-01800	Nano Farms Ltd	248
1+938	1+947	-020-01800	Nano Farms Ltd	9
1+947		-020-01800	Nano Farms Ltd	-
1+750	1+857	-020-01800	Nano Farms Ltd	-

Construction Costs

Allowances (Refer to Table A15-4) (D)

Engineering & Eligible Municipal Administrative Costs

Net HST ($F=[C+E]*0.0176$)

Total Interval Cost (C+D+E+F)

Interval 4 continued				
Work	Unit	Quantity (A)	Price (\$) (B)	Total (\$) (AxB)
Construct 1,200 x 3,000 mm CB.	each	1	7,000	7,000
900 mm HDPE pipe across 14 th Line by open cut. Existing crossing to be removed and disposed of.	L.S.	L.S.	10,000	10,000
Remove existing CB and construct new 900 x 1,800 mm CB.	each	1	4,000	4000
Remove and replace existing road culvert with 20 m of 600 mm pipe.	L.S.	1	2,500	2,500
Remove and replace existing lane culvert with 12 m of 450 mm pipe.	L.S.	1	1,500	1,500
Subtotal Construction				25,000
Lump sum contingency allowance (approximately 10%)				2,500
Total Construction (C)				27,500
				0
Engineering for Report and Processing				5,500
Construction Supervision and Finalization				4,000
Eligible Municipal Administrative Costs (approximately 3% of Construction and Engineering)				1,150
Total Engineering and Eligible Municipal Administrative Costs (E)				10,650
Net HST (1.76%) on Construction, Engineering and Eligible Municipal Administrative Costs (F=[C+E]*0.0176)				671
				38,821

Interval 5 continued				
Work	Unit	Quantity (A)	Price (\$) (B)	Total (\$) (AxB)
600 mm concrete tile with joint wrap including paralleling 450 mm tile and break up of old 200 mm drain	m	361	62	22,382
Construct new 900 x 1,200 mm CB. Existing CB to remain.	each	1	2,500	2,500
600 mm concrete tile with joint wrap including paralleling 450 mm tile and break up of old drain	m	248	62	15,376
600 mm HDPE pipe across laneway including paralleling 450 mm tile and break up of old drain	m	9	200	1,800
Remove existing CB and construct new 900 x 1,200 mm CB and cross-connect existing tile.	L.S.	L.S.	3,000	3,000
Construct tee sections for future connections (capped HDPE or concrete).	L.S.	L.S.	1,000	1,000
Subtotal Construction				46,058
Lump sum contingency allowance (approximately 10%)				4,642
Total Construction (C)				50,700
				4,350
Engineering for Report and Processing				12,000
Construction Supervision and Finalization				10,000
Eligible Municipal Administrative Costs (approximately 3% of Construction and Engineering)				2,200
Total Engineering and Eligible Municipal Administrative Costs (E)				24,200
Net HST (1.76%) on Construction, Engineering and Eligible Municipal Administrative Costs				1,318
				80,568

Table A15–5. Detailed Construction Costs continued

Interval 6				
From Station	To Station	Roll No. (12-58-010)	Owner	Distance (m)
1+947	2+320	-020-01800	Nano Farms Ltd	373
2+320			Trans Ontario Pipeline	-
2+320	2+335		Trans Ontario Pipeline	15
2+335		-020-01900	Nano Farms Ltd	-

Construction Costs

Allowances (Refer to Table A15-4) (D)

Engineering & Eligible Municipal Administrative Costs

Net HST ($F=[C+E]*0.0176$)

Total Interval Cost (C+D+E+F)

Interval 7				
From Station	To Station	Roll No. (12-58-010)	Owner	Distance (m)
0+016		-010-24400	L. & A. Singh	16
0+016	0+453	-010-24500	A. Earp & J. Earp-Sons	437
0+227		-010-24500	A. Earp & J. Earp-Sons	-
0+453		-010-24700	K. Palmer	-

Construction Costs

Allowances (Refer to Table A15-4) (D)

Engineering & Eligible Municipal Administrative Costs

Net HST ($F=[C+E]*0.0176$)

Total Interval Cost (C+D+E+F)

Interval 6 continued				
Work	Unit	Quantity (A)	Price (\$) (B)	Total (\$) (AxB)
600 mm concrete tile with joint wrap including paralleling 450 mm drain and break up of old drain	m	373	62	23,126
Construct new 1,200 x 2,400 mm junction box.	L.S.	L.S.	4,000	4,000
Pre-locate and protect existing 500 and 650 mm dia. pipelines, install three (3) - 450 mm HDPE pipe including removal of two existing drains and including two (2) - 5 m long x 6 m wide x 12 mm thick rubber pads.	m	45	140	6,300
Construct 1,200 x 2,400 mm CB.	L.S.	L.S.	6,000	6,000
Subtotal Construction				39,426
Lump sum contingency allowance (approximately 10%)				3,964
Total Construction (C)				43,390
				2,525
Engineering for Report and Processing				12,000
Construction Supervision and Finalization				10,000
Eligible Municipal Administrative Costs (approximately 3% of Construction and Engineering)				2,000
Total Engineering and Eligible Municipal Administrative Costs (E)				24,000
Net HST (1.76%) on Construction, Engineering and Eligible Municipal Administrative Costs (F=[C+E]*0.0176)				1,186
				71,101

Interval 7 continued				
Work	Unit	Quantity (A)	Price (\$) (B)	Total (\$) (AxB)
300 mm concrete drain tile with joint wrap to parallel existing 300 mm tile with break up of old 150 mm tile	m	16	42	672
300 mm concrete drain tile with joint wrap to parallel existing 300 mm tile with break up of old 150 mm tile	m	437	42	18,354
Construct terrace plus 150 mm dia. hickenbottom (WASCoB).	L.S.	L.S.	6,850	6,850
Construct new 900 x 1500 mm DICB and reconstruct berm.	L.S.	L.S.	4,500	4,500
Subtotal Construction				30,376
Lump sum contingency allowance (approximately 10%)				3,038
Total Construction (C)				33,414
				3,700
Engineering for Report and Processing				7,500
Construction Supervision and Finalization				5,500
Eligible Municipal Administrative Costs (approximately 3% of Construction and Engineering)				1,399
Total Engineering and Eligible Municipal Administrative Costs (E)				14,399
Net HST (1.76%) on Construction, Engineering and Eligible Municipal Administrative Costs (F=[C+E]*0.0176)				842
				52,355

For the purposes of the case study, the costs for allowances, engineering and eligible municipal administration for each interval are generally proportioned consistent with the construction costs. The contingency cost is approximately 10% of the estimated construction cost. These costs are summarized in Table A15–6.

Table A15–6. Total Cost Summary by Interval

Interval	Total Construction Costs (Includes Contingency – approximately 10%) (\$)	Engineering for Report and Processing Costs (\$)	Construction Supervision and Finalization Costs (\$)	Eligible Municipal Administrative Costs (\$)	Total Engineering and Eligible Municipal Administrative Costs (\$)	Net HST (1.76%) (\$)	Total Allowances (\$)	Total Cost (\$)
Main Drain								
1	80,570	18,000	15,000	3,400	36,400	2,059	13,500	132,529
2	30,000	6,000	5,500	1,445	12,945	756	0	43,701
3	72,000	15,000	12,000	3,000	30,000	1,795	3,380	107,175
4	27,500	5,500	4,000	1,150	10,650	671	0	38,821
5	50,700	12,000	10,000	2,200	24,200	1,318	4,350	80,568
6	43,390	12,000	10,000	2,000	24,000	1,186	2,525	71,101
Subtotal	304,160	68,500	56,500	13,195	138,195	7,785	23,755	473,895
Branch A								
7	33,414	7,500	5,500	1,399	14,399	842	3,700	52,355
TOTALS	337,574	76,000	62,000	14,594	152,594	8,627	27,455	526,250

Step 3: Calculate Special Benefits and Special Assessments

From the case study, on an interval by interval basis:

- calculate the *special benefit* (Part A, Chapter 9.3.3)
- calculate the *special assessment* (Part A, Chapter 9.3.4)
- calculate the *net interval cost*, which is the total cost minus both the special benefit and the special assessment

For the case study, Table A15–7 provides the special benefits and special assessments. The actual special assessment will be based on actual construction costs, actual increased engineering and eligible municipal administrative costs.

Table A15–7. Special Benefits and Special Assessments

Interval	Special Benefit (Section 24)	Special Assessment (Section 26)
1	Extra-wide private crossing at Station 0+750	4 th Line crossing at Station 0+270 to Station 0+290
2	—	County Rd 137 crossing
3	—	—
4	—	4 th Line crossing
5	Tee for future connections at Stations 1+750 and 1+857 (do not apply to future maintenance and repair)	—
6	—	TransOntario pipeline crossing at Station 2+320 to Station 2+335
7	—	—

Interval 1						
Special Benefit (Section 24)						
Roll No. (12-58-010)	Owner	Description				Total (\$)
-010-24300	R. Lucky	Culvert at Station 0+750. 9 m of 2,000 mm CSP is \$8,000 (9 m would be normal length). Pipe culvert cost for the extra 6 m of 2,000 mm CSP would be \$4,000 and is a special benefit. Special benefit is to be proratable and based on 33% of actual bid for the total culvert cost. Additional length is due to type of farm equipment used and lane approaches as available.				4,000
Total Special Benefit						4,000
Special Assessment (Section 26)						
Property/ Road	Description	Estimated Cost (\$ (A))	Equivalent Length Cost (\$ (B))	Increased Engineering and Eligible Municipal Administrative Costs (\$ (C))	Net HST (1.76%) on Total (\$) (D=[A-B+C]* 0.0176)	Total (\$) ([A-B+C+D])
4 th Line	Work on 4 th Line: supply & install two 31 m runs of 2,400 mm CSP including riprap and 5 m of ditch work	16,000	300 (if road not there, cost of ditch on 20 m is 300)	6,000 (3,000 during design and 3,000 expected during construction)	382	22,082
Total Special Assessment						22,082

Table A15–7. Special Benefits and Special Assessments continued.

Interval 2						
Special Assessment (Section 26)						
Property/ Road	Description	Estimated Cost (\$) (A)	Equivalent Length Cost (\$) (B)	Increased Engineering and Eligible Municipal Administrative Costs (\$) (C)	Net HST (1.76%) on Total (\$) (D=[A- B+C]*0.0176)	Total (\$) ([A- B+C+D])
County Road 137	Work on County Road: supply & install two 31 m runs of 750 mm HDPE including riprap and ditch work and 2 new CB's	27,250	2,870 (if road not there, average of cost of two 31 m runs of 750 mm tile)	10,000 (5,000 during design and 5,000 expected during construction)	605	34,985
Total Special Assessment						34,985

Interval 4						
Special Assessment (Section 26)						
Property/ Road	Description	Estimated Cost (\$) (A)	Equivalent Length Cost (\$) (B)	Increased Engineering and Eligible Municipal Administrative Costs (\$) (C)	Net HST (1.76%) on Total (\$) (D=[A- B+C]*0.0176)	Total (\$) ([A- B+C+D])
4 th Line	Work on 4 th Line: supply & install 29 m of 900 mm HDPE including two CB's and two surface culverts	25,000	8,800 (if road not there, cost of 29 m of 600 mm tile and large CB)	7,000 (4,000 during design and 3,000 expected during construction)	408	23,608
Total Special Assessment						23,608

Interval 5			
Special Benefit (Section 24)			
Roll No. (12-58-010)	Owner	Description	Total (\$)
-020-01800	Nano Farms Ltd	Construct tee sections for future connections (capped HDPE or concrete). Special Benefit to be non-proratable.	1,000
Total Special Benefit			1,000

Interval 6						
Special Assessment (Section 26)						
Property/ Road	Description	Estimated Cost (\$) (A)	Equivalent Length Cost (\$) (B)	Increased Engineering and Eligible Municipal Ad- ministrative Costs (\$) (C)	Net HST (1.76%) on Total (\$) (D=[A- B+C]*0.0176)	Total (\$) ([A- B+C+D])
Trans Ontario Pipeline		16,300 (Crossing, JB & CB)	3,930 (15 m of 600 mm tile plus one CB)	10,000 (6,000 during design and 4,000 expected during construction)	394	22,764
Total Special Assessment						22,764

Step 4: Select the Split between Benefit Assessment and Outlet Liability for Each Interval

Select an appropriate proportion of the net interval cost to be assessed as benefits for each interval (Part A, Chapter 9.5.3, Step 4). The engineer determined the proportion of benefit to net interval costs in each interval as shown in Table A15–8.

Table A15–8. Proportion of Benefit

Interval	Proportion of Benefit	Note
1	24%	Special benefit (Section 24) and special assessment (Section 26) applied
2	26%	Special assessment (Section 26) applied
3	28%	—
4	30%	Special assessment (Section 26) applied
5	60%	Special benefit (Section 24) applied
6	60%	Special assessment (Section 26) applied
7	40%	—

Step 5: Determine the Benefit Value for Individual Properties

Calculate the benefit value on a property-by-property basis over the interval and then total the benefit (Part A, Chapter 9.3.1).

Step 6: Calculate the Benefit Assessments for Each Property

Calculate the benefit assessments for each property as shown in Part A, Chapter 9.5.3, Step 6:

- If there is more than one property being assessed benefit in the interval, the interval benefit is pro-rated based on the benefit value.
- If there is only one property being assessed benefit in the interval, then it is assessed the full interval benefit.

Step 7: Divide the Interval Outlet Liability

Finally, calculate the outlet liability, which is the net interval cost minus benefits (Part A, Chapter 9.3.2). The balance of the costs is then assessed under the category of outlet liability. All of the assessments by interval are shown in Table A15–9.

Table A15-9. Interval Benefit Assessments

Interval 1								
Total Interval Cost (G)			\$132,529					
Total of Special Benefit (Refer to Table 15-7) (H)			\$4,000					
Total of Special Assessment (Refer to Table 15-7) (I)			\$22,082					
Balance (J = G – H – I)			\$106,447					
% Benefit of Total Net Interval Costs (Refer to Table 15-8) (K)			24					
Interval Benefit (IB = J x K / 100)			\$25,547					
Roll No. (12-58-010)	Owner	For Increased Market Value / Appearance / Easier Maintenance (\$ (A)	For Improved Sub-surface / Road Base Drainage (\$ (B)	For Improved Surface Drainage (\$ (C)	For Ease of Connection (\$ (D)	Other (\$ (E)	Total Benefit Value (\$ (F=A+B+C+D+E)	Benefit Assessment (\$ (F x IB / TB)
-020-01400	V. & W. Oley	-	100 m @ 10 = 1,000	100 m @ 10 = 1,000	-	30% of new culvert = 3,600 Rounded to 3,500	5,500	4,432
-020-01500	Crop Farms Inc.	1,000	50 m @ 10 = 500	50 m @ 10 = 500	-		2,000	1,612
-010-24300	R. Lucky	1,000	643 m @ 10 = 6,430 Rounded to 6,500	643 m @ 15 = 9,645 Rounded to 10,000	-	40% of new culvert not specially assessed = 3,500	21,000	16,924
4 th Line	-	1,000	170 m @ 10 = 1,700	20 m @ 20 = 400 Rounded to 500	-		3,200	2,579
Total Benefit (TB)		3,000	9,700	12,000	-	7,000	31,700 (TB)	25,547
Total Interval Cost (G)			\$132,529					
Total of Special Benefit, Special Assessments & Benefits (L = H + I + IB)			\$51,629					
Amount for outlet liability (M = G – L)			\$80,900					

Table A15-9. Interval Benefit Assessments continued

Interval 2							
Total Interval Cost (G)							\$43,701
Total of Special Benefit (Refer to Table 15-7) (H)							-
Total of Special Assessment (Refer to Table 15-7) (I)							\$34,985
Balance (J = G - H - I)							\$8,716
% Benefit of Total Net Interval Costs (Refer to Table 15-8) (K)							26
Interval Benefit (IB = J x K /100)							\$2,266
Roll No. (12-58-010)	Owner	For Increased Market Value / Appearance / Easier Maintenance (\$)(A)	For Improved Sub-surface / Road Base Drainage (\$)(B)	For Improved Surface Drainage (\$)(C)	For Ease of Connection (\$)(D)	Total Benefit Value (\$)(F=A+B+C+D+E)	Benefit Assessment (\$)(F x IB / TB)
	County of South	1,500	30 m @ 15 = 450 Rounded to 500	30 m @ 30 = 900 Rounded to 1,000	-	3,000	2,266
Total Benefit (TB)		1,500	500	1,000	-	3,000 (TB)	2,266
Total Interval Cost (G)							\$43,701
Total of Special Benefit, Special Assessment & Benefits (L = H + I + IB)							\$37,251
Amount for outlet liability (M = G - L)							\$6,450

Interval 3							
Total Interval Cost (G)							\$107,175
Total of Special Benefit (Refer to Table 15-7) (H)							-
Total of Special Assessment (Refer to Table 15-7) (I)							-
Balance (J = G - H - I)							\$107,175
% Benefit of Total Net Interval Costs (Refer to Table 15-8) (K)							28
Interval Benefit (IB = J x K /100)							\$30,009
Roll No. (12-58-010)	Owner	For Increased Market Value / Appearance / Easier Maintenance (\$)(A)	For Improved Sub-surface / Road Base Drainage (\$)(B)	For Improved Surface Drainage (\$)(C)	For Ease of Connection (\$)(D)	Total Benefit Value (\$)(F=A+B+C+D+E)	Benefit Assessment (\$)(F x IB / TB)
-010-24400	L. & A. Singh	8.4 @ 2,000 = 16,800	436 m @ 10 = 4,360 Rounded to 4,500	436 m @ 25 = 10,900 Rounded to 11,000	1,000	33,300	30,009
Total Benefit (TB)		16,800	4,500	11,000	1,000	33,300 (TB)	30,009
Total Interval Cost (G)							\$107,175
Total of Special Benefit, Special Assessment & Benefits (L = H + I + IB)							\$30,009
Amount for outlet liability (M = G - L)							\$77,166

Table A15-9. Interval Benefit Assessments continued

Interval 4							
Total Interval Cost (G)			\$38,821				
Total of Special Benefit (Refer to Table 15-7) (H)			-				
Total of Special Assessment (Refer to Table 15-7) (I)			\$23,608				
Balance (J = G – H – I)			\$15,213				
% Benefit of Total Net Interval Costs (Refer to Table 15-8) (K)			30				
Interval Benefit (IB = J x K / 100)			\$4,564				
Roll No. (12-58-010)	Owner	For Increased Market Value / Appearance / Easier Maintenance (\$) (A)	For Improved Sub-surface / Road Base Drainage (\$) (B)	For Improved Surface Drainage (\$) (C)	For Ease of Connection (\$) (D)	Total Benefit Value (\$) (F=A+B+C+D+E)	Benefit Assessment (\$) (F x IB / TB)
4 th Line	Twp of North	3,000	30 m @ 15 = 450 Rounded to 500	30 m @ 25 = 750 Rounded to 1000	-	4,500	4,564
Total Benefits (TB)		3,000	500	1,000	-	4,500 (TB)	4,564
Total Interval Cost (G)			\$38,821				
Total of Special Benefit, Special Assessment & Benefits (L = H + I + IB)			\$28,172				
Amount for outlet liability (M = G – L)			\$10,649				
Interval 5							
Total Interval Cost (G)			\$80,568				
Total of Special Benefit (Refer to Table 15-7) (H)			\$1,000				
Total of Special Assessment (Refer to Table 15-7) (I)			-				
Balance (J = G – H – I)			\$79,568				
% Benefit of Total Net Interval Costs (Refer to Table 15-8) (K)			60				
Interval Benefit (IB = J x K / 100)			\$47,741				
Roll No. (12-58-010)	Owner	For Increased Market Value / Appearance / Easier Maintenance (\$) (A)	For Improved Sub-surface / Road Base Drainage (\$) (B)	For Improved Surface Drainage (\$) (C)	For Ease of Connection (\$) (D)	Total Benefit Value (\$) (F=A+B+C+D+E)	Benefit Assessment (\$) (F x IB / TB)
-020-01600	Crop Farms Inc.	35 @ 700 = 24,500	361m @ 10 = 3,610 Rounded to 4,000	1,000	-	29,500	27,507
-020-01601	Crop Farms Inc.	6 @ 700 = 4,200	-	-	-	4,200	3,916
-020-01800	Nano Farms Ltd	20 @ 700 = 14,000	257 @ 10 = 2,570 Rounded to 3,000	500	-	17,500	16,318
Total Benefits (TB)		42,700	7,000	1,500	-	51,200 (TB)	47,741
Total Interval Cost (G)			\$80,568				
Total of Special Benefit, Special Assessment & Benefits (L = H + I + IB)			\$48,741				
Amount for outlet liability (M = G – L)			\$31,827				

Table A15-9. Interval Benefit Assessments continued

Interval 6							
Total Interval Cost (G)							\$71,101
Total of Special Benefit (Refer to Table 15-7) (H)							-
Total of Special Assessment (Refer to Table 15-7) (I)							\$22,764
Balance (J = G - H - I)							\$48,337
% Benefit of Total Net Interval Costs (Refer to Table 15-8) (K)							60
Interval Benefit (IB = J x K /100)							\$29,002
Roll No. (12-58-010)	Owner	For Increased Market Value / Appearance / Easier Maintenance (\$ (A)	For Improved Sub-surface / Road Base Drainage (\$ (B)	For Improved Surface Drainage (\$ (C)	For Ease of Connection (\$ (D)	Total Benefit Value (\$ (F=A+B+C+D+E)	Benefit Assessment (\$ (F x IB / TB)
-020-01800	Nano Farms Ltd	20 @ 750 = 15,000	388 m @ 10 = 3,880 Rounded to 4,000	1,500	-	20,500	19,493
-020-01900	Nano Farms Ltd	10 @ 750 = 7,500	60 m @ 10 = 600 Rounded to 1,000	1,500	-	10,000	9,509
Total Benefit (TB)		22,500	5,000	3,000	-	30,500 (TB)	29,002
Total Interval Cost (G)							\$71,101
Total of Special Benefit, Special Assessment & Benefits (L = H + I + IB)							\$51,766
Amount for outlet liability (M = G - L)							\$19,335

Interval 7							
Total Interval Cost (G)							\$52,355
Total of Special Benefit (Refer to Table 15-7) (H)							-
Total of Special Assessment (Refer to Table 15-7) (I)							-
Balance (J = G - H - I)							\$52,355
% Benefit of Total Net Interval Costs (Refer to Table 15-8) (K)							40
Interval Benefit (IB = J x K /100)							\$20,942
Roll No. (12-58-010)	Owner	For Increased Market Value / Appearance / Easier Maintenance (\$ (A)	For Improved Sub-surface / Road Base Drainage (\$ (B)	For Improved Surface Drainage (\$ (C)	For Ease of Connection (\$ (D)	Total Benefit Value (\$ (F=A+B+C+D+E)	Benefit Assessment (\$ (F x IB / TB)
-010-24500	A. Earp & J. Earp-Sons	10 @ 1,200 = 12,000	435 m @ 10 = 4,350 Rounded to 4,500	1,500	-	18,000	18,754
-010-24700	K. Palmer	-	60 m @ 10 = 600	1,500	-	2,100	2,188
Total Benefit (TB)		12,000	5,100	3,000	-	20,100 (TB)	20,942
Total Interval Cost (G)							\$52,355
Total of Special Benefit, Special Assessment & Benefits (L = H + I + IB)							\$20,942
Amount for outlet liability (M = G - L)							\$31,413

Table A15–10 itemizes by interval the project costs, the benefits, the special benefit, the special assessment, the outlet liability and the equivalent hectares to be used, for each property.

Table A15–10. Assessment by Property

		In Watershed		MAIN DRAIN		
				Interval 1 0+000 to 0+833 (Oley, 4 th Line & Lucky)		
COST ESTIMATE (Refer to Table 15-6)						
Allowances (\$)				13,500		
Construction (\$)				80,570		
Engineering & Eligible Municipal Administration Costs (\$)				36,400		
Net HST (\$)				2,059		
TOTAL COST (\$ (G))				132,529		
Roll No. (12-58-010)	Owner	Total Affected (Ha) (Refer to Table 15-3)	Total Adjusted (Ha) (Refer to Table 15-3)	Benefit Assessment (\$) (Refer to Table 15-9)	Adjusted (Ha) (A) (Refer to Table 5-3)	Outlet Liability (\$ (B= A x F))
-010-22900	J. Party	8.9	7.1	-	7.1	1,213
-010-23000	D. & D. Hatfield	36.5	35.3	-	35.3	6,029
-010-23100	J. & M. Jacks	6.1	4.0	-	4.0	683
-010-24300	R. Lucky	28.6	13.3	16,924	13.3	2,271
Special Benefit to Lucky				4,000	-	-
-010-24400	L. & A. Singh	15.6	15.6	-	15.6	2,664
-010-24500	A. Earp & J. Earp-Sons	15.6	14.0	-	14.0	2,391
-010-24700	K. Palmer	39.5	37.6	-	37.6	6,421
-010-24800	S. McCoy	32.4	32.2	-	32.2	5,499
-010-24900	H. & V. Robb & N. Shaw	1.4	0.4	-	0.4	61
-020-01400	V. & W. Oley	8.0	1.6	4,432	1.6	273
-020-01500	Crop Farms Inc.	11.0	2.2	1,612	2.2	376
-020-01600	Crop Farms Inc.	34.3	34.0	-	34.0	5,807
-020-01601	Crop Farms Inc.	6.0	12.0	-	12.0	2,049
-020-01800	Nano Farms Limited	40.1	40.1	-	40.1	6,848
Special Benefit to Nano Farms					-	-
-020-01801	J. Nano	0.4	0.6	-	0.6	102
-020-01900	Nano Farms Limited	38.0	38.0	-	38.0	6,490
-020-02000	K. & B. Smith	21.9	21.2	-	21.2	3,621
-020-02100	Oxbow Farms Ltd.	3.6	1.4	-	1.4	246
-020-03400	J. Wilson	18.0	18.0	-	18.0	3,074
-020-03500	J. Wilson	7.7	7.1	-	7.1	1,213
-020-03600	D. & P. McFee	16.9	11.3	-	11.3	1,934
-020-03700	Nano Farms Limited	40.5	40.5	-	40.5	6,917
-020-03800	Cash Farms Ltd.	39.4	35.9	-	35.9	6,131
-020-04000	J. & K. Oxbow	12.2	12.2	-	12.2	2,084
-020-05200	Okay Farms Ltd.	6.2	3.1	-	3.1	529
-020-05300	Cattle Farms Ltd.	13.0	10.4	-	10.4	1,776
-020-05400	D. Wolfman	4.5	1.5	-	1.5	254
Special Assessment TransOntario Pipeline				-	-	-
County Road 137 – County of South		3.4	6.8	-	6.8	1,161
Special Assessment to County Road 137				-	-	-
3 rd Line – Twp of North		0.5	0.8	-	0.8	137
4 th Line – Twp of North		5.0	7.5	2,579	7.5	1,281
Special Assessment to 4 th Line				22,082	-	-
5 th Line – Twp of North		2.8	5.6	-	5.6	956
Oxbow Sideroad – Twp of North		1.6	2.4	-	2.4	410
TOTALS		519.6	473.7	51,629	473.7	80,900
TOTAL BENEFIT ASSESSMENT (\$ (C))		-	-	51,629	-	-
OUTLET LIABILITY (\$ (D= G - C))		-	-	80,900	-	-
Land in Interval (Ha) (E)		-	-	473.7	-	-
Outlet Liability Rate (\$/Ha) (F=D / E)		-	-	170.78	-	-

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 (4 th Line)		
-			3,380			-		
30,000			72,000			27,500		
12,945			30,000			10,650		
756			1,795			671		
43,701			107,175			38,821		
Benefit Assessment (\$) (Refer to Table 15-9)	Adjusted (Ha) (A)	Outlet Liability (\$ (B= A x F)	Benefit Assessment (\$) (Refer to Table 15-9)	Adjusted (Ha) (A)	Outlet Liability (\$ (B= A x F)	Benefit Assessment (\$) (Refer to Table 15-9)	Adjusted (Ha) (A)	Outlet Liability (\$ (B= A x F)
-	7.1	101	-	7.1	1,290	-	-	-
-	35.3	501	-	35.3	6,395	-	-	-
-	4.0	57	-	4	725	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	15.6	221	30,009	5.6	1,015	-	-	-
-	14.0	199	-	13.6	2,464	-	-	-
-	37.6	534	-	37.6	6,812	-	-	-
-	32.2	457	-	32.2	5,834	-	10.1	363
-	0.4	5	-	0.36	65	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	34.0	482	-	29.2	5,290	-	29.2	1,051
-	12.0	170	-	12.0	2,174	-	12.0	432
-	40.1	569	-	40.1	7,265	-	40.1	1,443
-	-	-	-	-	-	-	-	-
-	0.6	9	-	0.6	109	-	0.6	22
-	38.0	539	-	38.0	6,885	-	38.0	1,367
-	21.2	301	-	21.2	3,841	-	21.2	763
-	1.4	20	-	1.4	261	-	1.4	52
-	18.0	255	-	9.2	1,667	-	9.2	331
-	7.1	101	-	7.1	1,286	-	7.1	255
-	11.3	161	-	11.3	2,051	-	11.3	407
-	40.5	575	-	40.5	7,337	-	40.5	1,457
-	35.9	509	-	35.9	6,504	-	35.9	1,292
-	12.2	173	-	12.2	2,210	-	12.2	439
-	3.1	44	-	3.1	562	-	3.1	112
-	10.4	148	-	10.4	1,884	-	10.4	374
-	1.5	21	-	1.5	269	-	1.5	53
-	-	-	-	-	-	-	-	-
2,266	4.6	65	-	-	-	-	-	-
34,985	-	-	-	-	-	-	-	-
-	0.8	11	-	0.8	145	-	-	-
-	7.6	108	-	7.6	1,377	4,564	4.1	148
-	-	-	-	-	-	23,608	-	-
-	5.6	79	-	5.6	1,015	-	5.6	202
-	2.4	34	-	2.4	435	-	2.4	86
37,251	454.5	6,450	30,009	425.9	77,166	28,172	295.9	10,649
37,251	-	-	30,009	-	-	28,172	-	-
6,450	-	-	77,166	-	-	10,649	-	-
454.5	-	-	425.9	-	-	295.9	-	-
14.19	-	-	181.17	-	-	35.98	-	-

Table A15–10. Assessment by Property continued.

		In Watershed		MAIN DRAIN		
				Interval 5 1+329 to 1+947 (Crop Farms and Nano Farms)		
COST ESTIMATE (Refer to Table 15-6)						
Allowances (\$)				4,350		
Construction (\$)				50,700		
Engineering & Eligible Municipal Administration Costs (\$)				24,200		
Net HST (\$)				1,318		
TOTAL COST (\$) (G)				80,568		
Roll No. (12-58-010)	Owner	Total Affected (Ha)	Total Adjusted (Ha)	Benefit Assessment (\$) (Refer to Table 15-9)	Adjusted (Ha) (A)	Outlet Liability (\$ (B= A x F)
-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	-	-	-
Special Benefit to Lucky				-	-	-
-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	1,201
-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	27,507	13.9	1,652
-020-01601	Crop Farms Inc.	6.0	12.0	3,916	-	-
-020-01800	Nano Farms Limited	40.1	40.1	16,318	40.1	4,767
Special Benefit to Nano Farms				1,000	-	-
-020-01801	J. Nano	0.4	0.6	-	0.6	71
-020-01900	Nano Farms Limited	38.0	38.0	-	38.0	4,517
-020-02000	K. & B. Smith	21.9	21.2	-	21.2	2,520
-020-02100	Oxbow Farms Ltd.	3.6	1.4	-	1.4	171
-020-03400	J. Wilson	18.0	18.0	-	9.2	1,094
-020-03500	J. Wilson	7.7	7.1	-	7.1	844
-020-03600	D. & P McFee	16.9	11.3	-	11.3	1,346
-020-03700	Nano Farms Limited	40.5	40.5	-	40.5	4,814
-020-03800	Cash Farms Ltd.	39.4	35.9	-	35.9	4,267
-020-04000	J. & K. Oxbow	12.2	12.2	-	12.2	1,450
-020-05200	Okay Farms Ltd.	6.2	3.1	-	3.1	368
-020-05300	Cattle Farms Ltd.	13.0	10.4	-	10.4	1,236
-020-05400	D. Wolfman	4.5	1.5	-	1.5	177
Special Assessment TransOntario Pipeline				-	-	-
County Road 137 - County of South		3.4	6.8	-	-	-
Special Assessment to County Road 137				-	-	-
3 rd Line - Twp of North		0.5	0.8	-	-	-
4 th Line - Twp of North		5.0	7.5	-	3.2	380
Special Assessment to 4 th Line				-	-	-
5 th Line - Twp of North		2.8	5.6	-	5.6	666
Oxbow Sideroad - Twp of North		1.6	2.4	-	2.4	285
TOTALS		519.6	473.7	48,741	267.7	31,827
TOTAL BENEFIT ASSESSMENT (\$) (C)		-	-	48,741	-	-
OUTLET LIABILITY (\$) (D=G - C)		-	-	31,827	-	-
Land in Interval (Ha) (E)		-	-	267.7	-	-
Outlet Liability Rate (\$/Ha) (F = D / E)		-	-	118.87	-	-

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		
2,525			3,700			27,455		
43,390			33,414			337,574		
24,000			14,399			152,594		
1,186			842			8,627		
71,101			52,355			526,250		
Benefit Assessment (\$ (Refer to Table 15-9)	Adjusted (Ha) (A)	Outlet Liability (\$) (B= A x F)	Benefit Assessment (\$ (Refer to Table 15-9)	Adjusted (Ha) (A)	Outlet Liability (\$) (B= A x F)	Total Benefit Assessment (\$ (H)	Total Outlet Liability (\$) (I)	Total Assessment (\$ (H+I)
-	-	-	-	7.12	2,139	-	4,742	4,742
-	-	-	-	35.3	10,603	-	23,528	23,528
-	-	-	-	4	1,201	-	2,666	2,666
-	-	-	-	-	-	16,924	2,271	19,195
-	-	-	-	-	-	4,000	-	4,000
-	-	-	-	-	-	30,009	3,900	33,909
-	-	-	18,754	9.3	2,793	18,754	7,847	26,601
-	-	-	2,188	25.6	7,690	2,188	21,457	23,645
-	3.0	300	-	22.1	6,638	-	20,292	20,292
-	-	-	-	0.36	108	-	240	240
-	0	-	-	-	-	4,432	273	4,705
-	-	-	-	-	-	1,612	376	1,988
-	-	-	-	-	-	27,507	14,282	41,789
-	-	-	-	-	-	3,916	4,826	8,742
19,493	6.1	609	-	-	-	35,811	21,501	57,312
-	-	-	-	-	-	1,000	-	1,000
-	-	-	-	-	-	-	313	313
9,509	38.0	3,794	-	-	-	9,509	23,592	33,101
-	21.2	2,117	-	-	-	-	13,162	13,162
-	1.44	144	-	-	-	-	894	894
-	-	-	-	-	-	-	6,421	6,421
-	-	-	-	-	-	-	3,699	3,699
-	11.3	1,131	-	-	-	-	7,030	7,030
-	40.5	4,044	-	-	-	-	25,144	25,144
-	35.9	3,584	-	-	-	-	22,288	22,288
-	12.2	1,218	-	-	-	-	7,574	7,574
-	3.1	310	-	-	-	-	1,925	1,925
-	10.4	1,038	-	-	-	-	6,457	6,457
-	1.5	148	-	-	-	-	922	922
22,764	-	-	-	-	-	22,764	-	22,764
-	-	-	-	-	-	2,266	1,227	3,492
-	-	-	-	-	-	34,985	-	34,985
-	-	-	-	0.8	240	-	533	533
-	1.0	100	-	-	-	7,143	3,393	10,536
-	-	-	-	-	-	45,690	-	45,690
-	5.6	559	-	-	-	-	3,477	3,477
-	2.4	240	-	-	-	-	1,490	1,490
51,766	193.6	19,335	20,942	104.6	31,413	268,510	257,740	526,250
51,766	-	-	20,942	-	-	-	-	-
19,335	-	-	31,413	-	-	-	-	-
193.6	-	-	104.6	-	-	-	-	-
99.85	-	-	300.37	-	-	-	-	-

Developing the Future Maintenance and Repair Assessments

For this case study, the construction assessments (Table A15–10) were used to develop the assessments for future maintenance and repair and adjusted as described in Steps 1–5. Based on discussion with the drainage superintendent, it was decided to present the assessment schedule for future maintenance in intervals.

Using the method in Part A, Chapter 9.5.5:

Step 1: The engineer used an estimated cost of \$10/m for work on private lands and \$20/m for work on road rights-of-way to develop an estimated future maintenance and repair cost for each interval.

For interval 1, the estimated cost is \$9,500.

Step 2: The engineer reviewed the proportion for benefit and outlet liability and made some adjustments. In the case study, the engineer established a range of percentages for maintenance benefit in each non-road interval from 30% in the downstream intervals of the drain to 60% for upstream intervals. For road intervals, the benefit percentages should be around 90% of the interval cost.

For interval 1, the proportion of benefit was changed to 33%.

Step 3: The benefit was allocated to the benefitting properties.

For interval 1, the benefit allocated is $\$9,500 \times 33\% = \$3,150$ and this was distributed to the four benefitting properties as follows:

- R. Lucky (Roll No 1258-010-010-24300) — \$1,500
- V. & W. Oley (Roll No. 1258-010-020-01400) — \$500
- Crop Farms Inc. (Roll No. 1258-010-020-01500) — \$150
- 4th Line — Twp. of North — \$1,000

Step 4: The remaining cost is allocated as outlet liability.

For interval 1:

- the outlet liability is $\$9,500 - \$3,150 = \$6,350$
- the outlet liability rate (\$/ha) is calculated using the outlet liability divided by the adjusted watershed area of the interval $\$6,350 / 473.7 \text{ ha} = \$13.40/\text{ha}$
- the outlet liability is allocated based on the total adjusted area of each property (e.g., R. Lucky (Roll No 1258-010-010-24300) — $13.3 \text{ ha} \times \$13.40 = \178.22 (use \$178.00))

Step 5: Determine the total maintenance assessment for each property by adding the benefit assessments and outlet liability assessments for each of the seven intervals. Table A15–11 provides an example for the K. Palmer property.

Table A15–11. Future Maintenance and Repair Assessment for K. Palmer (Roll No. 1258-010-010-24700)

Interval	Benefit Assessment (\$)	Outlet Liability Assessment (\$)	Total Assessment (\$)
1	-	505	505
2	-	8	8
3	-	177	177
4	-	-	-
5	-	-	-
6	-	-	-
7 (Branch A)	250	428	678
Total	250	1,118	1,368

The Total Maintenance Assessment for K. Palmer is \$1,368.

Table A15–12 provides a summary of the future maintenance assessments for all properties.

Table A15–12. Future Maintenance and Repair Table

		In Watershed		MAIN DRAIN			
				Interval 1 0+000 to 0+833 (Oley, 4 th Line & Lucky)			
TOTAL COST (\$) (G)				9,500			
Roll No. (12-58-010)	Owner	Total Affected (Ha)	Total Adjusted (Ha)	Benefit Assessment (\$)	Adjusted (Ha) (A)	Outlet Liability (\$ (B=A x F))	Total in Interval (\$)
-010-22900	J. Party	8.9	7.1	-	7.1	95	95
-010-23000	D. & D. Hatfield	36.5	35.3	-	35.3	473	473
-010-23100	J. & M. Jacks	6.1	4.0	-	4.0	54	54
-010-24300	R. Lucky	28.6	13.3	1,500	13.3	178	1,678
-010-24400	L. & A. Singh	15.6	15.6	-	15.6	209	209
-010-24500	A. Earp & J. Earp-Sons	15.6	14.0	-	14.0	188	188
-010-24700	K. Palmer	39.5	37.6	-	37.6	505	505
-010-24800	S. McCoy	32.4	32.2	-	32.2	431	431
-010-24900	H. & V. Robb & N. Shaw	1.4	0.4	-	0.4	5	5
-020-01400	V. & W. Oley	8.0	1.6	500	1.6	21	521
-020-01500	Crop Farms Inc.	11.0	2.2	150	2.2	29	179
-020-01600	Crop Farms Inc.	34.3	34.0	-	34.0	456	456
-020-01601	Crop Farms Inc.	6.0	12.0	-	12.0	161	161
-020-01800	Nano Farms Limited	40.1	40.1	-	40.1	538	538
-020-01801	J. Nano	0.4	0.6	-	0.6	8	8
-020-01900	Nano Farms Limited	38.0	38.0	-	38.0	509	509
-020-02000	K. & B. Smith	21.9	21.2	-	21.2	284	284
-020-02100	Oxbow Farms Ltd.	3.6	1.4	-	1.4	19	19
-020-03400	J. Wilson	18.0	18.0	-	18.0	241	241
-020-03500	J. Wilson	7.7	7.1	-	7.1	95	95
-020-03600	D. & P. McFee	16.9	11.3	-	11.3	152	152
-020-03700	Nano Farms Limited	40.5	40.5	-	40.5	544	544
-020-03800	Cash Farms Ltd.	39.4	35.9	-	35.9	481	481
-020-04000	J. & K. Oxbow	12.2	12.2	-	12.2	163	163
-020-05200	Okay Farms Ltd.	6.2	3.1	-	3.1	42	42
-020-05300	Cattle Farms Ltd.	13.0	10.4	-	10.4	139	139
-020-05400	D. Wolfman	4.5	1.5	-	1.5	20	20
Special Assessment TransOntario Pipeline		-	-	-	-	-	-
County Road 137 – County of South		3.4	6.8	-	6.8	91	91
3 rd Line – Twp of North		0.5	0.8	-	0.8	11	11
4 th Line – Twp of North		5.0	7.5	1,000	7.5	101	1,101
5 th Line – Twp of North		2.8	5.6	-	5.6	75	75
Oxbow Sideroad – Twp of North		1.6	2.4	-	2.4	32	32
TOTALS		519.6	473.7	3,150	473.7	6,350	9,500
TOTAL BENEFIT ASSESSMENT (C)		-	-	3,150	-	-	-
OUTLET LIABILITY (\$) (D = G- C)		-	-	6,350	-	-	-
Land in Interval (Ha) (E)		-	-	473.7	-	-	-
Outlet Liability Rate (\$/Ha) (F = D / E)		-	-	13.40	-	-	-

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 (4 th 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	-	-	-	-
3 rd Line – Twp of North		0.5	0.8	-	-	-	-
4 th Line – Twp of North		5.0	7.5	-	32	36	36
5 th 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 Li- ability (\$) (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
4 th 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
4 th 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					-
3 rd Line - Twp of North					0.5
4 th Line - Twp of North					5
Special Assessment to 4 th Line					-
5 th 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.

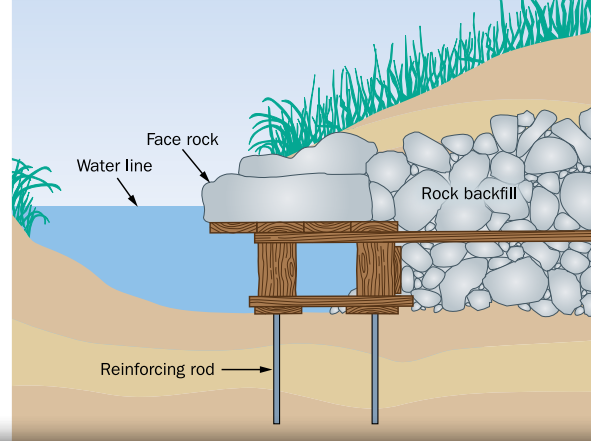
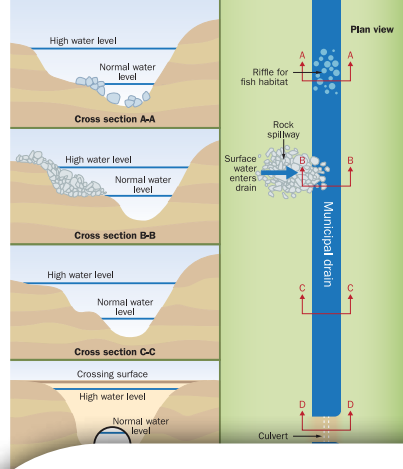
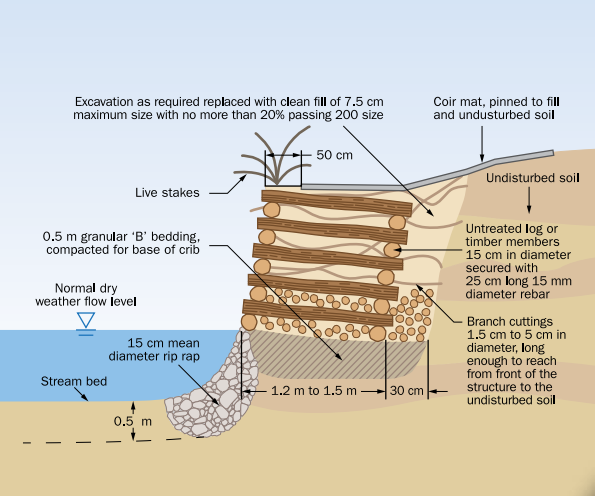
Table A15–15. Net Assessment Schedule for Construction

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
3 rd Line - Twp of North					533	-	-	533
4 th Line - Twp of North					10,536	-	-	10,536
Special Assessment to 4 th Line					45,690	-	-	45,690
5 th 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

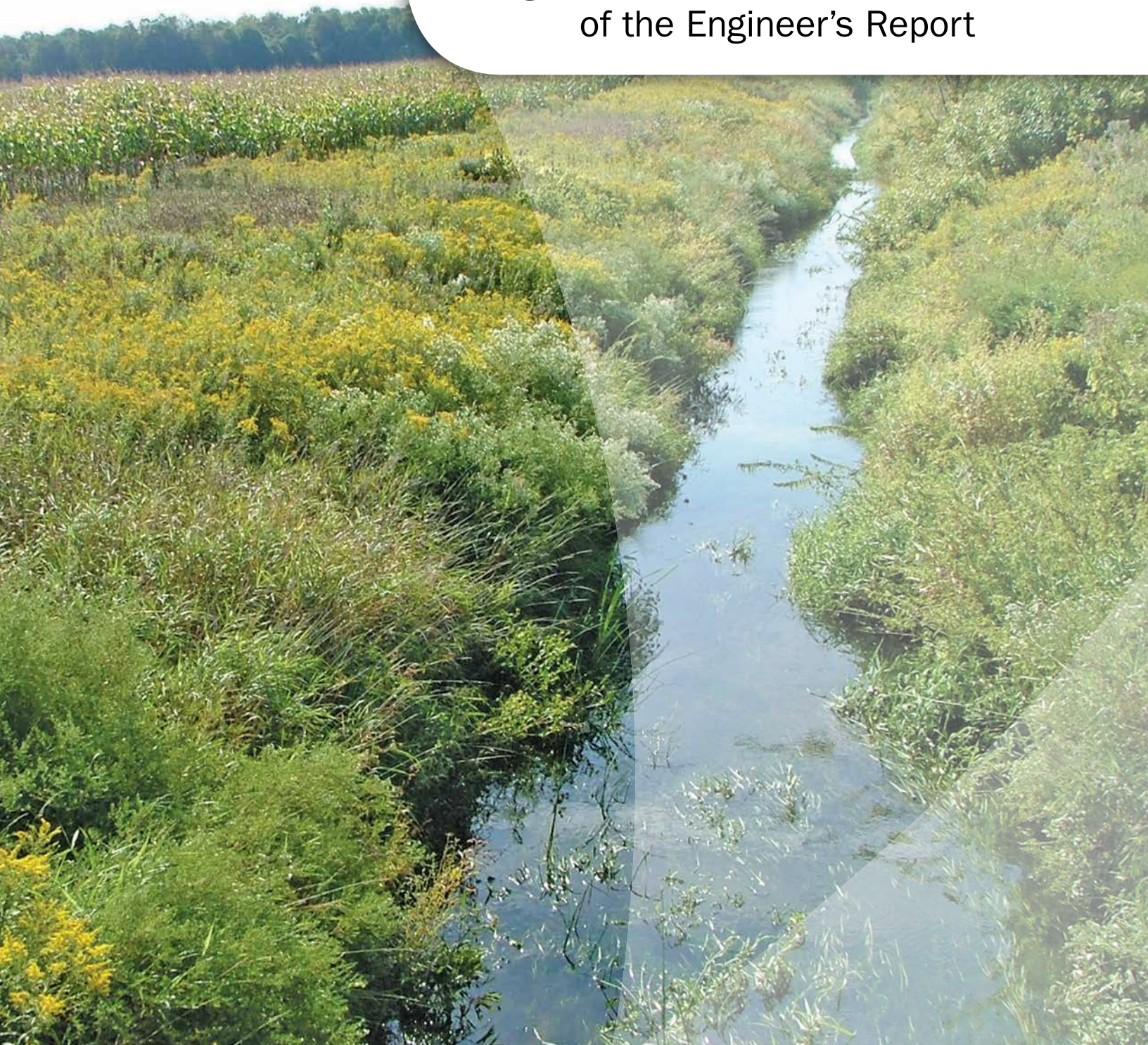
FPCTR (Yes / No)	Conc.	Lot	Roll No. (12-58-010)	Owner	MAIN DRAIN
					Interval 1 0+000 to 0+833 (Oley, 4 th Line & Lucky) (A)
Yes	3	Pt W½ 12	-010-22900	J. Party	95
Yes	3	W½ 13	-010-23000	D. & D. Hatfield	473
Yes	3	Pt SW¼	-010-23100	J. & M. Jacks	54
Yes	3	Pt 10	-010-24300	R. Lucky	1,678
Yes	3	SE¼ 11	-010-24400	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
3 rd Line - Twp of North					11
4 th Line - Twp of North					1,101
5 th 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 (4 th 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



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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).

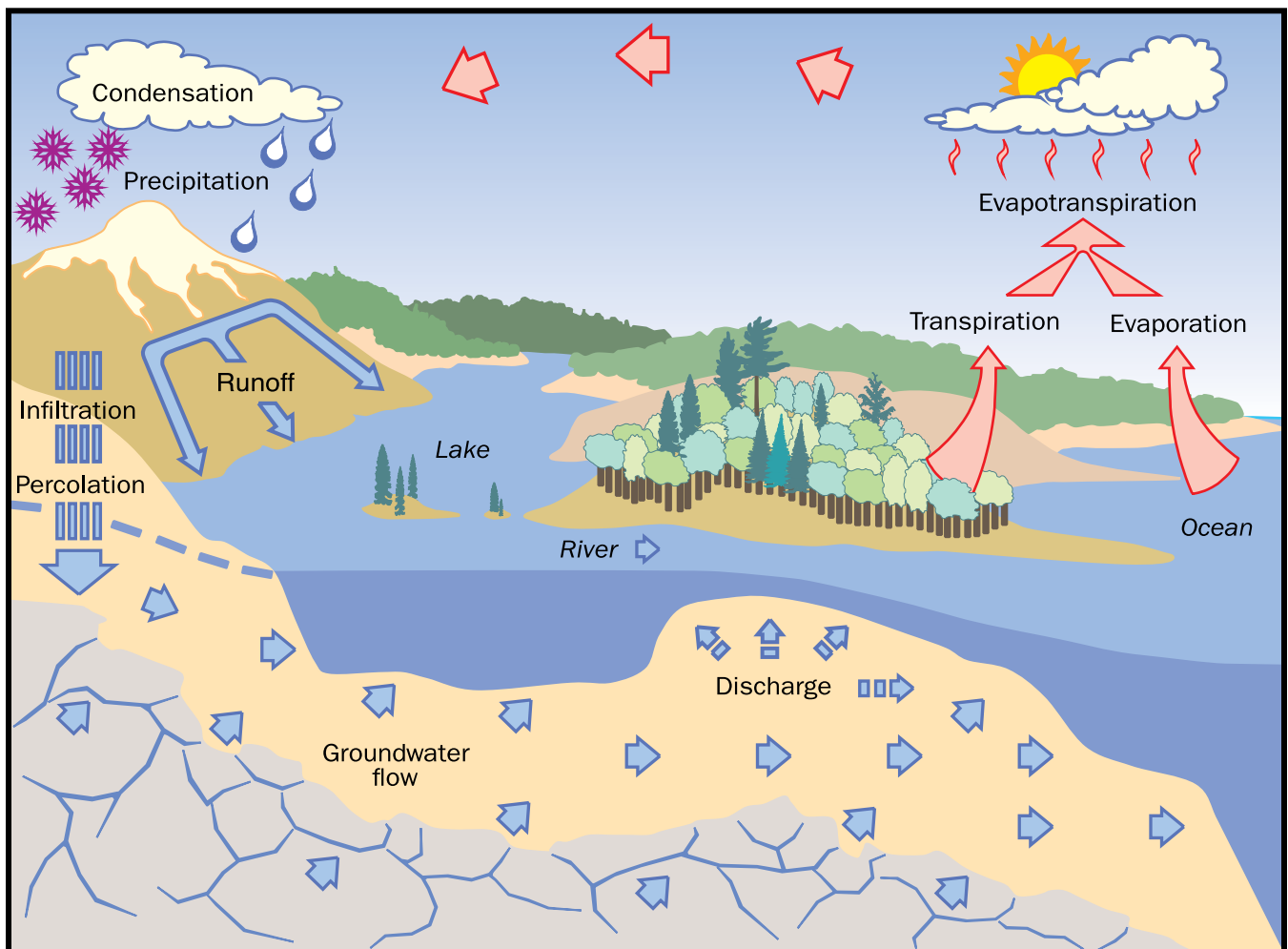


Figure B2–1. The water cycle — understanding groundwater.

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 km² (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 km² (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 km² (100 ha) and 100 km² (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).

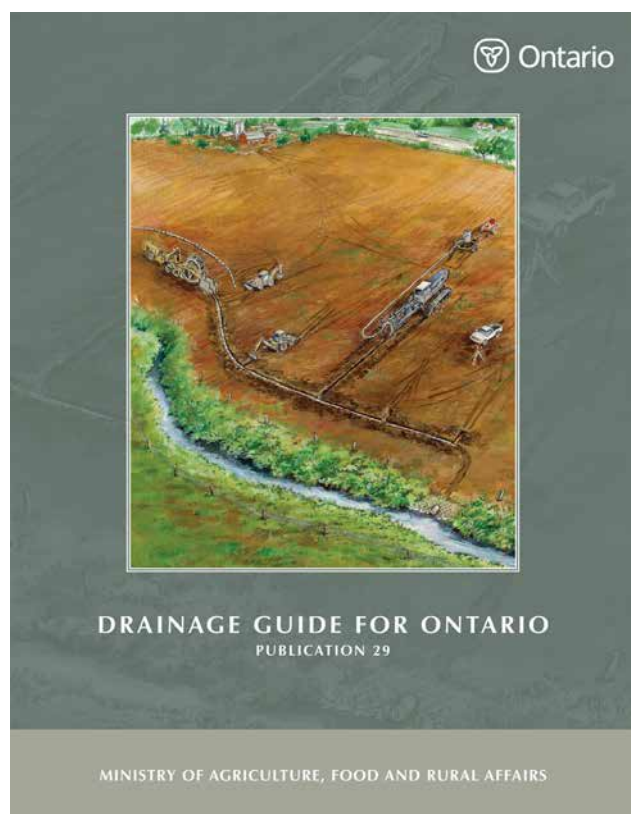


Figure B2–4. *Drainage Guide for Ontario*.

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 <i>Drainage Guide for Ontario</i> , 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.

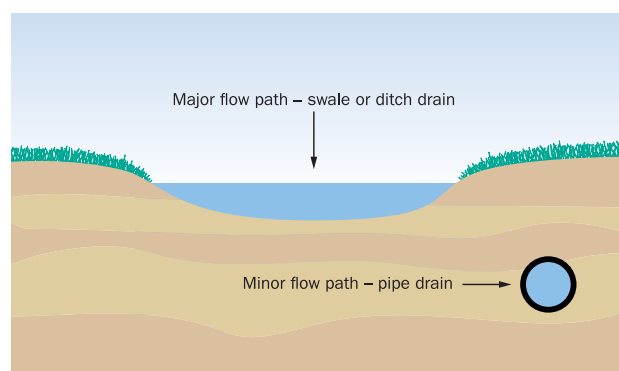
² May require an Environmental Compliance Approval from the MOECC.

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.

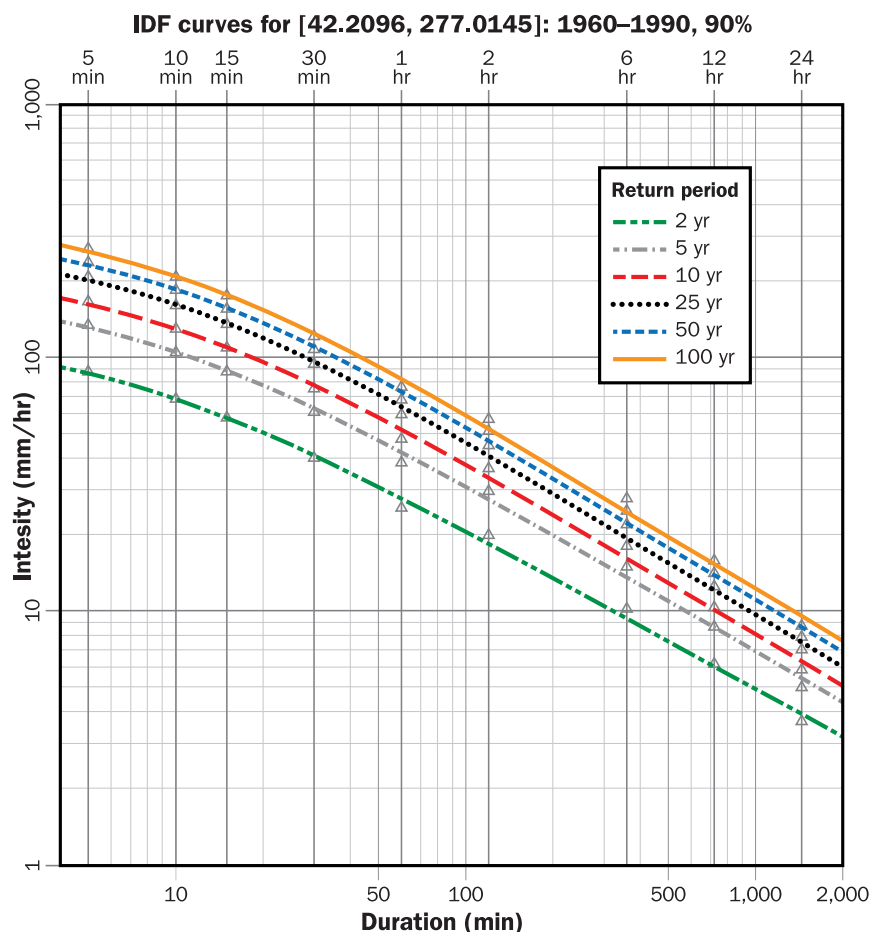


Figure B2–7. Example of an IDF curve.

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 (FHWA).
- 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, Ridgeway, 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.

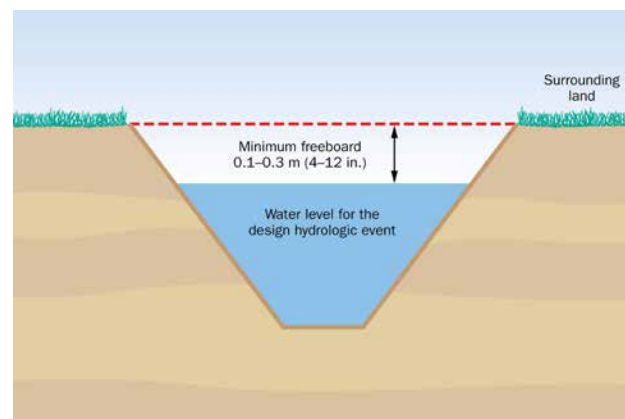


Figure B3–2. Channel freeboard.

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.

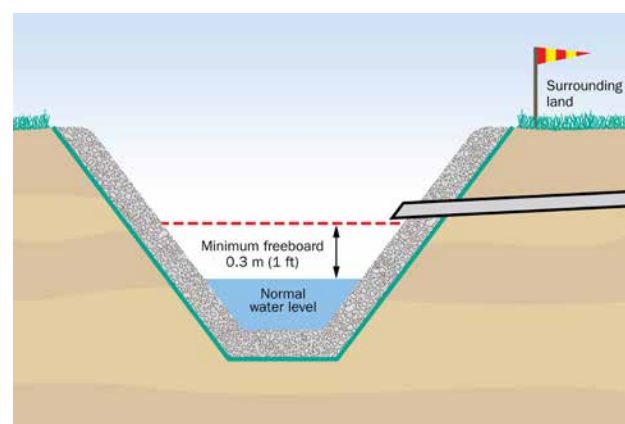


Figure B3–3. Piped drain freeboard.

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.

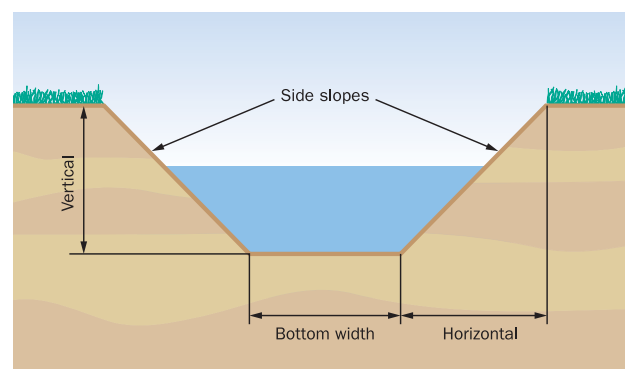


Figure B3–4. A channel showing side slopes and bottom width.

Table B3–3. Maximum Recommended Channel Side Slope Ratios

Soil Materials	Channel Depth <1.3 m	Channel Depth >1.3 m	Maximum Velocity m/s (ft/s)
	(vertical:horizontal)		
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.

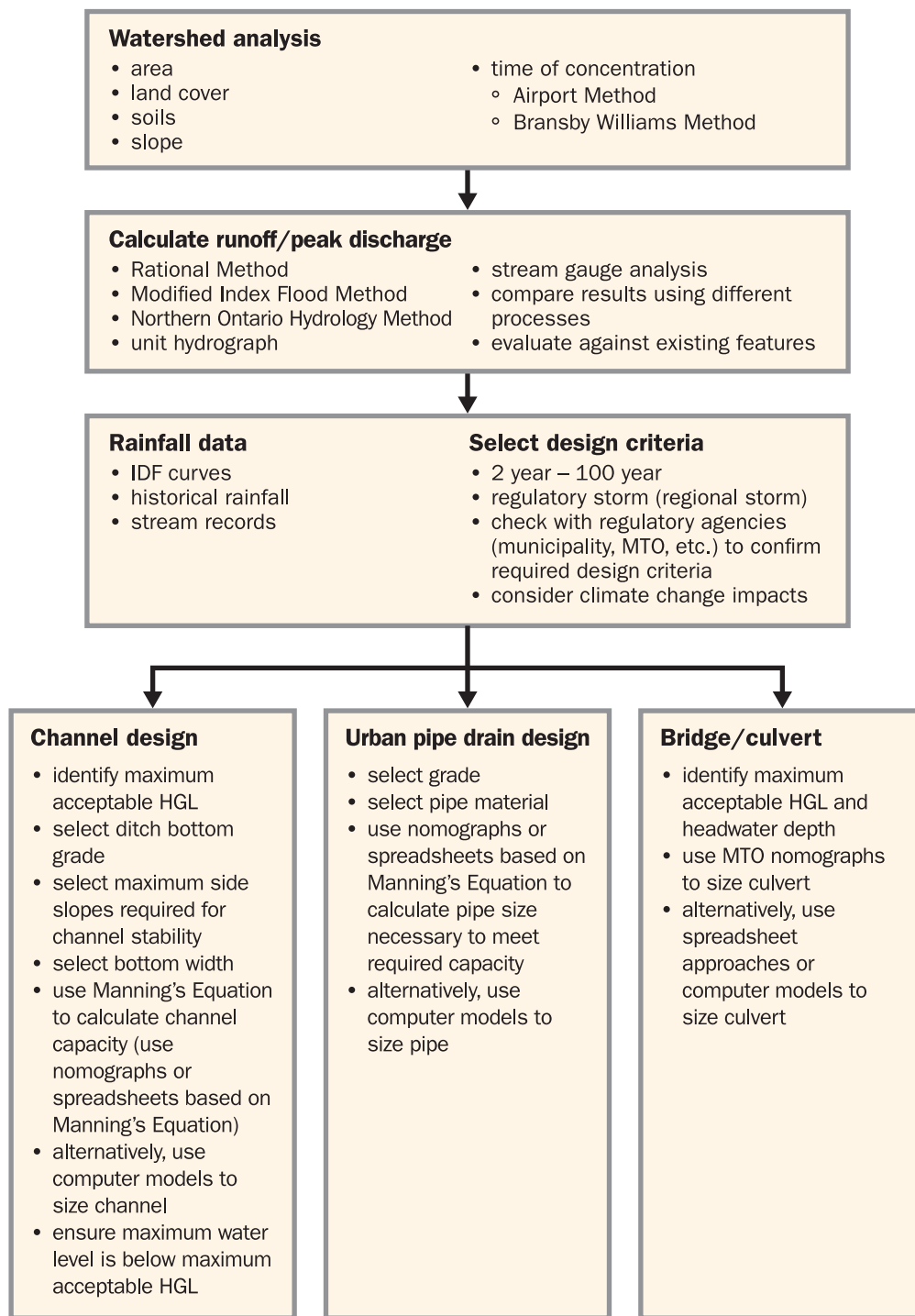


Figure B3–8. Recommended approach to hydrologic and hydraulic design of drainage works (excluding the drainage coefficient method).

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”).

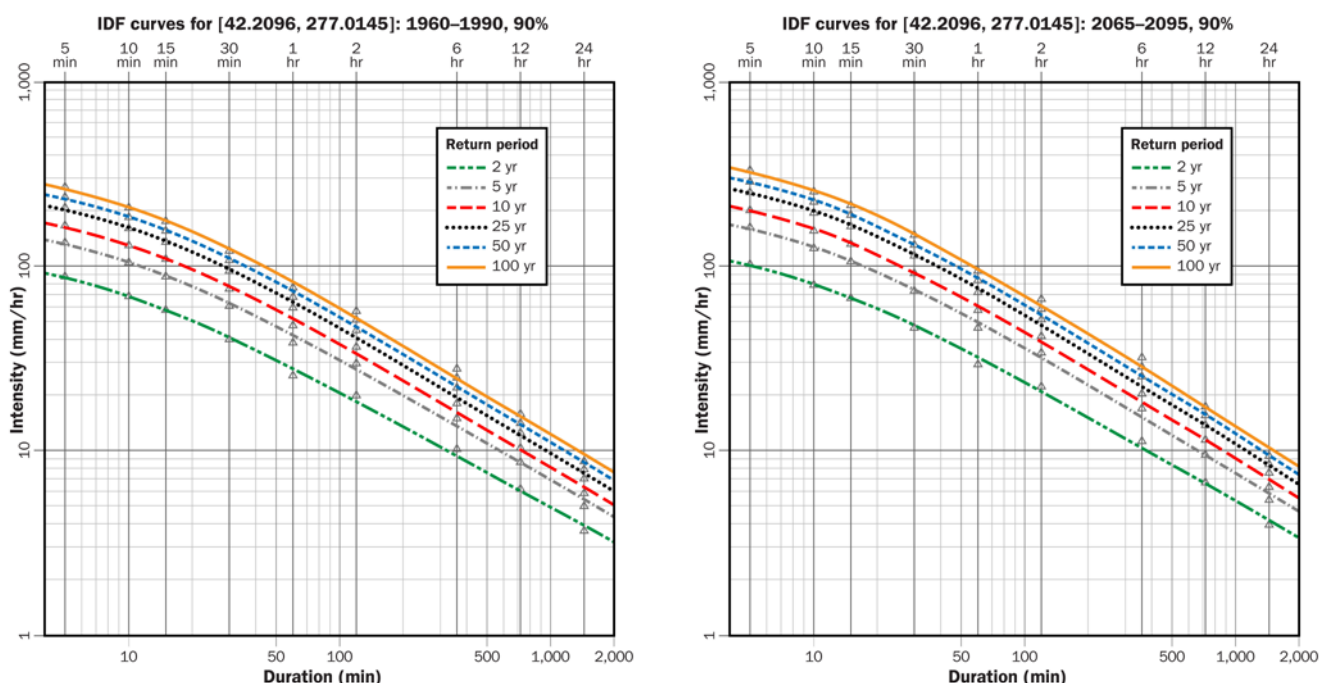


Figure B4–1. Current (1960–1990) and future (2065–2095) IDF curves for a specific 25 km x 25 km grid.

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.glsincities.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 Ministers 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 are 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.

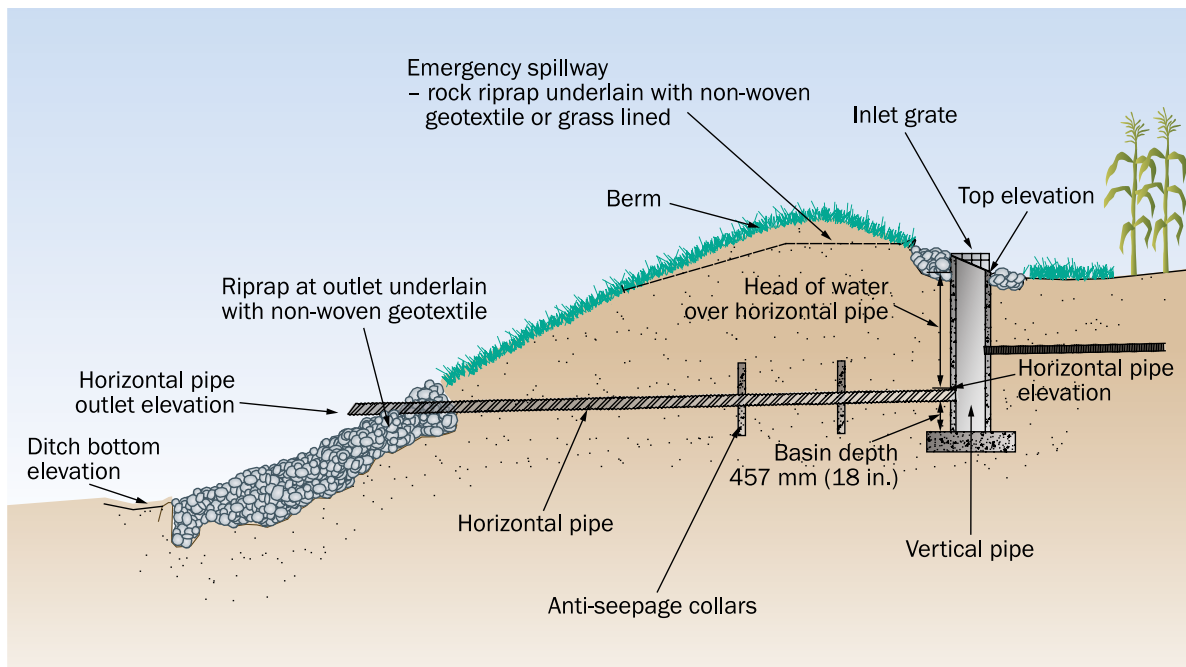


Figure B7-6. Drop inlet.

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.

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.



Figure B8-4. A water retention area.

Source: Maitland Valley Conservation Authority, Ontario.

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.

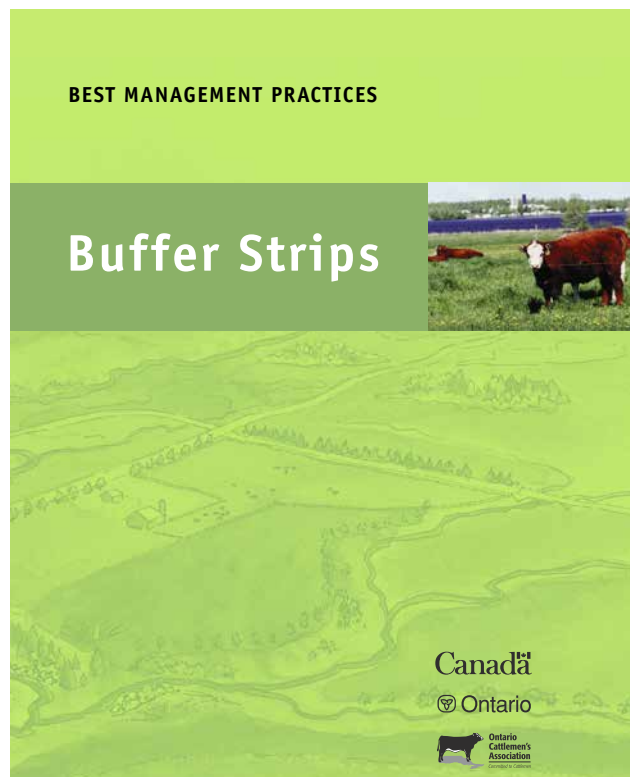


Figure B9–4. Best Management Practices: Buffer Strips, BMP 15, OMAFRA.

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.

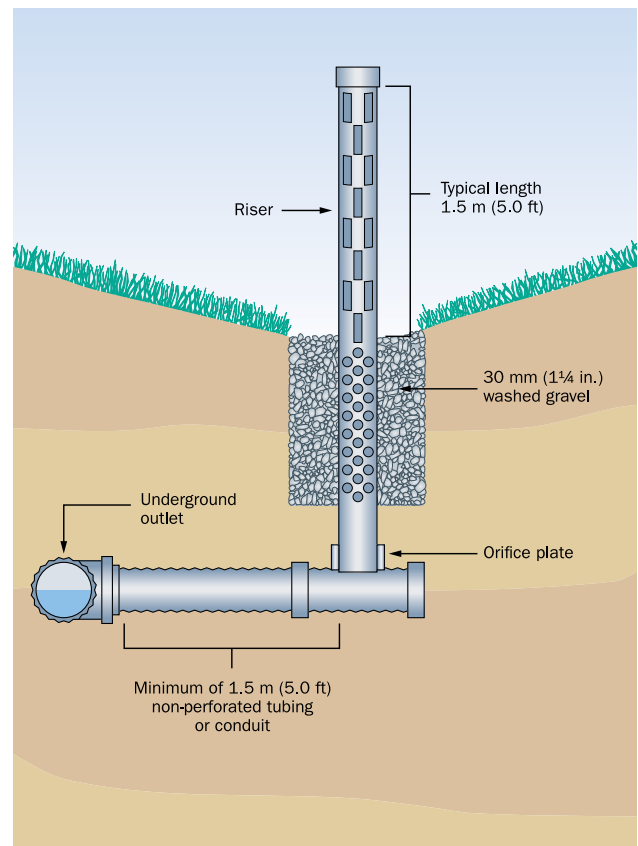


Figure B10–17. Offset riser inlet.

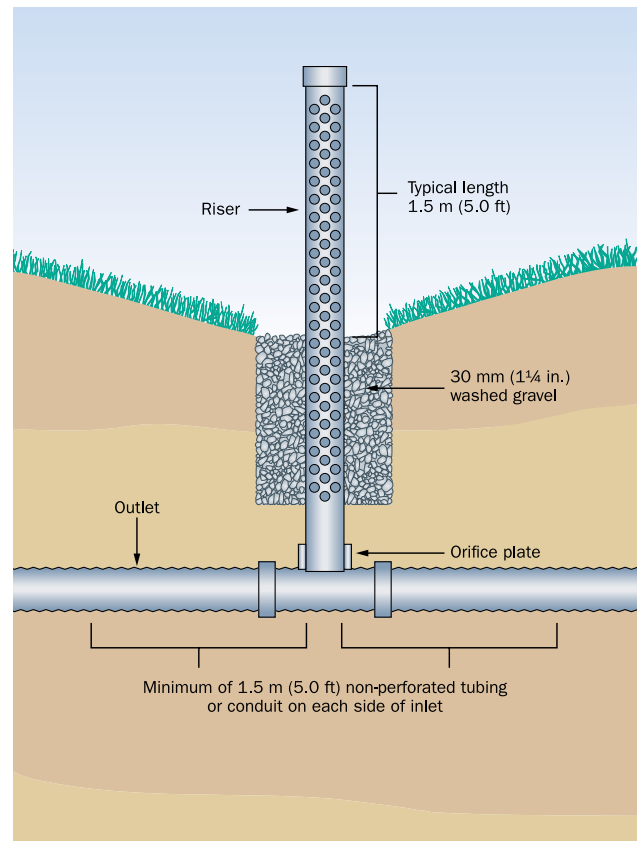


Figure B10–18. Online riser inlet.

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.

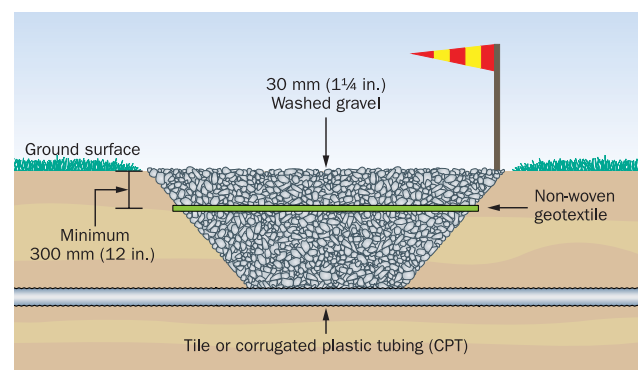


Figure B10–20. Side view of a blind inlet.



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.

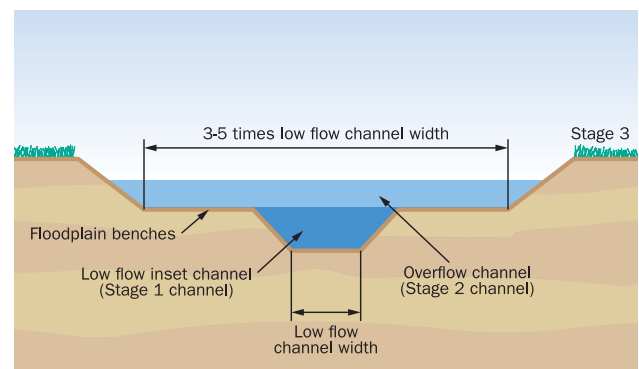


Figure B11–1. Cross-section of a two-stage channel.

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.

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.conservancyregistry.org search for “self-forming channel”)

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.

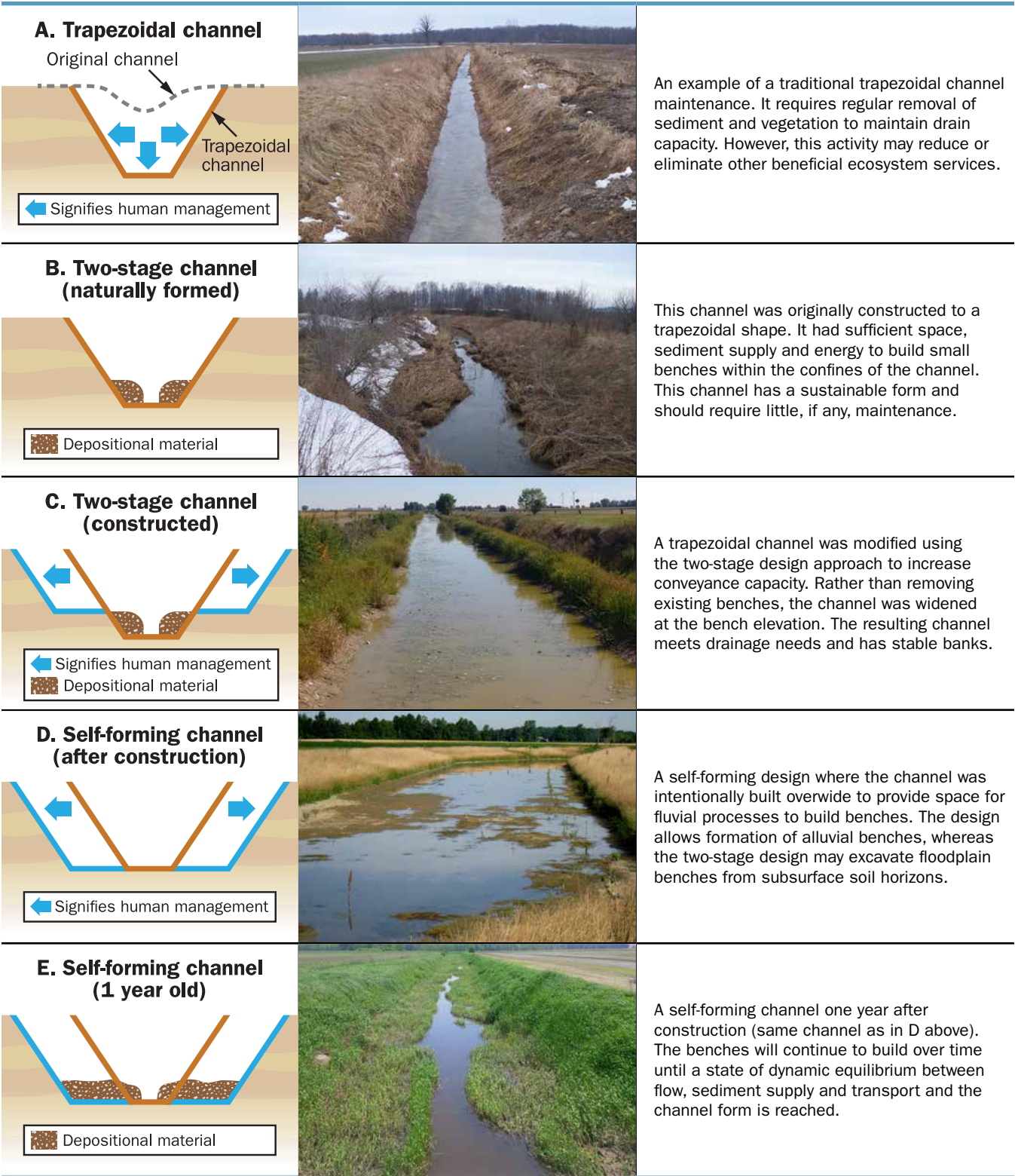


Figure B11–2. A comparison of channels.

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).

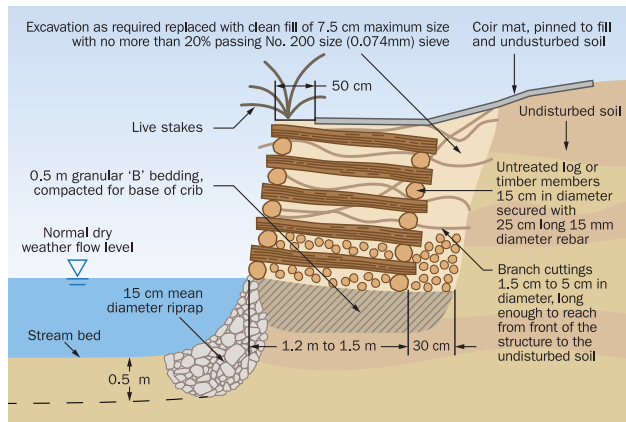


Figure B11-7. A live crib wall.

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 ovetop (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.

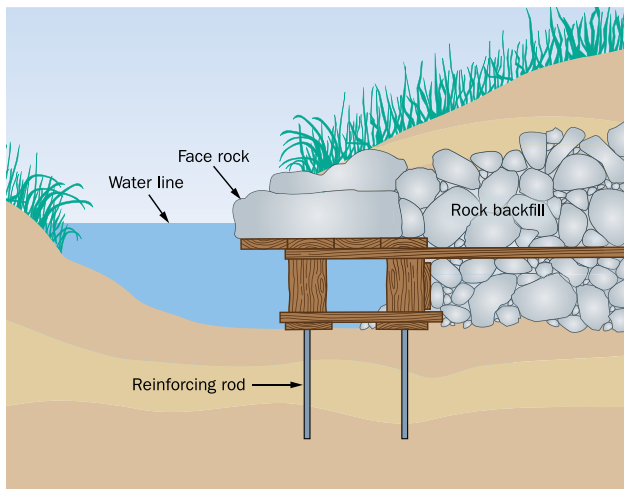


Figure B11–11. LUNKERS.

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.

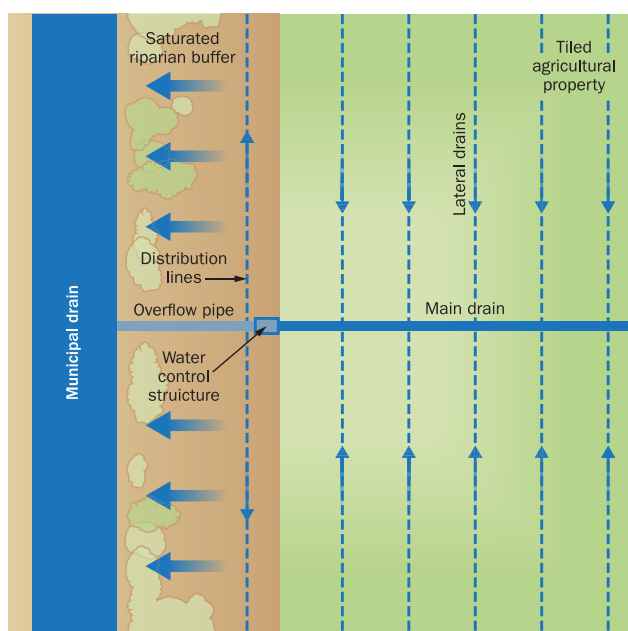


Figure B11-16. Water flow in a saturated riparian buffer.

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.

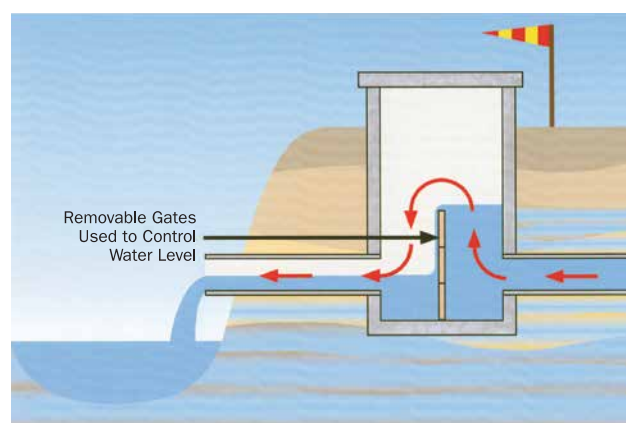


Figure B11-18. A side view of a controlled drainage structure.

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

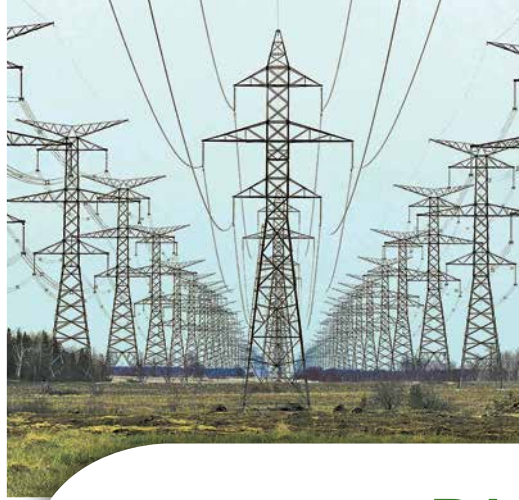
- Wetlands Protection and Restoration. United States Environmental Protection Agency (www.epa.gov/wetlands).
- *National Engineering Field Handbook*, Part 650, Chapter 13 Wetland Restoration, Enhancement, or Creation. United States Department of Agriculture. Natural Resources Conservation Service, April 2008 (www.nrcs.usda.gov).

Denitrifying Woodchip Bioreactors

- *Woodchip Bioreactors*. Purdue University, Indiana. (www.engineering.purdue.edu)

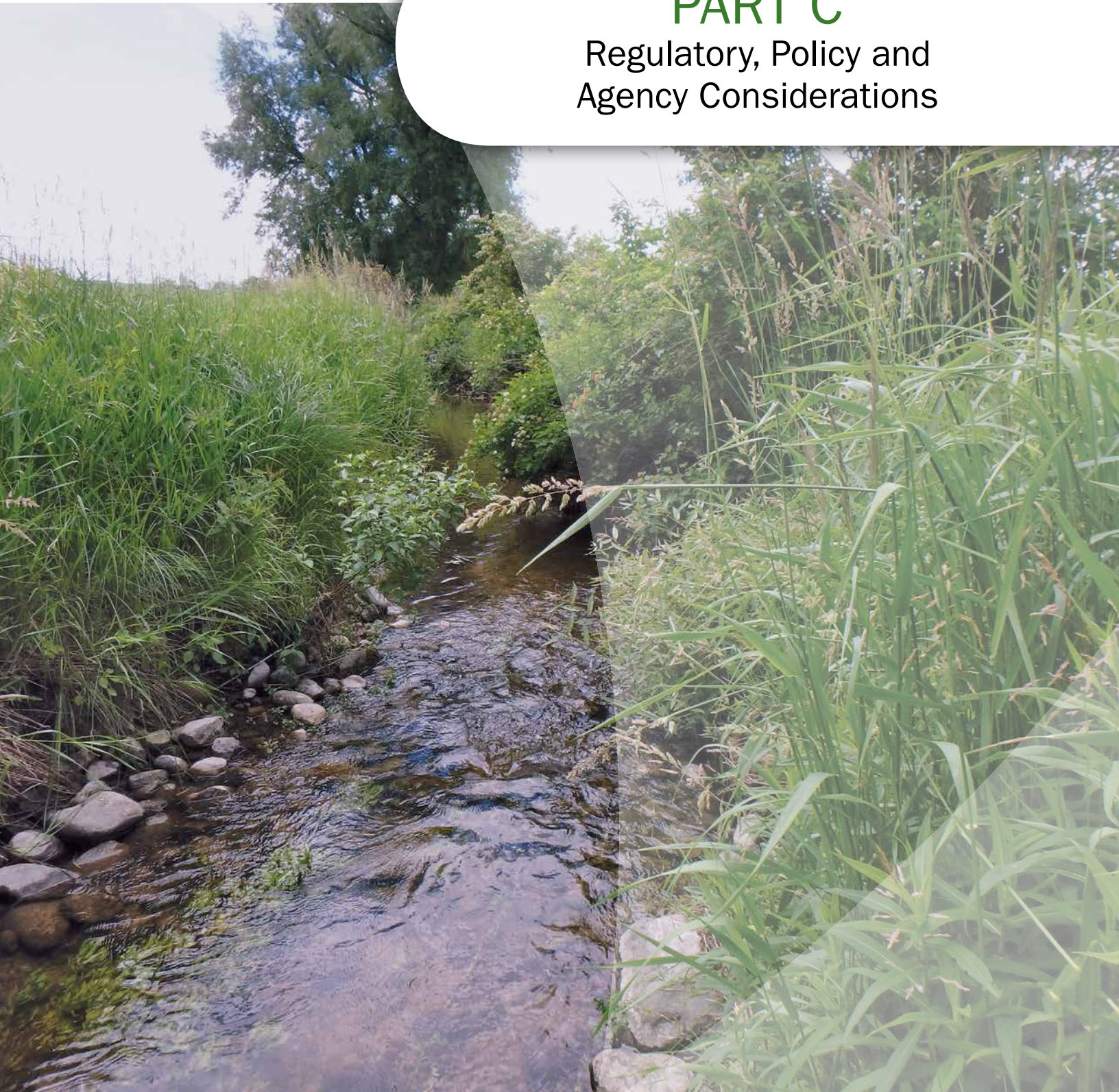
Low Impact Development

- *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



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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 <i>Drainage Act, 1990</i> (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. 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).

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.lanndrainageengineers.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 detriment 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

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).



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 m³/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 m³/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.





