Sustainable Technologies
EVALUATION PROGRAM

# Erosion and Sediment Control Guide

## For Urban Construction


Prepared by:
Toronto and Region Conservation Authority



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*The water component of STEP is a collaborative of:*

Lake Simcoe Region conservation authority

Credit Valley Conservation inspired by nature

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## THE SUSTAINABLE TECHNOLOGIES EVALUATION PROGRAM

The water component of the Sustainable Technologies Evaluation Program (STEP) is a partnership between Toronto and Region Conservation Authority (TRCA), Credit Valley Conservation and Lake Simcoe Region Conservation Authority. STEP supports broader implementation of sustainable technologies and practices within a Canadian context by:

- Carrying out research, monitoring and evaluation of clean water and low carbon technologies;
- Assessing technology implementation barriers and opportunities;
- Developing supporting tools, guidelines and policies;
- Delivering education and training programs;
- Advocating for effective sustainable technologies; and
- Collaborating with academic and industry partners through our Living Labs and other initiatives.

Technologies evaluated under STEP are not limited to physical devices or products; they may also include preventative measures, implementation protocols, alternative urban site designs, and other innovative practices that help create more sustainable and liveable communities.

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# 1.0 INTRODUCTION

Change is inherent to the land development process; the removal of vegetation, stripping of topsoil and alterations to topography and drainage patterns are common practices during the construction of infrastructure like buildings, roads, bridges and sewers. Without careful planning and oversight focused on minimizing these changes and mitigating their impacts, construction projects can have adverse impacts on adjacent and downstream natural features and other private property.

The release of sediment laden runoff and dust from construction sites can have a range of adverse impacts, including but not limited to the following:

- Excessive levels of deposited and suspended sediment in lakes, rivers and wetlands decreases the productive capacity of aquatic habitats and increases the frequency of dredging in reservoirs.
- Sediment deposited on gravel stream beds compromises spawning and alters the habitat of bottom-dwelling organisms and young fish.
- Elevated concentrations of suspended sediments in natural water features can cause abrasion of gills, a reduction in visibility required for breeding and feeding, and decreased sunlight penetration, which inhibits photosynthesis by algae and aquatic plants.
- Sediment can also carry other contaminants into receiving waters, including heavy metals and nutrients, which tend to bind to these particles.
- Vehicle tracking of sediment offsite results in sediment laden roads, and increased sediment loads to the storm sewer system and ultimately, to the receiving waters to which they discharge.
- Wind blown dust from construction sites can impair air quality and become deposited onto adjacent areas, including natural features, roads, residences and other private property.

Erosion and sediment controls (ESC) are technologies, practices and procedures that are applied to prevent the release of sediment from construction sites. They may include installed structural measures, like sediment control ponds and erosion control blankets, or improved design practices, like phased land stripping and riparian zone preservation.

As many previously rural municipalities in Ontario undergo rapid urbanization and growth, the adoption of effective and innovative approaches to ESC is of paramount importance. Moving forward, the application of effective ESC measures that are properly installed, inspected and maintained will be essential to mitigating sediment discharge from construction sites and protecting our natural features.

## 2.0 OBJECTIVES

The practice of erosion and sediment control in Ontario has progressed in significant ways since the release of the 2006 *Greater Golden Horseshoe Area Conservation Authorities Erosion and Sediment Control Guideline for Urban Construction.* As awareness of the importance of mitigating construction related environmental impacts has also continued to grow there have been many significant and fundamental changes in our knowledge and understanding of ESC best practices. Some of the more significant changes include:

- Expanded availability of ESC training programs and greater numbers of professionals engaging in training;
- Introduction of new policies to ensure protection of species at risk;
- Introduction of new legislation and changes to existing acts and regulations;
- Emergence of new ESC products and techniques;
- Improved understanding related to the application of ESC products for optimal effectiveness; and
- Recognition of the limitations of some older and more conventional ESC approaches.

The overarching objective of this document is to provide ESC practitioners, developers and regulatory agencies with up-to-date, relevant, clear and practical guidance on the effective application of erosion and sediment control measures. Specific objectives include:

- Define key terms and concepts necessary for understanding the science of erosion, sediment transport and sedimentation
- Define quantitative and qualitative erosion risk assessment methods and how risk assessment outcomes can aid in the selection of best management practices
- Detail strategies for effective application of ESC through all stages, including plan design, installation, inspections, maintenance, and decommissioning
- Clarify ESC plan submission requirements and approvals processes
- Clarify the roles and responsibilities of all parties involved in ESC
- Outline expectations for ESC inspections and performance monitoring on construction sites, including turbidity targets for receiving water systems and construction effluent
- Provide updated guidance on best management practices for erosion prevention, erosion control, sediment control, and isolation during in- or near-water works
- Provide a summary of relevant legislation and describe how they govern construction activities related to ESC

# 3.0 APPLICATION

This guide supersedes information provided in the 2006 *GGHA Conservation Authorities ESC Guide for Urban Construction*. While its intended application is for the control of erosion and sediment release from urban construction projects in Ontario, many of the best practices described herein can be applicable to other types of projects where ESC is required.

Who should use and become familiar with this document?

- Any ESC practitioners, including consulting engineers involved in ESC planning, contractors and inspectors / environmental monitors
- Regulatory agency personnel involved in the review of ESC plans or those who issue other construction related authorizations / approvals. This includes representatives from relevant federal and provincial ministries, municipalities and conservation authorities.
- Individuals / groups who develop land or manage the development of land on behalf of land owners
- Manufacturers, suppliers and distributors of ESC products
- Other interested parties, including environmental conservation groups and academics

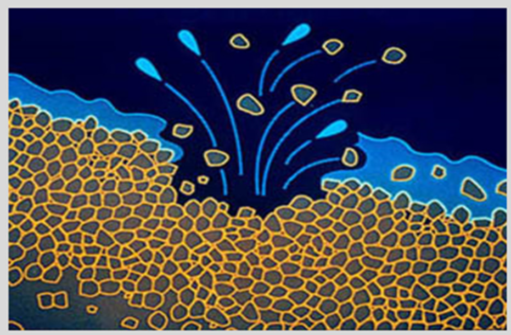
# 4.0 THE BASICS: EROSION, SEDIMENT TRANSPORT AND SEDIMENTATION

## 4.1 Understanding erosion

Erosion is the process by which a material becomes dislodged and worn away due to the force of an erosive agent. Land erosion is often caused by mobile agents such as water (e.g. stormwater) and wind. Natural erosion rates are accelerated by land use activities that leave soils exposed, like agriculture and land development. As erosion is accelerated, soil particles – often referred to as sediment - are suspended and carried away by rain water, flowing into receiving water bodies like streams and wetlands.

### TYPES OF EROSION

***Splash erosion*** is caused by the impact of raindrops on the land surface. This is the first step towards more extensive erosion as it impacts the surface soil structure and leads to reduced infiltration and increased surface runoff.



***Sheet erosion*** occurs when the soil erodes in a thin, uniform sheet or layer. Water moves in broad sheets over the soil surface rather than concentrating in small depressions, as it does during rill erosion.

***Rill erosion*** *occurs* when water running over the soil surface concentrates in small depressions and erodes the soil to form small channels (< 30 cm deep) known as rills.

***Gully erosion*** is a more advanced and extensive form of erosion. It occurs when rill erosion progresses, causing the rills to increase in size (> 30 cm deep) and become gullies.

***Gravitational erosion*** refers to the mass movement of soil downslope due to the force of gravity. Steep and/or unstable slopes are the most susceptible, particularly when saturated with rainfall. It may be a slow process, often referred to as creep, or occur quickly as in the case of mudslides and avalanches.

***Channel erosion*** occurs when the banks and/or bed of an existing natural or constructed channel is eroded by water flowing within it. While channel erosion is a natural process, it may be accelerated during land development due to increased flow rates, alterations to flow regimes, and scour from increased sediment loads.

***Wind erosion*** occurs when wind carries soil particles away from the land surface. This results in air pollution as well as the transport and deposition of sediment into other unintended areas.

**Figure 4.1:** Rill (left) and gully (centre and right) erosion on construction sites.

The potential for soil erosion is influenced by several factors, including:

- **Rainfall characteristics** | Droplet size, intensity, frequency, duration
- **Climate** | Soil temperatures, types of native vegetation, time of year
- **Soil erodibility** | Soil texture, structure, permeability, organic matter content
- **Topography** | Slope length and steepness
- **Ground cover** | Type and quality/areal density of cover

## 4.2 Understanding suspended sediment and sedimentation

Eroded soil particles – often referred to as sediments - are suspended and carried away by rain water until they have an opportunity to settle out, which occurs when the energy in the flowing water dissipates. While larger, heavier suspended sediment particles can settle out readily when the water slows, the finer, lighter particles can remain suspended for much longer. These fine particles may only settle after a significant detention period or with the aid of sediment controls (discussed in the next section).

The process by which suspended sediment settles out and becomes deposited on a surface is referred to as sedimentation. Sedimentation that occurs in undesirable locations, such as watercourses and wetlands, is one of the primary risks associated with construction projects. Sedimentation can also occur in intended areas, like within sediment control measures (e.g. detention ponds, sediment filter bags) within the construction site.

**Figure 4.2:** Unintended sediment deposition in natural areas.

## 4.3 The impacts of construction activities

When land is developed, existing vegetation is removed, topsoil is stripped, and natural drainage patterns are altered to facilitate the earth moving and grading activities necessary to construct buildings and infrastructure like roads and sewers. On many construction projects, which can be years long, most of these stripped areas remain bare until final site stabilization, which often only occurs near the end of the project.

Without the stabilizing effect of vegetation, erosion rates are accelerated, resulting in sediment laden stormwater runoff flowing into natural features like woodlots, streams and wetlands. Monitoring in the Greater Toronto Area shows that total suspended solid (TSS) concentrations in untreated runoff from construction sites can be up to 30 times greater than that of stabilized residential areas (SWAMP, 2005; TRCA and U of G, 2006; TRCA 2006). One study conducted at a construction site draining to Millers Creek in Ajax revealed that, based on in-stream monitoring of TSS concentrations during 9 rainfall events, the average event mean TSS concentration downstream of the construction site was 5 times higher than upstream. For events monitored, the downstream sediment concentrations ranged from 53 to 2290 mg/L. The observed increase in stream TSS levels from upstream to downstream occurred even though runoff volumes from the construction site comprised less than 25% of total stream flow and the planned erosion and sediment controls had been implemented on the site (Greenland International and TRCA, 2001).

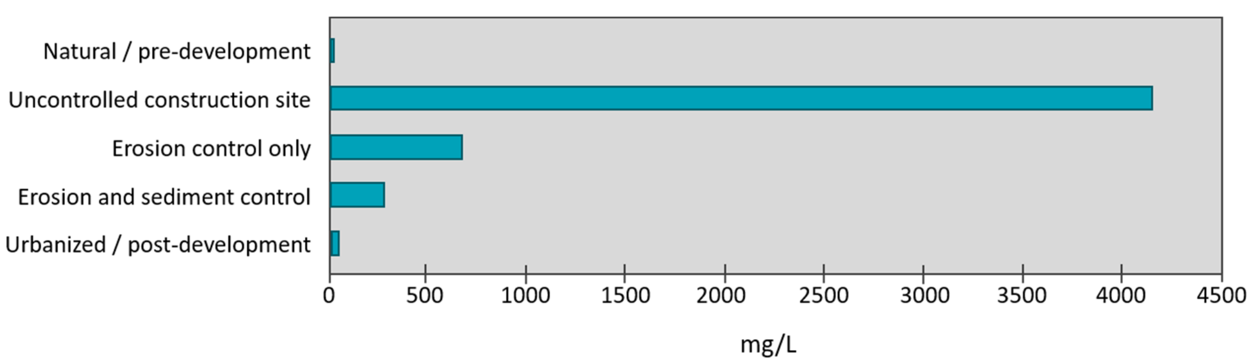



**Figure 4.3:** Stormwater sediment concentrations. Modified from: California Regional Water Quality Control Board Erosion and Sediment Control Field Manual (1999).

Sediment laden water may be released from a construction site through an intended discharge location (e.g. sediment control pond outfall) when controls on the site are insufficient, or it can sometimes occur elsewhere along the site perimeter where there is a failure of the controls in place (e.g. slope failure, breach of silt fencing). Inadequate vehicle tracking controls can also result in sediment transport offsite and deposition onto public roads. When this sediment is released to a natural water body like a stream, lake or wetland, it will increase the turbidity of the water and/or settle out of suspension and become deposited on the bed. Both outcomes can harm aquatic ecosystems, as many studies have documented (e.g. Waters, 1995; Newcombe and MacDonald, 1991; Robertson et al., 2006).

In addition to accelerated erosion rates and elevated suspended sediment levels in runoff, grading and earth moving activities cause changes to the local water balance, resulting in altered hydrological regimes for the water features to which the site drains. The regime may be altered in a variety of ways, including: (i) runoff volumes discharged to water features may increase or decrease, (ii) flow velocities may change, and (iii) the timing and duration of inflows may shift.

These construction impacts - soil erosion, increased sediment transport offsite, and altered receiving water hydrological regimes - can have significant negative effects on the surrounding environment as well as the success and profitability of the project itself. Consequences to the project may include:

- Unanticipated expenditures related to restoration of impacted natural features and/or clean up of sediment deposited on offsite infrastructure (e.g. roads, catchbasins, sewers);
- Delays related to the additional repair/restoration work as well as stop work orders that may be issued by regulatory bodies;
- Local community groups vocalizing concerns over wind blown dust from site and muddy infrastructure;
- Legal repercussions associated with violation of permits/approvals, including fines and delays to project progress; and
- Tarnished reputations for proponents or other project team members responsible for violations of permits/approvals that result in environmental impacts.

A summary of legislation relevant to ESC and the overall mitigation of construction sediment releases is provided in Appendix D. The potential environmental impacts associated with failing to provide and maintain appropriate ESC measures during construction are described in the following subsections.

### *4.3.1 Impacts to aquatic community health*

Suspended sediment

When sediment levels are elevated above naturally occurring levels in a receiving water system, there are several direct and indirect effects to the fish, invertebrates and aquatic plants inhabiting the area. High levels of suspended sediment result can result in:

- clogging and damage of the gill apparatus
- behavioral changes (e.g. movement, migration, defense of territories, dominance hierarchies)
- higher vulnerability to toxins, infection and disease, and
- reduced feeding (Singleton, 1985).

As suspended sediment concentrations are elevated above natural levels, fish growth is impaired in several ways. For example, reduced visibility makes it harder for fish to find and secure food. Sigler et al. (1984) observed that the feeding behavior of Oncorhynchus mykiss (steelhead trout) and Oncorhynchus kisutch (coho salmon) was affected, and growth significantly impaired, during laboratory simulation of elevated turbidity levels using clays, kaolinite and bentonite. Fish were also observed to engage in avoidance behavior during this study, migrating away from experimental channels where turbidity was elevated.

With respect to aquatic invertebrate communities, suspended sediments can cause impairments by scouring streambeds, dislodging organisms, abrading respiratory surfaces, and compromising feeding in filter-feeding invertebrates (Singleton, 1985). In a review of research on the effects of suspended sediment on aquatic organisms, Newcombe and MacDonald (1991) concluded that invertebrates are at least as sensitive to elevated suspended sediment levels as salmonid fishes.

When total suspended solids (TSS) concentrations are increased above the natural regime, aquatic plants are also impacted, creating a domino effect and altering community composition in the ecosystem. Suspended sediment particles can reduce the amount of sunlight that reaches aquatic plants, thereby inhibiting photosynthesis. More direct physical effects are also possible, like scouring of periphyton.

<u>Deposited sediment</u>

An increase in the deposition of sediment in natural water features, often associated with upstream land use changes, can impact the health of aquatic organisms in several ways, including:

- coating of fish eggs;
- alteration of substrate;
- smothering of invertebrates; and
- burial of aquatic vegetation.

**Figure 4.4:** Stream bed substrate

When sediment settles out onto the substrate of a natural water body, it can compromise habitat by reducing substrate composition and permeability. As interstitial voids in the substrate are filled with fine sediment, fish may use avoidance behaviours and leave their spawning beds. Further, because the survival of fish eggs depends on adequate oxygen availability and the removal of waste, the substrate must allow unimpeded flow of oxygenated water to the eggs – a process which is compromised when sediment deposits on the substrate and/or the eggs themselves. Fish eggs are particularly susceptible since they cannot swim to avoid sediment laden areas (Anderson et al. 1996). The survival of young fish that do hatch can also be compromised as deposited sediment reduces intragravel dissolved oxygen levels (Shumway and Warren 1964; McNeil 1966; Garside 1959; Silver et al. 1963).

Due to their small size and bottom dwelling nature, benthic macroinvertebrates are vulnerable to harm by smothering when sediment settles onto substrates. Deposition also compromises their microhabitat, and because they are relatively immobile relative to fish, they are less likely to migrate to avoid unfavourable conditions. Periphyton are similarly at risk of experiencing smothering and loss of habitat (e.g. stable substrates for attachment) from increased loads of deposited sediment (Nutall, 1972).

The settling of sediment in natural water features can also result in aquatic plant loss due to burial. As tolerance of sediment accumulation can vary among plant species, ongoing sediment deposition can over time lead to shifts in the pre-existing species composition (Terrados et al., 1998), which can have ripple effects on other organisms by causing changes in trophic interactions.

### 4.3.2 Water quality degradation

Elevated TSS also adversely affects water quality, as nutrients and metal compounds are bound to sediment particles being eroded into receiving water bodies. Increased nutrient loads to receiving water systems can result in eutrophication, excess algal growth and ultimately depleted oxygen levels. Some types of algae are also a human health concern (e.g. blue-green algae), as they cause the release of toxins that lead to restrictions on swimming and the consumption of fish. In drinking water treatment, excess algae and bacteria are one of the primary causes of odor and taste problems. Addressing water quality issues associated with elevated levels of sediment and associated contaminants increases the water treatment costs borne by municipalities.

### 4.3.3 Alterations to hydrological regime and geomorphology

Changes to the landscape associated with construction practices frequently results in increased runoff volumes and peak flow rates. These increases can result in significant alteration to the form and function of receiving water systems (Figure 4.5). Increases in flow rate and duration result in greater potential for stream erosion, which alters channel morphology, destabilizes banks, and increases the risk to public and private property due to flooding and flood damages. Sediment deposited in receiving water bodies can also create a sediment imbalance, resulting in altered flow patterns and conveyance capacities, which can impact the conveyance of flood flows and compromise recreational use and navigability.

**Figure 4.5:** Stream bank erosion.

## 4.4 What is Erosion and Sediment Control?

Erosion control practices ***prevent exposed soils from being entrained by a mobile agent*** such as stormwater or wind, while sediment controls address the ***removal of sediment suspended in stormwater***. Practices that reduce erosion rates include strategies to minimize the amount of land cleared, diversion of flows around high erosion risk areas, and the application of ground covers that stabilize soil and/or provide a physical barrier to soil particle detachment.

While erosion control is preventive in nature, as it is focused on keeping soil in place, sediment control measures are reactive in nature and meant to remove sediment that has already become suspended in stormwater. A ***multi-barrier approach*** to erosion and sediment control requires the application of both types of controls in series, to create a resilient system capable of protecting the natural environment from sediment impacts. This approach is defined in Chapter 7.0.

**Figure 4.6:** Erosion control blanket (left) and filter socks applied as sediment control check dams (right).

Sediment removal can be achieved in a variety of ways, but controls are generally focused on settling, filtration, or a combination of the two. Settling controls promote gravitational settling of suspended sediment by detaining stormwater and reducing flow velocities. They may be applied to treat concentrated flows (e.g. check dams) or sheet flows (e.g. sediment fence) and are often applied in conveyance systems (e.g. interceptor swales), at the site perimeter, or anywhere it is necessary to separate a significant sediment source from a protected receiver. Filtration controls are porous materials (e.g. geotextile fabric used for sediment bags) which hold back sediment from stormwater that passes through them, with the filter's apparent opening size dictating the size of particles it can filter out. Because filtration controls also reduce flow velocities, they can serve as settling controls as well. Table 4.1 provides a list of common erosion and sediment control best management practices (BMPs). Detailed guidance on the application of each of these BMPs is provided in Appendix B.

In-water isolation measures, also listed in Table 4.1, are often listed as a third category of practices that control the migration of sediment. This umbrella term encompasses structural sediment barriers – like turbidity curtains – but also includes broader isolation techniques like watercourse diversions and bypass pumping. Practices in this category are employed to achieve the following objectives:

(i) Isolate in-water or near water construction areas so that sediment generated in the work area is not released directly into the water flowing in the natural feature.
(ii) Minimize disruption and ecological risk to the natural feature.
(iii) Treat sediment laden water in a location away from the work area – using sediment control strategies like settling and filtration - to render the water suitable for release into the feature.

**Table 4.1** Erosion controls, sediment controls, and in-stream

| Erosion Controls (Appendix B1) | Sediment Controls (Appendix B2) | In-water controls (Appendix C) |
|---|---|---|
| Minimized or phased land clearing | Sediment control fence | Horizontal Directional Drilling |
| Vegetated filter strips | Filter socks | Sediment / Turbidity Curtains |
| Slope drains | Natural fibre logs and wattles | Temporary Stream Crossings via Temporary bridge or Culvert(s) |
| Interceptor swales | Rock check dams | Waterproof isolation barriers (e.g. cofferdams) |
| Outlet protection | Vehicle tracking controls | Diversion / bypass channel |
| Mulching | Sediment (dewatering) bags | Flume bypass |
| Seeding | Storm drain inlet protection | Bypass pumping |
| Surface roughening | Sediment traps | Dewatering |
| Rolled erosion control products | Sediment control ponds | |
| Chemical soil stabilization (e.g. tackifiers) | Weir tanks | |
| | Polymer flocculants | |
| | Active treatment systems | |

Practicing effective ESC on construction sites is a process that goes beyond the physical controls themselves and starts even before topsoil stripping begins. The following are the key activities required to practice effective ESC from project start to finish:

- Preliminary site data collection (to document baseline conditions) and erosion risk assessment
- ESC plan design
- Installation of ESC measures on site
- Routine inspection of ESC measures, documentation of inspections, and prompt response to problems identified
- ESC performance monitoring (e.g. turbidity measurement)
- Re-evaluation, maintenance and replacement of ESC measures as needed
- Permanent site stabilization and decommissioning of ESC measures.

Guidance on each of these elements of ESC are discussed in the chapters that follow.

# 5.0 PARTICIPANT ROLES AND RESPONSIBILITIES

Practicing effective erosion and sediment control over the course of a construction project requires that all parties involved understand their roles and are equipped with the knowledge and resources they need to fulfill their responsibilities. Table 5.1 lists the key parties involved in ESC on construction sites and the typical distribution of roles and responsibilities among them. While the land owner ultimately holds responsibility for ensuring that the project remains in compliance with all applicable legislation, the parties involved all carry liability for their individual responsibilities for the following reasons:

- They have been retained and compensated for carrying out these activities on behalf of the land owner / developer; and
- They often hold a professional accreditation, certification or affiliation that compels them to practice in accordance with the code of conduct / ethics defined by the governing body.

Many of these professional associations have codes of professional ethics that are relevant to environmental protection. Examples of organizations that offer certification or accreditation of the types of professionals who practice ESC include:

- Professional Engineers of Ontario (PEO)
- Ontario Association of Certified Engineering Technicians and Technologists (OACETT)
- Association of Professional Geoscientists of Ontario (APGO)
- Canadian Certified Inspector of Sediment and Erosion Control (CAN-CISEC)
- EnviroCert International (which administers the Certified Professional in Erosion and Sediment Control – CPESC – certification program)

### *Liability and due diligence*

Legal liability, as it relates to environmental protection, is directly tied to applicable legislation and associated permits, approvals and authorizations. More information on the legislative framework for ESC is provided in Appendix D. The extent to which an individual or company is in compliance with a given piece of legislation or the conditions of a permit / approval / authorization is typically assessed by considering whether they exercised ***due diligence*** in undertaking the activities in question. The demonstration of due diligence can mitigate both regulatory and civil liability in the event of a construction site incident that results in adverse impacts to aquatic and terrestrial communities, natural features or other private property.

**What is due diligence?**

Such a measure of prudence, activity, or assiduity, as is properly to be expected from, and ordinarily exercised by, a reasonable and prudent person under the particular circumstances; not measured by any absolute standard, but depending on the relative facts of the special case

*- Black's Law Dictionary, 10th ed. (2014)*

Due diligence means that every reasonable effort was made to remain in compliance with applicable legislation and the terms and conditions associated with any permits, approvals or authorizations issued for the project. One of the key questions that determines whether due diligence was exercised is the question of whether an incident (e.g. sediment release offsite) was foreseeable and preventable. Even if the incident is determined to have been unforeseeable or unpreventable, due diligence requires that corrective actions are undertaken in a timely manner to ensure that harm to aquatic and terrestrial communities or natural features is prevented. One of the key ways of exercising due diligence is by taking a ***proactive approach,*** in which potential erosion or sediment migration problems are identified before they result in non-compliance.

Key actions that demonstrate due diligence with respect to ESC on construction sites include, but are not limited to, the following:

- Train all construction staff to improve their understanding of ESC best management practices.
- Maintain ongoing communication among project team members, including regular construction meetings with mandatory attendance requirements for key parties.
- Conduct erosion risk assessment and apply outcomes to help inform the selection and placement of ESC measures as part of the ESC design process.
- Document – through inspection reporting, field notes and date stamped photos – any ESC issues and the steps taken to resolve them. See inspections guidance in Chapter 10.0 for more information.
- Monitor the quality of construction site discharges and/or downstream receiving water systems, as detailed in Chapter 10.0.
- Apply established best practices specified in local guidelines and policies.
- Apply a multi-barrier or treatment train approach to ESC as much as possible, as described Figure 7.1.
- Ensure all permits, approvals and/or authorizations required are secured prior to the commencement of the regulated activities.
- Develop spills response and contingency plans prior to the start of construction.
- Retain specialized professionals as needed to address ongoing problems (e.g. ecologists, fluvial geomorphologists, hydrogeologists, environmental monitoring experts).
- Demonstrate that every reasonable effort was made to prevent impacts.
- Ensure tools and replacement materials needed to repair and maintain ESCs are readily available or able to be delivered on short notice.
- Modify ESC plan with contractor during construction to adapt to site conditions, and ensure changes are documented and distributed to all relevant parties.
- Retain a qualified ESC inspector and ensure they complete inspections at the recommended frequency, as described in Chapter 10.0.

### *Roles of key parties*

The establishment of roles, responsibilities, communication protocols and reporting structures should occur prior to the start of construction so that all parties clearly understand expectations. The strength of an erosion and sediment control plan often lies with a thorough understanding of the undertaking. This comprehension is normally found in the contract administrator, who forms the core of the construction team. Traditionally the owner's representative on the project, the contract administrator liaises with all parties including the contractor, ESC inspector and regulatory agencies. Professionals involved in construction projects generally report directly to the land owner / developer or they are hired by the contractor (e.g. landscaping companies). Notably, the team size expands and contracts in response to project progress where specialized expertise is needed. Effective construction teams recognize when there is a need for additional expertise and rapidly engage those services to allow adequate time for consultation among project team members and ensure the project proceeds on schedule. Examples of specialized experts often retained on construction projects include monitoring specialists, fluvial geomorphologists, aquatic biologists and hydrogeologists.

It should be noted that the defined roles summarized in Table 5.1 will often vary from project to project, and in many cases one company will be hired by the land owner to handle multiple roles. These details should not affect the success of the project provided that adequate staff are assigned to work on the project and that they possess the experience and qualifications needed to carry out their assigned responsibilities.

**Figure 5.1:** Professionals involved in construction projects

The ESC inspector has a particularly important role that can have significant impact on the success of ESC measures and overall compliance efforts.  The role of ESC inspector is to conduct unbiased inspections of construction site activities, document findings, and report identified deficiencies to the relevant project team members. It should be kept distinct from other roles to ensure they are able to carry out their designated responsibilities. For example, the ESC inspector should not be responsible for handling other types of construction site inspections, carrying out construction work, or maintaining ESC measures.

Within Ontario, regulatory agencies commonly involved in ESC plan review are municipalities and conservation authorities.  Chapter 9.0 details the approval process for ESC and provides more information on specific agencies involved based on site and project circumstances.  For more information on the role of the ESC inspector, refer to Chapter 10 which covers inspections, monitoring and maintenance.

**Table 5.1:** Roles and responsibilities of key parties involved in construction site erosion and sediment control

| Party | Defined role | Key responsibilities |
|---|---|---|
| Land owner / developer<br><br>or<br><br>builder (once building construction phase has begun) | Company or individual who owns the land being developed, or is working to develop the land on behalf of the land owner(s). | • Holds ultimate responsibility for ensuring that ESC is implemented so that the project does not adversely affect natural features and other adjacent lands.<br>• Delegates responsibility to hired professionals (engineers, contractors, ecologists, inspectors) who design, install, inspect, monitor, maintain and decommission ESC measures.<br>• Ensures agreement with contractor on protocol for payment/reimbursement related to ESC maintenance, such that ESCs can be kept in working order throughout the project.<br>• Holds liability in the event of ESC failure or regulatory violation.<br>• Remains engaged throughout construction to ensure effectiveness of ESC planning and implementation.<br>• While the division of responsibilities and liabilities may vary from project to project, a builder will typically, upon transfer of ownership, become responsible for activities occurring on their lots. |
| Project manager / design manager / design engineer | Assists ESC plan designer in planning ESC as it relates to construction phases, schedules and site conditions. | • Oversees collection and analysis of pre-construction site data, as detailed in Section 6.1.<br>• Conducts erosion risk assessment based on site data collected (see Section 6.2).<br>• Provides information to support ESC plan design, e.g. site details, erosion risk and scheduling considerations.<br>• Reviews and stamps ESC drawings and report.<br>• Determines permits/approvals required and applies for them on behalf of land owner / developer.<br>• Maintains awareness of consequences regarding ESC failures from a regulatory perspective and remains in regular contact with land owner / developer.<br>• Remains aware of contingency plans and directs use when necessary. |

| | | |
|---|---|---|
| ESC plan designer | Develops (or leads the development of) ESC plans for all stages of construction | • Specifies ESC measures, their sizing, and placement on site based on site conditions and erosion risk.<br>• Designs ESC plans for each stage of construction (see Section 7.2), and includes instructions related to decommissioning of ESC measures.<br>• Ensures ESC plans are designed in accordance with established policies and best practices guidance.<br>• Ensures ESC plans, if implemented as designed, will prevent exceedance of turbidity targets (see Section 10.2.2).<br>• Conducts site visits before designing the plan and during its implementation.<br>• Designs ESC plans that are practical and implementable based on consultation with the contractor.<br>• Revises ESC plans as needed if regulatory agency review reveals that modifications are required.<br>• Reviews and approves of on-site ESC design modifications, communicates changes to appropriate approval agencies where required, and updates plans accordingly.<br>• Develops contingency plans for certain stages or activities as needed (e.g. dewatering activities).<br>• Directs implementation of the contingency plan if needed. |
| Contract administrator | Forms the core of the construction team and reports directly to the land owner/developer | • Provides construction specifics and schedules to the rest of the construction team.<br>• Ensures the necessary permits and approvals have been obtained and keeps copies of approved ESC plans, permits and inspection reports in a central location on site.<br>• Serves as the primary liaison between the project manager, plan designer, ESC inspector, and contractor(s).<br>• Liaises with all parties including land owner, design engineers, contractors and regulatory agencies.<br>• Makes recommendations for the requirement of specialists.<br>• Receives ESC inspection reports from inspector and communicates necessary actions to construction staff.<br>• Aid in spills response and reporting as defined in Section 7.7. |

| | | |
|---|---|---|
| ESC Inspector | Carries out ESC inspections, reporting directly to land owner / developer and approval agencies<br><br>Note: Inspector qualifications are detailed in Section 10.1.1. | • Understands the ESC plan, spills response and contingency plans, and construction methods.<br>• Familiarizes him or herself with the landscape, drainage patterns and natural features prior to the start of construction, taking notes and pictures to document pre-construction conditions.<br>• Conducts an initial site inspection to evaluate whether ESC measures are installed as per the approved plan.<br>• Recognizes effective application of ESCs and communicates recommendations with the contractor.<br>• Inspects all ESC measures every seven days at a minimum, before and after significant rainfall and snowmelt events, and at other times as detailed in Section 10.1.2 which provides guidance on inspection frequency.<br>• Completes ESC inspection reports and circulates them to the contract administrator, contractor and (depending on project requirements) regulatory agencies like municipalities, CAs, and any other permitting agencies.<br>• Establishes a protocol for communication with on- and off-site contacts and inspection report circulation.<br>• Monitors site effluent and/or receiving water system based on project-specific requirements (see Section 10.2).<br>• Understand the permits and approvals that have been secured for the project and any associated conditions. |
| Contractor | Undertakes construction and the implementation and maintenance of ESC measures | • Signs off on ESC plan to ensure it is practical and implementable on the site.<br>• Installs/constructs ESC measures based on approved ESC plans and according to plan specifications.<br>• Provides input on construction-related aspects of ESC plan implementation including labour, equipment and materials requirements, construction procedures and field constraints.<br>• Informs ESC inspector, contract administrator and in some cases the ESC plan designer about any failures or ongoing issues with the effectiveness of ESC measures, and suggests ESC design modifications if needed.<br>• Reads all ESC inspection reports and takes corrective actions recommended within the specified timeframes.<br>• Ensures ESC measures remain functional and are maintained / repaired as needed. |
| Regulatory agencies | Protect human and environmental health from water, air and noise pollution related to construction activities through development review, issuance of permits / approvals, and enforcement. | • Responsibilities vary according to the agency but involve plan review, permitting and enforcement responsibilities per their regulatory mandate and/or agreements with their partner agencies<br>• Establish best practices and disseminate through guidelines, training programs and other forms of advocacy.<br>• Communicate instructions on the development review process and submission requirements in a clear manner.<br>• Review ESC plans to ensure compliance with legislation and policies.<br>• Issue permits / approvals / authorizations as needed to permit development activities that are otherwise restricted or limited by federal, provincial or municipal legislation.<br>• Conduct site visits to assess effectiveness of ESCs and ensure compliance with conditions of permits/approvals. |

# 6.0 ASSESSING EXISTING CONDITIONS AND EROSION RISK

The following subsections provide guidance on methods for assessing erosion risk on construction projects, how to determine when erosion risk assessment is most needed, and how the outcomes of the assessment should inform the development of ESC plans.

## 6.1 Collecting and analyzing site information

Development of an effective ESC plan requires an understanding of existing site conditions. In order to evaluate the varying levels of erosion risk, a site assessment should be carried out to collect the following information:

- Soil types and associated erodibilities for soils at the relevant grading level
- Topography
- Natural heritage features adjacent to the site and/or to which the site drains
- Local climate conditions
- Potential vegetation preservation areas, including buffer strips
- Surrounding infrastructure, such as public streets and buildings
- Areas where stormwater flows onto and off the site

Photographs, mapping and data collected should be applied to aid in the development of the ESC report and drawings required for submission as defined in Chapter 8.0.

## 6.2 Erosion risk assessment (ERA)

Understanding a site's erosion risk and specifically identifying potential problem areas is essential to developing an effective ESC plan. Once existing conditions data has been collected it can be used to determine the site's natural erosion susceptibility as determined by soil characteristics, rainfall and climate conditions, and topography. The primary purpose of an erosion risk assessment (ERA) is to clearly define the level of risk and the probability of erosion and sedimentation occurring above natural or pre-development levels as a result of construction activities within a given study area.

### *6.2.1 When to do an ERA*

The ERA should be completed prior to preparing an ESC plan for the site. This is an important way that the ESC plan designer can demonstrate due diligence and show that the selection and placement of BMPs are directly tied to mitigating erosion, particularly in areas that have been identified as susceptible through the assessment. The ESC plan should follow logically from the risk assessment, such that enhanced controls and/or treatment trains (multiple controls installed in series, as defined in Chapter 7.0) are placed in the most erosion susceptible areas.

The ERA should be completed based on the planned condition of the site (i.e. grades and land cover) during construction stage 1 (topsoil stripping and grading), and should exclude any planned sediment control measures. The risk classifications of different parts of the site – as established through the ERA – should then inform which BMPs are selected and where they are placed in the stage 1 ESC plan. The erosion risk assessment can be repeated at each subsequent stage of construction (e.g. site servicing, building construction) in order to help inform the optimal selection and placement of ESC measures based on changing site conditions. If these specific stages don't apply to a given project, then the risk assessment should be repeated only when the site grading significantly changes and a second ESC plan is needed. Essentially, the ERA should be carried out every time a new staged ESC plan is required to be submitted for approval, with the outcomes helping to inform the best practices applied at each stage.

### *6.2.2 Sites for which an ERA should be completed*

While erosion risk should be considered during ESC planning on any projects where land stripping and grading is planned, a formal erosion risk assessment, as detailed in Section 6.2.3, is recommended on construction projects that meet any of the following criteria:

- Extent of land disturbance is greater than 10 ha ***and*** duration is longer than 30 days
- Construction activities are planned in or near natural water features (e.g. within CA regulated area)
- The site drains to species at risk habitat (as defined in O.Reg. 230/08)

Unless otherwise required by the overseeing regulatory agencies, the "hybrid qualtitative ERA approach" (section 6.2.3) should be method applied for ERA on these sites. A background discussion on other ERA approaches – including the Revised Universal Soil Loss Equation (RUSLE) for Application in Canada and the Ministry of Transportation's qualitative risk assessment approach – is provided in Appendix E.

### *6.2.3 Hybrid qualitative ERA approach*

The approach detailed in this section represents a hybrid of the MTO approach and the RUSLE method described in Appendix E. While qualitative like the MTO approach (described in the 2015 *Environmental Guide for Erosion and Sediment Control During Construction of Highway Projects*), it differs in that it does not consider risk classification of consequences and is instead focused solely on estimating erosion risk. The hybrid approach involves the following steps:

1) Dividing the site into polygons of like erosion potential that are delineated by using topographical and soils maps and aerial photographs. The base map used to select polygons should be developed at a scale suitable to the size and topography of the study area. The scale should be sufficient to discern areas with different erosion risk levels. Polygon sizes between 0.5 and 10 ha are recommended.
2) For each polygon, compile data on soil characteristics (K factor), topography (LS factor), and anticipated ground cover, if any (C factor).
3) Using the risk classification tables provided below, rate each polygon as having a high, moderate, or low risk of erosion.
4) Select best practices most appropriate for mitigating erosion based on the estimated risk. See BMP selection guidance in table 6.6.
5) Prepare ESC plan, specifying best practices for each polygon based on what is determined through the hybrid ERA approach.
6) Repeat this process for each construction stage with a distinct ESC plan, e.g. topsoil stripping & grading, site servicing, building construction.

### *Risk classification – soil erodibility (K factor)*

The key characteristics that determine the erodibility of a soil are:

- **Particle Size and Soil Texture** | Larger particle sizes (e.g. gravels with particles greater than 2 mm in diameter) are typically less susceptible to erosion, as these particles require higher energies for particle detachment and transport. Soils with high clay content also are less susceptible to erosion due to their cohesive strength. Soil texture also affects the rate and volume of runoff.

- **Soil Permeability and Soil Structure** | Generally defined as the extent to which a soil will permit water to flow through it. Soils with higher permeability will result in reduced runoff and onsite ponding following a storm or thaw event, therefore reducing the risk of erosion and sediment transport. Soil structure is indicative of the extent to which soil particles are bound to one another, which affects its erosion resistance. Where soils are compacted due to construction activities, permeability is reduced. This can be mitigated on construction projects by scarifying or roughening the soil surface, as described in Appendix B1.

- **Organic Matter** | Soils with high organic matter typically have a lower erosion susceptibility due to their moisture retention capacity and good soil structure. On construction projects that require extensive topsoil stripping, organic content in soils will typically be minimal.

Soil erodibility potential as it relates to soil texture is classified as shown in Table 6.2 below. ***It should be noted that determination of soil type for consideration in the ERA should be based on the soil present at the grading level of the works being conducted and not just the topsoil.***

**Table 6.2** – Erosion risk classification according to soil type

| Soil Type | Erodibility Classification | Soil Erodibility Rating |
|---|---|---|
| Well Graded Gravel | Least | Low |
| Poorly Graded Gravel | ↓ | Low |
| Sand | | Low |
| Loamy Sand | | Low |
| Heavy Clay | | Low |
| Clay | | Low |
| Sandy Clay | | Low |
| Silty Clay | | Moderate |
| Sandy Clay Loam | | Moderate |
| Silty Clay Loam | | Moderate |
| Sandy Loam | | Moderate |
| Silty Sand | | High |
| Loam | | High |
| Silt Loam | | High |
| Silt | Most | High |

***Source:*** *Adapted from Guidelines on Erosion and Sediment Control for Urban Construction Site (MNRF, 1987)*

### *Risk classification – topography (LS factor)*

The length, slope gradient and drainage patterns associated with an area of disturbance is one of the major contributors to erosion and sedimentation within a construction site. For the purpose of determining erosion potential, slope gradients can be separated into three classes: gentle (< 2%), moderate (2 to 10%) and steep (>10%). Slope lengths are divided into two categories – less than 30 metres or greater than 30 metres. Once the slope gradient, slope length and soil erodibility (as determined based on Table 6.2) are all known, the erosion risk classification can be determined as shown in Table 6.3. Because site topography is ever-evolving on construction sites, the risk assessment should be repeated for each distinct phase of construction, as described earlier in section 6.2.1.

**Table 6.3:** Erosion risk classification according to slope gradient, soil erodibility, and slope length

| Slope gradient | Soil erodibility | Erosion risk classification | |
|---|---|---|---|
| | | slope length <30 m | slope length >30m |
| <2% | Low | Low | Moderate |
| | Moderate | Moderate | Moderate |
| | High | Moderate | High |
| 2-10 % | Low | Low | Moderate |
| | Moderate | Moderate | High |
| | High | High | High |
| >10% | Low | Low | Moderate |
| | Moderate | High | High |
| | High | High | High |

Source: Adapted from *Guidelines on Erosion and Sediment Control for Urban Construction Sites* (MNRF, 1987)

### *Risk classification – ground cover (C factor)*

The establishment of a soil cover on disturbed areas of a construction site can significantly reduce erosion risk in the following ways:

- Canopy cover shields the ground from erosive forces associated with rainfall.
- Soil compaction is reduced and permeability is enhanced, thereby promoting greater water infiltration and lower runoff volumes.
- Established vegetation contains root mass that improves the structure of soils, reducing the potential for soil detachment during larger, more intense storm events.

The highest risk of erosion due to the lack of sufficient vegetation coverage typically occurs immediately following topsoil stripping and/or rough grading activities. Establishing a hardy and uniform ground cover is one of the most effective methods of preventing erosion on an active construction site.

The erosion risk classification for a variety of soil cover types are provided in Table 6.4. For construction projects where extensive vegetation removal, topsoil stripping, and/or grading are required, the erosion potential (based on soil cover) should be rated as high. If a defined polygon area contains more than one type of ground cover, the different cover areas should be assessed as separate polygons, particularly if the ground covers have very different erosion risk classifications (e.g. bare soil vs. established vegetation) and they each represent a significant portion of the polygon. Alternatively if one cover type covers most of the area, the risk classification for that cover could simply be applied for the whole polygon.

**Table 6.4:** Erosion risk classification according to soil cover type

| Cover Management | Erodibility | Erosion risk classification |
|---|---|---|
| Densely vegetated areas | Least | Low |
| Sodded/Established Vegetated Areas | ↓ | Low |
| Soil Sealant and Rolled Erosion Controls | ↓ | Moderate to Low[1] |
| Hydroseeded/Hydromulch Areas Prior to Significant Vegetation Growth | ↓ | Moderate to Low[1] |
| Established temporary crop covered/vegetated lands[2] | ↓ | Moderate |
| Seeded lands prior to significant vegetation growth | ↓ | High |
| Sparsely vegetated lands | ↓ | High |
| Bare lands (exposed soil) following topsoil stripping and/or grading | Most | High |

[1] Depends on the quality of the cover (e.g. good ground preparation and coverage, even application, rolled erosion control products properly secured in place). [2] Assumes planting and growth occurs during optimum growing conditions.

Source: RUSLE for Application in Canada: *A Handbook for Estimating Soil Loss from Water Erosion in Canada* (Wall et al., 2002)

### *Overall polygon erosion risk classification*

Based on the risk classifications from Tables 6.3 (slope gradient, slope length and soil erodibility) and 6.4 (soil cover type), an overall risk classification can be determined for each polygon, as depicted in Table 6.5. The risk classification for the polygon should be used to make decisions about the best management practices appropriate to mitigate erosion in that part of the site. The structural and non-structural best management practices recommended for different erosion risk classifications are discussed in section 6.2.4 and summarized in Table 6.6.

### *Additional considerations – rainfall duration and intensity*

While the value of the rainfall-runoff erosivity (R) factor does not vary within a site, since geographical variations in R-factor are much broader in scale, it is still important to consider seasonal temperature and rainfall variations and their impact on erosion potential. Highly erosive rains associated with higher intensity storm events typically occur during the summer months (from June through September). Construction during the late winter/early spring can also be subject to high runoff volumes and erosion risk due to the potential for snowmelt occurring on top of frozen soils. Further, areas disturbed over the winter months are challenging to stabilize due to unfavourable growing conditions. As a result, these areas may be highly susceptible to erosion once spring thaw occurs. When considering the polygon erosion risk classifications in Table 6.5, it would be appropriate to consider designating the erosion risk at the next level up for long duration projects that extend over multiple seasons.

**Table 6.5:** Overall erosion risk classification

| Slope/soil erodibility classification (based on Table 6.3) | Cover classification (based on Table 6.4) | Overall polygon erosion risk classification |
|---|---|---|
| Low | Low | Low |
| Moderate | Low | Low |
| High | Low | Moderate |
| Low | Moderate | Moderate |
| Moderate | Moderate | Moderate |
| High | Moderate | High |
| Low | High | Moderate |
| Moderate | High | High |
| High | high | High |

### *6.2.4 Selecting BMPs based on erosion risk*

The key objective of the ERA is to inform decisions on the types and locations of both structural (e.g. double-row silt fence) and non-structural (turbidity monitoring) best management practices that should be applied on the site. Table 6.6 lists recommended BMPs to be applied in each polygon based on its risk classification. For sites where RUSLE calculations are used to estimate erosion, Table 1.1. from the *RUSLE FAC* document should be referenced to determine if the calculated soil loss value is classified as very low, low, moderate, high, or severe. In referencing Table 6.6, ‘very low’ and ‘low’ classifications should be considered ‘low’ and ‘high’ or ‘severe’ classifications should be considered ‘high’.

The best management practices listed in Table 6.6 are described below for further clarification.

**Procedural ESC measures** | Procedural BMPs are nonstructural methods or procedures that can reduce erosion and sediment transport, such as site management and scheduling practices. Procedural BMPs include site management practices like minimizing exposed soils, careful control of site perimeter, and planning of site access points and signage for sensitive areas. Scheduling practices include examples such as working during dry seasons, abiding by fisheries timing windows and restoring the site as quickly as possible. *Procedural ESC measures should be applied on all construction projects.*

**ESC Plan** | This includes drawings, standard notes and reports depicting and describing the site conditions (e.g. grades, locations of natural features, soil stockpiles and other key points of interest) during a particular phase of construction, and the structural best management practices that will be applied to mitigate erosion and offsite sediment transport. ESC plans should be provided in stages reflecting the distinct phases of construction, which are normally categorized as: (i) topsoil stripping and grading, (ii) site servicing, and (iii) building construction. *Individual ESC Plans should be generated for each stage of every construction project.*

**Table 6.6:** Best management practices recommended at different erosion risk levels

| Minimum best practices recommended | Low risk | Moderate risk | High risk |
|---|---|---|---|
| **Procedural ESC Measures** | yes | yes | yes |
| **ESC Plan** | yes | yes | yes |
| **Routine inspection of ESC effectiveness** | yes | yes | yes |
| **Flow/Runoff Diversion** | optional | where possible | yes |
| **Phased Construction and Progressive Rehabilitation** | optional | where possible | yes |
| **More intensive ESC measures[1]** | optional | optional | yes |
| **Turbidity monitoring** | optional | Recommended after significant rainfall/snowmelt | Continuous recommended[2] |

Source: Adapted from *Environmental Guide for Erosion and Sediment Control During Construction of Highway Projects* (MTO, 2015).

[1]As described in section 6.2.4. [2]See Chapter 10 for more information on turbidity monitoring requirements.

**Routine inspection of ESC effectiveness** | ESC inspections involve regular assessment of the effectiveness of individual ESC measures and the overall ESC plan through site inspections and monitoring. This allows for identification of areas where maintenance (e.g. sediment removal) and repairs (e.g. replacement of damaged sediment fence) of ESC measures are needed, and also reveals when ESC measures should be replaced or augmented due to repeated failures. Guidance on inspection and monitoring is provided in chapter 10. *Routine ESC inspections should be carried out on all construction projects.*

**Flow/runoff diversion** | For construction site areas susceptible to erosion, where stabilization is not feasible, it may be advisable to divert runoff around bare soil areas with practices like interceptor swales or slope drains. These practices are detailed in Appendix B1. *Flow diversion should be considered on any unstabilized area, but is particularly necessary where erosion risk has been classified as high due to soil types or slopes.*

**Phased construction and progressive rehabilitation** | Staging construction and land clearing is a practice that requires strategic planning to schedule clearing and re-stabilization so that the total amount of time that bare soils are left exposed is minimized as much as possible. Guidance on the implementation of phased land clearing is provided in Appendix B1. *Phased construction and progressive rehabilitation should be considered on all construction projects, but is particularly necessary where erosion risk has been classified as high due to soil types or slopes.*

**More intensive ESC measures** │ This includes a range of practices that are considered more robust and effective than the most commonly applied sediment controls. Examples include: double row silt fence barriers (particularly adjacent to natural features), weir/settling tanks, active treatment systems (see Appendix B2), and other runoff detention measures (e.g. sediment traps, ponds). On high erosion risk sites, these types of measures can provide more assurance that sediment laden water will not leave the site, since they provide more opportunity for the removal of suspended sediment in runoff. *Intensive/ enhanced ESC measures should be considered on all construction projects, but are particularly necessary where erosion risk has been classified as high due to soil types or slopes.*

**Turbidity monitoring** │ Beyond the routine inspection and repair of individual ESC measures, it is important to evaluate the cumulative effectiveness of all the controls installed on a construction site by monitoring the quality of site discharges or the quality of receiving water systems downstream of the site. On construction sites, turbidity is an important and easily monitored parameter that gives an indication of the amount of suspended sediment in site runoff. Guidance on selecting a turbidity monitoring approach according to site conditions and project circumstances is provided in section 10.2.1. *Turbidity monitoring should be considered on all construction projects, with more intensive efforts applied on sites where erosion risk has been classified as high due to soil types or slopes.*

### *6.2.5 ERA submission components*

Documentation of the ERA process carried out and associated results can be provided as part of the ESC plan submission package described in Chapter 8.0. The following items should be provided to document the ERA process and its outcomes:

1) A site map showing (labelled) polygons of like erosion potential. The map should be developed at a scale suitable to the size and topography of the study area. The base map should be prepared from a detailed topographic map or air photo mosaic.
2) A table listing the erosion risk classification of each polygon and brief justification of the classification.
3) A description, in tabular or text form, of the BMPs that will be applied in each polygon, including a brief justification based on the risk classification. This may be combined with the polygon risk classification table described in #2 above if appropriate.
4) An ESC plan for the stage in question which includes BMPs that have been selected and located so as to best mitigate erosion in each polygon.

# 7.0 ESC PLAN DESIGN

## 7.1 Key principles

An effective ESC plan keeps construction sediment from migrating offsite by (i) preventing erosion and (ii) providing opportunities for removal of sediment from runoff before it leaves the site. It should provide protection strategies for the entire construction period, from the beginning of stripping through to final stabilization and decommissioning of ESC measures.

**The ESC planning process should be…**

**COMPREHENSIVE | All stages of the construction period and all relevant geographic areas should be included in the plan. ESC measures selected should be robust and provide for redundancy in case any one measure fails. One important way to achieve this is to apply a multi-barrier approach wherever possible.**

**COLLABORATIVE | The ESC designer creates a plan, using their technical expertise to establish sizing, design and placement of ESC measures. To the extent possible, the contractor should provide input on the suitability, practicality and constructability of the plans, taking into consideration labour, equipment, materials, construction practices and site constraints. Collaboration should continue throughout the construction, such that plans may evolve based on changing conditions and input from on site personnel like construction staff and inspectors.**

**STRATEGIC | During early planning, identify opportunities to phase development whenever possible. Phasing development requires strategic planning to schedule clearing and re-stabilization so that the total amount of time that bare soils are left exposed is minimized as much as possible. See Appendix B1 for guidance on phased stripping.**

**DYNAMIC | Approved ESC plans must be considered dynamic rather than static, with measures upgraded and/or amended as needed to mitigate risk of sediment release. Even when measures are implemented according to approved plans, adjustments must be made as necessary when inspection identifies a risk of ESC failure and potential ecological impact.**

Conventional ESC planning has often relied on sediment fences, check dams and temporary sediment ponds in a static ESC plan. More current approaches focus on better tailoring ESC measures to the specific project site and planned activities, and treating the plan as dynamic, evolving as needed to continuously mitigate impacts. Figure 7.1 summarizes the key design principles of comprehensive, collaborative, strategic and dynamic ESC planning. An ESC Planning checklist provided in Figure 7.2 lists the key activities involved in the ESC planning process. For checklists related to ESC plan submissions, see Chapter 8.0.

**Assess erosion risk**

- Based on soil characteristics, rainfall and climate conditions, and topography, the erosion risk assessment (Chapter 6.0) reveals the extent to which erosion and sedimentation are likely to occur at rates above natural or pre-development levels.
- Demonstrates due diligence on the part of the ESC plan designer.
- The ESC plan should follow logically from the risk assessment, such that enhanced controls and multiple barrier strategies (i.e. treatment trains) are applied in areas where erosion risk is highest.

**Consider erosion prevention first**

- Focus on erosion prevention as a first priority by minimizing the areal extent and duration of land disturbance, avoiding non-essential clearing and grading, and re-stabilizing as quickly as possible.
- Consider phasing development - dividing site into smaller parcels of more manageable size - with size dictated by availability of labour and equipment, construction seasons, project timelines, and any restrictions associated with permits and approvals (e.g. fisheries timing windows). See Appendix B for details.
- Stabilize bare soil areas that are inactive for 30 days or longer.

**Apply a multi-barrier approach, a.k.a treatment train**

- Construction site ***source*** controls prevent erosion through structural (e.g. ground covers) or non-structural (planning for phased development) means.
- Creating stable flow ***conveyance*** pathways mitigates erosion, and sediment controls installed along the pathways (e.g. check dams) remove suspended sediment in the stormwater.
- ***End-of-pipe*** controls (e.g. sediment control ponds, sediment traps) provide sediment removal, largely through detention, and control of peak flows, which reduces stream erosion and flooding risk.

**Slow down and detain runoff**

- Reducing flow velocities and detaining stormwater reduces runoff erosivity and provides opportunity for gravitational settling of suspended sediment.
- Slow runoff using flow interrupters (e.g. check dams) and erosion controls (e.g. vegetation).
- Detain water in practices like ponds, sediment traps and, on a smaller scale, through grading that allows for on site detention and increased opportunity for evaporation and infiltration of stormwater.
- Always consider flow interrupters in conveyance channels, stormwater outlets and along contours of slopes.

**Divert runoff around problem areas**

- Divert runoff around unstabilized areas like bare soils and steep slopes to mitigate erosion.
- Always consider whether a ground surface can withstand the erosive force of the runoff – whether it's concentrated or sheet flow – that will be directed towards it. If erosion is anticipated, the area should be better stabilized or flows must be diverted elsewhere.
- Diversion measures – like slope drains and interceptor swales – allow runoff to be collected and conveyed through a stabilized flow path, avoiding the formation of rills and gullies.

**Minimize slope lengths and gradients**

- Long (> 30 m) and steep (> 10%) slopes are far more susceptible to erosion (see Table 6.3).
- Wherever possible, grade site such that slope gradients and lengths are reduced.
- In cases where alternative grading is not possible, use stabilization, flow diversion (e.g. slope drains) and/or flow interruption to prevent the slope from eroding.

**Avoid concentrated flows**

- Concentrated stormwater flows are often more erosive and damaging than sheet flows.
- Concentrated flows should only occur where they are planned – such as within interceptor swales or other conveyance channels – and where the surface has been stabilized to withstand the anticipated flow rates.
- Discharges from pumps and other outlets, which are often concentrated, should be dissipated or dispersed to create more of a sheet flow (e.g. pump discharge into a geotextile sediment bag).

**Evolve ESC plan as needed**

- The ESC is a living document that should be updated as needed to ensure sufficient protections are always in place to mitigate risk of excess sediment release to natural features.
- ESC plan revisions that are minor and carried out within the limits of development can be marked up on the drawing and re-sent to regulatory agencies for their information.
- For any significant changes to ESC strategy for the site, and changes that are planned in the natural area outside the limits of development, the ESC plan must be formally revised and re-submitted for approval.

**Figure 7.1:** Principles of ESC planning

| ESC Planning Checklist | |
|---|---|
| Project Name | |
| Project Location | |
| ESC Plan Designer | Name, company, phone number, e-mail |
| Land Owner | Name, company, phone number, e-mail |
| Developer | Name, company, phone number, e-mail |
| Inspector | Name, company, phone number, e-mail |
| Municipal contact | |
| CA contact | |

**UNDERSTANDING THE SITE**

√ Conduct a site walk to make field observations about existing conditions before developing the ESC Plan.
√ Collect existing site condition data (e.g., topographic survey, site photos, soils reports).
√ Identify existing drainage patterns including internal and external flow routes. Identify areas with sheet flow, concentrated flow and receiving watercourses.
√ Identify all natural heritage features and conduct surveys to delineate boundaries where required (e.g., watercourses, wetlands, woodlots, riparian zone, etc.).
√ Establish baseline monitoring program if required.
√ Carry out an erosion risk assessment (see Chapter 6.0).

**CONSIDER THE GOALS OF ESC**

√ Protect all natural heritage features.
√ Undertake construction in a way that minimizes soil disturbance and vegetation clearing.
√ Aim to prevent erosion whenever possible.
√ Suggest techniques that allow for sedimentation by slowing down the velocity of flowing water.
√ Ensure that sediment is contained and managed onsite.
√ Undertake earthworks in phases in order to minimize the amount of time that soils are left exposed.
√ Manage internal drainage and convey or divert external drainage through or around the site.
√ Coordinate and schedule any in-water or near water works with applicable fish windows and planting seasons.
√ Select ESC measures appropriate to the season.
√ ESC is a dynamic process and plan designs must reflect different stages of construction and their associated issues.

**DESIGN THE ESC PLAN**

√ Prepare ESC plans that address each construction stage. Multiple plans are required.
- Stage 1: Topsoil stripping, grading and re-stabilization
- Stage 2: Site servicing
- Stage 3: Building construction

√ Select the types and locations of best management practices based on the outcome of the erosion risk assessment.
√ Preserve existing vegetation and maintain vegetation buffer whenever possible
√ Stabilize stockpiles and any other exposed soils on areas inactive for 30 days.
√ Protect exposed soils, particularly on steep slopes
√ Provide ESC practices to slow flow velocity and settle sediments
√ Protect storm inlets and storm sewer system
√ Conduct pre-construction meeting with the developer, contractor, environmental monitor and regulatory authorities to confirm constructability and practicality of the design.
√ Ensure that all standard ESC notes are included on the drawings.
√ Prepare an ESC report to accompany the drawings.

**INSPECTING ESC MEASURES AND UPDATING ESC PLAN**

√ Inspection, monitoring and maintenance
√ Revising ESC plan if needed due to changing site conditions or ineffectiveness of original measures.

**Figure 7.2:** ESC planning checklist

## 7.2 Staged ESC Planning

The term 'staging" in relation to ESC plans refers to the technique of designing different plans for each stage of construction. This approach involves identifying the distinct stages of construction during which specific activities take place and then selecting the types and locations of ESC measures most appropriate for each stage. The primary purpose of developing staged ESC plans is to ensure that measures selected are the most effective and appropriate based on site conditions and construction activities planned.

While construction sites are by their nature constantly evolving, it is possible to define distinct construction stages largely based on the key activities that will be completed. The following are the stages of construction for subdivision developments:

1. Topsoil stripping, grading and re-stabilization
2. Servicing
3. Building construction
4. Final stabilization/rehabilitation and ESC decommissioning

For in-water construction and linear infrastructure projects like highways, railways and pipelines, the stages are slightly different but should still be defined based on distinct differences in the types of activities underway. In general, most construction projects will involve the first and last stages - stripping and grading and final stabilization/rehabilitation and decommissioning. The ESC designer should apply their professional judgement to establish what other distinct stages should be planned for based on the specific project. Regulatory agencies should be consulted to confirm that the defined stages are appropriate to the construction activities planned, and that they will capture the changing environmental conditions so that impacts can be mitigated at every stage. Additional information on erosion and sediment control during in-water construction is provided in section 7.5 and Appendix C.

Staged ESC plans should be prepared to show specific ESC techniques, drainage patterns and transitional site conditions at each stage. While there is no preset number of required ESC drawings, major modifications to drainage patterns should be used as a trigger for a new staged ESC plan. The following sections detail the typical conditions and key considerations during each construction stage.

<u>Stage 1: Topsoil stripping, grading and re-stabilization</u>

**Figure 7.3:** Construction site grading

During this stage, vegetation and topsoil are removed and the soils are moved around the site (cut and fill) to achieve the necessary pre-grade elevations. ESC measures like sediment control ponds and perimeter and conveyance controls are installed just before topsoil stripping begins to ensure adequate protection is in place as soon as the soil stabilizing effect of vegetation is removed. While this stage of construction is typically subject to the most appropriate application of ESC measures, there are several ways in which common practices can be improved or enhanced.

Of particular importance is the prevention of erosion through phased development. ***Clearing of smaller, more manageable sections of the site – leaving other areas undisturbed and vegetated for as long***

***as possible – can be one of the most impactful strategies for mitigating sediment releases during earthworks and grading.*** When phasing is applied, topsoil stripping and grading activities are limited only to areas designated in that development phase. Phased clearing of lands during this stage should be based on the size of the site, the season and construction timelines, the cut and fill plan, and any requirements specified in permits and approvals. The grading plan and cut-fill analysis for the site must be available prior to phase planning. Detailed guidance on minimizing and/or phasing stripping on construction sites is provided in Appendix B1.

**STAGE 1 – KEY CONSIDERATIONS**

- Apply minimized clearing and development phasing
- Limit the amount of land stripped at a given time to the area that can reasonably be expected to be developed and stabilized within the same construction season
- Divert flows around unstabilized areas
- Install flow conveyance measures with proper spacing of check dams (see Appendix B2)
- Apply flow interception
- Reduce cut slope lengths and gradients where possible
- Maintain positive drainage to temporary sediment control ponds
- Use sediment traps to treat flows from smaller areas (< 2 ha) that don't drain to ponds
- Stabilize as you go, especially high risk areas and those inactive for 30 days or longer

<u>Stage 2: Site Servicing</u>

During stage 2 the installation of underground services, like storm sewers and water mains, and the construction of roads results in a significant alteration to the internal drainage patterns of the site. Pre-grading of building lots – such that the lot grade is lower than the roads and the sediment control ponds – can often result in localized ponding areas. Despite this, catchbasin inlet protection is still required, even after roads are paved, due to the large amounts of sediment tracked onto the roads from the still unstabilized lot areas. Inlet protection should be installed as soon as catchbasins start receiving runoff.


**Figure 7.4:** Site servicing

Careful consideration should be given to additional ESC requirements and flow control measures due to transitional grading during this stage. ESC measures applied in stage 1 should be re-assessed for suitability based on altered flow patterns and changes to construction activities during this stage.

**STAGE 2 – KEY CONSIDERATIONS**

- Redirect swales/ditches based on new grades and flow patterns
- Relocate ESC measures
- Stabilize inactive areas and steep slopes
- Install storm drain inlet protection (see Appendix B2) before storm drains start to receive runoff
- Provide for treatment of stormwater pumped out of excavated areas, and erosion protection/flow dispersion at the discharge location. See details under 'Pumping and dewatering' in this chapter.

## Stage 3: Building construction

**Figure 7.5:** Building construction stage

During stages 1 and 2, construction activities are mostly undertaken by the main earthworks contractor. Once the site is ready for building construction it is often turned over to the builder, and there are often many new contractors and sub-contractors who begin work on the site. While the earthworks contractor may have established a good communication protocol with project team members, including the landowner, ESC designer and inspectors, this may be lost once the additional building construction contractors become involved. ESC plans must include measures that will provide protection during the activities specific to this stage of construction.

One of the most common risks encountered during stage 3 is the migration of sediment into rear lot and road catchbasins. During Stage 2, catchbasins are elevated above the rough lot grades, and as such localized ponding provides some opportunity for sediment settling. Once lots are at their final grades but have not yet been stabilized, lot runoff runs directly into the catchbasins. Applying and maintaining effective inlet protection (described in Appendix B2) is an important way to mitigate sediment migration during building construction, before vegetative stabilization can be established on the lot.

**STAGE 3 – KEY CONSIDERATIONS**

- Stabilize construction vehicle access points with stone or pre-fabricated mud mat in order to minimize tracking sediment onto roadways
- Install inlet protection on all catchbasin inlets
- Apply perimeter controls (e.g. sediment fence, filter socks) as barriers between unstabilized lots and newly constructed roads
- Apply erosion controls (e.g. blankets) and/or perimeter sediment controls to stockpiled material from basement excavations
- Do not locate stockpiles on top of or directly adjacent to catchbasin inlets
- Stabilize bare soil areas as soon as possible

### Stage 4: Final stabilization and decommissioning

During the final stage of construction, home building has been completed and any remaining bare soil areas of the site can be stabilized. At this stage ESC measures are progressively removed as contributing drainage areas are effectively stabilized. Depending on the type of development, this may involve landscaping building lots and common areas like boulevard islands, recreational or parkland areas, and stormwater pond blocks.

**Figure 7.6:** Subdivision after final stabilization

The extent to which permanent vegetation is healthy and providing good soil coverage should be verified prior to the decommissioning of ESC measures. The stage 4 ESC plan should include decommissioning details for all ESC measures – including perimeter sediment control fencing – and provide information on the proper removal and offsite disposal of materials. Details should also be provided for restoration of areas from which in the ground ESCs have been removed (e.g. sediment fence). Restoration guidance is provided in Appendix G.

**STAGE 4 – KEY CONSIDERATIONS**

- Remove all accumulated sediment remaining on the site, with particular attention to sediment accumulated behind perimeter sediment controls, along roadways, and around catchbasin inlets
- For sites with low impact development (LID) measures that have been kept offline during construction, specify that all sediment accumulated in areas draining to the LID must be removed before it is put online. See section 7.6 for more detail on ESC for LIDs.
- Stabilize and/or restore all disturbed areas of the site
- Decommission temporary ESC measures as contributing drainage areas are effectively stabilized.
- Specify appropriate offsite disposal of ESC materials

## 7.3 BMP selection

Selecting the appropriate BMPs for a particular ESC application requires a clear understanding of how the BMPs function, their intended use, expected performance and what maintenance they will require. ESC designers who are familiar with a wide range of structural and non-structural BMPs – and how they are best applied – have more tools in their toolbox when it comes to addressing ESC challenges in construction projects. BMPs can be categorized according to their intended function as detailed in the following subsections. Detailed design, installation and maintenance guidance for all BMPs addressed in this section is provided in Appendix B.

### *7.3.1 Erosion prevention*

Practices that prevent erosion are the most effective BMPs because they address sediment at its source. Erosion prevention measures include minimized or phased stripping and strategies that divert flows around or away from erosion prone areas. Minimizing clearing involves the identification of site areas where vegetation can be preserved throughout the entire construction period. Preserving vegetated areas not only prevents erosion but also helps to manage runoff, as the topsoil, vegetation and root systems are effective at intercepting and infiltrating stormwater. Minimized clearing can often be achieved on some parcels of land designated for later development (e.g. school blocks), and is particularly important at the site perimeter and around natural features. Guidance on appropriate buffers around natural features is provided in Appendix B1.

Practices that are meant to prevent erosion by diverting and controlling runoff include structures like slope drains and interceptor swales. Slope drains convey runoff down a slope without allowing it to flow across the slope face. On long, steep and/or unstabilized slopes in particular, slope drains are an important way to reduce the chance of rill and gully formation on the slope.

### *7.3.2 Erosion control*

Erosion control measures are applied to bare or under-stabilized soils in order to improve resistance to erosion by water and wind. Key areas of the site where erosion controls should be applied include:

- areas inactive for 30 days or longer
- slopes
- soil stockpiles
- runoff conveyance channels (e.g. interceptor swales)
- areas immediately downstream of water outlets
- banks of detention ponds and sediment traps
- lay down areas for sediment (dewatering) bags
- other areas where erosion risk is high and runoff flows directly towards a sensitive area downstream (e.g. stream, wetland)

**Figure 7.7:** Soil stabilization with a rolled erosion control product

One of the most common and effective erosion controls – when properly applied and allowed to take root – is vegetative stabilization (i.e. seeding). An area may be seeded as a temporary/short term erosion control strategy or as part of the final site stabilization/restoration plan.

Other ground covers often applied to control erosion are rolled erosion control products (RECPs, as shown in Figure 7.7) like netting, blankets and matting. They serve as a physical barrier to erosive forces and, when applied over a newly seeded area, provide protection and insulation that can improve seed establishment. Detailed guidance on these and other erosion control measures, including mulching, surface roughening and chemical stabilization, are provided in Appendix B1.

On sites where dust is a concern, wind erosion is often mitigated by misting / irritating bare soil areas during dry weather periods. Due to the temporary nature of this control measure, application of more lasting stabilization techniques, such as the methods detailed in Appendix B1, should be pursued if wind-blown dust is anticipated to be an ongoing problem.

### 7.3.3 Stormwater detention

On construction sites, detention can be an effective mechanism for removing suspended sediment from stormwater before it can be released to the receiving system, as well as helping to reduce peak flow rates. End-of-pipe BMPs on construction sites - like detention ponds, sediment traps and settling (weir) tanks – provide extended detention of construction runoff on a large scale. Within the detention area, the flow velocities are reduced and sediment particles have the opportunity to settle out of suspension.

Temporary sediment control ponds (Figure 7.8) should be constructed to receive flows from any drainage areas larger than 2 ha, while sediment traps should be used for areas under 2 ha. While detention tanks can be useful in a variety of circumstances, they are often used to provide detention over the shorter term and where space to construct a pond is limited, such as during dewatering activities. Active treatment systems – which typically incorporate detention tanks and sometimes include polymer flocculants – are also useful for treating stormwater with elevated levels of sediment or other contaminants while occupying a comparatively small amount of space.

**Figure 7.8:** Temporary sediment control pond

The efficacy of detention ponds and sediment traps is largely dictated by (i) the extent to which they are properly sized and constructed as designed, (ii) whether the banks are stabilized immediately following its construction, and (iii) the extent to which they are regularly cleaned out / maintained. Even when detention BMPs are well designed and performing as intended with respect to sediment removal efficiency, effluent sediment levels can still be elevated above the thresholds required to protect aquatic habitat. Reducing the inflow sediment concentration ***and*** volume conveyed to detention BMPs is a key way to achieve lower effluent sediment concentrations. Techniques that prevent erosion and promote infiltration and evapotranspiration of stormwater are particularly effective in this regard. Practices such as development phasing, retention of existing vegetation, and provision of shallow soakaway / detention areas throughout the site are all good examples of how this can be accomplished.

### *7.3.4 Flow interruption*

Flow interruption devices are barriers applied perpendicular to a flow pathway to reduce water velocity and erosivity and to provide opportunity for sediment settling. While often permeable, flow interrupters are not meant to serve as filters. Examples of this type of device included filter socks, wattles, logs and rock check dams. Sediment control fence can be used for flow interruption for sheet flows but not across concentrated flow paths. Flow interruption devices can also serve to redirect sheet flows towards a treatment area.

These devices should be applied perpendicular to flow in runoff conveyance channels, across slopes (perpendicular to sheet flows), around soil stockpiles, at site perimeter (usually sediment fence) and along the up-gradient side of natural water features.

Flow interruption can also be applied to mitigate wind erosion. Windbreak fencing, which often consists of mesh sheeting held by structural supports, can be applied like water flow interrupters: perpendicular to the prevailing wind flow path at regular intervals that are determined based on the height of the fencing.

### *7.3.5 Filtration*

Filters used in ESC are typically fabric, and are defined by their apparent opening size (AOS), which is the largest opening available through which soil particles can pass. Manufactured geotextile filter fabric with a known opening size will filter out all particles that are larger than the AOS. In this way they differ from flow interrupting devices, although they do also provide the added benefit of reducing flow velocities and thereby increasing sediment settling. Examples of filtration BMPs include sediment (dewatering) bags and storm inlet filters.

### *7.3.6 Flocculation*

Polymers flocculants are chemicals that encourage sediment particles to bind together to form larger aggregate masses. These larger, heavier masses are more susceptible to gravitational settling in water detention areas and more readily removed when passed through a filter. Flocculants can be used on construction projects to enhance removal of suspended sediment, particularly in situations where the sediment-laden water cannot be detained long enough to allow particles to settle. They are often applied in conveyance systems like interceptor swales or, in detention practices like weir tanks. Detailed guidance on the application, design and installation of polymer flocculant based sediment removal systems are provided in Appendix B2.

## 7.4 Dewatering protocols and best practices

Most construction projects will at some point require active water movement; applying effective ESC measures during these dewatering activities is an important way to reduce offsite sediment migration. Dewatering protocols define methods for carrying out water movement activities, whether planned or unforeseen, such that the water is treated as needed and discharged in a way that does not contribute to erosion. An effective ESC plan should include dewatering protocols that direct onsite staff on how to handle active and passive pumping discharges. A detailed drawing of the dewatering set up should always be included in ESC plans.

Common construction activities involving dewatering of sediment laden water include:

- Sediment control pond dewatering to facilitate re-grading, maintenance or cleaning/dredging;
- Pumping out stormwater that accumulates in excavated (e.g. excavations for basements or underground services) or low lying areas following a large storm event;
- Using a sump pump to remove groundwater in excavations that extend below the water table; and
- Repair or replacement of underground services (e.g. storm sewer).

For planned dewatering the ESC plan should be specific on the treatment and location of discharge. Advanced planning of these activities will ensure that potential ecological impacts have been addressed and mitigated. The following are key factors to consider during the development of a dewatering protocol.

- **Allowable water movement rates specified in permits.** In Ontario a Permit to Take Water (PTTW) or Environmental Activity and Sector Registry (EASR) registration may be required when taking more than 50,000 litres of water in a day from a surface or ground water system. If pumped water is being discharged to a municipal sewer, discharge permits are typically required. While specific permit requirements will vary by municipality, they typically specify a maximum allowable discharge rate and water quality standards.
- **Receiving system water quality standards.** Water discharged directly to a municipal sewer (either storm or sanitary) is often subject to the applicable municipality's sewer use By-Law and the relevant contaminant limits defined therein. When dewatering discharge is being released into a natural water feature, the turbidity targets detailed in section 10.2.2 are applicable.
- **Temperature standards for discharge to natural features.** Water released to natural features should fall within an appropriate temperature range based on the natural regime and types of aquatic organisms supported by that habitat. Groundwater may often be significantly cooler than the receiving water system, so ensuring a gradual initial release is important to allowing aquatic organisms to adapt. In cases where warmer water is being discharged to a receiving water system that supports cool water species, like the provincially endangered Redside Dace, discharge temperatures should not exceed 24°C, as currently required by the Ministry of Natural Resources and Forestry. More detailed guidance on mitigating thermal impacts associated with discharges is available in *Environmental Effects Assessment of Freshwater Thermal Discharge* (Environment Canada, 2014).
- **Proximity of groundwater dewatering to natural surface water features.** When groundwater is being dewatered near a surface water feature, the water level in the feature may be impacted by the dewatering, depending on the zone of influence and the amount of water being pumped out. It is important to understand the groundwater condition in the area, through borehole logging for example, in advance of preparing a dewatering plan. If a natural surface water feature is located within the anticipated zone of influence, the local conservation authority should be consulted to provide advice and help establish strategies for preventing impacts to the hydrology of the surface water feature.

**Figure 7.9:** A wetland

- **Erodibility at discharge locations.** Preventing erosion at the outlet of a dewatering system can be just as important as sediment removal/treatment methods used in the system. Erosion mitigation starts with stabilization of the discharge/outlet area and the entire flow path from the outlet to the receiver. Stabilization with stone and geotextile, vegetation or rolled erosion control products (e.g. blankets) may be appropriate in this type of application, depending on the anticipated flow rates. Flow dispersion and energy dissipation should also be applied, particularly if flow rates are high or concentrated. Outlet protection is described in more detail in Appendix B1.

- **Requirements for quality and/or quantity monitoring.** Permits issued for dewatering activities – such as PTTWs, conservation authority permits (under the "Development, Interference with Wetlands and Alterations to Shorelines and Watercourses" regulations), MECP permits or authorizations under the Endangered Species Act (S.O. 2007) and sewer discharge permits – often include requirements for periodic or continuous monitoring of the quality and amount of water being moved. Guidance on turbidity monitoring of construction site discharges is provided in chapter 10.
- **Contingency plans.** Protecting natural features in the event that water treatment or erosion mitigation measures are failing during dewatering requires contingency planning. An effective contingency plan can be implemented on short notice, which means that the materials and equipment needed should be readily available to use if needed. A proactive approach to a potential water quality issue would be to have a plan to get a dewatering tank or active treatment system on site and installed quickly if needed. The preferred course of action in any situation where the treatment system in place during dewatering fails is to immediately cease dewatering activities until the issue is resolved.

The extent to which these factors will apply to a given dewatering activity depends largely on the volume of water being moved, where the water is coming from and where it is being discharged. Provincial permitting requirements related to water movement – known as the Permit to Take Water (PTTW) administered by the Ontario Ministry of Environment, Conservation and Parks – are detailed in Chapter 9.0. The following subsections detail suggested best practices to apply during dewatering activities.

**Figure 7.10:** A multi-barrier/treatment train approach to dewatering with a sediment bag

### Dewatering bag

Geotextile dewatering bags are commonly applied to filter water during pumping activities. As water is pumped through the bag, sediment is removed through filtration and gravitational settling caused by energy dissipation. The bag also disperses the water from the pump hose, preventing erosion typically associated with concentrated flows.

The dewatering bag should be placed on a relatively flat surface - to ensure the bag doesn't shift downslope – and in an area at least 30 m away from any natural water feature. Vehicle accessibility should be considered to ensure that the bag can be transported away when full. The placement of the bag on a stabilized surface, such as a grassed area or rock pad, will help to mitigate erosion. For a ***multi-barrier approach*** to dewatering through a sediment bag, see TRCA ESC Design Drawings 1 & 2 in Appendix B2. Bags should be inspected regularly and replaced when full, or if water discharged from the bag remains turbid. If water contains a large proportion of fine sediments and remains turbid following treatment, it may be appropriate to use a polymer-based treatment train approach as described below.

Additional design and inspection guidance for sediment bags is provided in Appendix B2.

### Polymer-based treatment train

In some circumstances it may be useful to promote greater settling during dewatering by using a polymer flocculant, which causes sediment particles to bind together. They are best applied to enhance sediment settling when turbidity levels are high and adequate detention times cannot be provided. This is often the case during dewatering, as space constraints typically don't allow for the construction of a large detention area. Flocculants can also be helpful when the water being moved contains a large proportion of fine sediments since these are difficult to settle out of suspension.

**Figure 7.11:** Polymer-based treatment train in a dewatering ditch

A common polymer-based treatment train is a dewatering ditch (Figure 7.11). Pump discharge is released into a ditch system designed to incorporate a polymer flocculant to optimize settling of suspended sediment particles. The ditch should be set up to provide opportunity for sediment removal by allowing for dosing, mixing, settling and final filtration. Appendix B2 provides more detailed guidance on the application of polymer flocculants for clarification of water on construction sites. Specific guidance on anionic polyacrylamide (PAM) is available in the *Anionic Polyacrylamide Application Guide for Urban Construction in Ontario* (TRCA, 2013).

### Dewatering tanks

**Figure 7.12:** Weir tank

Weir tanks (Figure 7.12) can be an important treatment option during construction site dewatering, as these systems detain water to promote sediment settling. Large volume tanks are particularly useful when anticipated pump rates are high. Compared to other detention measures that are built on site, like basins or sediment traps, tanks can be a convenient solution for short duration dewatering activities, since they are readily transported on and off site.

In order to prevent erosion, stabilization measures and flow dissipation should always be applied in the area where the tank discharges. Optimizing sizing with consideration for sediment removal targets, particle size distribution of sediment, anticipated pump rates and tank rental costs is necessary to ensure the system will achieve the desired outcomes. Dewatering (weir) tanks are addressed in more detail in Appendix B2.

### Active treatment systems

Active treatment systems (Figure 7.13) used on construction sites offer more intensive water treatment and are typically applied when:

- water contains elevated levels of certain contaminants of concern, or
- only sediment removal is required but simpler alternative practices cannot achieve the necessary removal rates.

**Figure 7.13:** Active treatment system

They can be particularly useful where effluent discharges directly to sensitive features (e.g. habitat for species at risk). These systems incorporate weir tanks, flocculants and filters in order to achieve a high contaminant removal rate while occupying a relatively small footprint. They differ from a passive polymer treatment train in that they offer more precise control of the treatment processes, such as flocculant dose metering and filter backwashing capabilities. They may incorporate hydrodynamic processes for physical separation of floatables and suspended particles from the water. Active treatment systems are highly customizable and can range from simple to complex, depending on the components included, the types of contaminants being removed and the removal rate required. Additional guidance on active treatment systems is provided in Appendix B2.

## 7.5 Protecting aquatic habitat during in and near water works

Watercourses are complex ecosystems that support a wide range of aquatic habitats and species. They can be flowing with water, intermittently wet, or dry, and include headwater drainage features, swales, creeks, streams, rivers, floodplains, lakes, ponds and wetlands. Some channelized creeks, constructed ditches or municipal drains may also be considered streams.

**The *Fisheries Act* (s. 34) defines fish habitat as areas that fish rely on directly or indirectly, and include spawning grounds, nursery, rearing, food supply and migration areas.**

Any proposed in-water or near-water works must protect fish and wildlife habitat. This includes the surface water feature, as well as the vegetated floodplain areas that provide nutrients and shade to the watercourse, wetland, etc. Fish habitat includes watercourse, streams, ditches, ponds and wetlands that provide water, food, or nutrients into a fish-bearing stream, even if they do not contain fish or if they have temporary or seasonal flows. Additional information on permitting and policies related to these activities, and guidance on the relevant agencies to consult, are provided in Chapter 9.0.

In-water works should be avoided if possible, and may be viewed as a last resort. The rationale behind this is to minimize potential ecological impacts, as in-water works are very intrusive to aquatic habitats and are considered high risk. In-water works can disrupt corridor function and linkages and result in temporary or permanent impairment or loss of aquatic and riparian habitat.

This section identifies standards and recommended best management practices for the planning, design and construction of both in-water and near-water projects. ***Detailed guidance and design drawings relating to best management practices for in and near water works are provided Appendix C.***

### *7.5.1 In-water work*

In-water works refer to any works within a stream channel, wetland, lake or pond. This may include new construction, retrofits or any maintenance activity. Examples include:

- Installation or removal of temporary and permanent stream crossings – culverts, bridges, etc.
- Infrastructure construction (pipelines/conduits/etc.)
- Maintenance of stream crossings or other infrastructure
- Emergency works
- Installing or repairing stormwater outfalls or water intakes
- Spill clean-up
- Erosion protection works
- Stabilization of streambanks / shorelines
- Habitat enhancement and restoration
- Dredging
- Construction or repair of docks or dams

**Figure 7.14:** In-water worksite isolation

All machinery working in the water should have containment for spills and leaks, so that fuel, or other hazardous liquids do not contaminate the aquatic community. For example, excavators may require 'diapers' to prevent leaks and spills. It is also recommended that all refueling or maintenance of equipment occur outside of the watercourse, and a minimum of 30 metres from any surface water feature, in order to prevent spills.

#### Working in the dry

To effectively isolate in-water works, and to 'work-in-the-dry', a physical, water-proof barrier needs to be installed within the surface water feature, or between the work area and the surface water feature requiring protection. The entire work area needs to be completely isolated. Water from the work area must then be removed and treated prior to release to the environment. Only clean water should be discharged back to the environment. Typically, dewatering effluent should be treated, and released a minimum of 30 metres from any surface water feature. The discharge location and flow path should be well vegetated or otherwise stabilized so that erosion of soil does not occur at the discharge point, and treated water does not pick up any additional sediment along the flow path back to the receiver. For any excavations, groundwater or seepage may also need to be removed from the work area. All water from the work area must be treated before release to the environment. Please refer to Section 7.4 on dewatering protocols for additional information.

#### Working in the wet

On occasion, in-water works may be permitted to be completed 'in-the-wet'. In these instances a turbidity barrier or other method may be used to isolate the work area and keep sediment from moving into the rest of the waterbody. Under some circumstances, work may be carried out in-the-wet without isolation of the work area. This is considered when the installation and removal of isolation measures are deemed to be more harmful to the aquatic system than proceeding without work area isolation. Some of the factors that come into play when deciding whether to work in-the-wet without isolation are: potential for risk to the aquatic community, existing aquatic habitat conditions, type of work proposed, and the duration and timing of the work.

As an example, works may be proposed that would occur more quickly and efficiently if isolation is not installed. In this case there may be a net benefit to getting in and out as quickly as possible, and putting in isolation measures could do more harm to the aquatic community than the work itself. Permissions associated with carrying out works without isolation measures are subject to approval by the local CA and other relevant regulatory agencies.

**Figure 7.15:** Turbidity curtain applied to isolate a work area when working in the wet

Work area isolation

When works occur in a watercourse, flows must always be maintained to downstream reaches. This may be achieved by limiting the work area to a portion of the width of the watercourse, so flows can continue unhindered around the work area. The amount of watercourse that may be blocked/restricted should be determined with input from the approval authority. Alternatively, on smaller watercourses the entire flow may need to be blocked, as long as clean creek water is effectively diverted from upstream to downstream of the work area. Stream flows do not require treatment, and can be directly discharged back into the creek, provided there is some erosion protection on the creek bed to prevent scour (see Appendix C for design guidance and drawings). Only the water removed from the work area requires treatment prior to release back to the environment.

Methods of creek flow diversion include dam and pump, by-pass with a temporary channel or flume, and others described in Appendix C. Dam and pump diversions are generally used for short term projects lasting a week or so. Pumps require a high level of inspection and maintenance, which is not efficient for longer term projects. Temporary by-pass channels and flumes are typically used for longer term projects of a few weeks, months or years. Sizing of any barriers and diversions should be determined by consultation between the consultants designing the measures and the approval authority. Guidance on sizing of barriers and diversions is provided in Appendix A, which describes the *Specified Flood Risk Calculation* and Appendix C, which details in water BMPs. The local CA or other relevant permitting agency must be consulted to determine the sizing of isolation measures such as cofferdams.

**The *Specified Flood Risk* calculation, detailed in Appendix A, is recommended for sizing of in-water isolation measures such as cofferdams. The calculation considers the anticipated lifespan of the measure and the acceptable level of risk, which for in-water projects should be 5% or less, as recommended by the MNRF.**

In-water works for which isolation measures are applied will often require a fish and wildlife rescue/relocation plan. As the in-water work area is dewatered, and the water levels decrease, any fish, amphibians, reptiles, or other organisms require rescue and relocation by a qualified biologist. The rescue and relocation of fish and wildlife may require collector's permits / authorizations from the MNRF or, if species at risk are involved, the MECP and Fisheries and Oceans Canada. These agencies should be consulted to determine project and location specific requirements.

### *7.5.2 Near-water work*

Near-water work refers to activities occurring in close proximity to a surface water feature, or activities occurring within its catchment and draining directly to the feature. They can include any works within a valley, ravine, or in a floodplain. Some examples of near water work include:

- Road works;
- Grading;
- Temporary and permanent stream crossings which avoid intrusion into the stream;
- Stormwater outfalls/channels that are set back from a stream;
- Ditching;
- Tree removals with grubbing/soil disturbance;
- Infrastructure installed on the floodplain, valley slope or tunneling under a stream (e.g. pipelines / conduits);
- Terrestrial habitat enhancement and restoration; and
- Groundwater dewatering.

These activities have the potential to impact the aquatic habitat, either directly or indirectly. Near-water works are usually assessed by their level of risk to the surface water feature. Some works may be immediately adjacent to the feature but due to the topography, may not drain directly to the feature, thereby involving a low level of risk. As a result, fisheries or construction timing windows or other restrictions may not apply. Alternatively, a work area that is further removed from the surface water feature but draining directly to it may be classified as having higher risk of sediment contamination. For example, roadwork or grading at the top of a hill, draining directly to a watercourse, may require additional mitigation or timing restrictions.

### *7.5.3 Effective design for in and near water works*

Both in-water and near-water works should have a minimal footprint. Encroachment into the floodplain or surface water feature should be minimized to the extent possible. This will help to maintain stream capacity, floodplain processes, and to minimize habitat destruction. Fish and wildlife passage should also be maintained.

All in-water construction methods should be clearly defined on the plans and contingency plans should be provided to outline actions to take if issues arise during construction (e.g. ice jams, flood conditions). Works should be carried out in an efficient and timely manner to minimize the time in and around the water.

All in-water and near-water works should be scheduled such that works are completed outside of the restricted activity timing windows listed in Table 7.1. These timing windows ensure that aquatic habitats are protected during critical life stages, such as spawning, juvenile stages and migration. Fisheries timing windows can also be called construction timing windows, and indicate when work is to be conducted. If the proposed works cannot be completed outside of the indicated spawning times, a timing window extension may be required, or the work may need to be phased over more than one year. MNRF is responsible for all fisheries timing windows in Ontario, and may defer to a local CA for some or all timing window applications and / or extensions. Proponents should consult with either the local CA or MNRF to determine all timing windows and if extensions may be granted.

**Table 7.1:** Ontario restricted activity timing windows for protection of fish and fish habitat during in-water and near-water works (source: Fisheries and Oceans Canada, 2013)

| | Fish Species | Northwest Region | Northeast Region | Southern Region |
|---|---|---|---|---|
| Spring spawning species | Walleye | April 1 to June 20 | April 1 to June 20 | March 15 to May 31 |
| | Northern Pike | April 1 to June 15 | April 1 to June 15 | March 15 to May 31 |
| | Lake Sturgeon | May 1 to June 30 | May 1 to July 15 | May 1 to June 30 |
| | Muskellunge | May 1 to July 15 | May 15 to July 15 | March 15 to May 31 |
| | Large/ Smallmouth Bass | May 15 to July 15 | May 15 to July 15 | May 1 to July 15 |
| | Rainbow Trout | April 1 to June 15 | April 1 to June 15 | March 15 to June 15 |
| | Other/Unknown Spring Spawning Species | April 1 to June 15 | April 1 to June 15 | March 15 to July 15 |
| Fall spawning species | Lake Trout | Sept. 1 to May 31 | Sept. 1 to May 31 | Oct. 1 to May 31 |
| | Brook Trout | Sept. 1 to June 15 | Sept. 1 to June 15 | Oct. 1 to May 31 |
| | Pacific Salmon | Sept. 1 to June 15 | Sept. 1 to June 15 | Sept. 15 to May 31 |
| | Lake Whitefish | Sept. 15 to May 31 | Sept. 15 to May 15 | Oct. 15 to May 31 |
| | Lake Herring | Oct. 1 to May 31 | Oct. 1 to May 31 | Oct. 15 to May 31 |
| | Other/Unknown Fall Spawning Species | Sept. 1 to June 15 | Sept. 1 to June 15 | Oct. 1 to May 31 |

The type of isolation measures must also be appropriate for the proposed works, time of year, and sensitivity of the habitats. Isolation measures may require specific design considerations, depending on the type of waterbody in, or near, the work area. For example, if works occur within a large river system during the winter, ice build-up and ice flows should be considered. In this instance the coffer dam may require sheet piling or metre bags for support. Please refer to Appendix C for additional information, and some of the various isolation measures currently used.

An effective in-water or near-water work plan should consider the following:

- Erosion risk – carry out an erosion risk assessment and choose and place BMPs to mitigate erosion in the highest risk areas
- Minimize work area footprint – reduce encroachment into the natural feature and minimize habitat destruction
- Know your site – How could site conditions change during construction? Where are the ecological sensitivities? What requires protection?
- Plan how water is to be managed for each stage of construction including treatment and discharge pathway
- Begin the design with erosion controls, and follow up with sediment controls
- Phase stripping and construction to minimize extent and duration of exposed soils
- Prevent the release of deleterious substances, including sediment
- Multi-barrier approach – be proactive and have back up controls (redundancy) in place
- Completely isolate work area from the influence of surface water
- Stabilize exposed soils as you go
- Work in co-operation with regulatory staff
- ESC plan is dynamic – need to manage unexpected conditions and update plans accordingly
- Regular inspections, documentation, maintenance and follow-up

## 7.6 Protecting low impact development sites

As the practice of stormwater management in Ontario continues to move towards more decentralized approaches like Low Impact Development, it has become necessary to re-imagine the way sites are planned from a water management perspective. That also means rethinking stormwater management on construction sites where LID practices are planned. The following subsections provide guidance on protecting LID stormwater measures during the construction process. More detailed information on LID construction is available in Credit Valley Conservation's *Low Impact Development Construction Guide* (2012) and the Canadian Standards Association (CSA) Standard W201-18: *Construction of Bioretention Systems*.

LID practices that may be compromised as a result of inadequate protection during construction are those applied at or below ground level to infiltrate stormwater. They include, but are not limited to the following:

- Bioretention areas
- Permeable pavement
- Infiltration trenches and chambers
- Enhanced grass swales
- Tree cells
- Exfiltration systems
- Other landscaped areas designed to receive stormwater and infiltrate stormwater.

**Figure 7.16:** Infiltration LID practices that can be vulnerable to impacts from construction. Clockwise from top left – bioretention area, permeable interlocking concrete pavement, underground infiltration chambers, enhanced grassed swale.

If protection measures are not in place, the functionality of LIDs may be compromised during site construction in the following ways:

- Clogging with sediment
- Erosion of inlets and beds (for planted areas)
- Subgrade compaction by heavy machinery
- Contamination by substances in construction runoff

A lack of understanding of the system can also result in damage to components like pipes and geotextile fabric. The risk of damage to LID measures continues throughout the construction process – from topsoil stripping to building construction – until the site is permanently stabilized. As such, it is necessary to maintain LID protection measures from the start of construction until:

- construction is complete;
- contributing drainage area is stabilized; and
- construction vehicle mud tracking has ceased.

Because LID measures are vulnerable to construction impacts that can reduce their functionality and lead to costly future repairs, it is imperative that project team members – from designers to inspectors to contractors – communicate effectively to ensure a high level of protection is maintained at all times. The establishment of a builder's agreement can be useful in ensuring protection of LIDs during construction, as they secure the contractor's and sub-contractors' commitment to keeping the LID installations functional (CVC, 2012). Municipalities can also require a letter of credit from the developer, which is tied to LID assumption protocols, and as such only refunded post-construction once the LID measures are confirmed to meet the pre-determined performance criteria. This is similar to the letter of credit system used during municipal assumption of subdivisions once they have been constructed and stabilized.

### *7.6.1 General best practices for LID protection*

- **Phase construction so that LID measures are constructed last.** Planning for the construction of LID measures late in the construction project, where possible, helps to mitigate the sedimentation of infiltration LIDs. If LID measures must be fully or partially constructed earlier, while much of the site is still bare and unstabilized soil, consider protection strategies described in Sections 7.6.2 – 7.6.4.

- **Identify and mark LID areas and increase awareness.** Ensure LID areas are properly identified on ESC plans as well as on the site. In new development sites, clear signage is critical to protecting LID areas, and signage indicating 'no heavy equipment' is particularly important for intended infiltration areas. Areas designated for LID installations should also be sectioned off (e.g. fenced) early in the construction process, when ESC measures are being installed. All staff should be aware of best practices for protecting these areas.

- **Keep LID perimeter controls in working order throughout construction**. Even short term failure of perimeter controls protecting LIDs can result in significant sediment deposition within the area and impacts to its functionality. Perimeter controls should be installed early and kept in place until the site is stabilized and vehicles are no longer tracking mud onto the pavement surfaces that drain into the LID measure. Examples of perimeter controls that are appropriate for protection of LIDs are filter socks, sand or pea gravel bags, natural fibre logs and wattles, and sediment fence. Detailed guidance on application of perimeters BMPs is provided in Appendix B.

- **Protect LID inlets.** LIDs that are kept offline during construction, which is the best approach for ensuring protection of the area, require the installation and maintenance of an impermeable physical barrier at the inlet. For example, curb cuts that serve as inlets for bioretention areas can be blocked off from receiving flows with sand bags or wood. For LIDs that are receiving runoff, permeable barriers can be installed at the inlet to help settle and/or filter out suspended sediment before the water enters the infiltration area. If underdrains and inlets meant to connect to the LID have accumulated construction sediment, they should be cleaned and/or flushed before the LID is constructed and online.

- **Avoid heavy equipment on intended infiltration sites.** In order to avoid compaction of native soil in LID areas, heavy equipment routes should be established as part of ESC plans. Signage indicating 'no heavy equipment' should be installed early in the construction process to identify LID measures, which should be sectioned off to keep all vehicle traffic off these areas.

- **Inspect LID areas during ESC site inspections.** ESC site inspections should be carried out weekly and before and after rain or snowmelt events to determine whether ESC measures installed are in good working order and functioning as intended. LID areas should be included in these inspections to confirm that LID protection measures are adequate, or to flag any instances where ESC repairs or enhancements are needed.

- **Be mindful of stockpile locations relative to LID areas.** Stockpiles of construction materials should be stored down gradient of LIDs to the extent possible (≥ 30 m recommended), since they can be a significant source of sediment that may be washed into the LID area. Sediment controls (e.g. sediment fence, filter socks) should be installed around all stockpiles, particularly those that are located up gradient of LIDs.

### *7.6.2 Protecting filtration and infiltration LIDs – flow diversion*

The best strategy for protecting ground level filtration (e.g. grassed swales) and infiltration (e.g. bioretention areas) LID installations is to keep them offline until construction is complete, the drainage area is stabilized, and vehicle mud tracking has stopped. Diverting flows around LID areas offers several benefits, including:

- Less risk of erosion and clogging with sediment;
- Greater opportunity for seeded/planted LID areas to become established; and
- Easier access to carry out additional construction, repairs or maintenance of the LID area

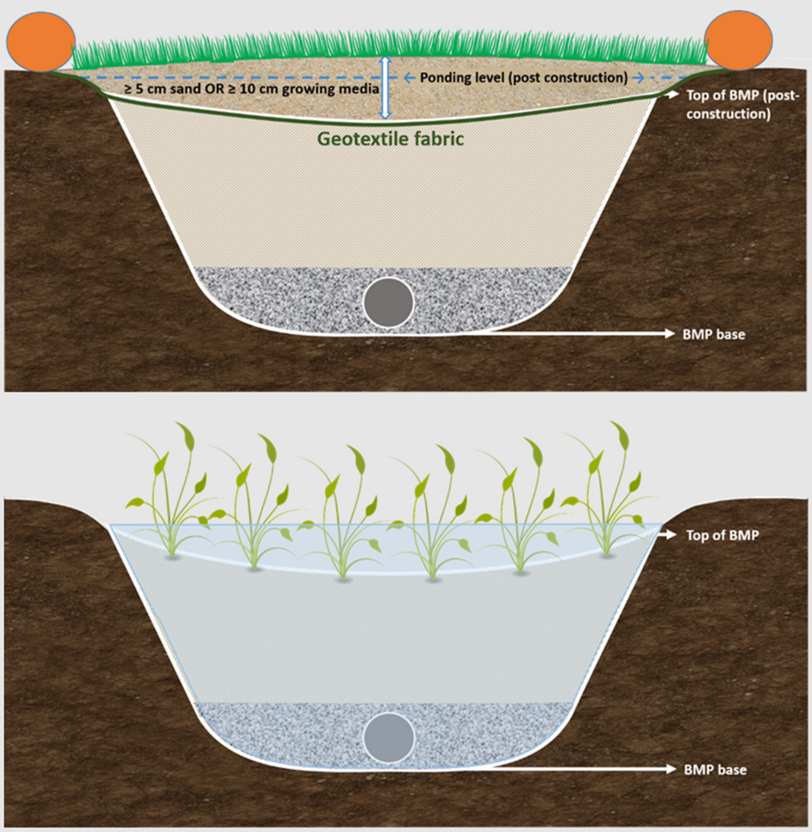
It is recognized that in some cases this cannot be achieved, and that the location of the LID area may require that it be used as a temporary runoff detention basin. Options for protecting LIDs that are being used for construction stormwater detention are provided in section 7.6.3.

Figure 7.17 provides a graphic depiction of methods used to protect an infiltration LID – a bioretention area in this case – in a situation where the LID can be constructed and then kept offline until drainage area construction and stabilization are complete. The top picture shows a sacrificial layer consisting of 10 cm of growing media or 5 cm of sand laid on a liner – geotextile fabric or an 8 mil poly sheet – over the final post-construction grade of the bioretention area. This sacrificial layer prevents the migration of sediment down into the growing media and underdrain. The layer should not be much greater than the stated recommended thickness, as excessive material weight could contribute to substrate compaction.

The middle picture depicts a multi-barrier approach to protection of the bioretention area, with perimeter filter socks and vegetative stabilization added on the sacrificial layer. With multiple barriers in place – including flow diversion, perimeter control, a sacrificial layer and stabilization – this option would provide the highest level of protection against sediment deposition in the bioretention area.

**PROTECTING SURFACE INFILTRATION LID WHEN FLOWS CAN BE DIVERTED**

***Bioretention example***




- Bioretention is built but not planted.
- A layer of growing media (≥10 cm) or sand (≥5 cm) and geotextile is added on top of the final post construction grade of the BMP.

- Additional controls recommended for enhanced protection of this BMP would be the addition of a compost biofilter sock or similar permeable barrier surrounding the area.
- Where possible the sacrificial growing media or sand layer should be stabilized.

- Bioretention depicted post-construction and filled with water during a storm event.
- This sacrificial protective layer of sand or growing media is removed once construction is complete and BMP starts receiving flow.

**Figure 7.17:** Methods used to protect surface infiltration LIDs that can be kept offline.

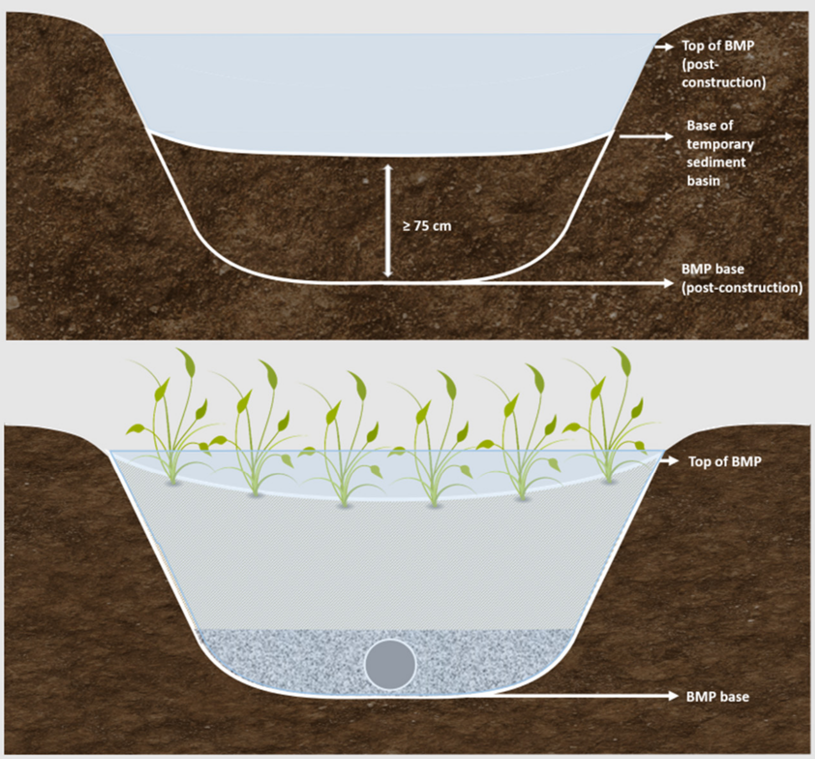
### *7.6.3 Protecting filtration and infiltration LID areas used for temporary stormwater detention*

The use of ground level LID areas as temporary detention basins should be avoided if possible, as it is associated with a higher risk of subgrade clogging and compaction from construction vehicles used to remove accumulated sediment. In cases where LIDs must be used for construction stormwater detention due to site topography and the layout of the development, protection measures can be applied to prevent accumulated sediment from migrating into the subgrade.

Figure 7.18 provides a graphic depiction of the use of a bioretention area as a temporary detention basin for construction runoff. As shown in the top image, the LID is not fully constructed – rather it is only excavated down to 75 cm above the final post-construction base of the bioretention. Maintaining at least 75 cm of native soil between the base of the temporary detention basin and the final post-construction base of the bioretention area ensures that fine particles will not migrate down into the subsoils.

**PROTECTING SURFACE INFILTRATION LID WHICH IS USED AS A TEMPORARY DETENTION BASIN**

***Bioretention example***




- When flows cannot be routed around LID during construction
- Retain ≥75 cm native soil between the base of the detention basin and the final base of the LID when complete.
- Sediment accumulation in detention basin removed during excavation to construct LID.

- Once LID is built, protect until construction and stabilization are complete.
- Bioretention depicted post-construction and filled with water during a storm event.

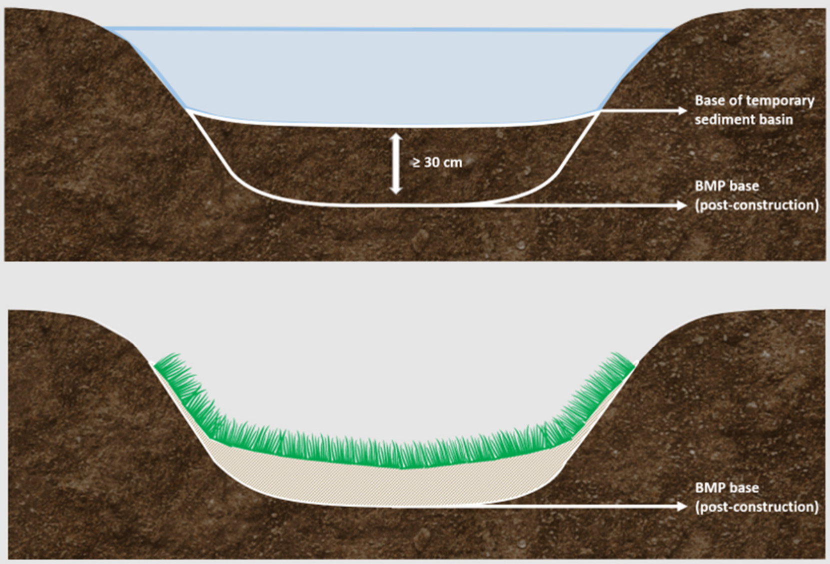
**Figure 7.18:** Protecting surface infiltration LIDs that are used as construction sediment detention basins

Sediment accumulated in the detention basin is ultimately removed as part of excavating to complete construction of the bioretention. The CSA Standard "Construction of Bioretention Systems" recommends scarification of any compacted native soil areas (CSA, 2018b). Once it is excavated and filled, ESC measures – such as perimeter controls, inlet protection and stabilization - should be put in place to protect it until all drainage area construction and stabilization are complete.

The same principles described above for protection of a surface infiltration LID can be applied in protecting a filtration LID – like a grass swale – when it is used as a temporary detention basin (Figure 7.19). In this case, the minimum depth of native soil between the base of the detention basin and the final base of the grassed swale LID should be 30 cm.

**PROTECTING SURFACE FILTRATION LID WHICH IS USED AS A TEMPORARY DETENTION BASIN**

***Grassed swale example***




- When flows cannot be routed around a filtration LID during construction.
- Retain ≥30 cm native soil between the base of the detention basin and the final base of the LID when complete.
- Once LID is built, protect until construction and stabilization are complete.
- Grassed swale depicted post-construction, after removal of the extra 30 cm of native soil and final stabilization.

**Figure 7.19:** Protecting filtration LIDs that are used as construction sediment detention basins

### *7.6.4 Protecting underground LIDs*

Underground infiltration LIDs, such as infiltration chambers and exfiltration systems, can be built early in the construction process (e.g. during cut and fill) provided that they are protected by a barrier preventing sediment laden construction runoff from entering the facility. A barrier, like a plug or bulkhead, should be installed to keep construction sediment from clogging the LID and an alternative flow route and/or detention area must be established. The underground infiltration facility should be kept offline until drainage area construction and stabilization are complete and vehicle mud tracking has ended. Figure 7.20 shows a schematic of an exfiltration system which has been kept offline with a temporary plug in order to keep construction sediment from clogging the system.

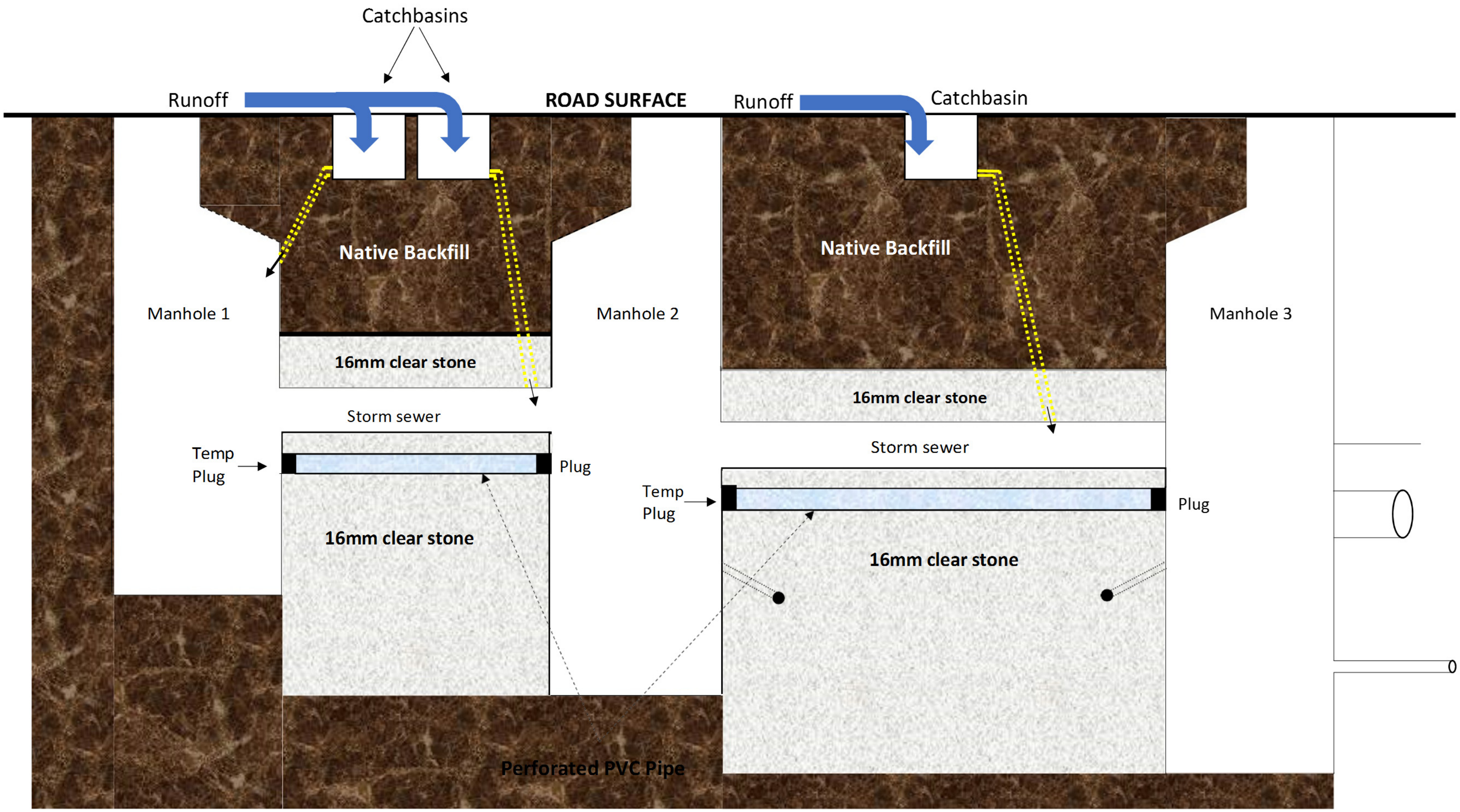



**Figure 7.20:** Exfiltration system schematic showing temporary plug keeping construction runoff out of the exfiltration area.

## 7.7 Spill response and control plan

**_What constitutes a spill?_**

In Ontario, a spill is a discharge of a pollutant into the natural environment that:

- is from or out of a structure, vehicle or other container; and
- is abnormal in quality or quantity in light of all the circumstances of the discharge.

Developing a plan for responding, controlling and reporting spills is an important component of ESC planning on construction projects. While spills may not be a routine occurrence, their impacts when they do occur can be substantial. Responding to these incidents quickly and effectively can greatly reduce the extent to which the natural environment is adversely impacted, and the resources needed for clean-up efforts. Having a spill response and control plan in place is also an important way to demonstrate due diligence in mitigating environmental harm.

While the level of detail and type of information needed in a spill response and control plan may vary based on project specific factors (e.g. location, activities planned, potential pollutants on site), the plan should, at minimum, including the following information:

- Relevant emergency contact numbers, including both project and external contacts (e.g. Spills Action Centre, municipal spills contact, land owner)
- Description of spills control equipment and materials that should be available on site, including quantities and locations
- Description of actions to be taken in the event of a spill, including procedures for responding, reporting, containment and clean up. If the required actions vary depending on the spill magnitude, all potential scenarios should be addressed.

### *7.7.1 Spills prevention*

As in many cases, an ounce of prevention is worth a pound of cure. Best practices for preventing spills include:

- Be aware of all potential pollutants on the site. Some of the more common pollutants to be considered on construction sites include fuels, concrete wash-out, and silt/sediment, if it is released into natural features.
- Consider potential pollutants and assess spill risk according to the intended use, quantity on site, and their location relative to storm drain inlets and natural features. Materials Safety Data Sheets should be available for reference as needed. Understanding the risks in advance is a key step towards getting the appropriate protection measures in place.
- Plan to store pollutants in a secure area at least 15 metres away from natural water features, storm drains or drainage channels. Maintain buffers around natural features, as detailed in Appendix B1.
- Ensure pollutants brought on site are delivered directly to the designated storage area, and that deliveries are supervised by knowledgeable on site staff.
- Locate any designated vehicle maintenance areas at least 15 metres away from natural features and storm drains.
- Ensure that the machinery and equipment used during construction operations in sensitive environments is appropriately sized for the activity and also be well maintained.

- Keep a spill kit on site in a central location (e.g. near construction trailer) and in key vehicles, and ensure that staff understand how to use it to clean up minor spills. Major spills need to be reported as described in the next section, and mitigation and clean-up efforts may require the advice and involvement of regulatory agencies.
- Keep instructional information and key spills contacts in a central location known to staff, ideally with the spill kit.
- Inspect pollutant storage areas regularly and ensure that control measures around them are kept in good working order. Ensure that pollutant storage containers are properly sealed and undamaged.
- Maintain ESC measures and carry out regular inspections at the frequency detailed in Section 10.1.2. Ensure ESC measures are robust and capable of holding up during large rainfall events.
- Prioritize ESC in areas of the site that are highest risk, as identified using the erosion risk assessment methodology detailed in Chapter 6.0. Large sediment releases often occur as a result of a major ESC deficiency, such as a slope failure due to inadequate stabilization, or the breaching of sediment control pond banks. Identifying the high risk areas will allow for better placement of protection measures and greater preparedness in the event of a sediment spill.

### 7.7.2 Spill response

All ***minor spills*** should be immediately contained, cleaned up and removed from site. Documentation of the incident and clean-up actions should be kept with ESC inspection records and other key documentation.

***Significant spills*** are those that have the potential for adverse impact on the water feature into which the spill occurred. They should be reported immediately to the contract administrator and ESC inspector. The contract administrator must notify the Ontario Spills Action Centre. The municipality, conservation authority enforcement officer for that area, and the landowner/developer should also be notified.

Monitoring efforts and documentation of incident details and containment/clean-up procedures should be initiated immediately upon detection of the spill. Documented details of the incident, as well as updates on site conditions and containment/clean-up efforts must be provided to the attending agency. The Ontario Spills Action Centre requests reporting of the following details when reporting a spill:

- Reporting individual’s name and phone number
- The name and phone number of the person or company in control of the product spilled
- Date, time and location of the spill
- Duration of the spill (if known) and whether the spill is ongoing
- Type and quantity of pollutant spilled, including hazard level or toxicity information
- Source of the spill and information on the cause
- Description of adverse effects
- Environmental conditions that affect the spill (weather, traffic, etc.)
- Actions being taken to respond
- Other agencies and parties responding

Following reporting of the spill, an Environmental Officer from the Ministry of Environment, Conservation and Parks will gather information, assess conditions and impacts, and ensure clean-up is properly undertaken by coordinating with other regulatory agencies, providing advice and issuing orders if needed.

# 8.0 ESC PLAN SUBMISSION REQUIREMENTS

The submission requirements for erosion and sediment control strategies outlined within the Guide are organized based on three planning stages: early, intermediate and late, which align with both the land-use and infrastructure planning processes. The terminology used to describe the planning stages varies from municipality to municipality and between planning and environmental assessment processes. This method uses the terms **early**, **intermediate** and **late** stages to generalize them and accommodate all of these processes, as shown in **Figure 8.1**.

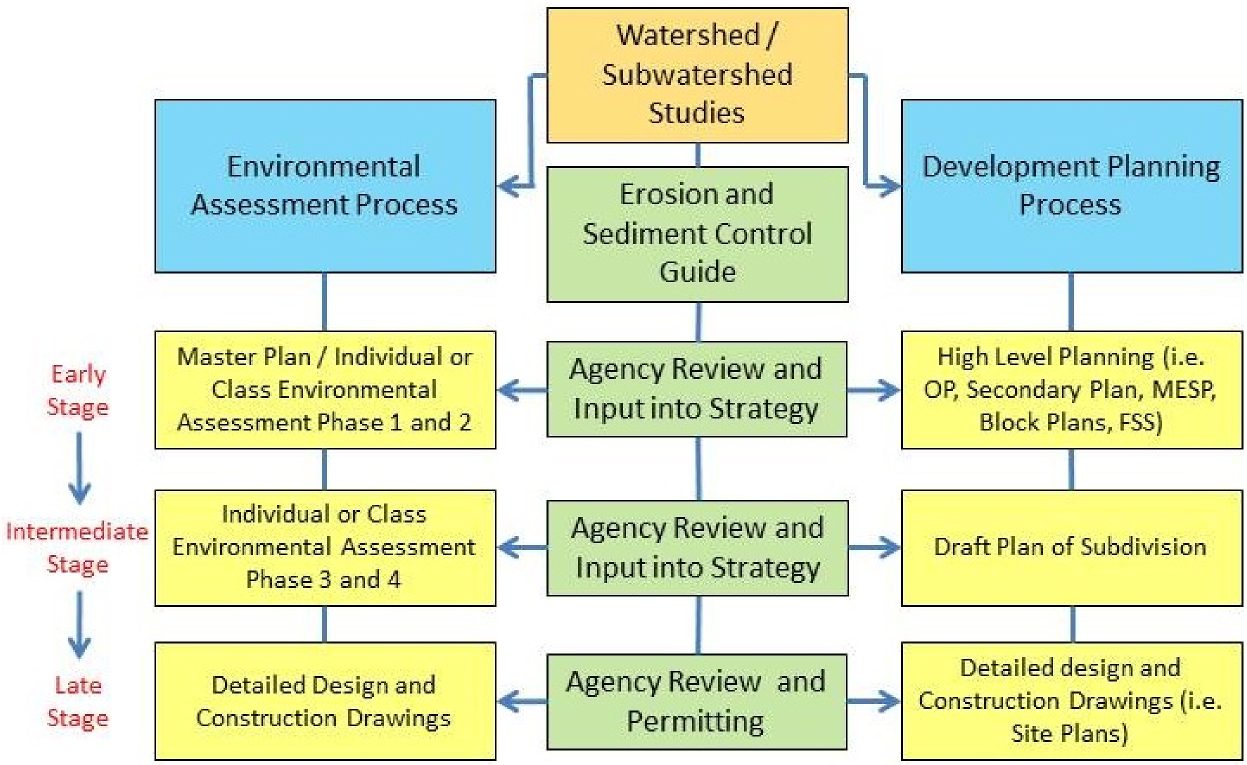



**Figure 8.1:** Agency plan review and permitting roles
Note: The planning instrument used to determine alternative alignments and the scale and level of detail of information provided for the early planning stages may vary by municipality.
OP = Official Plan, MESP = Master Environmental Servicing Plan, and FSS = Functional Servicing Study

Although these requirements are presented separately according to each stage, they build on each other, ensuring the required level of analysis is completed at the appropriate time to progressively inform planning and design. It is therefore important to understand the requirements within each stage to ensure a coordinated approach. The three stages are outlined below:

1. The **early stages** of planning refer to those activities in the environmental assessment and planning processes related to establishing the layout of the proposed development or the need for infrastructure and assessing alternative road or rail routing and alignments, as shown in Figure 8.1. The specific planning instruments adopted to undertake this stage, and the level of detail of the information provided varies by municipal jurisdiction. For example, for the planning process, the Master Planning stage may

provide input into the official plan, which is then further articulated in the secondary plan or official plan amendment stages. Master Environmental Servicing Plans, Block Plans, or Functional Servicing Studies may also be prepared at this stage. However, in some cases, impact assessment and conceptual design (intermediate stage) will also be undertaken through these studies. For the environmental assessment process, the early stage covers Phases 1 and 2 of the process relating to the identification of the problem / opportunity and the evaluation of alternative solutions.

Conservation Authorities will review and comment, working towards conditional approvals of applications at this stage based on efforts towards meeting the criteria as set in both conservation authority and provincial guideline documentation.

2. Once the infrastructure or development plan has been established, and the preferred layout determined, the activities in the intermediate stages of planning further refine the early stage planning decisions, including impact assessment and development of alternative conceptual designs. For example, the draft plan of subdivision phase and the Individual or Class Environmental Assessment Phases 3 and 4 represent intermediate stage planning activities. Conservation authorities will review and provide comments based on meeting the objectives outlined in guideline documentation.

3. The activities in the late stages of planning further refine the conceptual designs completed during the intermediate stages including development of the detailed design of the site. Conservation authorities will review and approve final designs, including construction and ESC drawings, through the permitting process.

## 8.1 Requirements for early stages of planning and design

During the early stages of planning and design, the focus of the erosion and sediment control works should coincide with the overall planning stage: high level conceptualization, strategizing, and an effort to understand the works to be conducted during subsequent design stages. In this manner, the efforts provided during this stage will feed into further studies, helping guide the ESC strategy to minimize impacts on the downstream receiving systems. It is understood that not all details of the proposed works will be known, and that only general guidance is requested at this point.

To meet this end, the early planning stages documentation should incorporate discussion on early strategizing for construction, using the engineering and ecological information at hand to determine the level of erosion and sediment controls required moving forward. High level documents, including Master Plans or Subwatershed Studies, can focus on the commitment for appropriate ESC strategies moving forward, where a more informed strategy can be investigated during Block Plans, Functional Servicing Studies or Individual or Class EA Phases. These strategies can include, but not be limited to:

- Discussion related to an ESC monitoring strategy and timing, if necessary based on site specific circumstances (see Chapter 10.0 for turbidity monitoring considerations);
- Conceptual construction phasing plans, if design has advanced to this stage; and
- Strategies to minimize unnecessary stripping of vegetation from the site.

These strategies can incorporate ecological and engineering information to determine the appropriate level of ESC plan necessary.

<u>Submission Requirements</u>

During the early planning stages, the following information should be provided with the appropriate documentation:

- Commitments to developing an ESC strategy during the various planning and design stages;
- Discussions related to the sensitivity of the downstream receiving systems and an estimated level of effort required during subsequent design stages; and
- If designs have advanced accordingly, a conceptual ESC strategy. Otherwise this can be provided at later stages.

## 8.2 Requirements for Intermediate Stages of Planning and Design

During the intermediate stages of planning and design, the focus of the erosion and sediment control works is on preparing site level strategies. The appropriateness of strategies prepared during previous planning and design stages will be verified based on consideration of advanced information available related to the site layout and grading requirements. Further, the works at this level will provide greater insight to the level of effort required in preparing the final ESC plans and reports during the final planning and design stages.

The level of detail expected during the intermediate stage would consist of preliminary site plans, rough grading requirements, and locations of required utilities, including stormwater management measures, with varying levels of ecological and geotechnical information provided. Working with this, ESC designers can determine the level of effort required at detailed design, including the following:

- If monitoring is determined to be required (see considerations in Section 10.2.1), a breakdown of the monitoring plan should be prepared, including:
  - What monitoring is required before and during construction (see section 10.2);
  - What parameters will be monitored and how;
  - Where the monitors will be located;
  - How long monitoring will continue; and
  - Who will conduct the monitoring.
- If infiltration LIDs are proposed as part of the SWM measures, a conceptual strategy to isolate the LID during construction (see Section 7.6) could be provided if that information is available at this stage in the project. Otherwise, LID isolation should be addressed in the detailed design submission.
- Investigations into construction phasing and stripping strategies can occur to reduce unnecessary stripping.

<u>Submission Requirements</u>

- If required, detailed monitoring plan describing the above, detailing when the monitoring plan will begin and outline a reporting scheme for the monitoring activity; and
- Preliminary level reporting discussing the current ESC strategy. If information on phasing and stripping strategies is available at this stage of the project, they should be included in the submission.

## 8.3 Requirements for Detailed Design Stages of Planning and Design

During the detailed design stage, a comprehensive ESC report and drawings are prepared using the strategies from previous design stages. The reports and plans need to clearly demonstrate the preferred strategy, including ESC measures in relation to construction phasing. The following sections provide more details for the report and drawing requirements.

Report

The purpose of the ESC report is to provide clarity to the ESC drawings, including discussion on specific areas of concern, erosion risk outcomes (including mapping), and overall direction for the ESC strategy during various construction phases. The report should be a stand-alone document that contains, at minimum, the following information:

- Site Location
- Existing Site Conditions
- Proposed Site Alteration
- Construction Phasing;
- Erosion Risk Assessment (section 6.2.5)
- Design Details for Erosion and Sediment Control Mitigation;
- Inspection and Maintenance;
- Monitoring Plan (if necessary); and
- Professional Engineer Seal, signed and dated.

Refer to **Table 8.1** for full details of the requirements of the ESC Report.

In specific circumstances, a monitoring plan may be required. In these instances, the information provided in the ESC Report will vary from site to site, and continuous communication with the permitting agencies will be necessary. In these instances, the monitoring plan information incorporated into the ESC Report will be outlined during the intermediate stage.

**Table 8.1:** ESC report content checklist – submission requirement during detailed design

| Section | Content description | Reference | Section included? | If no, provide reason |
|---|---|---|---|---|
| **Contact information / definition of roles** | i. Identify, and define roles of, key personnel including but not limited to:<br>• Site owner, project manager / design engineer, ESC inspector, 24 hour emergency contact<br>ii. Outline chain of communication | Chp. 5.0, Table 5.1 | ☐ Yes<br>☐ No | |
| **Site location** | Location, key map and site area (ha)<br>**provide in report or reference plan with this information | | ☐ Yes<br>☐ No | |
| **Existing site conditions** | Detail existing site conditions, including:<br>i. land cover and use<br>ii. vegetation<br>iii. general topography<br>iv. existing flow patterns and external drainage<br>v. adjacent properties and their land uses, including identification of any protected natural heritage features[1]<br>vi. soil characteristics. | | ☐ Yes<br>☐ No | |
| **Receiving water system** | Provide the following information about water system(s) that will receive runoff / discharge from the site:<br>i. Identification / names of features/systems that will be receiving site flows, whether natural (e.g. streams) or other (e.g. sewer system).<br>ii. Classification of natural receiving water body (coldwater, warmwater, species at risk habitat)<br>iii. Summary of current aquatic habitat conditions<br>iv. Identification of confined or unconfined valleys<br>v. Physical description of receiver (e.g. critical erosion areas, channel dimensions, slope, etc.) | | ☐ Yes<br>☐ No | |
| **Proposed Site Alteration** | Provide a brief discussion of the proposed activities, including:<br>i. description and location of permanent and temporary SWM measures<br>ii. plans for using permanent SWM facilities for sediment control during construction<br>iii. LID details if applicable, including types, locations, and any controls / methods applied to prevent sedimentation | LID protection measures (s. 7.6) | ☐ Yes<br>☐ No | |

| | | | | |
|---|---|---|---|---|
| **Construction phasing** | i. Provide a brief discussion on proposed construction phasing to minimize unnecessary stripping of the site and efforts to re-stabilize inactive areas where possible.<br>ii. Describe boundary of work zone(s), work proposed during each stage, and approximate time to complete each stage.<br>iii. Identify any applicable ecological timing windows that affect schedule. | Minimized or phased land clearing guidance (App. B, p. B1-2) | ☐ Yes<br>☐ No | |
| **Erosion Risk Assessment** | For applicable sites, provide documentation and results of Erosion Risk Assessment (ERA) which are detailed in Chapter 6.0. | ERA (Chp. 6.0) | ☐ Yes<br>☐ No | |
| **Design details and calculations for ESC measures** | Provide details on how ESCs will be implemented for each construction stage, including supporting calculations and design details.<br>• For sediment ponds, include detailed calculations related to permanent pool and active storage volumes, pond outlet and emergency spillway<br>• Where applicable, consider ERA outcomes when selecting and placing BMPs.<br>• Describe plans for site restoration / permanent stabilization, including proposed seed mix with species and percentage composition. | ESC BMP design (App B)<br>Sediment pond design (p. B2-32)<br>Seeding & restoration (App. G)<br>ERA outcomes for ESC planning (s. 6.2.5) | ☐ Yes<br>☐ No | |
| **Inspection, monitoring and maintenance** | Describe the ESC inspection and monitoring program by detailing:<br>i. inspection frequency<br>ii. documentation and reporting protocol<br>iii. chain of communication<br>iv. anticipated repair / maintenance timelines and<br>v. monitoring protocols | Inspection and monitoring guidance (Chp 10)<br>Recommended protocols for continuous turbidity monitoring (s.10.2) | ☐ Yes<br>☐ No | |
| **Emergency Contacts** | Provide list of emergency contacts (e.g. site supervisor, regulatory agency enforcement officer) and define the triggers (e.g. chemical spill, elevated stream turbidity levels) that constitute an emergency. | Turbidity targets (s. 10.2.2)<br>Spills response (s. 7.7) | ☐ Yes<br>☐ No | |
| **Sealing** | Report should be sealed, signed, and dated by a Professional Engineer. | | ☐ Yes<br>☐ No | |
| **Supporting documents** | If applicable, include: (i) soils report, (ii) sample ESC inspection form, (iii) monitoring protocol | | ☐ Yes<br>☐ No | |

1 – Protected natural heritage features include: watercourses, wetlands, woodlands, valleylands, Areas of Natural and Scientific Interest (ANSI), Environmentally Significant Areas (ESA), habitat of endangered and threatened species, fish habitat, seeps and springs, and significant wildlife habitat

Drawings

The purpose of the ESC drawings are to provide a visual representation of the ESC strategy and measures for the purposes of construction. The drawing package will support the ESC Report, with the ESC drawings prepared to be able to provide all ESC information pertinent for the site. In order to convey the ESC strategy effectively, the ESC drawings should provide, at minimum, the following information:

- Existing site conditions;
- Proposed site alterations;
- Construction phasing; and
- ESC design and details, which would include:
  - A drawing for each stage of construction (see Section 7.2)
  - ESC construction notes
  - Emergency contact information

Refer to Table 8.2 for full details of the requirements of the ESC Drawings.

**Table 8.2:** ESC drawings checklist – submission requirement during detailed design. *Note: not all projects require all drawings detailed here*

| Item | Description | Reference | Item complete? | If no, provide reason |
|---|---|---|---|---|
| **General items** | | | | |
| **Drawing formatting** | • Site address and application number<br>• Key plan including site limits<br>• Drawing scale<br>• North arrow<br>• Legend which includes identification of standard drawing elements and ESC measures | | ☐ Yes<br>☐ No | |
| **Emergency contacts** | In the event of an emergency, the following contacts need to be provided in the ESC notes on all drawings:<br>• The engineer responsible for the ESC drawings<br>• Site supervisor<br>• Pertinent agency enforcement officer | | ☐ Yes<br>☐ No | |
| **Standard notes** | Examples include:<br>• The ESC strategies outlined on the plans are not static and may need to be upgraded/amended as site conditions change to prevent sediment releases to the natural environment. Any changes from the approved ESC plans will be documented and reported to the Enforcement Office.<br>• Inspection of the proposed erosion and sediment control measures will occur at the frequency defined in section 10.1.2.<br>• All damaged ESC measures will be repaired and/or replaced within 48 hours or sooner if environmental receptors are at imminent and foreseeable risk of adverse impact.<br>• Disturbed areas left for 30 days or longer must be stabilized.<br>• Temporary sediment conveyance systems and sediment pond to be immediately stabilized (include stabilization method if possible, and notes on seasonally appropriate stabilization practices)<br>***Notes provided are for general reference only. Additional notes will be required as necessary based on ESC measures and strategy employed.*** | Consult with local CA for notes required | ☐ Yes<br>☐ No | |
| **Sealing** | All drawings must be sealed, signed, and dated by a Professional Engineer. | | ☐ Yes<br>☐ No | |

## Stage 1: Topsoil stripping, grading, and re-stabilization

| | | | | |
|---|---|---|---|---|
| **Drawing 1: Existing Site Conditions** | • Contour elevations at 0.5-1.0 m intervals;<br>• Drainage boundaries and directions;<br>• Vegetation locations<br>• Highly erodible areas, with a plan provided for any downstream areas where erosion risk is a concern;<br>• Water body locations;<br>• Regional storm floodplain and regulation areas. | | ☐ Yes<br>☐ No | |
| **CONDITIONAL REQUIREMENT: Proposed site alterations** | *Include only if the submission does not include other engineering drawings (e.g. SWM plan, or stage 3 or 4 ESC plan) that would show these details.*<br>• Show proposed site condition **<u>excluding</u>** ESC measures<br>• A cut/fill plan showing existing and proposed contours and spot elevations<br>• Clearing, grading, and site boundary limits<br>• Proposed SWM measures and their locations, including LID | | ☐ Yes<br>☐ No | |
| **Drawing 2: Stage 1 ESC Plan** | • Based on existing conditions drawing | Staged ESC planning (s. 7.2)<br>Minimized or phased land clearing (p. B1-2)<br>ESC BMPs guidance (App. B)<br>Dewatering protocols (s. 7.4)<br>Buffers (p. B1-2)<br>Perimeter controls (App. B)<br>Vehicle tracking controls (p. B2-48)<br>Interceptor swales (p. B1-9) | ☐ Yes<br>☐ No | |
| | • Construction phasing details, including limits of disturbance, phasing boundaries and construction sequencing details. | | ☐ Yes<br>☐ No | |
| | • Drainage areas identification, including delineation of all external and internal drainage boundaries, labels for catchment sizes (ha) and runoff coefficients, and depiction of overland flow routes | | ☐ Yes<br>☐ No | |
| | • Location and details for all ESC measures, including dewatering protocols to ensure appropriate treatment of pumped water. | | ☐ Yes<br>☐ No | |
| | • Identification of appropriate buffers / setbacks from natural features. | | ☐ Yes<br>☐ No | |
| | • Placement of perimeter controls, with appropriate setbacks / buffers applied and consideration of more robust controls upslope of sensitive areas | | ☐ Yes<br>☐ No | |

| | | | | |
|---|---|---|---|---|
| | • Vehicle access points - locations and ESC measures applied – and identification of internal haul roads. | Check dams (p. B2-8 to B2-17)<br>Sediment control ponds (p. B2-32)<br>LID protection during construction (s. 7.6) | ☐ Yes<br>☐ No | |
| | • Details on stormwater conveyance measures, including interceptor swale dimensions and design flows, erosion prevention measures, and placement of check dams. | | ☐ Yes<br>☐ No | |
| | • Details for temporary sediment control ponds, including:<br>i. Plan view of pond showing grading requirements<br>ii. Cross-sections of the pond, including length, width, and outlet structure<br>iii. Stage-storage tables showing adequate depth and volume<br>iv. Details of storm inlet, outlet, emergency overflow and any associated drainage facilities<br>v. Stabilization techniques<br>vi. Plans for decommissioning or conversion to permanent SWM facility. | | ☐ Yes<br>☐ No | |
| | • Where applicable, LID locations and any measures applied to mitigate compaction of infiltration LID areas. | | ☐ Yes<br>☐ No | |
| | • Stockpiles and/or berm locations, sizes and ESC measures, including stabilization for stockpiles idle for > 30 days. | | ☐ Yes<br>☐ No | |
| | • Notes related to ESC requirements. | | ☐ Yes<br>☐ No | |
| **Stage 2: Site servicing** | | | | |
| **Drawing 3: Stage 2 ESC Plan** | • Coordination with Stage 1 and Stage 3 Construction Activities | | ☐ Yes<br>☐ No | |
| | • Overlay of draft subdivision plan provided on ESC Plan (showing ultimate roadway and lot layout) | | ☐ Yes<br>☐ No | |

| | | | | |
|---|---|---|---|---|
| | • Updated locations and details for all ESC measures, including dewatering protocols to ensure appropriate treatment of pumped water. | ESC BMPs guidance (App. B)<br>Dewatering protocols (s. 7.4) | ☐ Yes<br>☐ No | |
| | • Where applicable, LID locations and any measures applied to protect against sedimentation and compaction of infiltration LID areas. | LID protection during construction (s. 7.6) | ☐ Yes<br>☐ No | |
| | • Updated drainage area details, including delineation of all external and internal drainage boundaries, labels for catchment sizes (ha) and runoff coefficients, and depiction of overland flow routes<br>• Catchbasin inlet protection types and locations | Inlet protection (p. B2-21) | ☐ Yes<br>☐ No | |
| | • Notes related to ESC requirements. | | ☐ Yes<br>☐ No | |
| **Stage 3: Building construction** | | | | |
| **Drawing 4: Stage 3 ESC Plan** | • Updated drainage area details, including delineation of all external and internal drainage boundaries, labels for catchment sizes (ha) and runoff coefficients, and depiction of overland flow routes<br>• Catchbasin inlet protection types and locations (e.g. all rear lot and street catchbasins) | Inlet protection (p. B2-21) | ☐ Yes<br>☐ No | |
| | • Updated locations and details for all ESC measures, including dewatering protocols to ensure appropriate treatment of pumped water. | ESC BMPs guidance (App. B)<br>Dewatering protocols (s. 7.4) | ☐ Yes<br>☐ No | |
| | • Updated details on stormwater conveyance measures, including interceptor swale dimensions and design flows, erosion prevention measures, and placement of check dams. | Interceptor swales (p. B1-9)<br>Check dams (p. B2-8 to B2-17) | ☐ Yes<br>☐ No | |
| | • Plan for dewatering sediment control ponds during construction of permanent stormwater management facilities, including:<br>i. details on discharge locations;<br>ii. measures for treating sediment laden water; and<br>iii. erosion prevention measures at discharge points. | Sediment ponds maintenance (p. B2-32)<br>Dewatering protocols (s. 7.4) | ☐ Yes<br>☐ No | |

| | | | | |
|---|---|---|---|---|
| | • Where applicable, LID locations and updated details on any measures applied to protect against sedimentation and compaction of infiltration LIDs. | LID protection during construction (s. 7.6) | ☐ Yes<br>☐ No | |
| | • Updated stockpiles and/or berm locations, sizes and ESC measures, including stabilization for stockpiles idle for > 30 days. | | ☐ Yes<br>☐ No | |
| | • Notes related to ESC requirements. | | ☐ Yes<br>☐ No | |
| **Stage 4: Final stabilization and decommissioning** | | | | |
| **Drawing 5: Stage 4 ESC Plan** | • Planting / site restoration plan depicting all permanent stabilization measures and timelines | Erosion control BMPs (App. B1)<br>Restoration guidelines (App. G) | ☐ Yes<br>☐ No | |
| | • Plan for dewatering sediment control ponds during construction of permanent stormwater management facilities, including:<br>iv. details on discharge locations;<br>v. measures for treating sediment laden water; and<br>erosion prevention measures at discharge points. | Sediment ponds maintenance (p. B2-32)<br>Dewatering protocols (s. 7.4) | ☐ Yes<br>☐ No | |
| | • Removal / decommissioning of ESC measures depicted in drawing and / or drawing notes. | | ☐ Yes<br>☐ No | |
| | • Where surface infiltration LIDs are planned for the site, provide details on LID planting / stabilization. | | ☐ Yes<br>☐ No | |
| | • Notes related to ESC requirements. | | ☐ Yes<br>☐ No | |

# 9.0 APPROVALS PROCESS

The permits and approvals required for an urban construction project are dictated by relevant legislation and various project and site specific circumstances. Having a clear understanding of these requirements can save time and help to keep construction projects on schedule and on budget. A summary of the legislative framework related to ESC is provided in Appendix D.

The review and approvals process related to ESC on construction projects will vary to some extent depending on project details such as:

- Geographic location
- Whether the site is in a conservation authority regulated area
- Proximity to protected natural features (e.g. Environmentally Significant Areas, Provincially Significant Wetlands)
- Presence of Species at Risk in Ontario (based on O.Reg. 230/08)
- Development type and construction activities planned (e.g. drilling, in water works, dewatering)
- Scale of development and associated ESC measures

The flow chart shown in Figure 9.2. illustrates the key factors that should be considered when establishing which ESC permits and approvals will be required for a given project. Early consultation with regulatory agencies is encouraged in order to allow time for any necessary permits and approvals to be issued, and thereby avoiding costly delays. The following definitions are provided to clarify some of the references made in Figure 9.2.

### *Limit of Development*

The development limit is defined as the point to which development can extend. For sites where CA permits are required, the limit is established and agreed to by CAs during the permit application process, based on the presence of natural hazards and features.

In the case of a Planning Act application, the municipality makes decisions about development limits but consults with CAs if the proposed development affects CA regulated areas or CA delegated responsibility for natural hazards. It is important to finalize this boundary is early on in the ESC approvals process, as it may differ from the property boundary and affect the amount of land area that can be developed. For infrastructure projects, this is known as the *limit of disturbance*, because these projects typically require the disturbance of land that is outside the boundaries of the actual infrastructure.

> **Approvals tip**
>
> Be sure to consult with the municipality and conservation authority to ***finalize the limits of development*** for your property ***before spending time and money*** developing an ESC plan.

### *Conservation Authority regulated areas*

The set of regulations known as “Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses” (Ontario Regulations 42/06 and 146/06 to 182/06) allow CAs to regulate development and other activities taking place within valley and stream corridors, wetlands and associated areas of interference, and the Great Lakes and inland lakes shorelines. These areas are often referred to collectively as the ‘regulated area’, and specifically includes:

- valley and stream corridors;

- shorelines of the Great Lakes and inland lakes;
- watercourses;
- hazardous lands;
- wetlands; and
- other areas where development could interfere with the hydrologic function of a wetland.

The regulated area represents the greatest physical extent of the combined hazards plus a prescribed allowance as set out in the regulation.

In the context of the regulation, the regulated activities that are considered 'development' are:

According to the Conservation Authorities Act,
***Hazardous lands***
are those that could be unsafe for development because of naturally occurring processes associated with flooding, erosion, dynamic beaches, or unstable soil or bedrock.

- the construction, reconstruction, erection or placing of a building or structure of any kind,
- any change to a building or structure that would have the effect of altering the use or potential use of the building or structure, increasing the size of the building or structure or increasing the number of dwelling units in the building or structure,
- site grading, or
- the temporary or permanent placing, dumping or removal of any material, originating on the site or elsewhere.

Additional activities that are regulated are those that would result in the straightening, changing, diverting or interfering in any way with the existing channel of a river, creek, stream, watercourse or the changing or interfering in any way with a wetland.

For more information on how the regulated area is defined, what specific activities are regulated, and the requirements for obtaining a permit under the regulation, see *The Living City Policies for Planning and Development in the Watersheds of the Toronto and Region Conservation Authority* (TRCA, 2014) or contact the local conservation authority.

### *Conservation Authority commenting roles*

Ontario CAs are required to comment on ESC plans as part of their delegated responsibilities under the Ontario Planning Act (RSO, 1990). Municipalities screen planning applications or circulate them to CAs to determine if a specific application requires CA review. If the location of the proposed development is determined to be within the CA's area of interest, the application is circulated to the CA for comment. CA areas of interest include, but are not limited to: features and hazards governed under the "Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses" regulations, areas requiring special stormwater management controls, Areas of Natural and Scientific Interest, Environmentally Significant Areas, and CA property. The CA is required to provide technical review and commentary regarding how the proposal would impact natural hazards or natural heritage features and functions.

***Communication is key***

Conservation authorities are committed to streamlining review and approvals processes and reducing the number of submissions and time required. This can be facilitated through ***early and improved communications*** between CA reviewers, consultant and landowners through working meetings.

Individual CAs also often have service agreements or memorandums of understanding with federal departments, provincial ministries and/or upper or lower tier municipalities. These agreements dictate the services the CA is required to provide based on their areas of interest and expertise. While these may vary, they often include requirements to undertake regulatory or approval responsibilities and/or provide technical review and comments.

For more specific information on conservation authority roles and policies related to review of ESC plans, contact the local conservation authority. Additional information on ESC submission requirements is provided in Chapter 8.0.

## *MECP Permit to Take Water*

The Ontario Water Resources Act (R.S.O. 1990) requires that a Permit to Take Water (PTTW) be obtained for water taking/movement in excess of 50,000 litres per day. The PTTW, which is issued by the MECP, would be required during some dewatering activities common on construction projects, where more than 50,000 L/day is being moved from a ground or surface water system, which may also include sediment control ponds.

**Figure 9.1:** Watercourse diversion during construction is exempt from requiring a PTTW.

Exemptions to this permit requirement that may apply during construction projects involving in-water works are the active and passive watercourse diversion exemptions. Active watercourse diversions – in which water is moved by means of a pump – are eligible for exemption if: (i) the water is returned to the same water body and not stored or otherwise used, (ii) ESC measures are properly applied, maintained and decommissioned, (iii) any fuel sources or re-fueling activities are located at least 30 m away from the watercourse, and (iv) upstream and downstream water quality and quantity are unaffected by the diversion. Exemption for a passive diversion – where no pump is used – simply requires that the upstream and downstream water levels are unaffected, and that water is simply re-directed but never moved *out* of the water body.

Some construction-related water takings that are greater than 50,000 L/day can also be exempt from requiring a full PTTW, instead requiring only registry in the Environmental Activity and Sector Registry (EASR). These include (i) ground or storm water taking during construction site dewatering if the average taking is less than 400,000 L/day and (ii) taking from certain water bodies for a set of defined uses during road construction (e.g. hydro-demolition, landscaping).

## *Species at Risk in Ontario*

As described in Appendix D, the Species at Risk in Ontario List (O.Reg. 230/08) contains all extirpated, endangered, threatened and special concern species that are protected under the provincial Endangered Species Act (S.O. 2007). If the project site contains species on the list, consultation with MECP is required to determine, based on the site and the activities planned, whether a permit or authorization is required. The need for authorization can be avoided where it is possible to work around protected species and habitats so that they are not subject to any adverse effects. The MECP will provide direction on options available to best protect these species, such as ESC best practices.

### *DFO Self Screening*

For construction projects involving in or near water works, determining whether a Fisheries and Oceans Canada (DFO) review and/or authorization is required must be done through a self-screening process. The types of water bodies and projects that are exempt from requiring review are listed on the DFO self-screening website. For projects that are subject to review, DFO will assess whether the activities proposed can be supported through a Letter of Advice, or whether they will result in death or fish or harmful alteration, disruption or destruction of fish habitat (as defined in the Fisheries Act), in which case a Fisheries Act authorization would be required.


**Figure 9.2:** ESC plan review and approvals process

# 10.0 INSPECTIONS, MONITORING AND MAINTENANCE

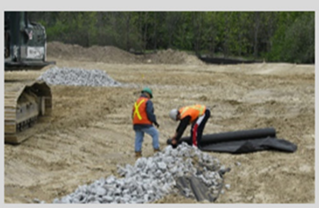
Inspection, performance monitoring and maintenance of ESC measures on construction sites are critical to ensuring that the ESC plan is effective at mitigating sediment release from the site. Beyond inspecting the condition and functionality of ESC measures on the site, an effective inspection and monitoring program requires ongoing assessment of adjacent natural features receiving runoff from the site. The following sections detail the most effective strategies for inspecting, monitoring and maintaining your site for the duration of construction.

**Your ESC plan is only as good as your inspections and maintenance program!**

Defining the three key activities that will keep sediment on your site.

**INSPECTION**
Routine walk through of construction site, carried out by a qualified ESC inspector, to identify and report on deficiencies in ESC measures.

**MONITORING**
Ongoing or periodic assessment of the quality of site discharge and downstream receiving water systems in order to identify potential changes/impacts associated with construction activities. Parameters often considered are water quality (mainly suspended solids or turbidity), water temperature, flow rates, and erosion.



**MAINTENANCE**

Repair, cleaning and replacement of ESC measures based on needs identified through inspections and monitoring.

## 10.1 Developing an Inspection Program

The effectiveness of construction site ESC inspection is dependent upon its frequency and the immediacy and robustness of actions taken to address any deficiencies. The objective of an inspection program is to:

- Regularly assess the effectiveness of individual ESC measures and the overall ESC plan
- Identify the need for maintenance (e.g. sediment removal) and repairs (e.g. replacement of damaged silt fence)
- Identify areas where ESC measures should be replaced or augmented due to repeated failures

As described in Figure 7.1, the ESC plan should evolve as necessary to ensure natural features remain protected. The efficacy of the inspection program is contingent on applying the information collected during inspections to adapt the ESC plan to the site conditions.

### *10.1.1 ESC inspector qualifications*

The responsibility for ESC inspections typically belongs to the land owner of the site or their representative. The owner should retain the services of an inspector who:

- Has completed training on ESC inspection
- Has experience conducting ESC inspections
- Is an effective communicator

All ESC inspections should be carried out by a professional who meets the criteria of Qualified Erosion and Sediment Control Inspector (QESCI) or QESCI in training (QESCI-IT) as defined in the Canadian Standards Association *Erosion and Sediment Control Inspection and Monitoring* standard (CSA, 2018). Those who do not meet this criteria but who have obtained the Certified Inspector of Sediment and Erosion Control (CAN-CISEC) designation will also be considered qualified to carry out ESC inspections. The roles and responsibilities of the ESC inspector are detailed in Chapter 5.0.

### *10.1.2 Inspection frequency*

During the initial installation of ESC measures on the site, the inspector should conduct an inspection to ensure that all the controls are installed as shown on the approved ESC plan, and that they are installed correctly. Once construction begins, a 'walk-through' inspection of the site should be undertaken in anticipation of rain, extended wet-weather periods, snowmelt events, or any conditions that could potentially yield significant runoff volumes or damage ESC measures. It is important to be aware of the predicted forecast for the week and plan inspections accordingly.

Regular ESC inspections should occur during all construction stages, starting when the first ESC measures are installed prior to topsoil stripping and ending when construction is complete and the site has reached 80% stabilization. Where possible, it is also recommended that the inspector visit the site before there is any activity to see the natural landscape, drainage and sensitive features. Notes and pictures should be taken to document the pre-construction site condition and establish an environmental baseline for future reference.

The following minimum frequency of inspection is recommended unless otherwise specified in site permits and approvals:

- On a weekly basis during active construction;
- Before and after significant* rainfall events;
- After significant snowmelt events;
- After any extreme weather (e.g. wind storms) which could result in damage to ESC measures;
- Daily during extended rain or snowmelt periods;
- Monthly during inactive periods (> 30 days);

- During or immediately following any spill event (see Section 7.7 for appropriate spill response procedures);
- Before construction is shut down for the winter to ensure the site is ready for freezing conditions and thaws; and
- At the end of construction to confirm that the site has achieved at least 80% stabilization (CSA, 2018) and that permanent vegetation areas are well-established and effectively preventing erosion.

*A rainfall event should be considered significant when either of the following criteria are met:

- An event during which ≥ 15 mm have been received within 24 hours; or
- An event with an intensity of ≥ 5mm/hr and during which at least 10 mm have been received.

Occasional inspections during rainfall or melt events are encouraged, particularly in areas where there are recurring problems. Visiting during wet weather can provide the inspector with a good understanding of how water is moving through the site and why ESC measures may be failing.

Refer to Appendix B for BMP-specific installation, inspection and maintenance guidance.

### 10.1.3 Inspection documentation and reporting

Maintaining up-to-date documentation on inspection activities is an essential component of effective ESC and the demonstration of due diligence. Documentation and reporting methods may be electronic, paper-based, or a combination of both. Electronic web-based reporting allows the inspector to complete an electronic inspection report on site and then save it, or upload it to a cloud-based storage platform. The advantage of cloud-based storage of inspection reports is that it provides a central location where files can be accessed online by all project team members. Moving toward electronic reporting is encouraged, as it facilitates timely communication of inspection outcomes to the appropriate project team members and governing agencies.

Inspection reports can become legal documents for a project site, as such it is recommended that they be kept by the landowner for at least 3 years after the end of construction. During construction, paper documentation should be kept on site, typically in the construction trailer, in addition to any electronic storage.

Regardless of whether reports are electronic or paper, the following elements form the basis of a thorough documentation system:

- Logbooks of completed inspection reports
- Notes on maintenance and repairs
- Date-stamped photographs from every inspection
- Any additional field notes and/or sketches necessary to best convey the inspector’s observations and recommendations
- Dated records of any relevant conversations with project team members, including onsite construction staff.

Inspection report formats and recipients should be discussed with the project team prior to starting the inspection program. It is important that the inspector understand and establish a protocol for on-site contacts, inspection report circulation, regulatory agency communication and the roles and responsibilities of all parties involved.

The following information should be included in all inspection reports, regardless of format or layout:

- Date and time of inspection
- Inspector's name
- Site location information
- List of inspection report recipients
- Reason for the inspection (e.g. routine weekly, pre-rainfall, post-rainfall)
- A brief description of weather conditions during the inspection, during the 24 hours prior to the inspection, and forecasted for the next few days.
- A brief description of the activities occurring on site (e.g. servicing, building construction)
- Map or drawing with notes to identify the specific areas of the site that are discussed in the report
- Descriptions (with pictures) of areas that have been repaired since the last inspection report
- Descriptions (with pictures) of newly identified ESC deficiencies and recommended repairs or maintenance
- Descriptions (with pictures) of recurring ESC deficiencies, recommended repairs or maintenance, and the amount of time that has passed since the deficiency was first reported.
- Any turbidity or suspended solids monitoring data collected since the last report or, if more appropriate, a summary of the data.

An inspection report template and an example of a completed inspection report are provided for reference in Appendix F.

### *10.1.4 On-Site Reference Tools*

Keeping key documents on site in the construction trailer is an important way to ensure any project team member can easily find up-to-date information in a central location. It is recommended that the inspector prepare a location in the trailer for storage of hardcopies of completed inspection reports, which will allow for easy access by the project team or governing agency representatives.

## 10.2 ESC Performance Monitoring

Beyond the routine inspection and repair of individual ESC measures, it is important to evaluate the cumulative effectiveness of all the controls installed on a construction site. This is best achieved by monitoring the quality of site discharges or the quality of the receiving water system downstream of the site.

On construction sites, total suspended sediment concentration (TSS) is the parameter typically measured to assess ESC effectiveness, but testing for other parameters may be advisable on sites where specific water quality concerns exist. In practice, water turbidity is often measured and used as a proxy for TSS, since turbidity can be measured onsite in real time with handheld or online (in-water) nephelometers (Figure 10.1). For this reason, and because duration of exposure to elevated turbidity is also a key factor in assessing aquatic impacts, ***the receiving water and effluent targets set out in this guide (section 10.2.2) are turbidity targets.***

**Figure 10.1:** An in-water turbidity monitoring station.

Table 10.1 summarizes the advantages and disadvantages of different approaches to turbidity monitoring on construction sites. Understanding these will help practitioners select the most appropriate option(s) based on project-specific circumstances.

### Turbidity vs. Total Suspended Solids (TSS) concentration

The turbidity of a liquid is a measure of its transparency – the degree to which light is scattered by substances that are dissolved or suspended within it. While elevated water turbidity can be caused by the presence of suspended sediment particles (e.g. silt and clay), it can also be attributed to dissolved organic matter, algae, microscopic organisms, and any other dissolved or suspended substance that affects the transmission of light through the water. When measured by a nephelometer in Nephelometric Turbidity Units (NTUs), turbidity is the intensity of scattered light detected at 90° from the incident light passing through a water sample.

TSS concentration differs from turbidity in that it is a measure of the amount of solids (both organic and inorganic) suspended in water. It is usually measured as a weight (milligrams) per unit volume (litre). While turbidity and TSS concentration are positively correlated, the relationship between them is not direct and will vary from site to site. Despite this, turbidity is often accepted as a satisfactory proxy for TSS concentration, since turbidity can be measured onsite in real time by handheld or online nephelometers (i.e. turbidimeters) while TSS concentration must be determined through laboratory analysis.

For frequent or continuous monitoring of water quality on construction sites, turbidity is a useful metric, allowing for quick onsite assessment and identification of potential problems with excess sediment release. Studying fluctuations in turbidity readings over time can help to identify areas of potential contamination. When there is a need for a more absolute and accurate assessment of the amount of suspended sediment in the water, it must be sampled and submitted for laboratory analysis.

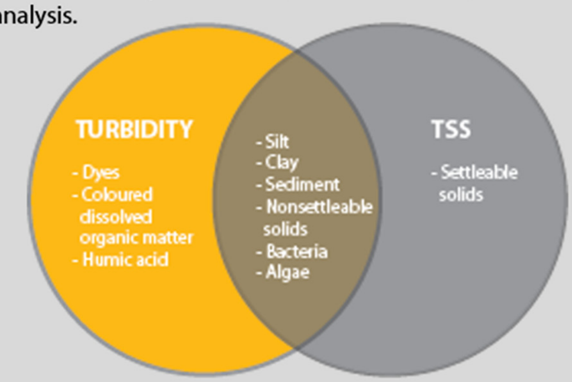


**Table 10.1:** Advantages and disadvantages of different approaches to turbidity monitoring on construction sites.

| Method | Location | Advantages | Disadvantages |
|---|---|---|---|
| Handheld turbidity measurement of grab samples | Site discharge points | • Straightforward<br>• Low equipment cost<br>• Direct measurement of site runoff = greater accountability<br>• Problem areas can be pinpointed<br>• Can be carried out even in the winter | • Staff costs for sampling<br>• Limited to locations where grab sampling is possible<br>• Potential for error due to poor sampling technique<br>• Duration is not assessed |
| | Receiving water D/s and U/s of site | • Low equipment cost<br>• More readily comparable to existing CWQG for aquatic life<br>• Can be carried out even in the winter | • Need to determine pre-construction background turbidity<br>• Staff cost for sampling |
| Continuous online turbidity measurement | Outlet of sediment control pond | • Concentration & duration = more accurate assessment<br>• Convenience - data logged at all times of day and night<br>• Set location means higher precision and comparability | • Equipment costs may be higher<br>• Site visits required to retrieve data – delays problem response<br>• Only pond effluent is assessed<br>• Not operational during winter<br>• Challenges associated with equipment maintenance and calibration to avoid false exceedances |
| | Receiving water D/s and U/s of site | • Concentration & duration = more accurate assessment<br>• Convenience - data logged at all times of day and night<br>• Set location means higher precision and comparability<br>• Readily comparable to existing CWQG for aquatic life | • Equipment costs may be higher<br>• Site visits required to retrieve data – delays problem response<br>• Not operational during winter<br>• Challenges associated with equipment maintenance and calibration to avoid false exceedances |
| Continuous online turbidity measurement with remote real-time access to data | Outlet of sediment control pond | • In addition to those listed above:<br>• Convenience of remote access<br>• Opportunity for faster problem response | • Additional cost for remote access, which may be offset by reduced staff costs for site visits<br>• Only pond effluent is assessed<br>• Not operational during winter<br>• Challenges associated with equipment maintenance and calibration to avoid false exceedances |
| | Receiving water D/s and U/s of site | • In addition to those listed above:<br>• Convenience of remote access<br>• Opportunity for faster problem response | • Additional cost for remote access, which may be offset by reduced staff costs for site visits<br>• Not operational during winter<br>• Challenges associated with equipment maintenance and calibration to avoid false exceedances |

CWQG: Canadian Water Quality Guideline for Aquatic Life. D/s: downstream, U/s: upstream

### 10.2.1 Site specific turbidity monitoring protocols

The extent of turbidity monitoring and methods used on a given construction project should be based on consideration of the following site specific factors:

**Figure 10.2:** Redside dace, a species at risk in Ontario

- **Erosion risk.** Determined based on site characteristics (e.g. slopes, soil type) and the work planned (extent of disturbance, project duration). This should be determined for all projects prior to the initiation of any work, as described in Chapter 6.0.
- **Receiving water flows.** Because online turbidity sensors typically need to be kept submerged in order to work effectively, consider whether the site discharges to a perennially flowing water feature and whether the low water level is deep enough to keep the sensor submerged. The type of receiver should also be considered – whether natural feature or municipal sewer system – as different water quality thresholds and monitoring requirements may apply.
- **Presence of species at risk.** As detailed in *Silt Smart - Erosion and Sediment Control Effectiveness Monitoring and Rapid Response Protocol for High Risk Construction Projects version 1.3* (MNRF et al., 2012). The *Protocol* defines sensitive streams as those which are known or potential habitat for species at risk in Ontario – as listed in Ontario Regulation 230/08 – as well as those serving as spawning or nursery habitat for coldwater species. Sensitive streams are identified in the *Protocol* as requiring more intensive turbidity monitoring. Specific monitoring requirements for construction sites draining to sensitive streams are established by MECP and DFO, as they administer species at risk legislation at the provincial and federal level, respectively.
- **Type and location of discharge points.** The location where site effluent is discharged into the receiving water system can sometimes dictate whether suitable in-water turbidity monitoring stations can be established. On sites that are not accessible by monitoring staff or where there are safety concerns, effluent monitoring may be the only option. Conversely, effluent monitoring in which online turbidity sensors are installed at pond outlets could be cost prohibitive on sites with several ponds. In these cases receiving water turbidity monitoring upstream and downstream of the site, where possible, may be more cost-effective.

On projects where turbidity monitoring will be limited to handheld turbidity measurement of grab samples, sampling should be undertaken during any activities or events that result in discharges of water from the site. In addition to rainfall events, this should include thaw events and any pumping and dewatering activities that result in discharges to the receiving water feature.

### 10.2.2 Turbidity targets for construction runoff and downstream receivers

When evaluating turbidity levels in construction site runoff or downstream receiving water systems, it's important to first establish the target turbidity or TSS concentration that will prevent adverse impacts to receiving water ecosystems. This section outlines targets that support a performance based approach to the assessment of ESC measures. In a performance based approach, the cumulative effectiveness of the ESC plan is assessed by evaluating whether water leaving the site meets set turbidity targets, and there is less focus on individual controls.

The 'Total Particulate Matter' guideline within the *Canadian Water Quality Guidelines (CWQG) for the Protection of Aquatic Life* (CCME, 2002) is one of the primary guidance documents that detail target suspended sediment concentrations for preventing impacts to aquatic organisms. The CWQG for total particulate matter provides maximum allowable increases in TSS concentration above the receiving water's background concentration, and provides separate thresholds for dry weather (clear flow) and wet weather (high flow) conditions.

The *Guidelines* include thresholds for both TSS concentration and the duration of exposure to that concentration, as do other key research studies that are often cited when considering the impacts of sediment on aquatic ecosystems. One such study is Newcombe (1986), which puts forth a fisheries impact framework which is depicted in a modified form in Figure 10.3.

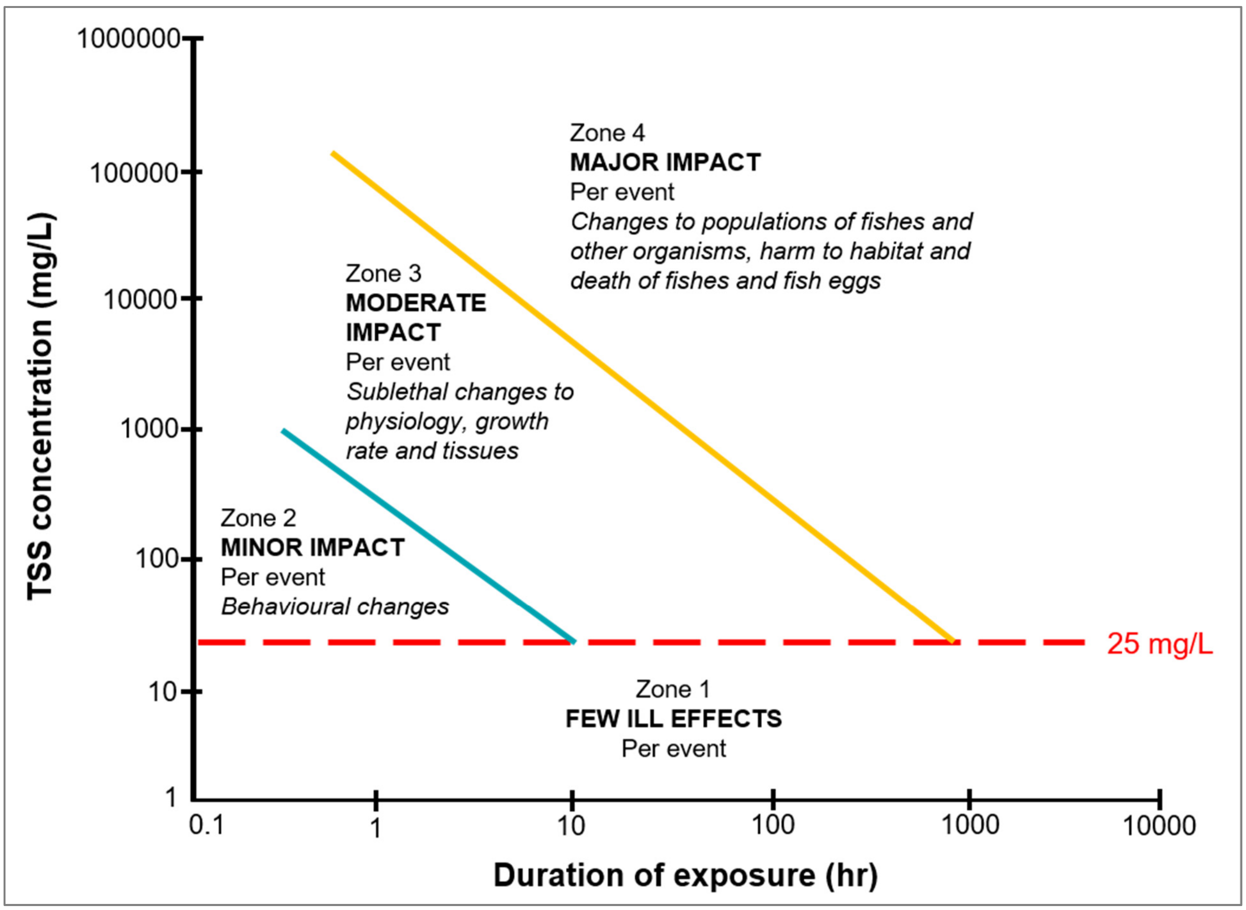



**Figure 10.3:** Impacts to fish and habitat health based on TSS concentration and the duration of exposure (modified from Newcombe, 1986)

Receiving water target

A receiving water target applies downstream of the construction site, in the water body to which the site drains. The framework described in this section has been established to define turbidity targets for receiving water systems downstream of construction sites based on the CWQG, the fisheries impact framework in Newcombe (1986), and past construction site monitoring in the Greater Toronto Area (TRCA and University of Guelph, 2006). It is based on an assumed TSS to turbidity correlation of 1:1. While TSS-turbidity correlations can vary greatly from one site to another, a 1:1 correlation approximates that which has been observed during instream turbidity monitoring downstream of a construction site in Markham, Ontario (TRCA and University of Guelph, 2006) and monitoring of effluent from a flow balancing system that treated stormwater runoff and combined sewer overflows at the Lake Ontario shoreline in Scarborough, Ontario (SWAMP, 2005).

**THE BENEFITS OF A PERFORMANCE BASED APPROACH TO ESC**

**Applying a performance based approach to ESC means that the effectiveness of the ESC plan is determined by the extent to which certain performance metrics – or targets – are being achieved. Where there is an established turbidity (or suspended sediment) target applicable to construction runoff (or downstream receiving water systems), monitoring can be carried out to assess the extent of compliance with these targets.**

***A performance based approach is beneficial because it:***

- **Provides context for monitoring efforts by establishing a set target to be achieved;**
- **Focuses on the desired outcome – less sediment leaving the site – rather than the performance of individual controls;**
- **Promotes more rigorous and frequent inspection and monitoring of the site; and**
- **Is more appropriate to the dynamic nature of construction projects, as it allows for the ESC plan to evolve as necessary to achieve the set targets.**

Figure 10.4, which mirrors the Newcombe framework in Figure 10.3, identifies four impact classification zones based on the turbidity level and the duration of exposure. Some key thresholds to be noted are:

- At turbidity concentrations ≤ 25 NTU there are few adverse impacts, regardless of duration
- At turbidity concentrations of ≥ 1000 NTU, even short exposures (< 1 hr) result in moderate impacts

***The turbidity target for receiving water systems downstream of construction sites is to maintain turbidity levels within the "few ill effects" or "minor impact" zones of Figure 10.4***. Assessment is based not only on the turbidity level but also on the associated duration of exposure to that turbidity. ***Exceedance of the target should be determined by the extent of increase above typical (pre-construction) turbidity levels in the stream in order to ensure that construction projects are not held accountable for natural sediment fluctuations***.

The equation of the line dividing the "minor impact" zone from "moderate impact" zone is:

$$\mathbf{t = 324.1 \times d^{-1.232}}$$

Where t = turbidity (in NTU) and d = duration (in hours)

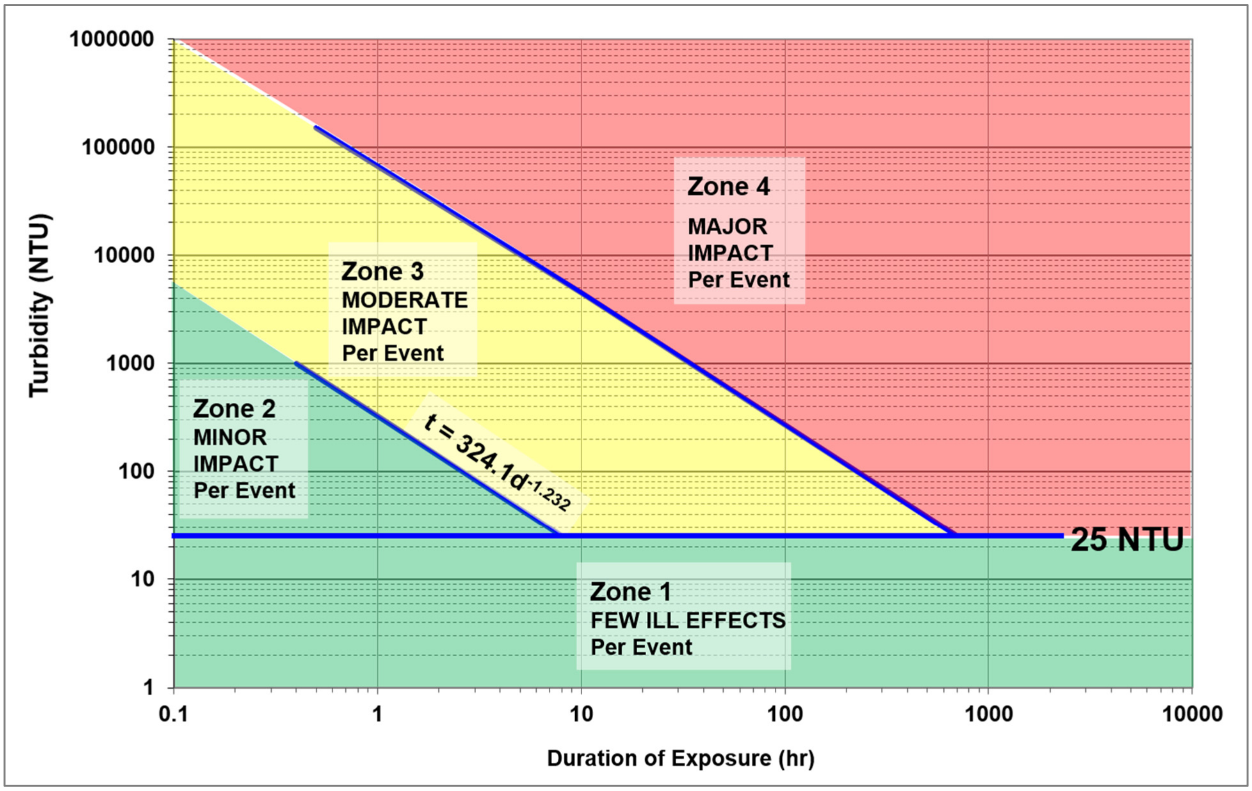



**Figure 10.4:** Receiving water ecosystem impact classification zones based on turbidity and the duration of exposure (modified from Newcombe, 1986).

In order to assess the extent of compliance with this target, continuous turbidity and duration data must be available. With this data and the equation of the minor-moderate impact dividing line, it is possible to continuously assess whether the receiving water exceeds the target. Table 10.2 provides turbidity and associated duration thresholds that define the target zones (few ill effects or minor impact). These values have been calculated using the equation of the line defined above ($t = 324.1 \times d^{-1.232}$).

**Table 10.2:** Maximum allowable construction-based turbidity increases in the receiving water system at different durations

| Construction-based turbidity increase (NTU) | Duration (h) |
|---|---|
| ≤ 25 | Any duration |
| 761 | 0.5 |
| 324 | 1 |
| 138 | 2 |
| 84 | 3 |
| 59 | 4 |
| 45 | 5 |
| 36 | 6 |
| 29 | 7 |

<u>Continuous monitoring for assessing compliance with receiving water target</u>

For sites where a receiving water turbidity target is most appropriate (see considerations in section 10.2.1), assessing compliance, including consideration of duration, requires continuous monitoring in the receiving water system immediately upstream and downstream of the construction site. The monitoring program for sites applying the receiving water target should include the following components:

- **One continuous online (in water) turbidity monitoring station downstream of the site.** The downstream station should be situated 5 to 15 m downstream of the last site discharge point. The location should be selected based on allowing enough distance for dispersion of the effluent into the stream, but not so much distance that additional sediment sources begin to impact receiver turbidity.
- **At least one continuous online (in water) turbidity monitoring station upstream of the site.** The upstream station is used to isolate and account for sediment contributions that are naturally occurring or which are coming from a sediment source upstream of the site. It represents typical (pre-construction) turbidity levels against which downstream levels are compared to determine compliance with targets. The upstream station should be located as close to the site as possible. If there are any flow contributions between the upstream and downstream stations (e.g. stream confluence, outfall from another site) which are not originating from the construction site, the other contribution should also be quantified. For stream confluences, an additional turbidity monitoring station should be set up, just downstream of the confluence but upstream of the next construction site discharge point.

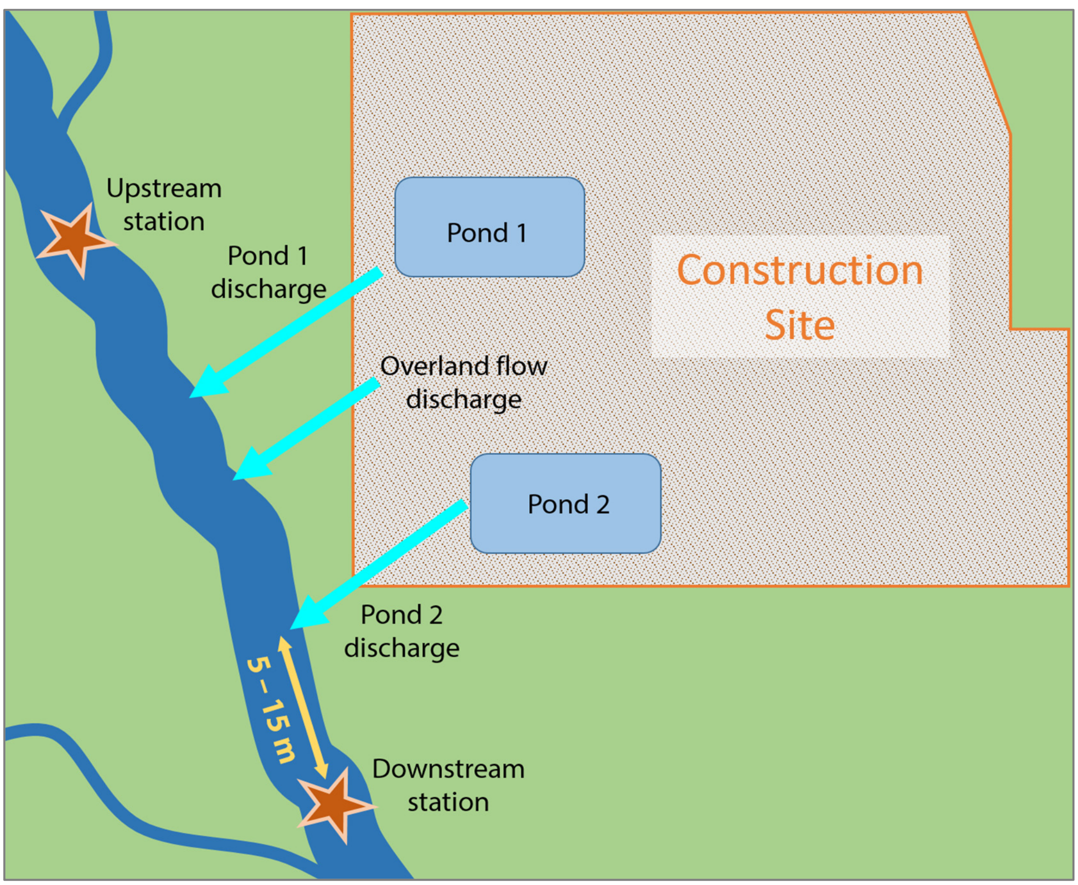



**Figure 10.5**: Turbidity monitoring station locations relative to construction site discharge points

- **Each turbidity monitoring station equipped with: (i) a turbidimeter (a sonde with a turbidity sensor), (ii) a data logger, (iii) power supply (e.g. batteries, solar panels), and (iv) an enclosure to protect equipment.** On sites where rapid response to address elevated turbidity levels is required (e.g. species at risk sites), monitoring stations should also be installed with telemetry equipment to allow remote data access. All equipment should be maintained and calibrated regularly in accordance with the manufacturer's recommendations.

- **Continuous turbidity monitoring throughout the construction period until the site achieves at least 80% *effective* permanent stabilization.** This is the threshold after which ESC inspections are no longer required, as described in the CSA *ESC Inspection and Monitoring Standard* (CSA, 2018). If otherwise specified by the overseeing regulatory agency and/or if turbidity issues are demonstrated to be an ongoing concern, despite reaching this threshold, monitoring may be required to continue.

- **Collection of data from a nearby rain gauge.** Precipitation data from a rain gauge no further than 5 km from the site will facilitate the interpretation of turbidity exceedances. Where real time systems are in place, rain data should also be available in real time. If not available from an existing nearby gauge, a new telemetered gauge should be established on site. If observed exceedances of turbidity targets are not occurring as a result of wet weather, active water discharges (e.g. pumping) should be considered as the potential cause of elevated turbidity.

**LOCATION IS EVERYTHING!**

***Considerations for setting up monitoring stations***

- Locate sensor where flows are not highly turbulent, as turbulent stream flows can impact the accuracy of turbidity readings
- Ensure site is accessible by personnel installing and maintaining equipment
- Locate so as to avoid areas where excessive debris could land on or accumulate around the sensor
- Locate in an area that is not at high risk of damage from construction activities or vandalism
- Attach sensor to a concrete block or existing structure so that it is firmly anchored in place.
- Install sensor at least 10 cm from the stream bed in order to prevent it from being buried in sediment, while also ensuring that the selected height will allow the sensor to remain submerged at all times.

- **Data analysis software / tool.** Analyzing and interpreting continuous turbidity data to assess compliance with the target requires the establishment of appropriate data management software and/or tools. The tools used may be relatively simple, like a spreadsheet set up with the relevant formulas, or more sophisticated, like a specialized application developed for interpretation of this type of data. Ideally, these systems should be set up to filter data such that false exceedances (e.g. passing debris) are excluded from consideration. Where real time systems are in place, the tool should also interpret the data in real time. It should be capable of processing and interpreting turbidity and duration data on a continuous basis to determine compliance with targets and push that information out to the pre-determined recipients (e.g. ESC inspector).

- **Grab sampling when continuous monitoring is infeasible.** During site conditions when continuous in-stream monitoring is not possible (e.g. frozen conditions), turbidity should still be monitored during rainfall and snowmelt events by collecting grab samples and testing with a handheld device. In this case, receiving water and/or effluent samples may be appropriate depending on stream and site conditions, what activities are occurring on the site, and where high turbidity runoff is observed during inspections.

Example: Assessing compliance with the receiving water target

In order to assess the turbidity increase attributable to the construction site, it is necessary to account for typical (pre-construction) turbidity levels as well as turbidity increases from upstream activities. The following calculation can be carried out to isolate the construction-based turbidity increase:

**Construction based turbidity increase = (measured DS turbidity) – (measured US turbidity)**

*Where:*

**DS =** downstream station

**US =** upstream station

To illustrate the application of this equation for assessing compliance, the following sample calculation is provided:

*Assuming:*

Measured US turbidity = 50 NTU

Measured DS turbidity = 200 NTU

*Then:*

**Construction based turbidity increase = (200 NTU - 50 NTU) = 150 NTU**

Once this is determined, the turbidity-duration chart can be referenced to determine the duration at which this turbidity increase would constitute an exceedance of the target (i.e. enter the “moderate impact” zone). This method is demonstrated in Figure 10.6, which shows that if the construction site is causing a turbidity increase of 150 NTU from the upstream to the downstream stations, the duration of this elevated turbidity should be no longer than 1.85 hours (1 hr and 52 min). If it occurs for longer, the receiving water system is in the “moderate impact” zone and the site is not in compliance with the turbidity target. If this occurs, the reasons for the exceedance should be investigated on site. Once sediment sources are pinpointed, modifications, replacements, repairs and / or maintenance should be carried out on site as needed to prevent ongoing sediment releases.

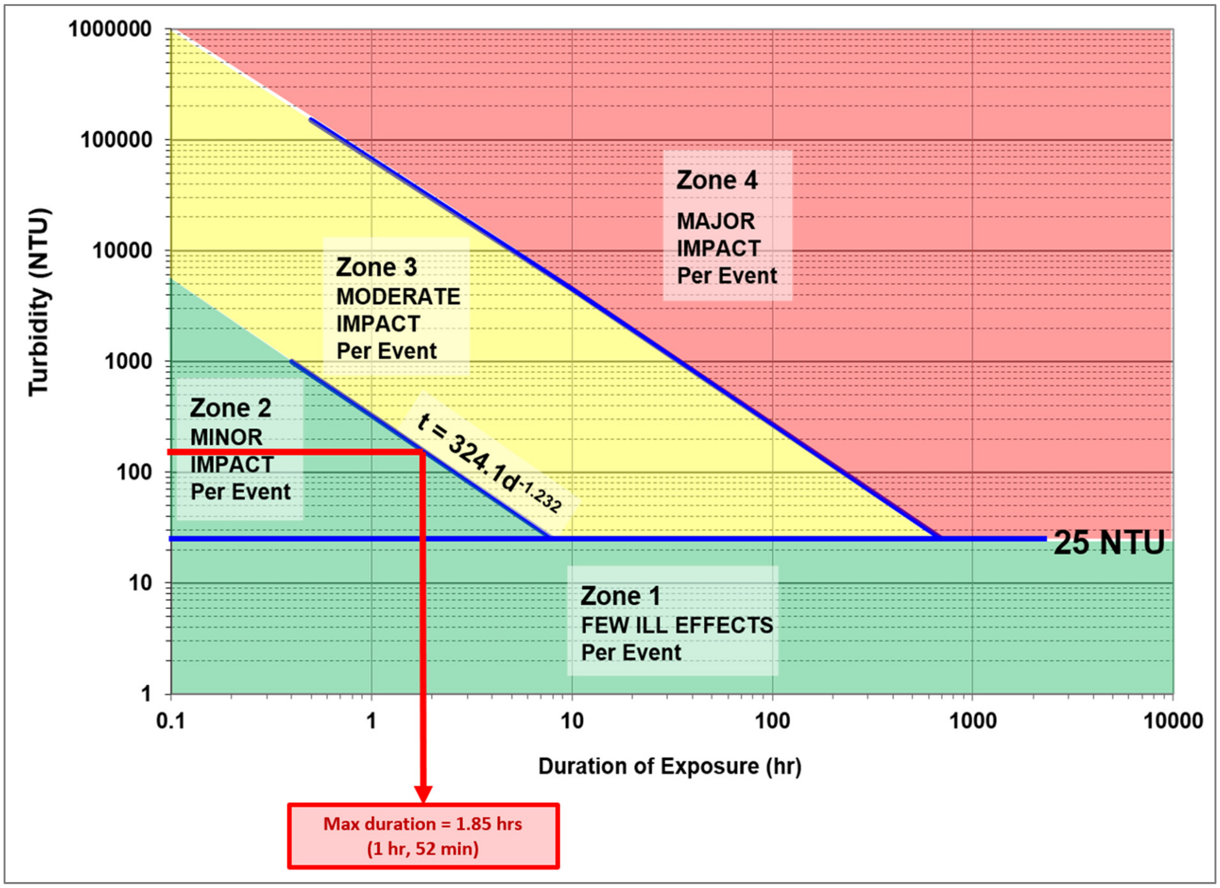



**Figure 10.6:** Example of the use of interpolation to determine the maximum allowable duration of a construction based turbidity increase of 150 NTU in a receiving water system.

## Construction effluent target

A construction effluent target applies to ***any direct runoff/discharge from the construction site, before it is subject to any dilution in a receiving water system*** This includes both active and passive discharge. Measurement of effluent quality provides a very direct assessment of construction sediment releases and can facilitate the identification of specific problem areas on the site. It also makes it possible to conclusively identify instances when the construction site is not the source of elevated sediment levels in downstream receiving water systems, provided that all site effluent is being monitored.

Turbidity targets for construction effluent are also based on the framework shown in Figure 10.4. Like the receiving water target, the effluent target is based on the assumption that there is a 1:1 correlation between TSS and turbidity. The target is applicable where it is not superseded by other site-specific regulatory requirement governing discharges from the construction site (e.g. contaminant thresholds in sewer use by laws

***The turbidity target for construction site effluent is to maintain turbidity levels within the "few ill effects" or "minor impact" zones of Figure 10.4***. It differs from the receiving water target in that the typical (pre-construction) turbidity in the receiving system is not considered. The turbidity of the effluent itself (and the duration over which it occurs), should fall within the "few ill effects" or "minor impact" zones.

The equation of the line dividing the “minor impact” zone from “moderate impact” zone is:

$$t = 324.1 \times d^{-1.232}$$

Where t = turbidity (in NTU) and d = duration (in hours)

Table 10.3 provides turbidity and associated duration thresholds that define the target zones. These values have been calculated using the equation of the line defined above ($t = 324.1 \times d^{-1.232}$).

**Table 10.3:** Maximum allowable construction effluent turbidity at different durations

| Construction effluent turbidity (NTU) | Duration (h) |
|---|---|
| ≤ 25 | Any duration |
| 761 | 0.5 |
| 324 | 1 |
| 138 | 2 |
| 84 | 3 |
| 59 | 4 |
| 45 | 5 |
| 36 | 6 |
| 29 | 7 |

<u>Continuous monitoring for assessing compliance with construction effluent target</u>

For sites where an effluent turbidity target is most appropriate (see considerations in section 10.2.1), assessing compliance, including consideration of duration, requires continuous monitoring of effluent at any discharge locations where the sensor can remain permanently submerged. During a rainfall event, effluent from any site discharge locations can be sampled and subsequently analysed, but continuous online turbidity sensors can only be installed where they can be permanently submerged (e.g. in a sediment control pond). In ponds, a turbidity sensor is typically installed at the outlet if it is meant to measure effluent.

The monitoring program for sites applying the effluent target should include the following components:

- **Continuous online (in water) turbidity monitoring stations at all permanently wet discharge locations.** In most cases, these locations will be sediment control pond outlets. On sites where there are many ponds and establishing stations at all of them is impractical, priority should be given to monitoring of ponds that receive runoff from drainage areas that are larger and/or more vulnerable to erosion (i.e. minimal stabilization measures are in place).
- **Each turbidity monitoring station equipped with: (i) a turbidimeter (a sonde with a turbidity sensor), (ii) a data logger, (iii) power supply (e.g. batteries, solar panels), and (iv) an enclosure**

**to protect equipment.** On sites where rapid response to address elevated turbidity levels is required (e.g. species at risk sites), monitoring stations should also be installed with telemetry equipment to allow remote data access. All equipment should be maintained and calibrated regularly in accordance with the manufacturer's recommendations.

- **Continuous turbidity monitoring throughout the construction period until the site achieves at least 80% *effective* permanent stabilization.** This is the threshold after which ESC inspections are no longer required, as described in the CSA *ESC Inspection and Monitoring Standard* (CSA, 2018). If otherwise specified by the overseeing regulatory agency and/or if turbidity issues are demonstrated to be an ongoing concern, despite reaching this threshold, monitoring may be required to continue.
- **Collection of data from a nearby rain gauge.** Precipitation data from a rain gauge no further than 5 km from the site will facilitate the interpretation of turbidity exceedances. Where real time systems are in place, rain data should also be available in real time. If not available from an existing nearby gauge, a new telemetered gauge should be established on site. If observed exceedances of turbidity targets are not occurring as a result of wet weather, active water discharges (e.g. pumping) should be considered as the potential cause of elevated turbidity.
- **Data analysis software / tool.** Analyzing and interpreting continuous turbidity data to assess compliance with the target requires the establishment of appropriate data management software and/or tools. The tools used may be relatively simple, like a spreadsheet set up with the relevant formulas, or more sophisticated, like a specialized application developed for interpretation of this type of data. Ideally, these systems should be set up to filter data such that false exceedances (e.g. passing debris) are excluded from consideration. Where real time systems are in place, the tool should also interpret the data in real time. It should be capable of processing and interpreting turbidity and duration data on a continuous basis to determine compliance with targets and push that information out to the pre-determined recipients (e.g. ESC inspector).
- **Grab sampling when continuous monitoring is infeasible.** During site conditions when continuous in-stream monitoring is not possible (e.g. frozen conditions), turbidity should still be monitored during rainfall and snowmelt events by collecting grab samples and testing with a handheld device. In this case, receiving water and/or effluent samples may be appropriate depending on stream and site conditions, what activities are occurring on the site, and where high turbidity runoff is observed during inspections.

### *10.2.3 Response protocols for turbidity exceedances*

Protocols for responding to and reporting turbidity exceedances should be established on all sites where effluent or receiving water turbidity is being continuously monitored. The protocol should outline the parties to be contacted when an exceedance occurs, including the project team members and relevant regulatory agencies, and identify necessary actions and when they should be undertaken. When an exceedance occurs, preliminary investigations should take place to confirm whether the exceedance is valid (e.g. not simply a result of passing debris) and whether the construction site itself is the source of elevated turbidity measurements.

The following actions are recommended when continuous monitoring reveals that construction site effluent (or the downstream receiving water system) has reached a turbidity level that is in the "moderate impact" zone (Figure 10.4):

Parties to be notified

- ESC inspector
- Contract administrator
- Contractor (once corrective actions are determined
- Overseeing regulatory agencies as defined by permits / approvals (if applicable)

Actions and reporting

Upon confirmation of the exceedance, and no later than 10 hours after the exceedance began (or 10 hours after first light if the exceedance occurs at night), a preliminary notification should be sent out to relevant parties. The ***preliminary notification*** should include the following information:

- Date and time of inspection
- Inspector's name
- Site location information
- List of report recipients
- Timing, location, magnitude and duration of turbidity exceedance
- Any information about suspected source of sediment
- If known, describe the repairs, maintenance and/or modifications of ESC measures planned in order to address the elevated sediment releases causing turbidity exceedances.
- If known, estimated timing for the completion of repairs, maintenance and/or modifications.

In the case that turbidity exceedances continue despite initial efforts to rectify ESC deficiencies, update reports should be sent to the listed parties daily until turbidity falls back below the applicable target. Depending on the site, the nature of the construction work, the magnitude and duration of the exceedance, and any relevant approval or permit conditions, stop work orders and other consequences may apply to ongoing exceedances that are not rectified in a timely manner.

All update and final reports - should include the following information:

- Reason for the inspection (e.g. routine weekly, pre-rainfall, post-rainfall)
- A brief description of weather conditions during the inspection, during the 24 hours prior to the inspection, and forecasted for the next few days.
- Map or drawing with notes to identify the specific areas of the site that are discussed in the report

Beyond this basic information the following should be included in specific types of reports:

**Update report**

- Provide information on the timing, location, magnitude and duration of the continued exceedance
- Explain the status and outcome of the planned remedial actions described in the preliminary assessment report, including why they failed to reduce turbidity back below the target.
- Provide a timeline and recommendations on strategies for reducing effluent turbidity and getting the receiving water turbidity back below the applicable target.

**Final assessment report**

- Provide a summary of the exceedance that occurred, including location, the total duration and range of turbidities measured.
- Explain the deficiencies that resulted in the turbidity exceedance and how they were addressed.
- Describe the actions taken to mitigate future turbidity exceedances.

## 10.3 BMP Maintenance

Carrying out maintenance of ESC BMPs in a timely manner is an important way to demonstrate due diligence on construction projects. For temporary ESC measures, maintenance and repair should continue until the measure is no longer needed. Some measures will require more regular maintenance (e.g. removal of accumulated sediment), while others may only require periodic maintenance when accumulated sediment levels reach a certain threshold (e.g. sediment control ponds). BMP-specific maintenance requirements are provided in Appendix B.

**Figure 10.7:** Maintenance of rock check dams

Repairs, maintenance or replacement of BMPs should be conducted as soon as possible upon issuance of an inspection, and the inspector should specify the priority level of maintenance needs based on the risk of impacts to natural features. In order to expedite maintenance activities, back up supplies of frequently replaced ESC materials should be kept on site where possible.

In general, BMPs requiring maintenance should be repaired / cleaned within 48 hours of notification or sooner if environmental receptors are at imminent and foreseeable risk of adverse impact. In the event of a spill, as detailed in section 7.7, immediate response is required.

A sample inspection report, provided in Appendix F, demonstrates the appropriate way to document the need for maintenance. This includes photos, location identification, description of maintenance needs, and details on how long the area in question has been in disrepair.

# APPENDIX A: SPECIFIED FLOOD RISK CALCULATION

## Specified flood risk calculation for sizing in water BMPs

The concept of ***specified flood risk*** is useful in determining the sizing of some BMPs that are temporary in nature, as it considers the accepted level of risk or BMP failure and its intended service life.

The Ministry of Natural Resources and Forestry recommends that sizing of certain BMPs applied during in or near water works, like cofferdams and temporary watercourse diversion channels, should be calculated based on consideration of the ***specified flood risk***, as described in *Hydrology of Floods in Canada: A Guide to Planning and Design* (National Research Council of Canada, 1989).

The design return period (T) which the BMP should be sized to accommodate is based on the anticipated service life of the BMP (L) in units of years and the specified risk (R), which is unitless. As per the National Research Council of Canada guide (1989), the level of risk commonly applied when sizing a temporary watercourse diversion or cofferdam is 0.05 to 0.1 (i.e. between 5 and 10 percent).

The equation for determining the design return period is:

$$T = \frac{1}{1-\sqrt[L]{1-R}}$$

Example: Calculation of design return period (T) of water surface elevation where a cofferdam should be designed that has service life (L) of 75 days (0.21 year) and specified risk (R) of 0.05.

$$T = \frac{1}{1-\sqrt[0.21]{1-0.05}}$$

The return period (T) is ~ 5 years.

***A return period of 2 years should be assumed if the calculated return period is less than 2 years. In-water BMPs should not be sized to convey less than the 2 year flows unless approved by the relevant regulatory agency.***

***Calculation of return period for in-water BMPs (e.g. waterproof isolation barriers) should be based on a maximum risk of 5%.*** Once the return period is calculated, rainfall depths can be determined and, based on the drainage area, the maximum flow rate to be accommodated can be determined. In calculating maximum flow rates, the drainage area imperviousness (runoff coefficient) applied should be based on the anticipated site conditions during the service life of the BMP. If drainage area imperviousness is expected to increase during the service life of the BMP, the higher imperviousness (highest expected runoff coefficient) should be assumed in the calculation.

This type of calculation can also be applied to aid in the proper sizing of other conveyance BMPs on construction projects (e.g. slope drains), particularly if the BMP conveys water into a natural feature. In these instances, the specified risk (R) value chosen should be based on potential consequences if the measure was to fail / overtop. For example, a slope drain on a steep and / or long slope that drains to a sensitive feature should be designed based on a low specified risk (e.g. R= 0.05), since its failure could result in major slope erosion and sedimentation in the downstream sensitive area.

# APPENDIX B: EROSION AND SEDIMENT CONTROL BEST MANAGEMENT PRACTICES

# B1: EROSION CONTROL PRACTICES

Preventing erosion is the most effective means of keeping sediment onsite during construction projects. Practices that reduce erosion rates include strategies to minimize the amount of land cleared, diversion of flows around high erosion risk areas, and the application of ground covers that stabilize soil and/or provide a physical barrier to soil particle detachment.

Detailed guidance on the following erosion control practices are included in Appendix B1:

## MINIMIZED OR PHASED LAND CLEARING

The preservation of vegetated areas on active construction sites is a practice that offers several advantages from an erosion control and runoff management perspective. The topsoil, vegetation and root systems that are part of pre-existing vegetated areas make them effective at intercepting and infiltrating rainfall and keeping soil in place.

**Figure B1-1:** Buffer of vegetation retained at site perimeter

Minimizing clearing involves the identification of site areas where vegetation can be preserved throughout the entire construction period. Areas cleared are smaller and more manageable with respect to control erosion and sediment migration. Phased clearing, by contrast, does not completely avoid stripping but instead requires strategic planning to schedule clearing, development and re-stabilization of the site so that the total amount of time that bare soils are left exposed is minimized as much as possible. When development is phased, only a portion of the site is stripped and developed at any given time, and the next parcel/phase is only initiated once the earlier phase is complete, including re-stabilization.

### Application

- Parcels designated for later development (e.g. school blocks, parks).
- Any areas of a site where construction activity is not planned for an extended period of time. On stripped areas that are inactive for 30 days or longer, stabilization measures should be applied.
- Phasing is most appropriate for larger sites (>10 ha), where it is more feasible to divide the development into smaller phases.
- It is particularly import to retain a buffer of vegetation along the site perimeter and around natural features.

Prioritizing ***Sustainability***

The preservation of existing vegetation is a highly sustainable practice as it does not generate significant solid or liquid waste or air pollution, nor does it require the consumption of natural resources.

### Design

- Consider minimizing stripping first. Early in the planning process, identify areas where vegetation can be retained. Where minimized clearing can be planned and executed efficiently, it can be more cost-effective than stripping vegetation that must later be re-established.
- The maximum amount of land stripped at a given time should be limited by the area that can reasonably be expected to be developed and stabilized within the same construction season (before freezing conditions set in).
- Identify any areas that will be inactive in the long term (longer than one construction season) for designation as vegetation preservation areas.
- Avoid using vegetation preservation areas for soil stockpiling. If these areas are used for stockpiles or other materials storage, their erosion control and infiltration benefits cannot be fully realized.
- Vegetated buffers, as established in the approved draft plan of subdivision or site plan for the subject property, should be preserved around the site

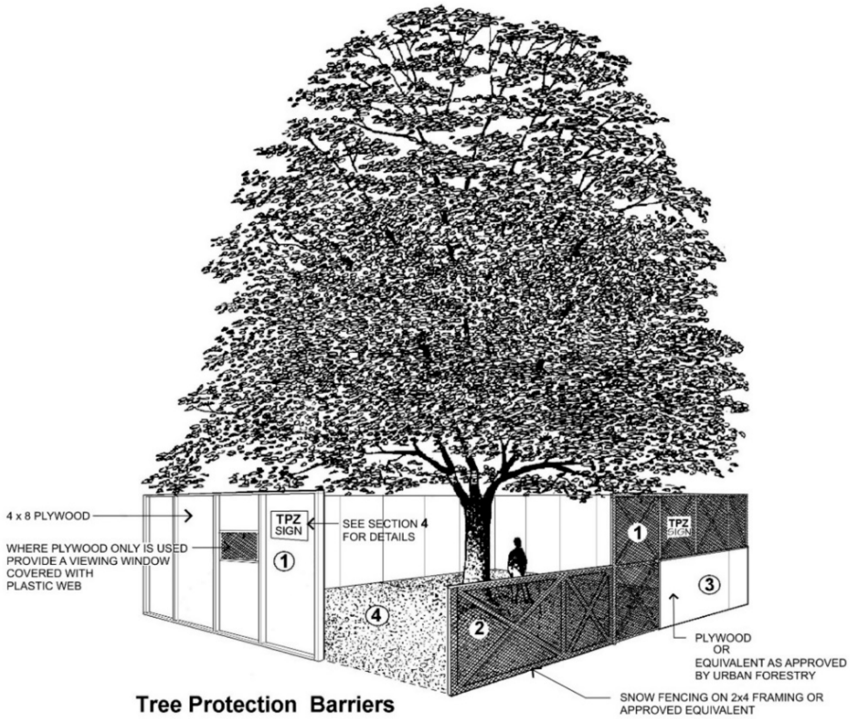
**DON'T FORGET TO STABILIZE!**

Any areas of the site where no active construction is planned for 30 days or longer should be stabilized perimeter and adjacent to natural features. For specific requirements on buffers around natural features and hazards, consult with the local regulatory agency (i.e. municipality, CA). Recommended buffers applicable within the TRCA jurisdiction are detailed in *The Living City Policies for Planning and Development in the Watersheds of the Toronto and Region Conservation Authority* (TRCA, 2014), and within the CVC jurisdiction in *Credit Valley Conservation Watershed Planning and Regulation Policies* (CVC, 2010).

- Preserved areas should be fenced off to provide protection from vehicle tracking.
- Plans should identify trees and shrubs that have been designated for protection. Trees should be surrounded by sturdy tree protection fencing (Figure B1-2), which should be placed far enough from the trunk that the root systems are also protected. Root systems can extend more than 3 times the dripline distance (City of Toronto, 2016). Local municipal policies and bylaws on tree protection should be referenced prior to creating topsoil stripping plans in order to establish appropriate tree protection zones. A tree inventory / preservation plan may be required for removal and preservation of species. Consultation with a qualified arborist is recommended.
- Where phasing is being implemented it should be considered at the early stages of planning and design. Co-ordination of workplans, construction schedules and permitting/approvals timelines is key.
- Identify effective, low-cost temporary stabilization options and implement on areas that have already been subject to stripping and earth moving, and which are expected to remain inactive for longer than 30 days.

### Inspection and maintenance

- Inspect vegetation preservation areas and re-stabilized areas on a weekly basis, and before and after significant rainfall (see definition in Section 10.1.2) or snowmelt events, and keep a record of the inspection. Beyond this routine inspection, additional inspections of seeded areas may be needed when the seed is newly planted as well as during periods of drought.
- Ensure vehicles and equipment are not driving over vegetation preservation areas or other areas that have been re-vegetated.
- Inspect vegetation protection fencing to determine if maintenance is required (Figure B1-2).
- Visually evaluate the condition of vegetation preservation areas, including buffers, trees and shrubs.
- Identify any observed decline in vegetation health that could be attributable to construction activities and recommend ESC improvements to mitigate any further harm. Common impacts to trees can include structural damage, root cutting and soil compaction, while other vegetated areas may be subject to erosion and/or sediment deposition due to altered site hydrology and vehicle tracking.
- If re-stabilization measures have been implemented (e.g. seeding, rolled erosion control products, mulching), refer to the BMP specific guidance in this chapter for detailed inspection and monitoring requirements.
- Look for any evidence of erosion on vegetation preservation areas or re-stabilized areas. Where erosion is occurring, determine whether the areas should be reinforced with additional erosion control measures (e.g. seeding, blankets, mats), or if flows should be re-routed around the area.
- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact. If buffers around natural features are compromised due to erosion or sediment deposition, their restoration should be set as a high priority, particularly when they are failing to protect the natural area from construction activities.




**Tree Protection Barriers**

① **Tree protection barriers must be constructed with a solid wood frame clad with plywood or approved equivalent. Height of hoarding may be less than 8 ft. to accomodate any branches that may be lower.**

② **Tree protection barriers for trees situated on the City road allowance where visibility must be maintained can be 1.2m (4ft.) high and consist of orange plastic web snow fencing on a wood frame made of 2 x 4s.**

③ **Where some excavate or fill has to be temporarily located near a tree protection barrier, plywood must be used to ensure no material enters the Tree Protection Zone.**

④ **No construction activity, grade changes, surface treatment or excavations of any kind is permitted within the Tree Protection Zone.**

**Note:**
**Sediment control fencing shall be installed in locations indicated in an Urban Forestry approved Tree Protection Plan. The sediment control fencing must be installed to Ontario Provicial Standards (OPSD-219.130) heavy duty silt fence barrier and to the satisfaction of Urban Forestry. See Detail TP- 2**

TORONTO
Urban Forestry

Parks, Forestry and Recreation
February 2016 **Detail TP-1**

**Figure B1-2:** City of Toronto tree protection barrier detail (City of Toronto, 2016)

## VEGETATED FILTER STRIPS

**(a.k.a. vegetated/vegetative buffer strips)**

Vegetative filter strips are areas of vegetation that are left in-situ in order to act as temporary or permanent, low-cost and effective erosion and sediment control measures. Well-established, existing vegetation can reduce the velocity of surface runoff, promote infiltration and reduce discharge by capturing and holding sediment and other pollutants.

### Application

- Determine areas and construction activities that may benefit from leaving vegetation in place such as diversion swales, adjacent to buffers, and identify the locations on the construction drawings.

**Existing grass** that is **thick** and **matted** is the ***most effective*** type of vegetative filter.

### Design and Installation

Vegetative buffer strips to be provided down gradient of sediment fencing according to the following criteria:

- 3 m for perimeter fencing
- 15 m for fencing adjacent to a warm water watercourse
- 30 m for fencing adjacent to a coldwater watercourse supplemented with a second row of fencing 2 metres beyond the initial row

- Avoidance of the area will be required in order to ensure that the vegetation is not trampled and killed.
- Climate conditions and seasonal variability may influence the effectiveness of the vegetation and additional ESC measures may be required during times of vegetation die-back.
- Additional ESC measures upslope of the filter strips may be required if excessive sedimentation is anticipated.
- It may be necessary to delineate the vegetation to remain so that the area can be protected from excavation, grading, foot and vehicular traffic.
- Space will be required to store equipment, vehicles, material and soil stockpiles away from areas where soil compaction and/or vehicle tracking may damage vegetation and tree roots.
- Vegetative filter trips aren't effective at filtering high velocity flows from paved areas, steep slopes or hilly areas without additional ESC measures.

### Inspection and maintenance

- Inspect weekly, and before and after significant rainfall (see definition in Section 10.1.2) or snowmelt events, and keep a record of the inspection.
- Repair any damage to fencing within 48 hours and remove, by hand, and dispose of any mounds of accumulated sediment or debris.

## SLOPE DRAIN

Slope drains are heavy duty, often flexible, pipes that convey runoff from the top of a slope to the bottom of a slope. This runoff diversion practice is used to prevent concentrated runoff from flowing directly over the bare face of the slope thereby reducing erosion and, in some cases, slope failure.

Slope drains are installed with water containment or diversion structures, such as interceptor/diversion swales, berms, or barriers that help collect and convey upslope runoff towards the slope drain

On long slopes the installation of terraces across the slope face will also mitigate erosion from sheet flow over the bare soil of the slope.  The terraces intercept runoff and direct them to the slope drain pipe, thereby preventing the formation of rills and gullies on the slope.

Prevent erosion on susceptible bare soil areas by ***diverting*** and ***intercepting*** runoff using practices like:

- Interceptor swales
- Berms
- Barriers
- Slope drains

### Application

- Exposed slopes where runoff is being conveyed from top to bottom
- Where it is anticipated that concentrated flows will flow over the slope face
- Particularly important on long and/or steep slopes
- In conjunction with a multi-barrier approach that includes water detention and/or diversion measures.

**Figure B1-3:** Slope drain

### Design and installation

- Calculate the pipe size based on maximum flows to be conveyed in the drain and provide on ESC plan drawings. The "Specified Flood Risk" calculation detailed in Appendix A may be applied for calculating return periods when sizing slope drains, particularly where the drain conveys water into or close to a natural feature. The calculation considers the acceptable level of risk (if the drain was to be overtopped) and the anticipated service life of the swale in determining the return period.  This may be useful where there is a low tolerance of risk of failure and/or the slope drain will be in place for a long time.
- Once the return period is established, determine maximum flow volumes to be conveyed based on the size and runoff coefficient of the contributing drainage area.
- Ensure proper securement of the pipe ex. stakes, grommets, stones, etc. and securement spacing along the length of the slope drain.
- Ensure that pipe will extend beyond the toe of the slope to a flat area.
- Anticipate using more than one slope drain pending site drainage area and anticipated runoff flows.

- Inlet should include a berm and inlet protection. Install the slope drain and construct a compacted inlet berm (in 150 mm soil lifts) or barrier with a minimum of 0.45 m compacted soil cover above the top of the pipe to secure inlet.
- Direct the flows from the top of the slope to the proposed location of the slope drain.
- Place slope drain(s) on undisturbed soils or compacted fill per locations on construction drawings.

**Inspection tip**

Always look out for seepage and scour to ensure your slope drain doesn't fail

- Anchor pipes along the slope.
- Ensure erosion doesn't occur at the inlets and outlets by installing erosion mitigation pads at the inlet and energy dissipaters at the downstream end.
- Position outlet so that it does not discharge to unprotected soils a receiving waterbody without flowing into a multi-barrier sediment control measure.

## Inspection and maintenance

- Inspect weekly, and before and after significant rainfall (see definition in Section 10.1.2) or snowmelt events, and keep a record of the inspection.
- Table B1-1 lists slope drain components to inspect and how common problems should be addressed.
- Inspect the length of the top of slope to ensure that runoff is being directed to the slope drain and is not flowing down slope face.
- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact.

## Decommissioning

- Ensure that areas receiving runoff are well-stabilized. If the final grading will result in runoff that was conveyed through the drain flowing over the slope, ensure that the slope is fully stabilized. If it has been seeded, vegetated, ensure that the seed/vegetation is fully established.
- Remove slope drains with as little disturbance of the slope as possible.
- Stabilize and restore all disturbed areas.

Prioritizing ***sustainability***

**Reducing waste** | Slope drain pipes can be reused elsewhere if not clogged with sediment and debris.

**Preventing erosion** | With runoff diverted, a dense vegetative cover can be more readily established on

**Table B1-1:** Recommended inspection and maintenance of slope drains

| Items to inspect | Inspection findings | Maintenance/repairs needed |
|---|---|---|
| Inlet | Erosion and seepage around the inlet | - Consider re-grading to reduce the inflow angle.<br>- Repair erosion, compact soil<br>- Stabilize inlet area with flared end section, rolled erosion control or filter fabric and riprap.<br>- Ensure pipe connections are watertight and that pipe is well secured. |
| | Sediment accumulation at the inlet | - Remove sediment when it begins to impede flow rates and compromise the ability of the pipe to convey all the water from the drainage area.<br>- Sediment accumulation greater than one-third the height of the berm should be removed.<br>- Consider stabilization of drainage area where possible. |
| Outlet | Erosion | - Repair erosion, compact soil.<br>- Consider incorporating outlet flow dispersion (e.g. flared pipe end) and/or energy dissipaters.<br>- Stabilize outlet (e.g. filter fabric and rip rap, rolled erosion control, vegetation) |
| | Sediment accumulation at the outlet | - Remove sediment when it begins to impede flow rates and compromise the ability of the pipe to convey all the water from the drainage area.<br>- Consider stabilization of drainage area where possible. |
| Pipe | Detachment and/or seepage | - Ensure pipe is re-secured and well-anchored to the slope.<br>- Consider improving anchoring methods to increase stability.<br>- If pipe seepage is noted, inspect pipe connections and repair/replace sections that area leaking. |
| | Clogging | - When sediment accumulation in the pipe leads to clogging and impeded flow, the pipe should be flushed out.<br>- If clogging is occurring too often, consider stabilization of drainage area and/or the installation of an inlet screen or grate to keep out larger debris. |
| | Overtopping | - Overtopping not caused by clogging indicates that the drainage area is too large of the flow velocity is too high for the pipe size used.<br>- Address overtopping by reducing drainage area, increasing pipe size, or slowing flows.<br>- Reducing drainage area requires re-grading and installing additional slope drains.<br>- Where flow velocity is the issue, consider re-grading and installation of barriers (e.g. check dams) to slow down runoff conveyed to the drain. |

Adapted from: “Pipe slope drains” in *Storm Water Management BMP Handbook* (South Carolina Dept. of Health and Environmental Control, 2005)

# INTERCEPTOR SWALES

### (a.k.a. diversion swales, cut-off swales)

Interceptor/diversion swales are conveyance systems that intercept, collect and convey runoff away from bare soil areas and towards sediment control measures. They may be used along or constructed with compacted earthen dikes alongside.

The purpose of these types of swales – which may be installed on a temporary or permanent basis - is to reduce erosion on susceptible areas by collecting and transporting runoff around a construction site in a defined and (ideally) stabilized flow path. They also facilitate site drainage after a wet weather event, preventing storm flows from accumulating in unwanted areas (e.g. adjacent properties, site areas where construction is underway).

## Application

While interceptor swales can be an effective erosion prevention practice for conveying runoff through any unstabilized areas, they are particularly important in the following circumstances:

- When the upslope drainage area is greater than 2 ha, and in particular in areas with highly erodible soils.
- When the following is true:

  $(S^2 \times L) \geq 0.75$ m

  Where S is the slope of the upslope drainage area (dimensionless), and L is length of the upstream slope (m).

**Figure B1-4:** Stabilized interceptor swale

Priority areas where interceptor swales should be applied include:

- Along the top of unstabilized long or steep slopes (in conjunction with slope drains).
- Along the perimeter of the site.
- Along the toe of slopes.
- Adjacent to valley and stream corridors.
- Where flows are being diverted around an area that is being stabilized/restored, in order to allow vegetation to become established.

## Design and installation

- Interceptor/diversion swales and dikes are intended to convey small flows along low-gradient channels. They should be directed towards a suitable sediment control measure, like sediment traps or sediment control ponds.

- Calculate the appropriate capacity of the swale and provide on ESC plan drawings. Sizing should consider the expected service life of the swale and potential consequences if it is overtopped.
- Calculate the gradient of the swale and provide on ESC plan drawings. Gradient should be calculated based on the intended capacity of the swale and the desired flow rate within the swale. In general, slopes should be the minimum possible that will maintain positive drainage. Velocities greater than 1.2 m/s will erode the invert of a grassed swale.

**Making the Grade**

Interceptor swales should have a grade of at least ***1%*** to maintain positive drainage, but grades steeper than ***2%*** could cause erosion.

- Dikes/berms greater than 1 m in height should be designed by a geotechnical engineer. The consequences of failure must be considered. Use a multi-barrier approach if swale overtopping would result in sediment release to natural features or other private property.
- Swales should be shaped like an inverted trapezoid, with side slopes no steeper than 2H:1V (Figure B1-5). Where dikes are used, they should be compacted and also constructed with side slopes no steeper than 2H:1V.
- An interceptor swale should be stabilized with a suitable erosion control BMP (e.g. vegetation, RECP, stone), particularly if it will be in place for more than 30 days. Swale inlets and outlets are important to stabilize due to their susceptibility to erosion. Unstabilized swales contribute to suspended sediment loads in runoff being conveyed, ultimately resulting in more sediment accumulation in downslope sediment control measures.
- In order to reduce the potential for swale erosion and provide opportunity for sediment settling, flow interruption devices (e.g. check dams, filter socks, coir logs) should be installed within the swales. See individual flow interruption BMPs for guidance on spacing in swale applications.

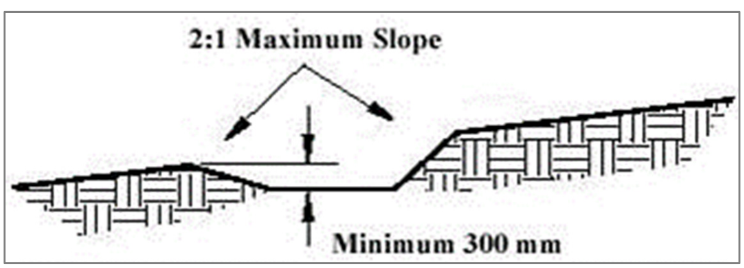



**Figure B1-5:** Cross-section of recommended interceptor swale design.

## Inspection and maintenance

- Inspect weekly, and before and after significant rainfall (see definition in Section 10.1.2) or snowmelt events, and keep a record of the inspection.
- Look for any signs of erosion, in the swale and/or dike, particularly at the inlet and outlet.
- Where stabilization measures are already in place, fill and re-stabilize eroded areas. Consider whether stabilization measures should be upgraded to hardier materials.
- Where erosion is observed and stabilization measures are absent or inadequate, consider adding stabilization measures as described under "Design and installation" above.

- Determine whether high flow rates are causing excessive erosion and if so, consider adding flow interruption devices, reducing the size of the area draining to the swale, or re-grading the swale to a flatter slope.
- Inspect all flow interruption devices to ensure they are properly installed and functioning as intended. Sediment and/or debris accumulation behind the device should be removed before it reaches approximately 30% of the device height.
- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact.

### Decommissioning

- Ensure flows are re-routed appropriately prior to decommissioning of the swale, to mitigate erosion or flooding issues.
- Fill swale, stabilize and restore the disturbed area.
- Ensure flow interruption devices are properly disposed of.

# SURFACE ROUGHENING

**(a.k.a. scarification)**

Surface roughening of bare soil areas is a technique that creates uneven surfaces and depressions that minimize erosion by reducing runoff velocities, providing greater opportunity for infiltration, and encouraging sediment trapping. In areas being seeded, these depressions can also help to keep seed in place and improve the establishment of vegetation.

Typically, surface roughening is done by tracking equipment to create horizontal depressions that are parallel to site contours and perpendicular to the runoff flow path. Surface roughening methods include: dimpling, track walking (Fig. B1-6), stair stepping and grooving.

**Figure B1-6:** Track walking applied to bare soil

## Application

- Can be applied to any inactive disturbed surface that will be left exposed on a temporary basis (less than 30 days). Areas exposed and inactive for longer than 30 days should be stabilized with vegetation and/or RECPs.
- Useful on exposed slopes and any other areas susceptible to erosion.
- Should be applied on any slopes steeper than 3H:1V, where vertical height is more than 1.5 metres.
- Useful where vegetation cannot be immediately established due to the season.
- Effectiveness is limited on very sandy or rocky soil.
- Should only be used alone on a temporary basis.
- Most effective when used with other stabilizing practices such as mulching and seeding.

A roughened slope is better able to ***catch and retain seed, mulch and moisture***, and **reduce runoff velocity**.

## Design and Installation

- Should be applied after grading activities have ceased (temporarily or permanently) in an area.
- The selection of an appropriate method depends on slope grade, mowing requirements after vegetative cover is established (if any), whether the slope was formed by cutting or filling, and type of equipment available.
- Roughening tracks should be made parallel to the site contours (perpendicular to runoff flow path). Applying tracks in the incorrect direction encourages the formation of rills and gullies.
- Surface is considered roughened if depression depths are 50 to 100 mm deep, and 100 to 150 mm apart.

- A chisel or ripping instrument can be used in most soil conditions.
- On slopes steeper than 2H:1V, the tracks left by a bulldozer driving perpendicular to the contour can leave acceptable horizontal depressions.

## Inspection and Maintenance

- Inspect scarified areas weekly, and before and after significant rainfall (see definition in Section 10.1.2) or snowmelt events, and keep a record of the inspection.
- Ensure vehicles and equipment are not driving over areas that have been roughened as this may result in the breakdown of the depressions and the creation of tracks which channel water down slopes and encourage erosion.
- Where roughening has been applied in conjunction with seed, inspect areas to determine the success of seed establishment and re-seed as needed.
- Identify any areas where roughening should be repeating or where it is providing insufficient erosion protection.
- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact.

# MULCHING

Mulch is a layer of organic material applied to a soil surface to help to retain moisture, regulate temperature and enhance soil health. Common materials used as mulch or as part of a hydraulic mulch mix are straw, shredded trees or bark, wood shavings, paper fiber and compost. When applied alone on bare soil it can reduce erosion by absorbing rainfall and acting as a protective physical barrier. It is often applied in conjunction with seed since it provides the added benefits of insulating the seeds and keeping them in place until they germinate.

Mulch is typically applied using one of the following methods:

- **Placement and spreading by construction equipment** | Dry mulch may be placed and spread using construction vehicles such as rubber-tired loaders or dozers. For smaller areas or those with no vehicle access, manual placement and raking may be suitable. Once applied, dry straw or hay can be kept in place by crimping it into the soil using a crimper (Figure B1-7).

**Figure B1-7:** Dry straw crimped into place (left) and hydromulched area (right)

- **Hydraulic application** | Hydraulically applied mulch, also referred to as 'hydro-mulch' is a slurry containing mulch materials (typically wood or paper based), water and a tackifier (Figure B1-7). Similar to a hydroseed mixture, it is stored in a tank and sprayed onto the soil surface using a hose. Helicopters with hydro-mulch sprayers are used when it is necessary to cover very large areas (e.g. following forest fires).
- **Pneumatically applied using a blower truck** | A blower truck can be used to apply dry mulch alone or with a tackifier. When applied as a dry mulch it is more appropriate for application on planted areas rather than on bare soil areas where it may not stay in place. Blower truck application of mulch with soil and seed is detailed in the 'Seeding' section.

## Application

- Short term erosion control on bare soil areas that are not subject to concentrated flows.
- Dry mulch best used on areas that have been seeded.
- Hydro-mulch (with tackifier) should only be applied alone to areas requiring temporary erosion control, including areas that are not meant to be seeded at time of mulching.
- Mulch applied for erosion protection on slopes steeper than 2H:1V should be in conjunction with a tackifier and/or seeding.

## Design and Installation


**Figure B1-8:** Straw crimper

- Mulching is most effective for erosion control when it is applied in conjunction with seeding, so that it can insulate seeds, retain moisture and prevent erosion.
- Select a mulch material which is derived from organic matter, and is free of weeds, seeds and fragments of invasive species. Straw mulch should be oat or wheat straw, while a hydraulic mulch should consist of wood or paper fibres, water, and a tackifier (OPSS.PROV 804, 2014). Mulch should not be derived from chemically treated wood or contain any additives that could inhibit growth of vegetation. Guidance on tackifiers is provided under “Chemical Stabilization” in this Appendix.
- Compost used as mulch should be stable, humus-like material produced from the aerobic decomposition of organic feedstocks, composted and cured until maturity. Compost quality should comply with mandatory Ontario MECP Compost Quality Standards for Category ‘AA’ or ‘A’ and be applied at rates that comply with Canadian Food and Inspection Agency (CFIA) regulations T-4-93 (CFIA, 1997a) and T-4-120 (CFIA, 1997b).
- Prior to application of hydro-mulch, the soil surface should be prepared by removing large rocks or other deleterious materials and filling in any rills or gullies. Roughening soil surface prior to application can help to keep mulch in place.
- Hydraulic mulch should be applied to the soil surface with good coverage. It should be applied with a uniform thickness, although slightly denser application may be warranted in erosion prone areas.
- Dry straw mulch should be kept in place by application of a tackifier or by crimping into place with a crimper (Figure B1-8).
- When applying hydro-mulch, consider the drying time and ensure that there will be an opportunity for the application to dry before the next rainfall event.
- Hydro-mulch should not be applied to frozen soil or during freezing or rainy conditions.
- For direction on the use of mulch in permanent/post-construction site restoration, see the guide entitled *Preserving and Restoring Healthy Soils: Best Practices for Urban Construction* (TRCA, 2012).

## Inspection and Maintenance

- Inspect mulched areas weekly, and before and after significant rainfall (see definition in Section 10.1.2) or snowmelt events. Keep a record of inspections.
- Ensure mulch applied on-site is consistent with approved plans with respect to the type and quality.
- Ensure vehicles and equipment are not driving over areas that have been mulched.
- Look for any evidence of insufficient coverage, migration of mulch due to poor attachment or soil erosion (e.g. rilling). Where erosion is occurring, determine whether re-application is needed, if the area should be reinforced with additional erosion control measures, or if flows should be re-routed around the area.

- Regrade and re-apply mulch in areas where coverage was insufficient or where mulch has been removed due to erosion.
- Refer to inspection and maintenance guidance in ‘Seeding’ section (p. B1-17) for mulched areas that have also been seeded.
- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact.

## SEEDING

The term seeding covers a range of practices, all of which involve the application of plant seed to a soil surface in order to establish a vegetative cover.  Seeding is an important means of stabilizing soil and reducing erosion during construction as well as at the conclusion of the project.  An area may be seeded as a temporary/short term erosion control strategy or as part of the final site stabilization/restoration plan.

The most common seed application methods are:

- **Broadcast** | Applying seed by hand or with a seed spreader.   Because this is labour intensive it is normally done for relatively small areas or those that are not easy to access with vehicles.
- **Mechanical** | Seed applied directly into the soil by mechanical equipment such as a seed driller (Figure B1-9). Only vehicle accessible areas can be seeded mechanically.

**Figure B1-9:** Mechanically seeded area (left) and mechanical seeding equipment (right)

- **Hydroseeding (a.k.a. hydraulic mulch seeding)** | A slurry containing seed, mulch, water and often a tackifier, stored in a tank and sprayed onto the soil surface using a hose (Figure B1-10).  The mixture may also incorporate additives to improve vegetation growth, such as fertilizer.  In very large scale applications, helicopters equipped with sprayers can be used for application.

**Figure B1-10:** Hydroseeded area (left) and application of hydroseeding (right)

- **Pneumatic (blown) seeding with growing media** | A calibrated mixture of seed and composted soil (or other growing media) that is applied onto bare soil surfaces with a blower truck (Figure B1-11). The one-step application of seed with growing media - and various optional soil amendments - results in seed that is planted the place where it's applied, rather than close to the surface where it could be vulnerable to erosive forces. This technique can be useful for any kind of stabilization, but may be cost-prohibitive to apply where only short term stabilization is needed.

**Figure B1-11:** Pneumatic seeding with growing media

## Application

| Seeding method | Soil stockpiles | Long term inactive areas (e.g. school blocks, rear yards) | Slopes | Interceptor swales | Sediment pond banks | Permanent stabilization areas (e.g. pond blocks, front/rear yards) | Riparian zones |
|---|---|---|---|---|---|---|---|
| Broadcast | For small areas | √ | √ | √ | | For small areas | √ |
| Mechanical | | √ | √ | | | √ | |
| Hydroseeding | √ | √ | √ | √ | √ | √ | √ |
| Pneumatic seeding with growing media | | √ | √ | Cost-prohibitive unless long term or permanent | √ | √ | √ |

## Design and Installation

- In addition to the seed application method, information on the species in the seed mix and application rates should also be provided to the local Conservation Authority for review.
- Seeding or other suitable stabilization should be applied on any stripped areas of the site that are inactive for more than 30 days.
- More detailed guidance on establishing a healthy soil and vegetative cover in permanent stabilization areas is available in *Preserving and Restoring Healthy Soil: Best Practices for Urban Construction* (TRCA, 2012). Download at: www.sustainabletechnologies.ca.

**Pro Tip**

Applying a rolled erosion control product or mulch will help mitigate erosion, improve moisture retention and protect your seeds from drying out in the sun.

### *Ground preparation:*

- Vehicle track and remove larger obstacles.
- Ensure that the area to be seeded is not compacted, has been roughened or scarified to create a rough and loose surface.

- For more information on assessing soil compaction and de-compacting methods, see *Preserving and Restoring Healthy Soil: Best Practices for Urban Construction* (TRCA, 2012), section 5.0.

### *Topsoil (where applicable):*

- Ensure the topsoil does not contain materials or contaminants at levels that would be harmful to plant growth, impair drainage, or adversely impact its intended use. Topsoil should:
  - Be free of refuse, stones, wood or debris larger than 50 mm in diameter;
  - Be free of deleterious substances, plant or soil pests, undesirable grasses, noxious weeds or weed seeds.
  - Meet topsoil specifications found in *Construction Specifications for Implementing Compost Amended Planting Soil in Ontario* (TRCA, 2017), available at www.sustainabletechnologies.ca.
- Topsoil should have a pH of 6.0 to 8.0 and contain 5 to 15% organic matter (by dry weight), depending on the type of vegetation to be established. A higher organic matter content is recommended for planting beds and tree pits, since larger, deeper rooting plants need deeper and richer topsoil to thrive.
- Ensure topsoil application at a minimum thickness of 200 mm. Where a pneumatic seeding application is used, topsoil may be substituted with the pneumatically applied growing media itself.
- Total uncompacted soil depth (topsoil + subsoil) should be at least 300 mm.

### *Seed:*

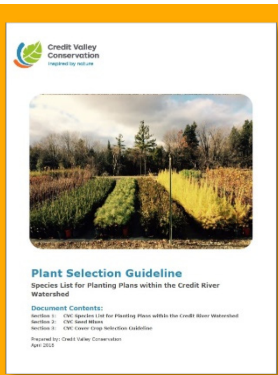
**Optimal Seeding Times**

April 15 – October 15

Late spring is ideal during drier conditions

Fall is best for dormant wildflower seeds

- Consider whether you need a secondary erosion barrier during seed establishment:
  - Where broadcast or mechanical seeding is being used, additional erosion protection (e.g. rolled erosion control product) is required until seed is well established.
  - If hydroseeding is being used, the area can be considered stabilized as soon as the application is successfully completed, provided that a tackifier was included in the slurry. If no tackifier was included, additional erosion protection (e.g. rolled erosion control products) should be used until seed is established, particularly in high erosion risk areas.
  - Where pneumatic seeding with growing media is used, it can prevent erosion immediately after application.
  - Regardless of seeding method used, more intensive erosion controls (e.g. hard armoring, cellular confinement system) may also be necessary in high erosion risk areas (e.g. slopes steeper than 2H:1V).
- For permanent stabilization areas (e.g. restoration areas, stormwater pond blocks), choose an appropriate seed mix based on site conditions, climate, surrounding vegetation community, topography, soil conditions, and adjacent land uses.
- Native seed mixes are required in CA regulated areas and recommended in non-regulated areas.
- For permanent stabilization areas, seed mix should be applied at a rate of 22-25 kg/ha or approximately 250g/90 m² for smaller areas.
- A nurse/cover crop should be added to every seeding application – to aid in the quick establishment of erosion and weed control – at a rate of 15-22kg/ha.




**For plant lists and detailed guidance on selecting species for planting plans, seed mixes, and cover crops, see Credit Valley Conservation's *Plant Selection Guide* (CVC, 2018).**

**The Guide is available at www.cvc.ca or in the Sustainable Technologies Evaluation Program Resource Library at sustainabletechnologies.ca/resource-library/water.**

- If cover crop is being used alone (e.g. temporary stabilization areas), application rate should be 25-60 kg/ha, depending on the density of cover needed to prevent erosion.
- For cover crops, ensure that the timing of the application coincides with appropriate growing windows as listed in Figure B1-12.
- If germination is not anticipated during the same growing season when seeding was carried out, additional erosion control measures (e.g. rolled erosion control products) are required to provide interim stabilization until vegetation is visible.

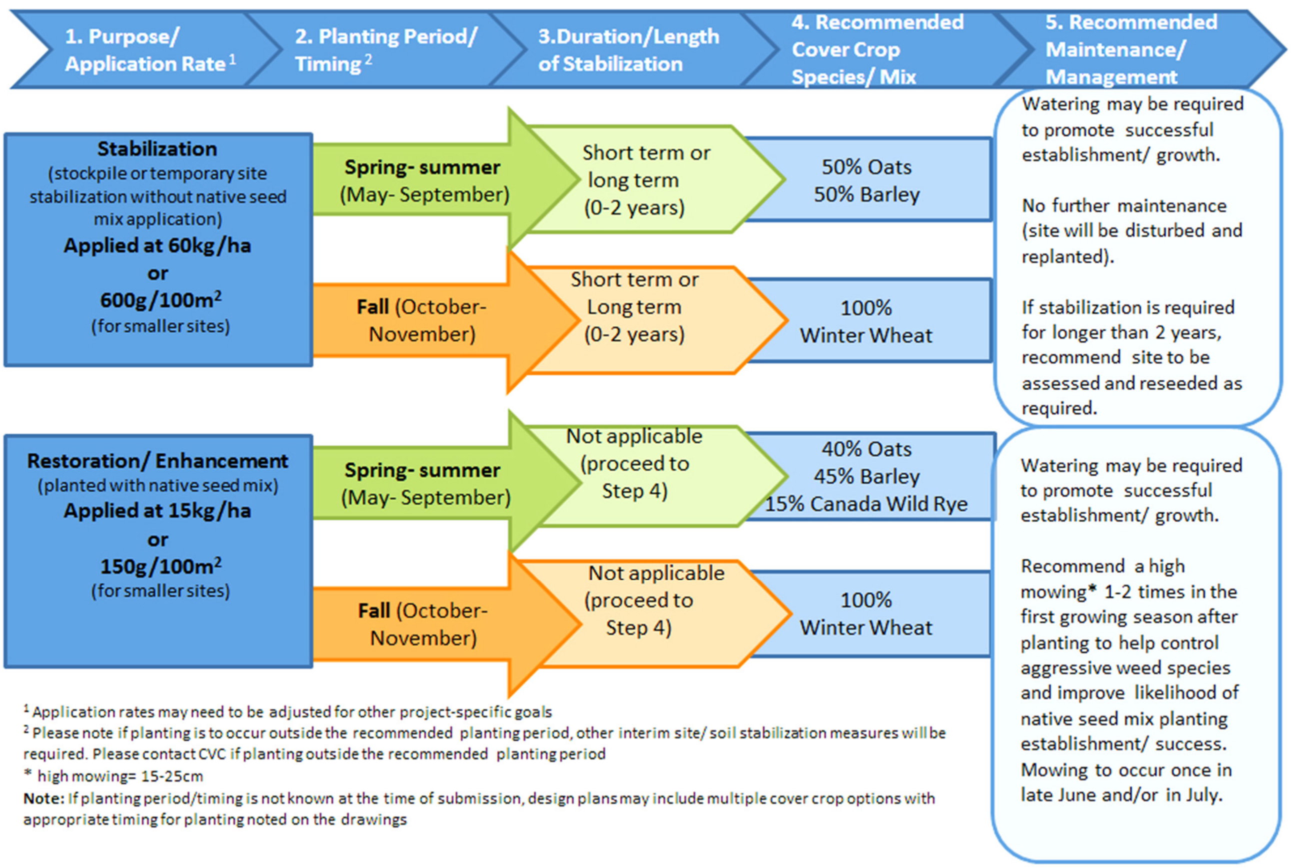



**Figure B1-12:** Decision guide for cover crop selection. Source: Plant Selection Guide (CVC, 2018).

### Inspection and Maintenance

- During seeding, check seed tags to confirm that the correct (approved) seed mix is being applied.
- Inspect seeded areas weekly, and before and after significant rainfall (see definition in Section 10.1.2) or snowmelt events, and keep a record of the inspection. Beyond this routine inspection, additional inspections of seeded areas may be needed when the seed is newly planted as well as during periods of drought.
- Establish a plan to ensure seeded areas are irrigated as needed, particularly if application is occurring during dry weather periods.
- Ensure vehicles and equipment are not driving over areas that have been seeded. To prevent damage, seeded areas should be fenced off during vegetation establishment, particularly if it is a busy and heavily used area.
- During inspection, determine whether seed is well established with good coverage (>80%).
- Look for any evidence of erosion on seeded areas (rilling). Where erosion is occurring, determine whether a higher seed application rate is needed, if the area should be reinforced with additional erosion control measures (e.g. blankets, mats), or if flows should be re-routed around the seeded area.
- Regrade and re-apply topsoil and seed in areas that didn't take or that have been removed by erosion.
- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact.
- Consider planning and budgeting for long-term as re-seeding may be required over time.

# OUTLET PROTECTION

Outlet protection practices prevent scour erosion immediately downstream of pipe and channel outlets that discharge water from construction sites. They fall into the following two general categories:

- **Energy dissipation devices** │ These structural devices are placed downstream of outlets, in the path of concentrated flows, in order to interrupt flows, reduce water velocities and thereby lessen the potential for scour. Examples of common energy dissipating devices include check dams, wattles and baffle blocks (Figure B1-12). Level spreaders are also applied to dissipate energy and reduce water erosivity by forcing water to leave the outlet area as sheet flow.

- **Surface hardening / ground covers** │ Creating a more erosion-resistant surface is another important way to prevent scour from concentrated flows downstream of outlets. The greater and more concentrated the flow being discharged from the outlet, the more resilient the surface cover should be. Surface covers downstream of outlets can range from a soft-armored natural cover (e.g. RECP-reinforced vegetated area, thick and matted vegetative cover) to harder manufactured structures (e.g. concrete headwalls, riprap lining, flexible rubber mats).

**Figure B1-12:** Erosion blanket in an outlet area (top) and baffle blocks for energy dissipation (bottom)

## Application

- At the base of any stormwater outlet releasing concentrated flow, including but not limited to: drainage tiles, detention facility outfalls, and piped or channel conveyance systems.
- Applied to mitigate scour erosion resulting from discharge ***leaving*** the site as well as discharges related to ***water movement within the active construction area*** (e.g. slope drain outlets, pumping and watercourse diversions).
- Need for outlet protection is greatest where flows are high and concentrated, and where discharge is being conveyed directly off the site and into a natural feature. In these cases, outlet protection is the last line of defense protecting the natural feature from erosion and sediment deposition.

## Design and Installation

- Outlet protection measures should be designed to blend in with the surrounding natural environment as much as possible, incorporating vegetation and stone to create scour resistant surfaces. Where manufactured support structures are necessary due to high flow rates, they should be integrated with vegetation if possible.
- Providing adequate protection against scour at stormwater outlets typically requires at least some hard armoring, typically incorporating riprap. Riprap stone should be underlain with a geotextile (or graded aggregate filter), covered with a stone base, and be sized to resist the tractive forces of the flow from the outfall and, where applicable, the lateral flow of the receiving channel. Typically the minimum diameter of riprap stone should be 300 mm.

- Where stone (sub-angular recommended) is used for protection below an outlet in a natural feature, geotextile liners should not be installed below the stone, as this compromises the stream bed as a habitat for aquatic organisms.
- For outlets discharging to a flowing receiving channel, pipes and structures must be aligned to avoid erosion caused by lateral flows in the vicinity of the exposed structure.

A manufactured scour prevention and flow dissipation device that has been integrated with vegetation. The pictures depict the same area immediately following installation (left) and after vegetation has become established (right).

- Energy dissipation in the form of structural stilling basins, baffle (chute) blocks or other structural flow interrupters are often required for stormwater discharge velocities ≥ 3 m/s.
- Where the outlet discharges to a grass-lined ditches/channels, flow velocities should not exceed 1.2 m/s. Flows above this threshold will typically cause the channel to erode. If discharge velocities cannot be reduced or some of the flow diverted to a different outlet, then energy dissipation measures should be employed in the channel to slow down the water as it moves into and through the channel.
- Where level spreaders are applied they must be installed so that they are completely level, otherwise flows will concentrate at the low point instead of flowing uniformly over the spreader.
- Protection measures must be in place prior to any conveyance of runoff through the outlet structure.

## Inspection and Maintenance

**DISSIPATE AND DISPERSE**

For temporary pipe outlets used during pumping and dewatering activities, consider using a ***sediment bag*** to ***dissipate*** and ***disperse concentrated discharge***.

- Inspect all stormwater outlets weekly, and before and after significant rainfall (see definition in Section 10.1.2) or snowmelt events, and keep a record of the inspection. Prioritize inspection and maintenance of outlets that discharge directly to natural features.
- Look for evidence of erosion downstream of the outlet and recommend options for either reinforcing/hardening the surface, dissipating energy through flow interruption, reducing flow from the outlet, or a combination of these solutions.
- Assess the degree of sediment accumulation behind energy dissipation devices. Sediment accumulated behind flow interrupters like baffle blocks, check dams, filter socks and wattles/logs should be removed when it has reached approximately 30% of the height of the device, or sooner if there is evidence that sediment is being re-suspended.
- If a sediment bag has been used to dissipate and disperse flow from an outlet, inspect the sediment bag to determine whether it requires changing or is damaged in any way. Additional guidance on sediment (dewatering) bags is provided in Appendix B2
- Assess whether there has been any shifting of structural components or structural damage to hard or soft armored surfaces downstream of outlets, and recommend the necessary maintenance and/or repairs.

- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact.

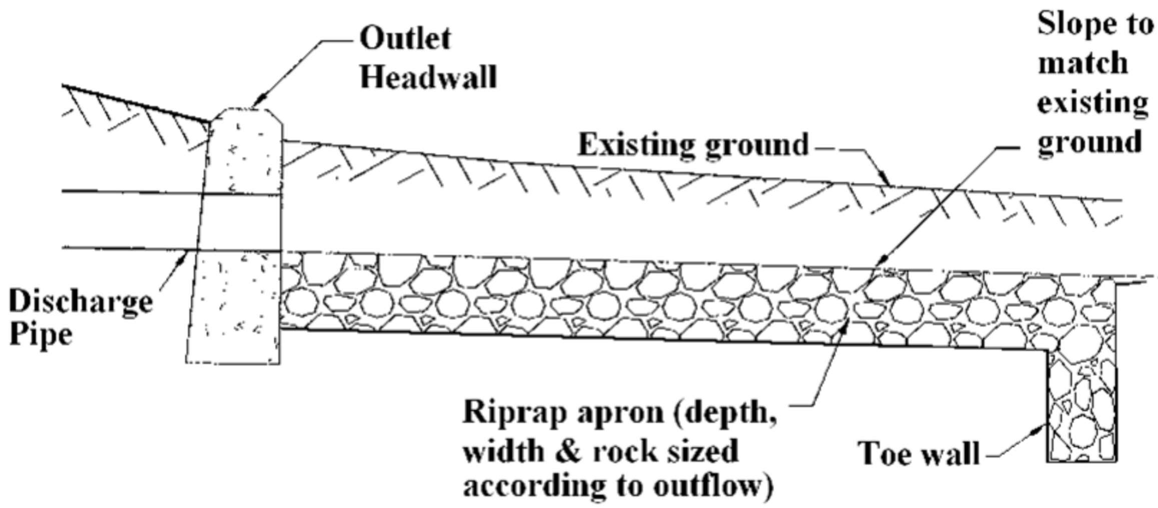



**Figure B1-13**: Storm drain outfall protection. Source: *Sediment & Erosion Control on Construction Sites – Field Guide* (University of Virgin Islands, 2003).

## ROLLED EROSION CONTROL PRODUCTS

**(abbr. RECPs)**

Rolled Erosion Control Products (RECP) are prefabricated blanket-like ground covers, made up of organic and/or synthetic materials and designed to act as a physical barrier to erosive forces. RECPs are typically applied and stapled into place over bare soil areas or on newly seeded areas, but sometimes are set up for added long term stabilization of vegetated areas with high erosion risk. In addition to acting as a physical erosion barrier, RECPs promote the establishment of vegetation by allowing for water infiltration (resulting in higher soil moisture levels), protecting seed from being carried away or consumed by wildlife, and moderating soil temperatures.

Specific types of RECPs include:

- **Netting** | A woven degradable net composed of material like jute, straw or coir (coconut fibre), which provides temporary stabilization to aid in the establishment of vegetation. Highly erodible slopes may require application of a sub layer of straw mulch overlain with netting, which is stapled through to enhance ground contact.

- **Blankets** | Typically composed of coir, straw or wood fibre woven within a photodegradable netting to form a thick blanket. Often used as a temporary measure to protect against erosion during seed establishment, although some types can last up to 2 years. They have a lower tensile strength compared to mats, but are capable of better ground contact.

- **Turf reinforcement mats (TRM)** | Hardy materials, such as coconut husk fibers or synthetic polypropylene fibers, woven together to provide the highest tensile strength and most long term erosion control of any of the RECPs. Composite TRMs combine the protection of a blanket with the added reinforcement of netting in areas requiring long term or permanent stabilization.



**Figure B1-14:** From top to bottom - jute netting, coir blanket and a turf reinforcement mat

### Application

- Un-vegetated areas that convey concentrated flows, including swales and ditches.
- Any slopes steeper than 2H:1V that have not been stabilized with other erosion control measures (e.g. vegetation).Newly seeded areas where germination/vegetation establishment has not yet occurred. See “Seeding” section for guidance on when seeded areas require secondary erosion controls.
- Riparian areas or within natural water features or watercourse diversions if conservation authority approval has been granted.
- Banks of sediment control traps or basins, on a temporary basis until they are seeded. RECPs should also be used on newly seeded banks if the seeding method does not provide immediate soil stabilization.
- Erosion scars.

**To net or not to net?**

RECPs that include biodegradable or photodegradable plastic netting can provide a significant erosion control advantage due to their higher tensile strength, but netting can also ***ensnare small wildlife like snakes, turtles and frogs***.

When choosing an RECP for application in areas frequented by wildlife – like riparian areas, natural features and stormwater pond banks - opt for ***100% biodegradable products*** that are ***free of plastic netting,*** like ***jute, sisal,*** or ***coir fiber.*** Products with a loose-weave design and movable joints are ideal. Where plastic netting must be used, remove it as soon as it is no longer needed, as long as its removal will not damage vegetation.

- Any other areas requiring erosion protection and where ground surface is not rocky.
- Not suitable for application when ground is frozen.

## Design and Installation

**Figure B1-15:** RECP installed on a slope and anchored in place at the top

- Consult with RECP suppliers for information and guidance on selection of an appropriate product, with consideration for required longevity, slopes, and flow velocities.
- Site conditions and the required longevity of the RECP will inform which product is best suited for the application. Biodegradable RECPs should be selected where they are serving as a temporary erosion control. Non-biodegradable plastic components may be necessary in some permanent installations where long term heavy duty stabilization is required, but in general these types of plastics should not be installed and left in vegetated areas indefinitely.
- Consult the local Conservation Authority if the application is proposed within a water feature or watercourse diversion channel.
- Prepare the exposed surface by removing mounds, protruding objects that could cause punctures, etc. to ensure that there will be a firm, continuous contact between the RECP and the ground. Tenting must be avoided as it creates a drip zone that will lead to erosion of the soil under the blanket.
- Where RECP is protecting a seeded area, apply topsoil and seed prior to installing the RECP.
- RECPs should be installed vertically down slopes for slopes 3H:1V or steeper. On slopes with a lower grade, RECPs can be installed horizontally across the slope where necessary. (see Figure B1-16)
- Ensure that sections overlap at edges and at the ends. The upslope segment of the RECP should always be on top as it overlaps with the next downslope segment. This prevents the RECP from being breached by water flowing over the surface. RECP segments overlapping parallel to the direction of flow should overlap at least 10 cm, while segments overlapping perpendicular to the direction of flow should overlap at least 30 cm. See Figure B1-16.
- For installations on either slopes or channels/swales, RECPs should always be installed starting at the top of the slope (or side slopes in the case of a channel/swale). Without protection the top of slope will

be highly susceptible to rill erosion, which could ultimately undermine the RECP.

- When applied on slopes or conveyance channels, the use of an anchor trench at the top and/or bottom ends can help to keep the RECP in place (see Figure B1-16). Anchor trenches should be at least 15 cm by 15 cm. If the RECP is not long enough to extend the full length or the slope of channel, a check slot (15 cm by 15 cm in size) should be constructed at the location where the RECP will overlap with the next downslope piece in order to help keep the downslope segment in place.
- RECPs should be attached to the ground surface with wire staples, metal geotextile stake pins, or triangular wooden stakes, all of which should be at least 15 cm long.

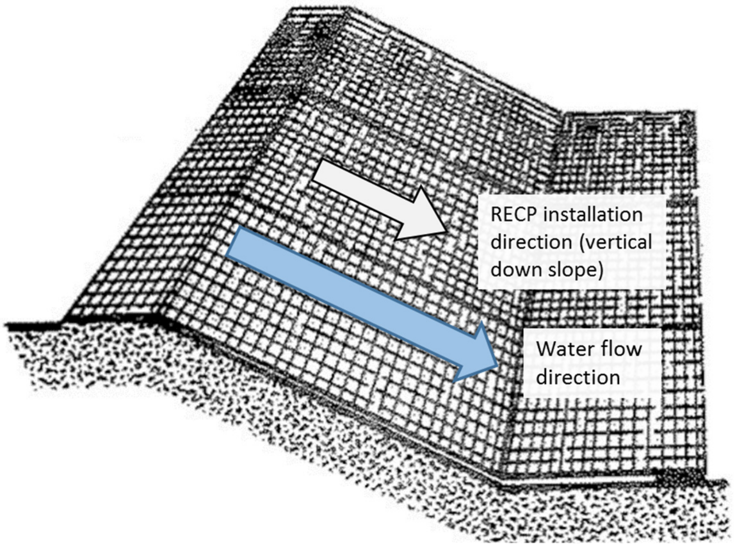
**Seeding + RECP = *Success!***

RECPs work best as a support for vegetation establishment, and will often fail when underlying seeding is sparse or poorly established.

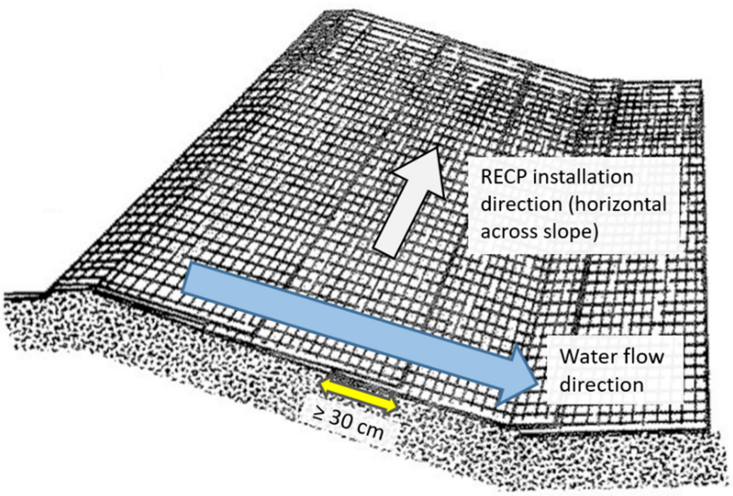
- Figure B1-16 provides some general guidance for installation, but the manufacturer should be consulted on the best method for application. Follow manufacturer's product specific application instructions, including anchoring and staple patterns.

## Inspection and Maintenance

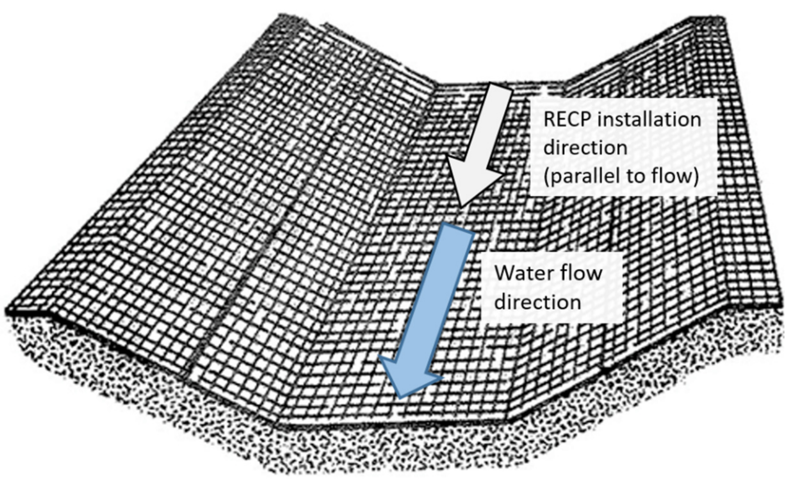
- Until vegetative cover is well established, inspect areas covered with RECPs weekly, and before and after significant rainfall (see definition in Section 10.1.2) or snowmelt events, and keep a record of the inspection. Newly seeded RECP-covered areas may warrant more frequent inspection. See pages B1-17 to B1-21 for guidance on inspection and maintenance of seeded areas.
- Ensure good contact with the ground and that there is no tenting of the RECP or erosion of the soil surface under the blanket.
- Inspect the condition of the RECP to ensure it has not been torn or detached.
- Re-attach or replace any RECP anchors (e.g. staples, stakes) that have come loose.
- Where anchor trenches or check slots are used, ensure RECPs are still firmly secured.
- Ensure vehicles and equipment are not driving over areas that have been covered with RECPs. To prevent damage, areas should be fenced off during vegetation establishment, particularly if it is a busy and heavily used area.
- Where erosion is occurring under the RECP, consider whether the blanket needs better contact with the ground, if a higher tensile strength RECP should be used, or if flows should be re-routed around the area.
- Repair eroded areas by removing RECPs, re-grading, re-applying topsoil and/or seed, and re-installing RECPs.
- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact.




- RECPs should be installed vertically down slopes, particularly on slopes 3H:1V or steeper
- Anchor trench should be constructed at the top and bottom of slope
- Overlap of adjacent strips of RECP should be at least 10 cm.




- RECPs may be installed horizontally across slopes less steep than 3H:1V where necessary.
- Anchor trench should be constructed at the top and bottom of slope
- Upslope segments should be on top, overlapping downslope segments by at least 30 cm.




- In ditches and channels, RECPs should be installed vertically in the direction of flow.
- Anchor trenches should be installed at the beginning of the channel and along the tops of channel slopes.
- Down the side slopes, the upslope segments should be on top of the downslope segments and should overlap at least 10 cm.
- Down the length of the channel, upslope segments should be on top of downslope segments, overlapping by at least 30 cm.

**Figure B1-16**: Recommended orientation and overlap of RECPs on slopes and channels. *Adapted from: Keeping Soil on Construction Sites* (HRCA & HCA, 1994).

# CHEMICAL STABILIZATION

**(a.k.a. tackifiers, soil binders, polymers, soil stabilizers)**

Chemical stabilization is an umbrella term that includes a variety of substances – ranging from natural to synthetic – that can be applied to increase the cohesion of soil surfaces by binding soil particles to one another, and/or to mulch. They are often applied for protection from both water and wind erosion on construction sites. Chemical stabilization can be particularly useful in areas where soil stabilizing vegetation has been difficult to establish.

While they can provide some erosion protection when used alone, soil stabilizers work most effectively when applied to keep soil in place during seed establishment, often as part of a hydroseeding or hydromulch mix. When added to these hydraulically applied products, they help to establish more long term or permanent vegetative stabilization. Because chemical soil stabilizers allow water to infiltrate while keeping soil, mulch and seed in place, they promote moisture retention and improved vegetation establishment. Some chemical stabilizers can also help to improve the consistency of hydraulic mixes, making them easier to apply.

Chemical soil stabilizers are often categorized as follows:

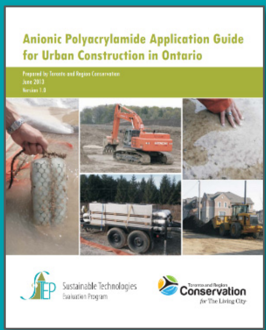
- Plant-based short term (e.g. guar, psyllium, starch), and long term (e.g. pitch and rosin emulsions)
- Synthetic petroleum-derived polymers (e.g. anionic polyacrylamide, polyacrylate)
- Cementitious binders (e.g. gypsum)

**Figure B1-17:** Application of hydroseed containing tackifier (left) and granular anionic polyacrylamide (right)

## Application

- Use in and/or within 30 m of a natural water feature is subject to CA approval. Toxicity data as described under ‘Design and Installation’ must be available upon request.
- Best used in conjunction with seeding, such as within a hydroseeding or hydromulching mix in order to establish a more lasting stabilization.
- When used with seed, suitable for any areas requiring erosion protection, including slopes, interceptor swales and any other areas not subject to vehicle traffic.
- Only applied on bare/unseeded soil if the following criteria apply:
    - Regular reapplication at the supplier’s recommended frequency can be maintained.
    - The area is receiving only non-concentrated sheet flows
    - The area will not be subject to vehicle traffic or other earth disturbing activities
    - Stabilization is only needed on a short term basis

- Local policies on the use of chemical stabilization may differ from the information provided herein. Confirm local policies prior to including chemical stabilization on ESC plans.




**For specific and detailed guidance on using anionic polyacrylamide on construction sites, see Toronto and Region Conservation Authority's *Anionic Polyacrylamide Application Guide for Urban Construction in Ontario* (TRCA, 2013).**

**The Guide is available in the Sustainable Technologies Evaluation Program Resource Library at:**

**sustainabletechnologies.ca**

## Design and Installation

- If the product is being mixed and applied by a third party, ensure that they are following the requirements listed herein.
- Chitosan and other cationic polymers (e.g. cationic polyacrylamide) should not be applied as soil stabilizers on construction sites due to their toxicity to aquatic organisms.
- Application rates vary according to the method of application and the specific type of chemical stabilizer. Ensure the product is applied at the manufacturer's recommended application rate.
- Ensure product labelling and/or packaging is available for the chemical stabilizer, which specifies the following:
  - product expiry date
  - use instructions, including application rates and mixing methods (if applicable)
  - recommended re-application frequency and other maintenance requirements
  - safe handling, storage and disposal information
- Any applications of anionic PAM-based products should meet the criteria detailed in *Anionic Polyacrylamide Application Guide for Urban Construction in Ontario* (TRCA, 2013).

Prioritizing ***Sustainability***

Always consider biodegradability when choosing a stabilizer.

Biodegradable products are the sustainable choice because they can **break down**, **safely** and relatively **quickly**, through **biological processes**.

- The chemical stabilizer must be safe at the expected application rate and based on the intended use. Evidence of this should be available in the product's Material Safety Data Sheet (MSDS) and/or toxicity reports. As a minimum, acute and chronic toxicity data, based on testing by an accredited third party, should be available for the following aquatic organisms: fathead minnow (Pimephales promelas), rainbow trout (Oncorhynchus mykiss) and water flea (Daphnia magna). The LC-50 concentrations (the concentration of polymer that is lethal to 50% of the sample population) listed in toxicity reports must exceed the maximum anticipated release rate of the product based on the way it's being used.

- Certain chemical stabilizer products, such as anionic PAM based products, are available in different formulations designed to bind different soil types. Where this type of product is being used, ensure that the formulation selected is effective for the specific soil on site. This is often done by submitting a soil sample to the supplier for testing. Chemical stabilizers that are ineffective at binding to soil will be easily washed away during a rainfall event, and could end up in undesired locations such as natural features.
- Prior to application of a chemical stabilizer, alone or as part of a hydraulic mix, the soil surface should be prepared by removing large rocks or other deleterious materials and filling in any rills or gullies
- When using a chemical stabilizer in conjunction with seeding, the top few inches of soil should be de-compacted to ensure good germination.
- Consider the drying time for the selected chemical stabilizer and ensure that there will be an opportunity for the application to dry before the next rainfall event.
- Avoid hydraulic application of chemical stabilizers during windy conditions in order to avoid having the product end up in unintended areas.
- Chemical stabilizers should not be applied to frozen soil or during freezing or rainy conditions.

**Figure B1-18:** Soil surface stabilized with anionic PAM

## Inspection and Maintenance

- Inspect chemically stabilized areas weekly, and before and after significant rainfall (see definition in Section 10.1.2) or snowmelt events, and keep a record of the inspection. Beyond this routine inspection, additional inspections of seeded areas may be needed when the seed is newly planted as well as during periods of drought.
- Where the stabilizer has been applied in conjunction with seed, refer to guidance on inspection and maintenance of seeding on p B1-21.
- Confirm that the chemical stabilizer has been applied evenly with coverage of at least 80%.
- If the stabilizer has failed to adsorb to the soil particles, it can be easily washed away during a rainfall event and migrate downslope from the intended treatment area. If this is observed it may mean the stabilizer is ineffective for the soil type, and that a different formulation should be applied.
- Ensure vehicles and equipment are not driving over areas that have been treated. To prevent damage, chemically stabilized areas can be fenced off, particularly if it is a busy and heavily used area.
- Look for any evidence of erosion on chemically stabilized areas (rilling). Where erosion is occurring, determine whether a second application is needed, if the area should be reinforced with additional erosion control measures (e.g. blankets, mats), or if flows are too concentrated and should be re-routed around the treated area.
- Regrade and re-apply stabilizer in areas that have been subject to erosion or where the initial application was deficient.
- Re-apply at the frequency recommended by the product supplier/manufacturer to ensure area remains stabilized. If stabilizer was applied with seed, re-application of chemical stabilizer is needed (at the recommended frequency) only until vegetation is well established.

- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact.
- Consider planning and budgeting for long-term as re-application may be required over time.

# B2: SEDIMENT CONTROL PRACTICES

While erosion control is preventive in nature, as it is focused on keeping soil in place, sediment control measures are corrective in nature, meant to remove sediment that has already become suspended in stormwater. The multi-barrier approach to erosion and sediment control requires the application of both types of controls in series to create a resilient system to protect the natural environment from sediment impacts. Sediment removal can be achieved in a variety of ways, but controls are generally focused on settling, filtration, or a combination of the two.

Settling controls promote gravitational settling of suspended sediment by detaining stormwater and reducing flow velocities. While chemical flocculants can also be used to promote gravitational settling, they do so by agglomerating particles, making them heavier, larger, and more susceptible to settling or filtration. Settling controls may be applied to treat concentrated flows (e.g. check dams) or sheet flows (e.g. silt fencing). They are often applied in conveyance systems (e.g. interceptor swales), at the site perimeter, or anywhere it is necessary to separate a significant sediment source from a protected receiver. For example, controls may be applied around a storm drain inlet in order to prevent sediment from entering catchbasins, and eventually the receiving water system.

Filtration controls are porous materials (e.g. geotextile) which hold back sediment from stormwater that passes through them, with the filter's apparent opening size dictating the size of particles it can filter out. Because filtration controls also tend to reduce flow velocities, they can serve as settling controls as well.

Detailed guidance on the following sediment control practices are included in Appendix B2:

## SEDIMENT CONTROL FENCE
### (a.k.a. Silt fence)

**Figure B2-1:** Sediment control fence

Sediment control fence consists of geotextile material supported by posts and trenched in to the ground. It functions as a settling control by reducing velocity, ponding sheet flows and promoting gravitational settling of suspended sediment. It is also an effective means of redirecting sheet flows towards a treatment area (e.g. sediment control pond or trap). Despite the permeability of the non-woven geotextile fabric used in this type of fencing, it should not be used as a means of filtering sediment laden water as it does not effectively filter out fine particles (< 50 µm).

There are three primary components that make up sediment control fence: geotextile fabric, structural fencing support, and posts. The structural fencing support, often a page wire fence to which the geotextile is attached, keeps the geotextile fabric upright in between posts, while the posts keep the entire installation upright.

### Application

- Along the perimeter of a construction site
- Along the up-gradient side of sensitive areas, streams and river corridors
- Around stockpiles of excavated material, such as topsoil
- Approximately 1.5 metre away from the base of moderate slopes
- Any other areas where sediment laden sheet flow requires treatment, provided that the fencing is installed parallel to the site contours.
- Sediment control fences should ***not*** be used perpendicular to flow in watercourses or other concentrated flow paths.
- Sediment control fence is meant to be used as a treatment measure for sheet flows and does not need to be installed as a means of delineating site boundaries if the area does not receive any sheet flow (e.g. high point). In these areas other types of fencing may be used if desired.
- For installation of sediment control fence on slopes, the grade and slope length must be considered to ensure that flows will not overwhelm the structural stability of the fence. The following are the maximum lengths of slopes on which sediment control fencing should be installed, according to grade.

| Slope grade | Maximum slope length for sediment control fence |
|---|---|
| 2H : 1V | 15 m |
| 3H : 1V | 25 m |
| 4H : 1V | 40 m |

## Design and installation

Materials specifications

**SEDIMENT FENCE SHOULD NEVER BE…**

- used as a filter
- used in a concentrated flow path or in the path of large overland flow volumes
- installed perpendicular to flow in a watercourse
- pre-fabricated with wooden stakes attached
- installed with snow fence as the structural (support) fencing

- Posts used to support sediment control fence should be sturdy material such as steel t-bar with length ≥ 1.5 m.
- In areas where sediment control fence is being used as a barrier to protect a natural feature, wooden posts (recommended cross-section 10 cm by 10 cm) should be used instead of t-bars. Alternatively, a double row of t-bar supported sediment control fence (Figure B2-2) could be applied in these sensitive areas to provide multiple barriers and a high level of protection.
- Structural support fencing should be a high tensile strength galvanized page wire fence. Recommended specifications are 14 gauge wire thickness and opening size of 10 by 10 cm. Structural support fencing with similar strength, flexibility, and weather resistance is also suitable.
- Prefabricated sediment control fence products with wooden stakes already attached to geotextile should be avoided due to their lack of structural stability and inability to allow deep water ponding.
- Geotextile used in sediment fence should be non-woven and meet or exceed the following specifications:

| Material property | Test methods | Minimum value | Type of value |
|---|---|---|---|
| Grab strength (machine direction) | ASTM D4632/D4632M | 550 N[1] | Minimum ARV[2] |
| Grab strength (cross direction) | ASTM D4632/D4632M | 450 N[1] | Minimum ARV[2] |
| Permittivity | ASTM D4491/D4491M | 0.05 $sec^{-1}$ | Minimum ARV[2] |
| Apparent Opening Size (AOS) | ASTM D4751 | 0.60 mm | Maximum ARV[2] |
| UV Stability | ASTM D4355/D4355M | 70% after 500 hrs of exposure | |

[1] Products with tensile strengths up to 10% less than specified minimum may also be considered.
[2] ARV: Average Roll Value

Fence installation

- Support posts should be no more than 2 metres apart and driven into the ground to a depth of at least 90 cm.
- Brace the fence posts diagonally in areas where deep ponding is anticipated.

- Geotextile fabric should be stretched tight across the structural fencing with no sagging and extend up from the ground to a minimum height of 60 cm. Fabric should be fastened to the structural support fencing and support posts with wire ties tied at the posts.
- Where the geotextile is joined to provide a continuous run, the ends should be overlapped at least 50 cm and securely fastened to posts.
- The bottom 30 cm of the geotextile should be tied into soil, using either static slicing or trenching methods, to ensure there is no space between the bottom of the geotextile and the ground. The trench should be constructed to be at least 20 cm deep an 40 cm wide (see Figure B2-3a).

**Figure B2-2:** Double row sediment control fencing

- The trench should be backfilled and compacted to ensure structural stability of the fence.
- In frozen soil conditions, if trenching cannot be achieved the geotextile should be secured with a filter sock (recommended diameter of 450 mm) staked into place along the upstream side of the fence (see Figure B2-3b)
- Double row sediment control fence should be installed with straw bales or a similar measure to provide structural support in between the fence rows.

<u>Fence placement</u>

- In sensitive areas (e.g. within or adjacent to natural features) consider whether sediment control fence installation will create excessive ground disturbance. In these cases, a different type of sediment control barrier may be advisable or recommended by the local Conservation Authority.
- Maintain a vegetated buffer of at least 3 m down gradient of sediment control fencing. Larger buffers are required adjacent to natural features based on defined limits of development, as described under “Vegetated buffer strips”.
- Consider installing additional sediment controls, double row sediment control fence, or sediment control fence supported by wooden posts in areas within or adjacent to natural features.
- Always install sediment fence:
  - along the contour and not on up and down slopes;
  - with end sections constructed up the slope to stop runoff from flowing around the ends of the fence; and
  - on the flat area at least 1.5 m away from the toe of a slope.
- Place wisely to avoid using more fencing than needed, resulting in additional waste sent to landfill. Installing sediment fence upgradient of sediment sources should be avoided if possible, with other simpler and more reusable types of fence used when the only objective is delineating boundaries.

## Inspection and maintenance

- Inspect the entire length of sediment fence weekly, and before and after significant rainfall (see definition in Section 10.1.2) or snowmelt events, and keep a record of the inspection.
- Inspect the fence to look for any signs of damage to the geotextile or compromising of the structural integrity of the fence. Ensure the fence has been properly installed as defined under "Design and Installation" section above.
- Remove and properly dispose of sediment before it reaches approximately 30% of the height of the fence, or sooner if not functioning as intended.
- A supply of sediment control fence materials should be kept on site to allow for quick repairs or the installation of additional fencing as needed.
- Where fence continues to fail on an ongoing basis, consider reinforcing problem areas or replacing with an alternative sediment retention device. If failure is a result of concentrated flows being directed to the fence, consider re-designing surface water flow paths to reduce volumes being directed to the problem area.
- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact. Higher priority should be assigned to repair of sediment fence installed upgradient of natural features.

## Decommissioning

- Ensure removal and proper disposal of accumulated sediment.
- All materials associated with the sediment fence must be removed once the site has been restored and disturbed areas have been stabilized.
- All sediment fence materials should be removed from the site. Reusable components can be salvaged for future use and others should be disposed of at an appropriate waste facility.

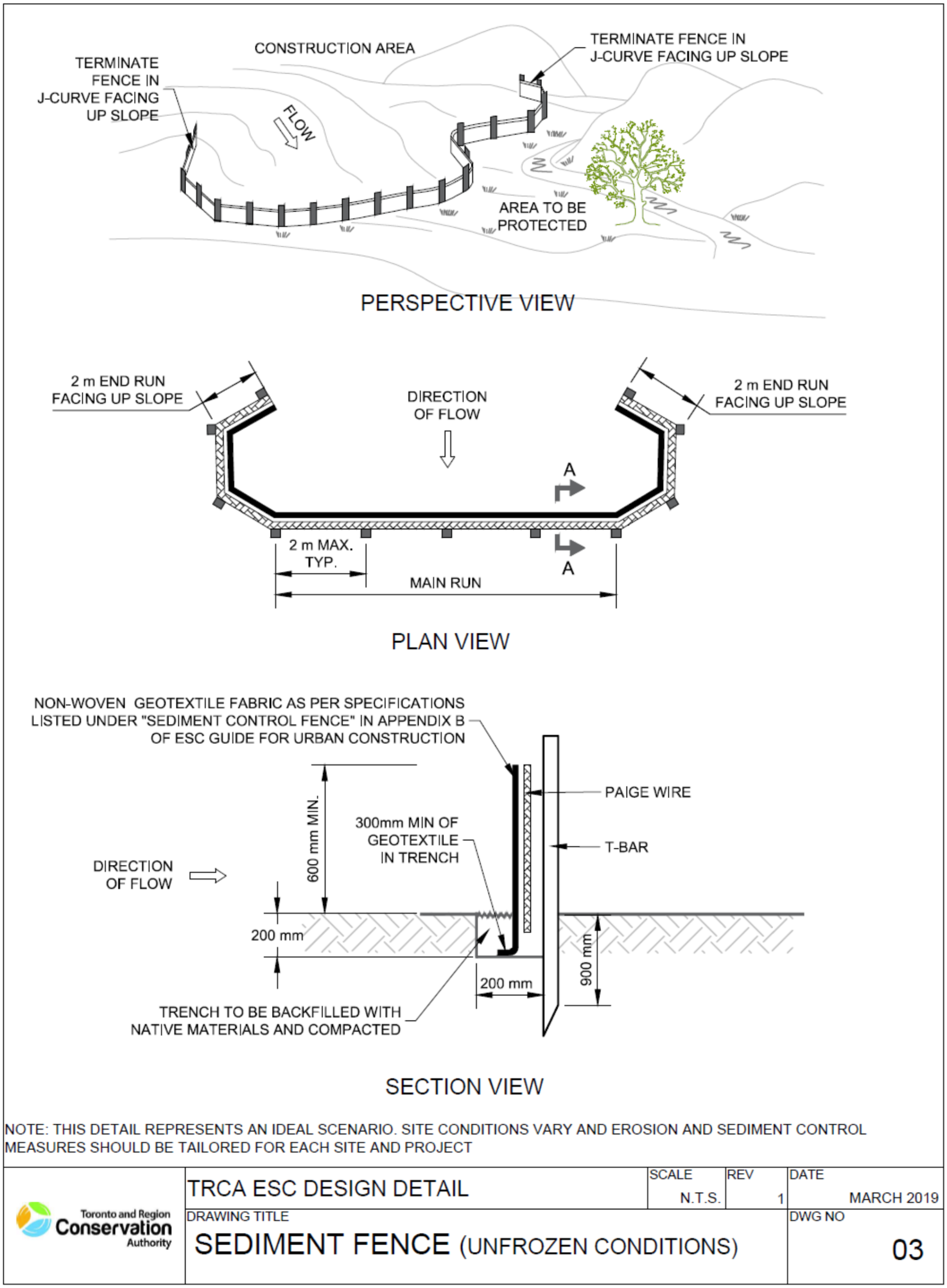



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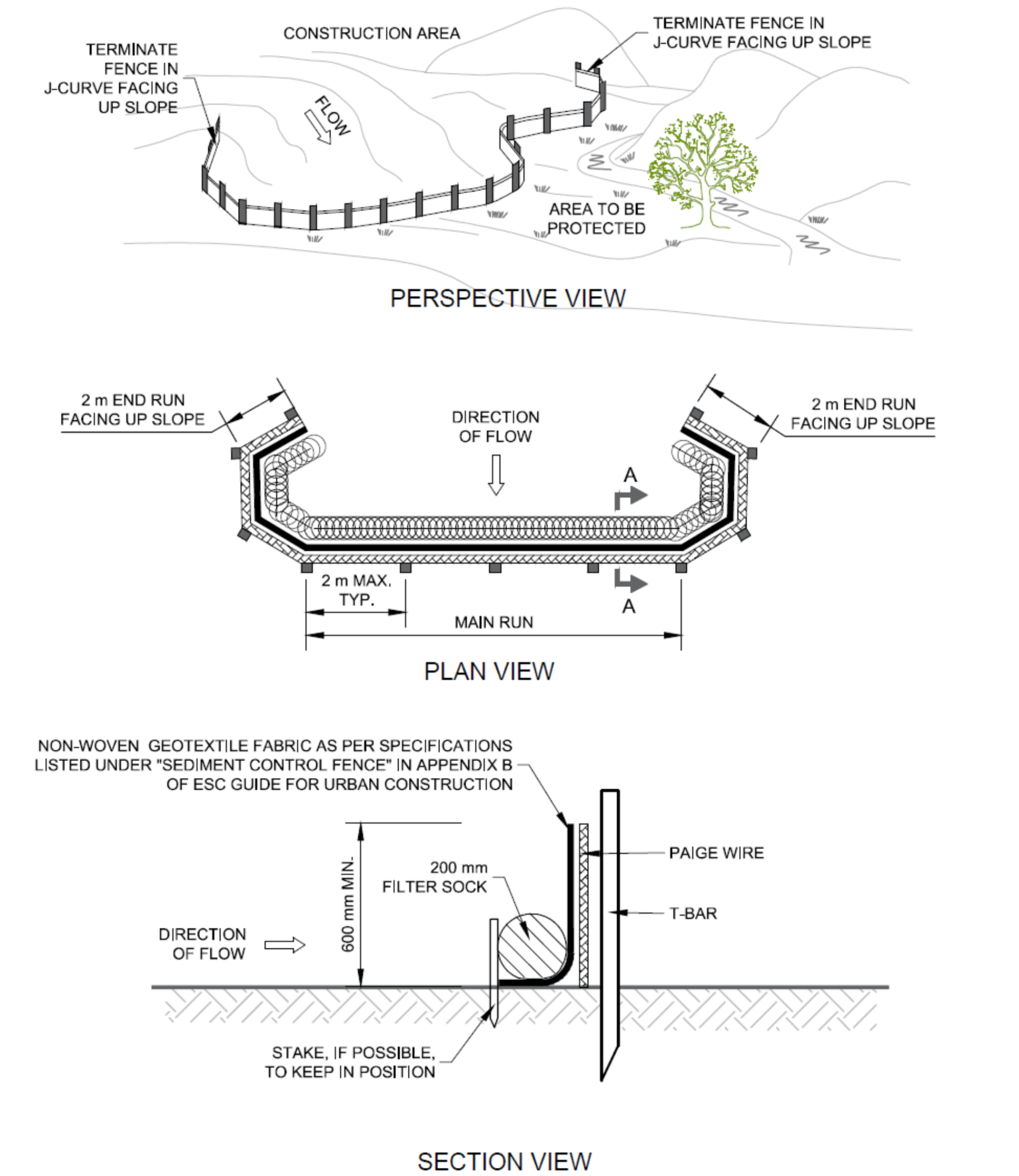
**Figure B2-3a:** Design detail for sediment control fence (unfrozen conditions).




NOTE: THIS DETAIL REPRESENTS AN IDEAL SCENARIO. SITE CONDITIONS VARY AND EROSION AND SEDIMENT CONTROL MEASURES SHOULD BE TAILORED FOR EACH SITE AND PROJECT

| | | | | |
|---|---|---|---|---|
| Toronto and Region Conservation Authority | TRCA ESC DESIGN DETAIL | SCALE N.T.S. | REV 1 | DATE MARCH 2019 |
| | DRAWING TITLE SEDIMENT FENCE (FROZEN CONDITIONS) | | | DWG NO 04 |

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**Figure B2-3b:** Design detail for sediment control fence (frozen conditions).

## FILTER SOCK
### (a.k.a. biofilter sock)

A filter sock consists of a tubular mesh casing that is filled with a natural material, such as compost or wood chips. They are typically filled on site using a pneumatic blower truck (Figure B2-4). Filter socks function as settling controls, decreasing flow velocities to cause gravitational settling of suspended sediments behind and within the sock.

**Figure B2-4:** Filter sock being filled on site

Depending on the fill material used, contaminants other than sediment may also be attenuated and degraded through chemical and biological processes. For example, the microbial activity in compost – present at much higher concentrations than in soil – can degrade hydrocarbons and convert them to nontoxic by-products (Khan, et al., 2006). Despite the capabilities of filter sock variations, the guidance herein focuses on the removal of sediment (and sediment-bound contaminants) with compost and wood-chip filled socks, which occurs primarily through physical settling.

- **Wood chip fill │** Socks filled with uncomposted wood chips can be an effective means of causing construction sediment to settle out of suspension. This process can also result in significant removal of other contaminants that adhere to sediment particles, such as metals and nutrients. Where sediment removal is the only objective, wood chip filled socks are often more cost effective than their compost filled counterparts.
- **Compost fill │** The properties of compost - including its texture, porosity, water retention capacity and hummus content – make it an effective media for filtering out sediment and other contaminants, including those which do not adhere to sediment particle surfaces (e.g. petroleum hydrocarbons, soluble nutrients). Beyond this added contaminant removal benefit, socks filled with compost can also support vegetation, which means they can be seeded at the time of installation. Alternatively, compost from socks with biodegradable mesh can be spread around and seeded as part of their decommissioning.

**Figure B2-5:** Compost fill (left) and wood chip fill (right) used in filter socks.

## Application

Filter socks can be used in a variety of sediment control applications depending on their circumference, length and how they are placed/positioned. Common sediment control applications of filter socks include:

- As flow interruption on level and sloped areas where they are applied along contours, perpendicular to runoff sheet flows;
- At the base of slopes, at a recommended distance of at least 1.5 m from the based in order to provide adequate space for sediment deposition;
- Along the site perimeter in areas of sheet flow;
- Perpendicular to channelized flow in swales and ditches where they function as check dams;
- Around storm drain inlets receiving sheet flows;
- At the base of topsoil stockpiles;
- Around sediment bags as part of a dewatering treatment train (see ‘sediment bags’ on p. B2-25);
- During frozen conditions in place of sediment fence that cannot be trenched in; and
- Any other areas where it is necessary to dissipate flow velocities and pond water to promote sediment settling.

## Design and installation

<u>Product specifications - casing</u>

- Biodegradable and non-biodegradable casings are available depending on the intended application. Where filter socks are being used for permanent stabilization, particularly for construction projects in natural water features, biodegradable mesh casing can be a useful option. Confirm casing life span with the product manufacturer / supplier.
- Non-biodegradable mesh casing should be UV stable and durable. Typical thickness is approximately 5 mm and size of openings is approximately 3 mm.

<u>Product specifications – wood chip fill</u>

- Free of any refuse, weeds, contaminants or other materials toxic to plants, wildlife or humans.
- Material shall be relatively free (<1% by dry weight) of inert or foreign man made materials.
- Wood chip fill material must also meet the following specifications:
  - pH: 5.0 - 8.0
  - Particle size: 99% passing a 50mm sieve and a maximum of 40% passing a 9.5mm sieve
  - Moisture content: ≤ 60%

<u>Product specifications – compost fill</u>

- Free of any refuse, weeds, contaminants or other materials toxic to plant growth.
- Material shall be relatively free (<1% by dry weight) of inert or foreign man made materials.

- Stable, humus-like material produced from the aerobic decomposition of organic feedstocks, composted and cured until maturity.
- Certified to comply with mandatory Ontario Ministry of Environment Conservation and Parks (OMECP) Compost Quality Standards for Category ‘AA’ or ‘A’ and Canadian Food and Inspection Agency (CFIA) regulations T-4-93 (CFIA, 1997a) and T-4-120 (CFIA, 1997b).
- Analytical methods acceptable for the eleven regulated metals and the pathogen testing are described in the Sampling and Analysis Protocol of O. Reg. 267/03. Analytical methods that should be used for determination of mature compost respiration rate, moisture content, organic matter, foreign matter content and other relevant parameters are those referenced in the Bureau de Normalization du Quebec (BNQ) Industry Standard CAN/BNQ 0413-200/2005 “Organic soil conditioners – Composts”.

<u>Product performance</u>

- Filter sock products should be capable of removing at least 70% of suspended solids.
- Removal performance should be based on testing by an independent third party.
- Testing should be carried out using American Society for Testing and Materials (ASTM) Standard D7351-13, which is the “Standard Test Method for Determination of Sediment Retention Device Effectiveness in Sheet Flow Applications”.

<u>Sheet flow applications</u>

- For optimal performance, the upslope area draining to the sock should be stabilized.
- Filter socks applied as sediment control for runoff sheet flow - e.g. at site perimeter, along contours of sloping areas, around storm drain inlets - should be sized such that flows from most storm events will not overtop the socks.
- Consult with supplier for guidance on selecting appropriate sock diameter based on slope grades and lengths and the design storm which is meant to be treated by the filter sock. In general, the sizing should be based on the 5 year design storm, however sizing for a larger design storm may be necessary where socks are being applied to protect adjacent natural features.

**Figure B2-6:** Filter socks installed along contours of a slope

- Prepare the ground surface prior to filter sock placement to ensure good ground contact. Creating a shallow depression in which to place the sock can help to improve ground contact.
- Place filter socks on level contours to ensure they receive sheet flows rather than concentrated flows.
- Where filter socks are applied at the base of a slope, a distance of at 1.5 m from the base is recommended in order to provide adequate space for sediment settling.
- Install socks perpendicular to the sheet flow path and install with ends turned upslope to discourage water from flowing around the ends.
- For slopes steeper than 2H:1V, multiple parallel filter socks may need to be installed on the slope to dissipate runoff energy and reduce the risk of rill erosion.
- Secure filter socks by staking them into place with long wooden stakes driven into the centre of the sock, or alternatively on both sides of the sock if tearing of the mesh casing is a concern. Where ground below is paved, secure with heavy concrete blocks or other appropriate means.
- Stakes should be driven into the ground at least 20 cm and extend above the height of the sock.
- Stakes should be placed at regular intervals as needed to secure the sock, with intervals varying based on the sock diameter and the slope of the drainage area. Confirm appropriate spacing with supplier.
- Consult with supplier to confirm recommended staking procedures, including staking depths and stake placement.

<u>Concentrated flow applications:</u>

- Filter socks can be used as sediment control check dam structures to treat concentrated flows in small open construction site channels like interceptor swales (Figure B2-7).
- For use of filter socks as check dams, consult with supplier for guidance on selecting appropriate sock diameter based on the design storm to be treated by the filter sock. In general, the sizing should be based on the 5 year design storm, however sizing for a larger design storm may be necessary where there is a low tolerance of risk of failure.
- Treatment of larger flow volumes should be addressed by selecting the largest sock diameter that is recommended for the swale and reducing the spacing interval between socks. Stacking of socks may also help increase capacity but should be decided on based on supplier guidance.

**Figure B2-7:** Filter socks installed in a swale

- Spacing of filter socks in the swale is based on the swale gradient and anticipated flows. Consult with supplier for guidance on optimal spacing along the swale.
- Prepare the ground surface prior to filter sock placement to ensure good ground contact. The sock should be pressed in to the ground during installation. Creating a shallow depression in which to place the sock can help to improve ground contact.

- The filter sock should be installed in the swale in a U-shape with ends pointed slightly upslope to encourage water to pond and – during large events – overtop the sock in the middle rather than around the sides. The sock should be long enough to extent to the top of the swale.
- As a minimum, stake into place in the centre and at both ends. To avoid damage to the casing, stakes can instead be placed on either side of the sock to create a brace. Stakes should be driven into the ground at least 20 cm and extend above the height of the sock.
- For best results, swales in which filter socks are installed should be stabilized.

## Inspection and maintenance

- Inspect all filter socks weekly, and before and after significant rainfall (see definition in Section 10.1.2) or snowmelt events, and keep a record of the inspection.
- Look for any signs of erosion and areas where water is undermining the sock and consider how positioning, ground contact or flow rates can be adjusted to prevent continued undermining.
- Inspect positioning and placement of filter socks to ensure they haven't shifted substantially. Re-position and re-stake as needed.
- Where flows are exceeding the retention capacity of the sock (e.g. frequent overtopping, water flowing around check dams), re-consider filter sock diameters used, add additional socks (for swale applications) or stack socks to create a higher barrier.
- Where socks continue to fail on an ongoing basis, consider replacing with an alternative sediment retention device. If failure is a result of concentrated flows being directed to socks being applied for sheet flow control, consider re-designing surface water flow paths to reduce volumes being directed to the problem area.
- Sediment and/or debris accumulation behind socks should be removed before it reaches approximately 30% of the sock height.
- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact. Higher priority should be assigned to repair of filter socks installed upgradient of natural features.

## Decommissioning

- Remove and properly dispose of accumulated sediment.
- Where desired, and if fill material is not contaminated, socks may be cut open so that fill can be used onsite as mulch for restoration works.
- Remove and dispose of any non-biodegradable material.
- Where socks will be seeded and left as a permanent part of the landscape (e.g. in restoration areas) ensure it is seeded with a weed-free, native seed mix. In these instances, only socks with a biodegradable casing should be used.

# NATURAL FIBRE LOGS
**(a.k.a. Natural fibre wattles)**

Natural fibre logs are a category of sediment control devices encompassing several products that are, like filter socks, applied for sediment removal from sheet flow or concentrated flows in swales. By decreasing flow velocities they promote gravitational settling of suspended sediments and help reduce runoff erosivity. They differ from filter socks in their material composition and the fact that they are pre-fabricated and not typically filled onsite. They are composed of various biodegradable natural fibres and are typically uniform throughout. Lengths and diameters vary according to the product type and manufacturer. Examples of natural fibre logs / wattles commonly used for ESC include:

- **Coir logs** | Coconut fibre encased in a coconut fibre twine netting.
- **Straw logs** | Agricultural straw typically encased in a tubular synthetic netting
- **Wood fibre logs** | Wood excelsior fibre (wood slivers) logs, typically encased in a tubular synthetic netting.

**Figure B2-8:** Natural fibre logs

## Application

Natural fibre logs can be used in a variety of sediment control applications depending on their diameter, length and how they are placed/positioned. Common sediment control applications of logs include:

- As flow interruption on level and sloped areas where they are applied along contours, perpendicular to runoff sheet flows;
- At the base of slopes, at a recommended distance of at least 1.5 m from the based in order to provide adequate space for sediment deposition;
- Along the site perimeter in areas of sheet flow;
- Perpendicular to channelized flow in swales and ditches where they function as check dams;
- Around storm drain inlets receiving sheet flows;
- At the base of topsoil stockpiles;
- Around sediment bags as part of a dewatering treatment train;
- During frozen conditions in place of sediment fence that cannot be trenched in; and
- Any other areas where it is necessary to dissipate flow velocities and pond water to promote sediment settling.

## Design and installation

Product specifications

- Biodegradable and non-biodegradable casings are available depending on the product and intended application. Where logs are being used for permanent stabilization, particularly for construction projects in natural water features, biodegradable casing can be a useful option. Confirm casing life span with the product supplier.
- Fibre material should be free of any refuse, weeds, contaminants or other materials toxic to plants, wildlife or humans. It should also be relatively free (<1% by dry weight) of inert or foreign man made materials.

Product performance

- Confirm removal efficiency of any natural fibre log product prior to applying it on the site. It is recommended that products are selected that can demonstrate sediment removal efficiency ≥ 70% based on testing by an independent third party. Where this removal efficiency cannot be verified, the products should only be used in low risk applications, and not applied as the primary barrier protecting an adjacent natural feature.
- Sediment retention testing should be carried out using American Society for Testing and Materials (ASTM) Standard D7351-13, which is the "Standard Test Method for Determination of Sediment Retention Device Effectiveness in Sheet Flow Applications".

Sheet flow applications

- For optimal performance, upslope area draining to the log should be stabilized, particularly if the application is on a slope.
- Logs applied as sediment control for runoff sheet flow - e.g. at site perimeter, along contours of sloping areas, around storm drain inlets - should be sized such that flows from most storm events will not overtop the logs.
- Consult with supplier for guidance on selecting appropriate log diameter based on slope grades and lengths and the design storm which is meant to be treated. In general, the sizing should be based on the 5 year design storm, however sizing for a larger design storm may be necessary if logs are being applied to protect adjacent natural features.
- Prepare the ground surface prior to log placement to ensure good ground contact. Creating a shallow depression in which to place the log can help to improve ground contact.
- Place logs on level contours to ensure they receive sheet flows rather than concentrated flows.
- Where logs are applied at the base of a slope, a distance of at 1.5 m from the base is recommended in order to provide adequate space for sediment settling.
- Install logs perpendicular to the sheet flow path and install with ends turned upslope to discourage water from flowing around the ends.
- For slopes steeper than 2H:1V, multiple parallel logs may need to be installed on the slope to dissipate runoff energy and reduce the risk of rill erosion.

- Secure logs by staking them into place with long wooden stakes driven into the centre, or alternatively on both sides if tearing of the casing is a concern. Where ground below is paved, secure with heavy concrete blocks or other appropriate means to ensure good ground contact and discourage shifting.
- Stakes should be driven into the ground at least 20 cm and extend above the height of the log.
- Stakes should be placed at regular intervals as needed to secure the log, with intervals varying based on the sock diameter and the slope of the drainage area. Confirm appropriate spacing with supplier.
- Consult with supplier to confirm recommended staking procedures, including staking depths and stake placement.

Concentrated flow applications:

- Natural fibre logs can be used as sediment control check dam structures to treat concentrated flows in small open construction site channels like interceptor swales.
- For use of logs as check dams, consult with supplier for guidance on selecting appropriate log diameter based on the design storm to be treated. In general, the sizing should be based on the 5 year design storm, however sizing for a larger design storm may be necessary where there is a low tolerance of risk of failure.
- Treatment of larger flow volumes should be addressed by selecting the largest log diameter that is recommended for the swale and reducing the spacing interval between logs. Stacking logs may also help increase capacity but should be decided on based on supplier guidance.
- Spacing of logs in the swale is based on the swale gradient and anticipated flows. Consult with supplier for guidance on optimal spacing along the swale.
- Prepare the ground surface prior to device placement to ensure good ground contact. The log should be pressed in to the ground during installation. Creating a shallow depression in which to place the log can help to improve ground contact.
- The log should be installed in the swale in a U-shape with ends pointed slightly upslope to encourage water to pond and – during large events – overtop the log in the middle rather than around the sides. The log should be long enough to extent to the top of the swale.
- As a minimum, stake into place in the centre and at both ends. To avoid damage to the casing, stakes can instead be placed on either side of the log to create a brace. Stakes should be driven into the ground at least 20 cm and extend above the height of the log.
- For best results, swales in which natural fibre logs are installed should be stabilized.

## Inspection and maintenance

- Inspect all logs weekly, and before and after significant rainfall (see definition in Section 10.1.2) or snowmelt events, and keep a record of the inspection.
- Look for any signs of erosion and areas where water is undermining the log and consider how positioning, ground contact or flow rates can be adjusted to prevent continued undermining.
- Inspect positioning and placement of logs to ensure they haven't shifted substantially. Re-position and re-stake as needed.

- Where flows are exceeding the retention capacity of the log (e.g. frequent overtopping, water flowing around check dams), re-consider log diameter used, add additional logs (for swale applications) or stack them to create a higher barrier.
- Where logs continue to fail on an ongoing basis, consider replacing with an alternative sediment retention device. If failure is a result of concentrated flows being directed to logs being applied for sheet flow control, consider re-designing surface water flow paths to reduce volumes being directed to the problem area.
- Sediment and/or debris accumulation behind logs should be removed before it reaches approximately 30% of the log height.
- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact. Higher priority should be assigned to repair of logs installed upgradient of natural features.

### Decommissioning

- Remove and properly dispose of accumulated sediment.
- Where desired, and if fill material is not contaminated, some types of logs may be cut open so that fill can be used onsite as mulch for restoration works.
- Remove and dispose of any non-biodegradable material.

# ROCK CHECK DAMS

Rock check dams are flow interrupters applied across low flow construction site conveyance channels to reduce flow velocities and thereby decrease the erosivity of the water and promote sediment settling. These temporary dam structures are constructed from granular material and geotextile fabric. They are applied in series at intervals determined based on the gradient of the conveyance channel.

Due to their limited capacity to pond water, they are ineffective at causing settling of fine particles. Other products that are also used as check dams are filter socks and natural fibre logs or wattles.

**Figure B2-9:** Rock check dam

## Application

- Perpendicular to flows in low flow conveyance channels on construction sites (e.g. interceptor swales).
- Particularly important in long or steeply sloped (3H:1V or steeper) channels.
- In any concentrated flow path where flow interruption for erosion prevention or sediment settling is needed.
- Never installed in natural watercourses or other natural water features.

## Design and installation

While check dams can be composed of other products and materials (e.g. filter socks, logs), only rock check dams are discussed in this section. Spacing guidance provided is applicable to other types of check dams.

- Rock check dams should be constructed with the following three layers:

| Layer | Material | Thickness | Notes |
|---|---|---|---|
| Bottom | Granular material | 50 mm diameter stone stacked 45 cm high | |
| Middle | non-woven geotextile | n/a | ○ Trench in at upstream end extended beyond the check dam anchor to form an underlying "spill apron" |
| Top | Granular material | 150 mm diameter stone in a layer ≥ 10 cm | ○ Extend from the conveyance channel invert to the top of the bottom layer<br>○ Form a spillway 0.3 m below the top of the drainage ditch to prevent outflanking |

- Construct check dam to create upstream gradient of 2H:1V, downstream gradient of ≤ 4H:1V and centre of the dam ≤ 1.0 m high

- Avoid undermining by making the outer sides approximately 0.5 m higher than the center and notch the center (~ 15 cm deep) to concentrate flow in low area
- Refer to Ontario Provincial Standard Drawings in Figures B2-10 and B2-11 for depiction of rock check dam designs in V-notch and flat bottom conveyance channels, respectively.
- Place multiple dams in series along long or steeply sloped (3H:1V or steeper) channels.
- Space check dams such that top of the middle (spillway) of each downstream check dam at the same elevation as the base of the previous dam.
- Ensure erosion control measures are applied in the area draining to the conveyance channel in order to minimize sediment loads to the channel. Ensure the flows from the channel are conveyed to a sediment control measures (e.g. sediment trap) for additional sediment removal as needed.

## Inspection and maintenance

- Inspect weekly, and before and after significant rainfall (see definition in Section 10.1.2) or snowmelt events, and keep a record of the inspection.
- Look for any signs of erosion and areas where water is undermining the check dam and consider how spillway construction or flow rates can be adjusted to prevent continued undermining.
- Ensure check dams remain structurally sound. Replace and regrade the stone as required to maintain its shape.
- Where erosion is observed and stabilization measures are absent or inadequate, consider adding stabilization measures.
- Determine whether high flow rates are causing excessive erosion and if so, consider reducing the size of the area draining to the swale, or re-grading the swale to a flatter slope.
- Sediment and/or debris accumulation behind the check dam should be removed before it reaches approximately 30% of the device height.
- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact.

## Decommissioning

- When conveyance channel is no longer in use, remove and properly dispose of sediment, granular material and geotextile.

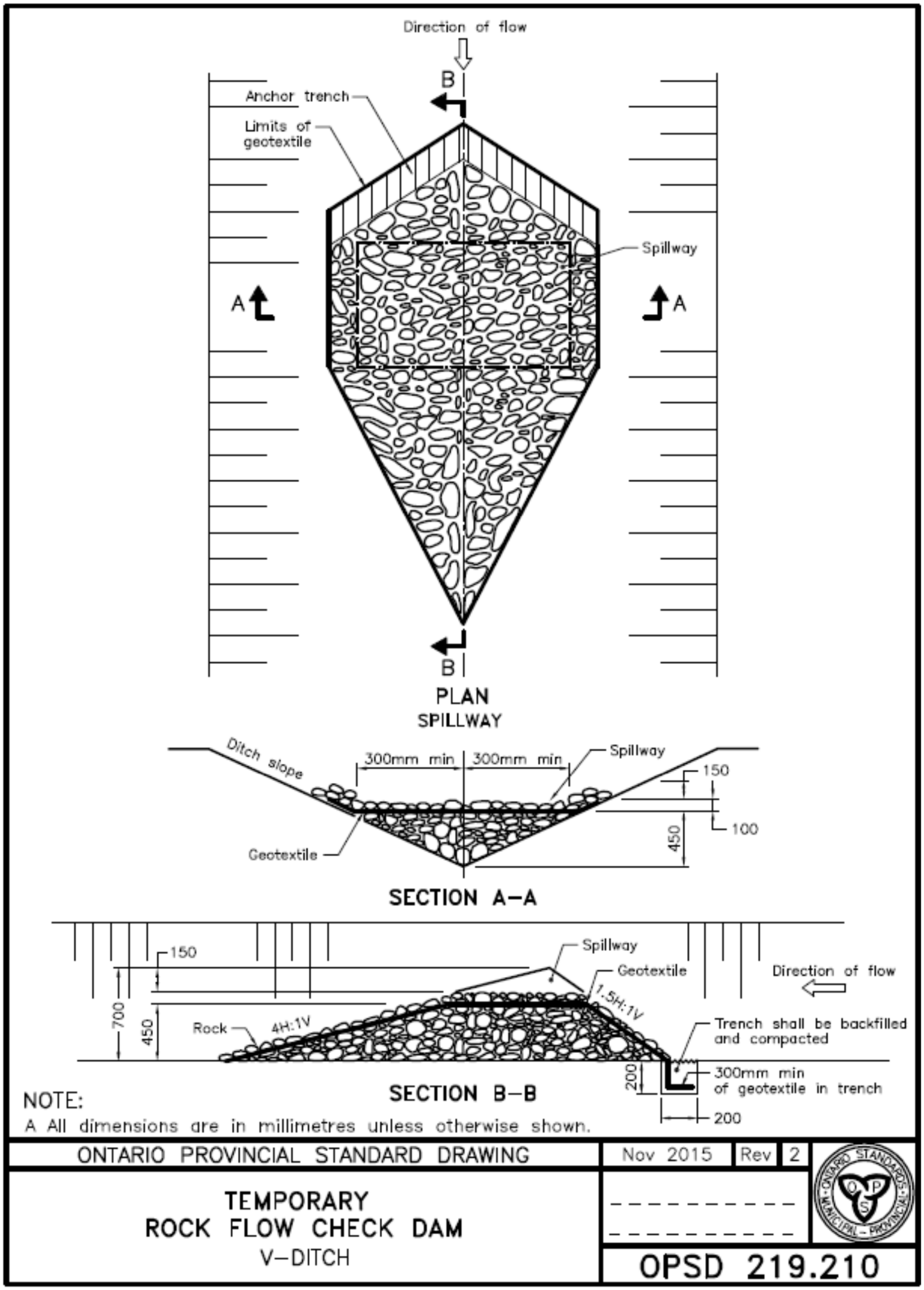



**Figure B2-10:** Ontario Provincial Standard Drawing (Nov. 2015) for temporary rock check dam in a v-shaped conveyance channel

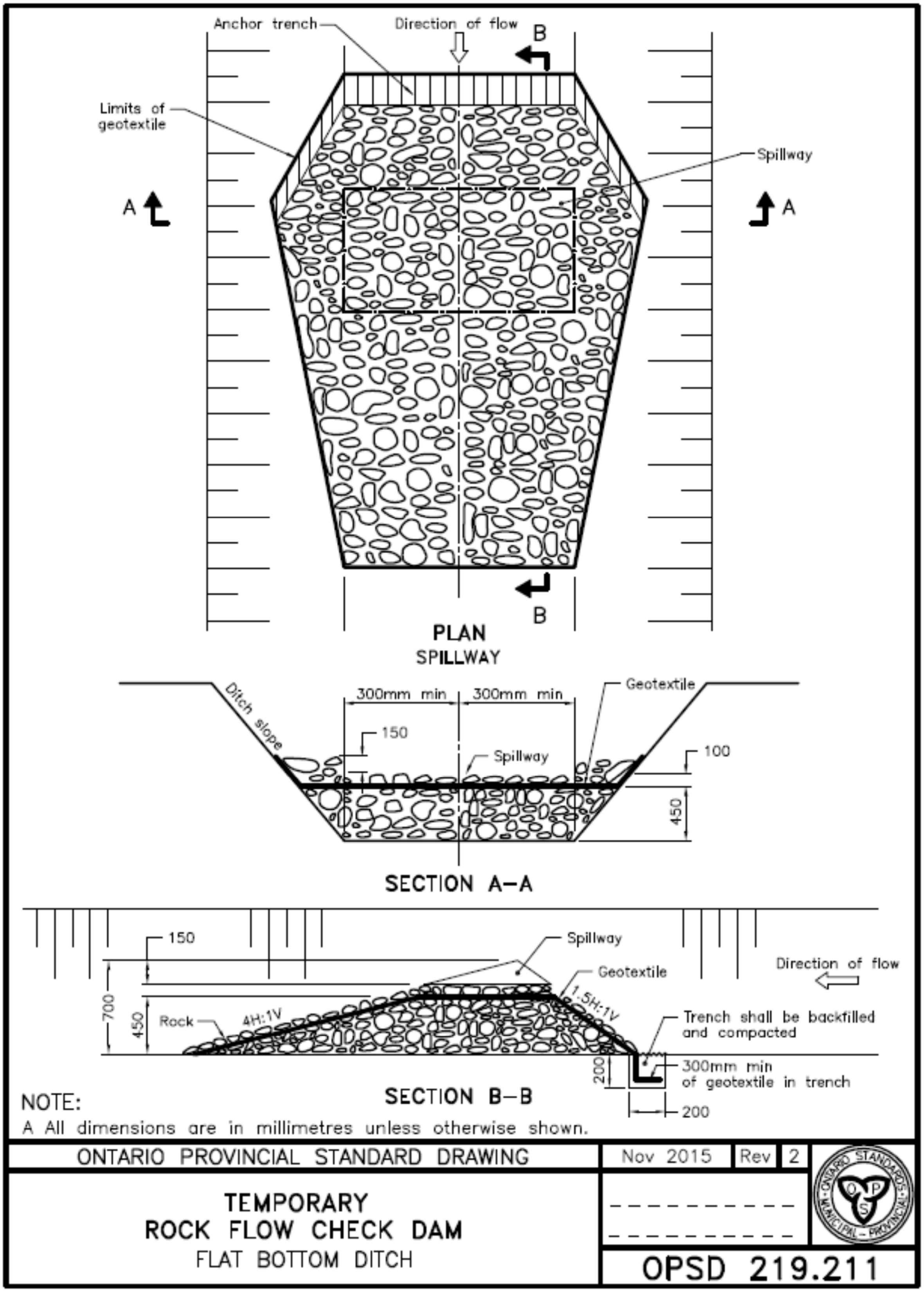



**Figure B2-11:** Ontario Provincial Standard Drawing (Nov. 2015) for temporary rock check dam in a flat-bottomed conveyance channel

## STORM DRAIN INLET PROTECTION

The protection of storm drain inlets from sediment laden runoff can be achieved using various practices applied around or under the storm drain inlet. Protecting inlets is an important way to prevent high sediment loads to ponds, which in turn results in improved pond performance and less frequent sediment removal required in ponds and catchbasins. Flows entering storm drains may also be conveyed directly to a receiving water system without passing through an end-of-pipe control, in which case the necessity of reducing sediment entry into the storm drain is even greater.

The types of sediment control measures often applied to block sediment entry into these inlets are sediment retention barriers and filters. By applying these types of measures, the inlet still receives runoff but sediment is removed as the water flows in from the drainage area.

**Figure B2-12:** Storm drain inlet protection measures

### Application

- Applied on all operational storm drain inlets on the site
- Applied at grade around or overtop the inlet or applied below grade inside a storm drain
- For drainage areas >1 ha, multiple barriers are needed and the inlet protection device should not be the only ESC measure installed.

### Design and installation

- Install immediately once the connection of the storm sewer system is live.
- Determine the drainage area in order to properly size the inlet protection device.
- Common types of devices that provide effective inlet protection are filters in a bag/sack configuration that hangs below the inlet grate, sediment retention barriers that are applied around the outside of the inlet, and filter pads that are placed over the inlet grate. Some examples are shown in Figure B2-12.

**Structural reinforcement options**

- Cinder blocks
- Wood panels
- Stakes
- Granular materials
- T-bars

- Refer to manufacturer specifications (for the device being installed) to determine sizing and appropriate installation techniques specific to the product.
- Ensure there's structural reinforcement to prevent movement or shifting of the protection. For filter socks used for inlet protection, ensure sock is staked into place.
- Ensure that any inlet inserts have handles so that they can be easily removed with machinery and install so that the handles are easily accessed.
- Place any structural reinforcement used on the inside of the sediment retention device
- For protection devices installed around or above the inlet, ensure that it is not completely blocking the inlet grate and preventing flow through. Filters applied overtop of the inlet, like coir inlet filter pads, are an exception as they allow flow through.
- The use of geotextile fabric placed under the inlet grate as a standalone inlet protection measure is discouraged due to the frequent cleaning required in order to maintain effectiveness.
- For areas with heavy vehicle traffic, select below grade inlet protection in order to minimize risk of device damage and need for frequent repairs.
- Consider excavating the area around the inlet or installing a rock/gravel jacket around or in front of the inlet to allow more opportunity for ponding of water (see Figures B2-13 and B2-14). This should encourage localized ponding in the immediate area of the inlet, not flooding into the roadway or other adjacent areas.

## Inspection and maintenance

**Maintenance is the key!**

With inlet protection devices, maintenance is essential to ensure continued performance and the ***prevention of clogging and associated flooding***.

***Inspect and clean them out regularly***

- Inspect weekly, and before and after significant rainfall (see definition in Section 10.1.2) or snowmelt events, and keep a record of the inspection.
- Look for any signs that runoff is undermining or otherwise bypassing the sediment control measure and repair as needed.
- Remove any sediment accumulation that has reached approximately 30% of the height of the sediment retention barrier and ensure proper disposal.
- For below grade installations, like filter fabric sacks/bags, ensure that it is cleaned out at the frequency specified by the manufacturer/supplier. The sediment accumulation threshold at which clean out is needed may vary from one product to another, but is normally 50% accumulation. If there are signs of clogging causing impeded flow through and flooding, clean out immediately.
- Clean and/or replace the device if there is any evidence of clogging significantly impeding flow through and leading to flooding.
- Look for any signs of structural damage to the device. If it is being damaged due to vehicle traffic, consider substituting with a below grade device.
- If using granular material, periodically rake to reshape and remove and replace any granular material overloaded with sediment.

- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact.
- Ensure the inlet grate is not being unintentionally blocked by the protection device.

## Decommissioning

- Remove accumulated sediment.
- Carefully remove inlet inserts by the handles. Remove all components of the inlet protection devices so as to minimize disturbance of the area and accidental release of sediment into the inlet.

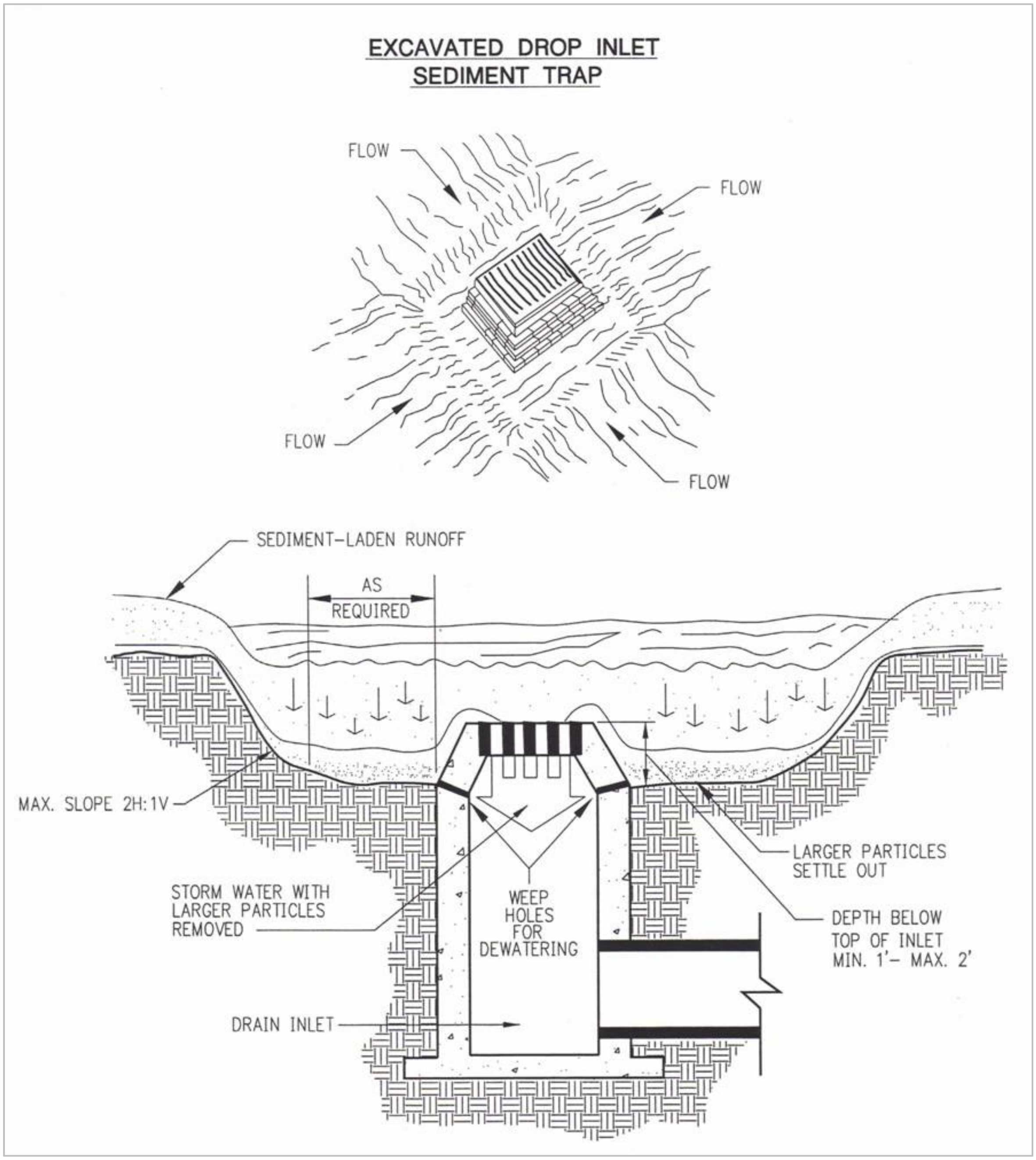



**Figure B2-13:** Excavated drop inlet structure for trapping sediment

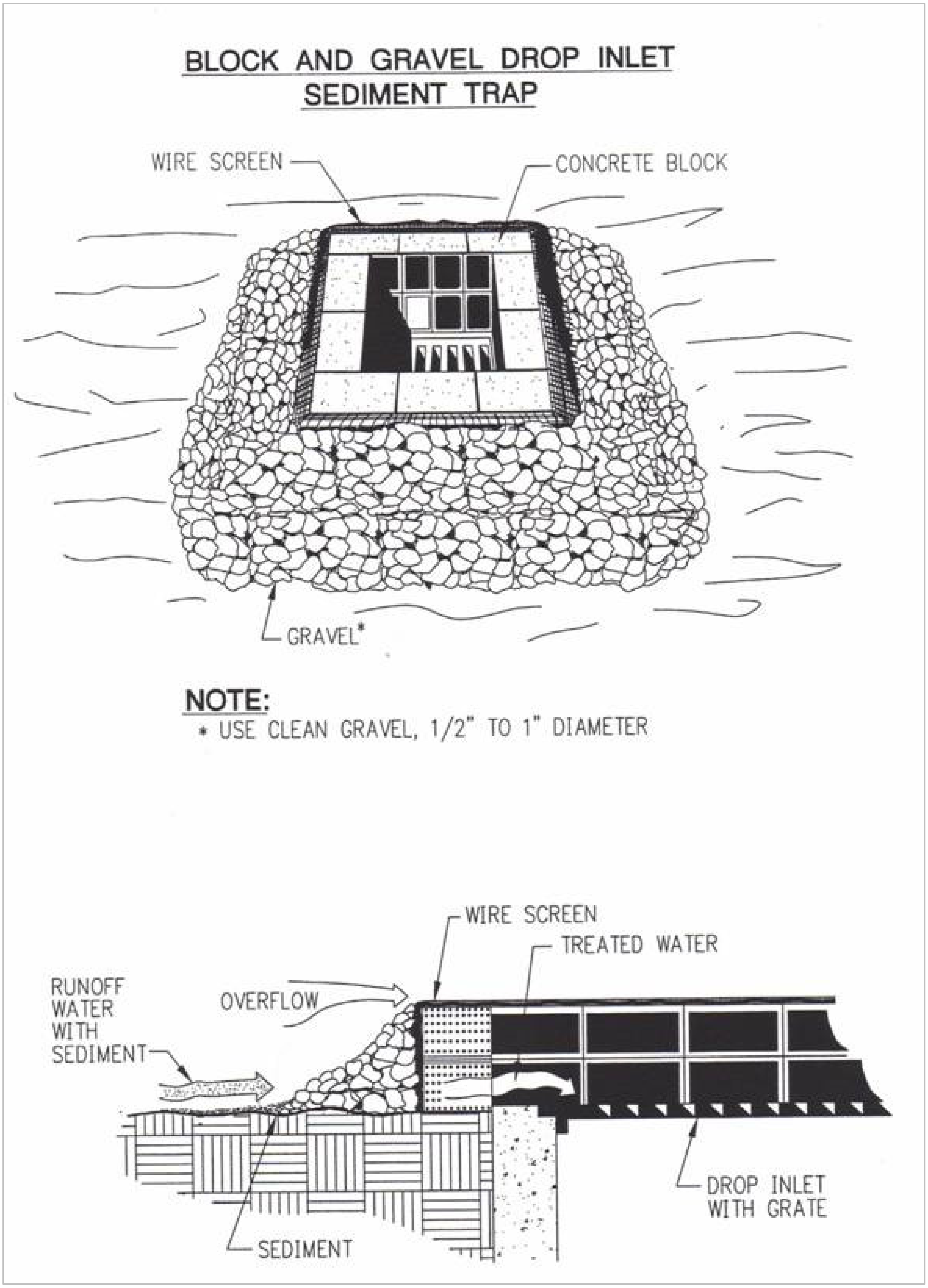



**Figure B2-14:** Gravel jacket installed around drop inlet.

## SEDIMENT (DEWATERING) BAG

A sediment bag is a large geotextile bag that is used to filter sediment laden water from a pump hose. They are commonly applied to treat water during construction site dewatering activities. As water is pumped through the bag, sediment is removed through filtration and gravitational settling caused by energy dissipation. The bag also disperses the water from the pump hose, preventing erosion typically associated with concentrated flows.

**Figure B2-15:** Sediment bag surrounded by filter sock

While the apparent opening size (AOS) of the geotextile fabric determines the maximum size of particle is filtered out, a significant amount of sediment removal is attributed to the reduction in flow velocity and associated gravitational settling.

### Application

- Suitable anywhere dewatering of sediment laden water is necessary to create a dry work area, and particularly where space is limited.
- Examples: dewatering of an isolated in stream work area, tunneling, excavating for a basement, or drawing down a sediment control pond to allow for maintenance.
- Applied where flow dispersion is needed to prevent erosion, as the bag receives concentrated water from the hose and disperses.
- Best used as a dewatering treatment train (see Figure B216- and B2-17).

### Design and installation

- Sediment bags are manufactured in various sizes and are pre-sealed on all sides except for a small opening on one end, adequately sized for a dewatering hose. Refer to the manufacturer's specifications for capacity and sizing details as well as proper clamping procedure.
- Select sediment bag constructed from durable, non-woven UV stabilized geotextile with a high puncture and tear resistance.
- Ensure the manufacturer's specified water flow rate and apparent opening size are appropriate for the planned flow rates and the expected particle size distribution of the water being treated.
- Bag should be located at least 30 m from any natural water feature in order to minimize risk of a sediment spill into the feature if the bag ruptures. Where siting 30 m away is not possible, consult with the local CA for guidance on potential laydown areas and any additional measures (e.g. dewatering treatment train setup) and monitoring efforts that can be applied to mitigate risk.
- Bag should be located so that it is easily accessed for maintenance and removal purposes and so that water discharged from the bag doesn't cause or aggravate erosion.
- Place bags on a relatively flat surface to ensure the bag doesn't shift downslope.

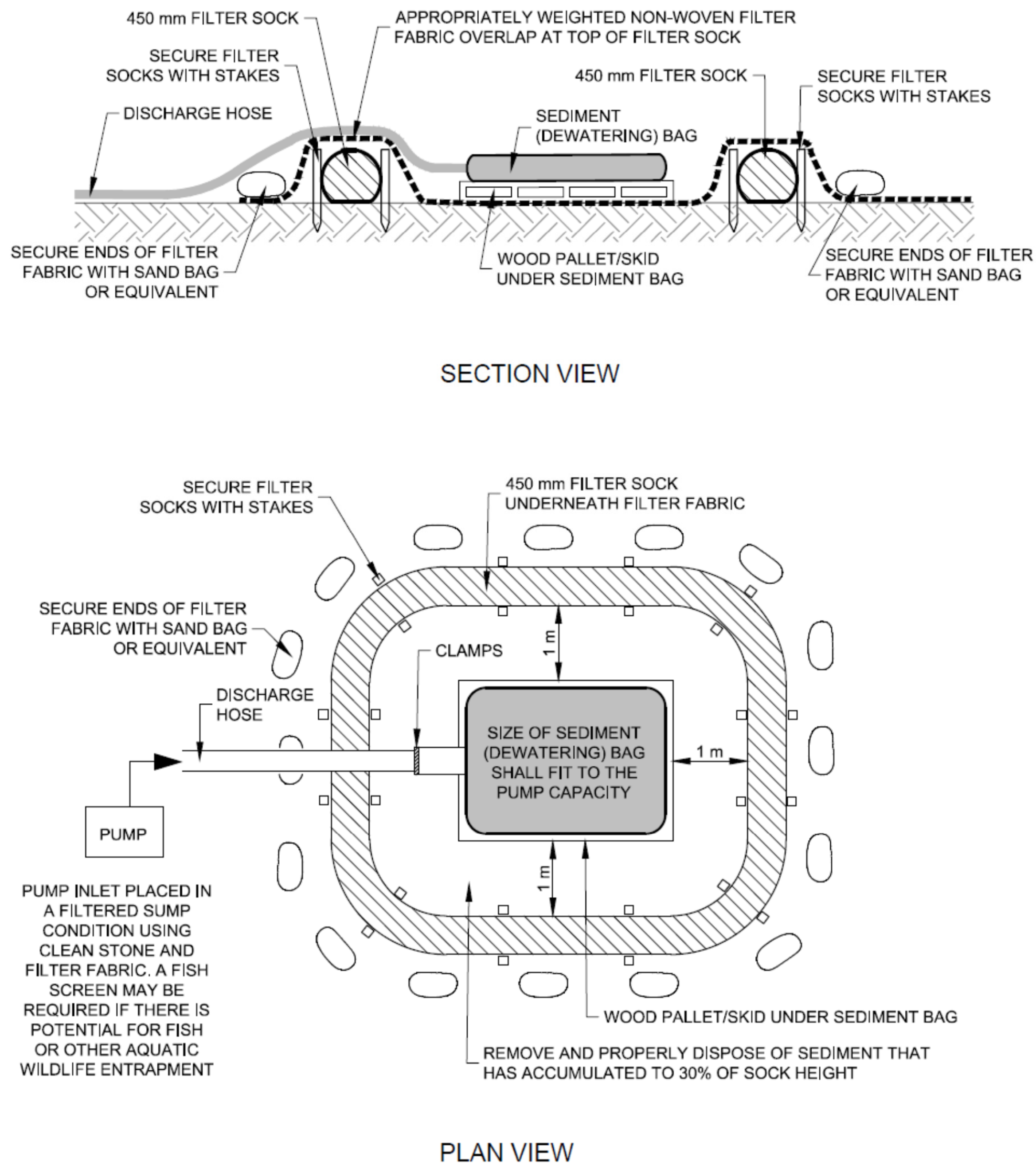
- Place on stabilized ground (e.g. grassed surface, rock pad) and underlain with non-woven geotextile fabric to prevent erosion under and around the bag. Installing a rock pad or wood pallet below the bag can be beneficial as it make allow for better drainage out of the bottom of the bag.
- As part of a ***treatment train*** or ***multi-barrier approach*** to dewatering through a sediment bag, install a sediment control barrier such as a filter sock around the bag in order to provide more opportunity for sediment settling. See dewatering treatment train shown in Figures B2-16 and B2-17.
- Ensure the planned flow path from the bag to the ultimate receiver is stable, and where it is not, create a stable flow pathway to ensure the discharge doesn't cause erosion.
- During freezing conditions keep the bag elevated, such as with a rock pad, to prevent it from freezing to the ground and tearing when being lifted away for removal.

## Inspection and maintenance

- Inspect daily during active pumping into the bag to ensure that there are no tears or leaks in the seals or the bag, and also check that the discharge from the bag is not causing erosion underneath it or anywhere along the flow path from the bag to the receiver. Keep a record of the inspection.
- Where there is evidence of erosion, re-consider whether stabilization is adequate to protect against erosion based on the flows coming out of the bag.
- Confirm that the pumps and bag size are continuing to provide the desired level of water treatment. Where sediment levels in discharged water remain elevated, consider adding or replacing with a different dewatering practice (e.g. weir tanks) to provide additional sediment removal.
- Inspect bag to determine whether it is full and requires replacement.
- Where the bag is damaged or no longer functioning, cease pumping immediately and replace or repair components.
- Replace the bag once it's not functioning and/or according to the manufacturer's instructions. If the flow through rate begins to decline significantly that may indicate the bags is full and requires replacement. The amount of sediment contained in the bag can also be confirmed once pumping is ceased and the bag is left to drain.
- Keep additional bag(s) on site so that replacement can be handled quickly when needed.
- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact.

## Decommissioning

- Allow bag to drain over time until the bulk of the water is gone.
- Remove bag with minimal disturbance to stabilized areas or nearly natural features. The full bag should never be lifted over a water feature or a person.
- Dispose of or reuse sediment based on its quality and the requirements stated in existing excess soil policy and legislation.
- Properly disposed of the sediment bag.
- Clean and restore the sediment bag lay down area.




NOTE: THIS DETAIL REPRESENTS AN IDEAL SCENARIO. SITE CONDITIONS VARY AND EROSION AND SEDIMENT CONTROL MEASURES SHOULD BE TAILORED FOR EACH SITE AND PROJECT

| Toronto and Region Conservation Authority | TRCA ESC DESIGN DETAIL | SCALE N.T.S. | REV 1 | DATE MARCH 2019 |
|---|---|---|---|---|
| | DRAWING TITLE DEWATERING TREATMENT TRAIN | | | DWG NO 01 |

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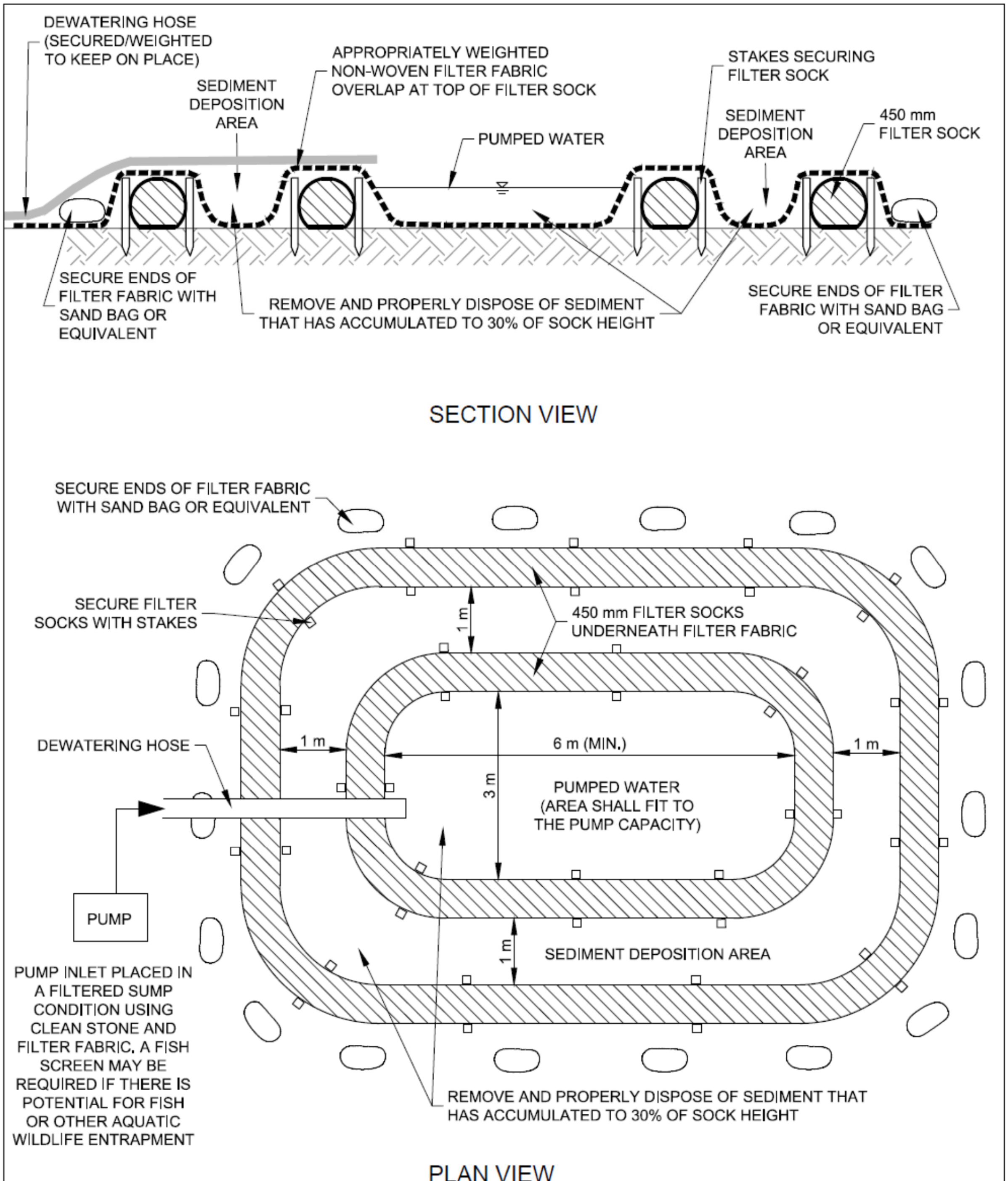
**Figure B2-16:** Dewatering bag treatment train (unfrozen conditions)

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| Toronto and Region Conservation Authority | TRCA ESC DESIGN DETAIL | SCALE N.T.S. | REV 1 | DATE MARCH 2019 |
|---|---|---|---|---|
| | DRAWING TITLE<br>DEWATERING TREATMENT TRAIN (FROZEN CONDITIONS) | | | DWG NO<br>02 |



**Figure B2-17:** Dewatering bag treatment train (frozen conditions)

# SEDIMENT TRAP

A sediment trap is a runoff detention area created by constructing an embankment across a runoff drainage/conveyance feature (e.g. ditch, swale) or by excavating below grade to create a depression. The purpose of the trap is to detain runoff and provide an opportunity for gravitational settling of sediment. Sediment traps are typically applied near the end of a treatment train (i.e. end of pipe measure) to provide sediment removal before water is discharged to the receiver. They are meant to receive flows from smaller drainage areas – less than or equal to 2 ha – that don't drain to a sediment control pond or other detention feature.

## Application

- At or near the end of a treatment train (i.e. end of pipe) for sediment removal from stormwater (via detention) before it is discharged offsite.
- Typically installed across drainage/conveyance features.
- For ***drainage areas ≤ 2 ha*** that do not drain to another detention feature (e.g. sediment control pond).

## Design and installation

- Construct the trap at grade by constructing berms or below grade by excavating.
- Design to provide at least 125 $m^3$ of storage for each hectare of contributing drainage area.
- Construct with stabilization on the bottom and all side slopes. Suitable stabilizations measures for sediment traps include well-established vegetation with turf reinforcement mats (if needed) or rock underlain with non-woven geotextile fabric.
- Trap should be designed to be between 1.0 and 2.0 metres deep. Minimum depth recommended is to avoid re-suspension of previously settled sediment. Maximum depth recommended is for safety reasons. Where a depth > 2 metres is unavoidable, the local municipality should be consulted to determine whether the trap needs to fenced off.
- Sediment trap should be ≤ 20 metres long and the maximum width should be half the length.
- Ensure proper grading of 0.5H: 1V side slopes and compaction to prevent slumping and slope failure.
- Recommended sediment trap side slope grade is 0.5H:1V
- Sediment trap outlet should be a stable open channel spillway located at the downstream end of the trap. Spillway construction is critical to prevent failure of the structure during high flows. All specifications provided by the plan designer should be implemented.
- Construct a check dam structure (rock or filter sock) at the outlet to provide additional detention and opportunity for sediment settling. Filter socks should be configured to form a pyramid for added stability and more opportunity for sediment retention. Any check dam structure should be lower in the centre and extend up the channel slopes to ensure that water leaving the trap flows over the centre of the check dam rather than around the sides.
- Erosion protection measures should be installed immediately downstream of the spillway outlet.
- Refer to design detail in Figure B2-18 for sediment trap design within a ditch.

## Inspection and maintenance

- Inspect weekly, and before and after significant rainfall (see definition in Section 10.1.2) or snowmelt events, and keep a record of the inspection.
- Look for any signs of erosion at the inlet, outlet or side slopes. Repair eroded areas by filling in rills, smoothing out the surface and re-installing or augmenting the stabilization that was in place. Consider whether the stabilization measures in place are failing due to poor condition or because flows are higher than anticipated.
- Remove sediment that has accumulated to 50% of the height of the sediment trap.
- Observe and/or analyze (e.g. handheld turbidity testing) sediment trap effluent to assess whether the trap continues to effectively remove suspended sediment.
- Where effluent turbidity is elevated, consider sediment trap storage capacity and stabilization to pinpoint reasons for under-performance. Consider adding additional measures upstream (e.g. ditch/swale stabilization) and/or downstream of the trap to achieve greater sediment removal.
- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact.
- Ensure spillway remains structurally sound and repair as needed when damage occurs. Replace and regrade the stone as required to maintain its shape.

## Decommissioning

- When sediment trap is no longer in use, remove and properly dispose of sediment, granular material and geotextile.

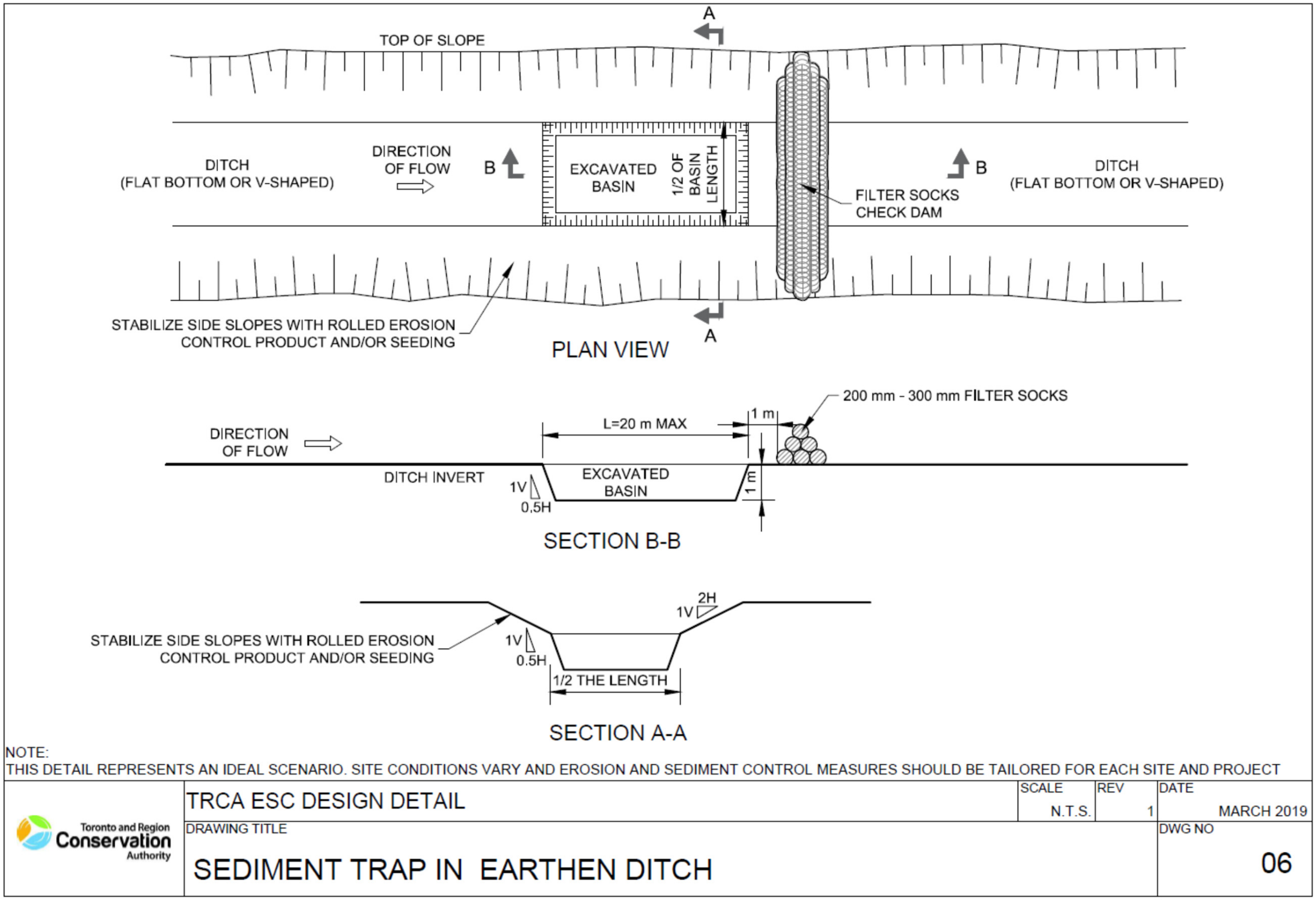


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**Figure B2-18:** Design detail for sediment trap within an earthen ditch

## SEDIMENT CONTROL PONDS

### (a.k.a. Sediment basins, detention ponds or basins)

A sediment control pond is a large excavated area used to detain construction site runoff and promote settling of suspended sediment particles. They are wet ponds, which means they are designed to hold a permanent pool of water and provide additional storage – known as active storage – for detaining incoming flows. As such they are very similar to stormwater management wet ponds that are built as permanent detention facilities to treat runoff from developed areas.

**Figure B2-19:** Sediment control ponds

In addition to removing suspended sediment, sediment control ponds prevent downstream erosion by releasing water through an outlet structure at a fixed rate over an extended period of time. This protects downstream features from the erosive impact of storm event peak flows.

Several aspects of sediment pond design determine their capacity to improve water quality and reduce peak flows. These include permanent pool storage volume, active storage volume, length-to-width ratio, presence of a forebay or cells, and the location of the inlet and outlet

Sediment ponds are 'end-of-pipe' practices that are typically the final BMP through which stormwater flows before it is discharged offsite. They receive flows from all the other ESC measures installed in the contributing drainage area as well as overland flow, often from stripped land areas. As such they are particularly important components of ESC plans, providing the last line of defense against the release of excess sediment to natural water features.

### Application

- Treatment of runoff from any construction site drainage areas > 2 ha.
- Applied as an end-of-pipe control.

### Design and installation

- Sediment ponds must be constructed prior to any construction activities except for topsoil stripping and grading associated with the construction of the pond.
- Once excavation and grading is complete, pond banks must be compacted and stabilized with vegetation. An

**Thinking beyond ponds**

Studies has shown that while properly designed ponds have good removal efficiencies, high incoming runoff volumes and sediment concentrations often result in effluent sediment concentrations that exceed thresholds for the protection of aquatic organisms and their habitats.

Apply a ***multi-barrier approach*** and focus on ***stabilizing the site*** in order to keep sediment out of the stream.

RECP may also be needed until vegetation is well established and effectively preventing erosion.

- The maximum recommended contributing drainage area for a sediment pond is 10 ha.
- Consider whether there is a need to construct the pond with a liner to prevent interaction with groundwater. This is particularly important if there is a downward gradient and hydraulic conductivity of soils is greater than $10^{-7}$ m/s, or if the pond is to be located in a vulnerable area, which may include: (i) highly vulnerable aquifers, (ii) significant groundwater recharge areas, (iii) wellhead protection area A or (iv) wellhead protection area B (if the area has a vulnerability score ≥ 8).

### Siting

- Install the sediment basin based on topography and in a low area allows the maximum control of sediment laden runoff from the disturbed areas.
- Consult with local CA if proposed location is the also the location of the ultimate (post-construction) stormwater management pond.

### Pond and forebay design

The following design specifications should be applied in the design and sizing of sediment control ponds and their forebay areas:

| Design component | Specifications | Notes |
|---|---|---|
| Forebay / berms | At least one forebay designed as follows:<br>• ≥ 1 metre deep<br>• Sized to ensure non-erosive velocities leaving forebay<br>• ≤ 33% of permanent pool<br>***AND***<br>A submerged berm or turbidity curtain | Submerged berm/turbidity curtain applied across the width of the pond, half way between the initial forebay berm and the outlet structure. |
| Permanent pool volume | ≥ 125 $m^3$ per hectare contributing drainage area | • 185 $m^3$/ha provided if length-to-width ratio or drawdown requirements are not met<br>• Confirm volume with local CA |
| Active storage volume | ≥ 125 $m^3$ per ha drainage area | |
| Drawdown time | ≥ 48 hours | |
| Length-to-width ratio | ≥ 4:1 | A baffle may be required to increase length of the flow path and prevent short circuiting |
| Permanent pool depth | 1 – 3 metres | • Refers to maximum depth (deepest point)<br>• Minimum depth is applied to avoid re-suspension of previously settled sediment<br>• Maximum depth is a safety precaution |
| Slope grades | • Interior side slopes graded no steeper than 4H:1V<br>• Exterior side slopes graded no steeper than 2H:1V | |

Inlet design

- For swale inlets typically in place before site servicing is complete,  ensure structural stability and the application of erosion controls.  Options include embedded stone, well established vegetation installed with turf reinforcement matting, or other hard or soft armoring techniques.
- Ensure stabilization selected will withstand erosive forces of the runoff flowing through the channel inlet.
- Install flow interruption devices in the swale upstream of the pond in order to dissipate the energy in the runoff and reduce its erosivity.
- A slope drain or similar structure is recommended to allow runoff to be conveyed down into the pond with minimal erosion risk.

Outlet design

- Include a perforated riser pipe outlet or approved equivalent to release effluent at a controlled rate. The riser pipe outlet should be covered with a layer of small clear stone (25 mm – 50 mm) over a layer of larger (150 mm - 200 mm).
- The orifice in the outlet structure should have a diameter ≥ 75 mm to prevent clogging.
- A vegetated filter strip (10 metres length recommended) should be planted at the sediment control pond outfall.
- The outfall should be constructed with an animal protection grate and a flow dispersion measure to prevent erosion.

Emergency spillway design

- Ensure that a stable, open channel emergency spillway is constructed to prevent overtopping or structural failure during high flows.  Installation should adhere to all specifications provided by the ESC plan designer.
- The spillway must be designed to safely pass the 100 year design storm.
- Stabilize the spillway.  Options include embedded stone, well established vegetation installed with turf reinforcement matting, or other hard or soft armoring techniques.
- Install erosion protection immediately downstream of the spillway, including both ground stabilization and energy dissipation measures as needed.

Calculations required

The following calculations should be submitted with associated ESC plan drawings and reports:

- Velocity calculations demonstrating that settling velocities can be achieved based on the proposed design
- Determination of permanent pool and active storage volumes
- Drawdown calculations

## Inspection and maintenance

- Inspect weekly, and before and after significant rainfall (see definition in Section 10.1.2) or snowmelt events, and keep a record of the inspection.
- Ensure pond has been constructed prior to any construction activities except for activities associated with the construction of the pond, such as topsoil stripping and grading.
- Verify that pond and its specific components (i.e. inlet, forebay, berms, outlet, emergency spillway) appear to be constructed as per detailed drawings in ESC plan.
- Verify stabilization of pond banks and inlet and look for any evidence of erosion.  Repair or augment stabilization measures as needed, i.e. fill rills, re-seed and apply RECP.
- Inspect inlet for signs of excess sediment accumulation and/or large debris.  Remove sediment accumulation in the forebay before it reaches 50% of the forebay storage capacity.
- Measure sediment accumulation in the pond at least once every six months. Guidance on proper sediment depth measurement is available in Section 6.1 of the *Inspection and Maintenance Guide for Stormwater Management Ponds and Constructed Wetlands* (TRCA and CH2M, 2016).
- Remove sediment accumulation in the pond when it reaches approximately 30% of the permanent pool storage volume.

**Figure B2-20:** Sediment removal from a pond

- Observe and/or analyze pond effluent suspended sediment and/or turbidity levels to assess performance. This should be done before and after significant rainfall and snowmelt events or more frequently as needed. See Chapter 10.0 for addition guidance ESC performance monitoring.
- Where effluent turbidity is elevated, consider potential reasons for under-performance including:
    - Water short circuiting flow path due error in design or implementation
    - Erosion from banks or swale inlet
    - High sediment loads entering the pond due to inadequate ESC in the contributing drainage area.
    - Excessive sediment accumulation in the pond
- Address deficiencies and carry out follow up monitoring to assess whether actions taken have resulting in pond performance improvement.
- Ensure spillway remains structurally sound and repair as needed when damage occurs. Replace and regrade the stone as required to maintain its shape.
- For more detailed guidance on pond maintenance, refer to the *Inspection and Maintenance Guide for Stormwater Management Ponds and Constructed Wetlands* (TRCA and CH2M, 2016).
- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact.

## Decommissioning

- In the case where the sediment control pond is in the location of the ultimate (post-construction) pond, and construction is complete, accumulated sediment must be removed (and appropriately disposed of) and the permanent pool storage must be restored to the design level.
- Water pumped out of ponds that are being decommissioned should be treated with a sediment control measure prior to release to the receiving water system. Appropriate sediment removal BMPs for application during pond dewatering include sediment bags, weir tanks, or treatment trains that may incorporate these measures. See dewatering protocols (Section 6.4) and BMP details on p. B2-25 and B2-45 for guidance.
- Sediment and liner materials should be removed from the bottom of the pond and properly disposed of based on sediment quality. Refer to the *Inspection and Maintenance Guide for Stormwater Management Ponds and Constructed Wetlands* (TRCA and CH2M, 2016) for best practices related to pond sediment disposal / reuse.

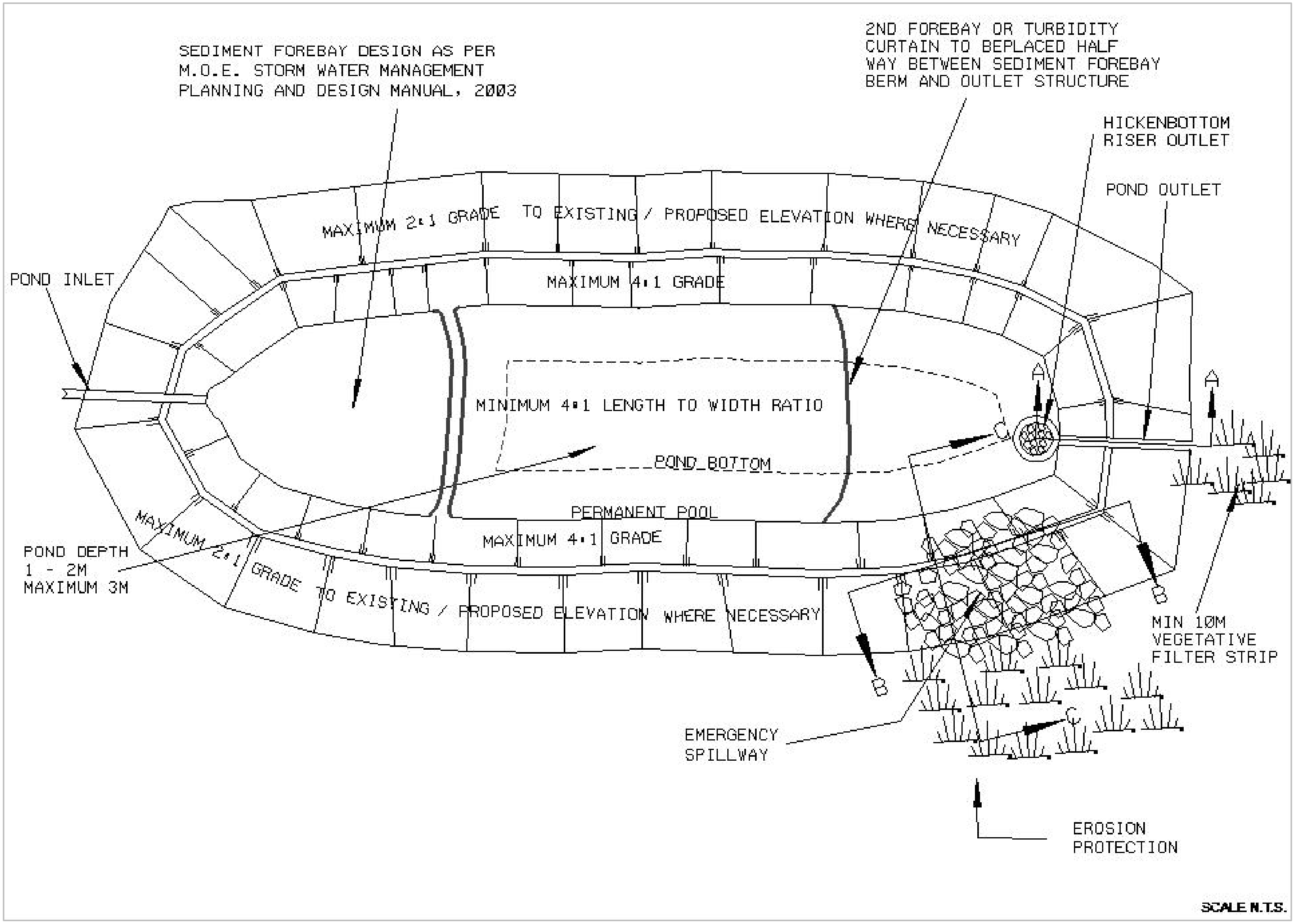



**Figure B2-21:** Plan view depiction of sediment control pond design specifications

# WEIR TANKS
### (a.k.a. dewatering tanks)

Weir tanks can be used on construction sites to detain stormwater runoff and promote sediment settling. Compared to other detention measures that are built on site, like basins or sediment traps, tanks can be a convenient and small footprint solution for short duration dewatering activities, since they are readily transported on and off site. The internal structure of the tank includes bottom weirs to help detain water and dissipate energy to aid in the settling of suspended solids.

**Figure B2-22:** Weir tanks

## Application

Weir tanks are can be used alone or as the settling component of a larger water treatment system. Tanks can be particularly useful when:

- Sediment removal is required for short-term pumping / dewatering activities, such that taking the time to construct a BMP with similar sediment removal capacity (e.g. sediment control pond) would be impractical;
- Site specific requirements dictate more stringent effluent water quality standards than are achievable when applying other sediment control BMPs used during dewatering (e.g. sediment bags); or
- Planned pumping rates are high and require a large capacity BMP.

## Design and installation

- Tank selection should be done in consultation with the system supplier and determined based on consideration of the anticipated pump rates and the target detention time and sediment removal efficiency. Sediment particle size distribution should also be considered, since finer particles are more difficult to settle.
- Determine the location where the system will be placed based on consideration of the following:
    - Stability of the ground surface.
    - Accessibility by vehicles that will be transporting the tank.

  - Distance from any natural water feature (≥ 30 m recommended where possible)

- The rate at which effluent is discharged from the tank should be based on the capacity of the downstream receiving area to accommodate those flow rates. Ensure the system discharges to a well stabilized area, with flow dispersion and interruption devices placed as needed. Consider the entire flow path to the receiver and apply stabilization measures along the path as needed.
- For a multi-barrier approach, add a sediment control barrier around the area where the active treatment system is placed. This will provide added protection in the event of any pipe leaks.
- Keep a spill response kit near the active treatment system and ensure staff are aware of spills response and reporting protocols.

### Inspections and monitoring

- Inspect daily during active use of the system and keep a record of the inspection.
- Carry out routine inspection of sediment accumulation in the tank to determine when clean out is required and ensure previously settled sediment is not becoming re-suspended.
- Carry out routine effluent monitoring to verify performance and ensure that effluent quality meets any applicable standards. If performance declines, consider whether pump rates need to be adjusted or accumulated sediment needs to be removed. Consider enhancing removal efficiency through the use of a polymer flocculant based system.
- Ensure system is monitored daily during active pumping and that staff overseeing the use of the system have a thorough knowledge of proper operation.
- Where there is evidence of erosion at the discharge point or along the flow path downstream of the discharge locations, re-consider whether stabilization is adequate to protect against erosion based on the flows.
- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact.

## POLYMER FLOCCULANTS

Polymers flocculants have been used for in various industries for decades – including food processing, aquaculture and mining – as a means of facilitating the separation of solids and liquids. Polymer flocculants are chemicals that adsorb onto suspended particles to form bridges between them, as shown in Figure B2-23. As particles are bound together they form larger aggregate masses, which are then more readily removed from suspension through gravitational settling or filtration (Figure B2-24).

Polymer flocculants can be used on construction projects to enhance removal of suspended sediment, particularly in situations where the sediment-laden water cannot be detained long enough to allow particles to settle.

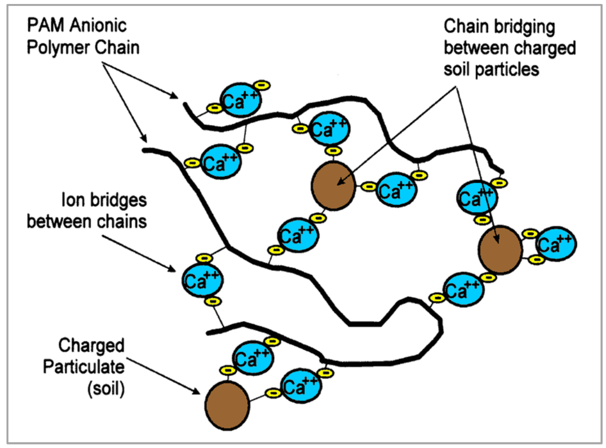



**Figure B2-23:** Interaction between anionic PAM and soil particles in the presence of calcium (Orts et al., 2002).

There are various polymer flocculants currently used to promote solid-liquid separations, but only some are suitable for ESC applications. Polymers used for ESC or other environmental applications should be:

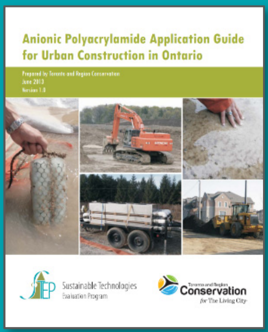
- non-toxic to humans and other terrestrial and aquatic organisms;
- effective at reducing water turbidity and/or preventing soil erosion;
- practical for use in the outdoors; and
- otherwise safe.

Two of the most common construction runoff clarification flocculants are polyacrylamides and chitosan.

**Polyacrylamides (PAM)** | PAMs are synthetic organic polymers created through the polymerization of acrylamide. PAMs used in construction stormwater clarification applications are water-soluble (having a linear chain structure) and negatively charged (anionic). Cationic (positively charged) PAMs are also effective flocculants but exhibit a higher toxicity to aquatic organisms than anionic forms. Linear anionic PAM products are typically available in the following three forms: (i) powders used for dry application or for mixing with water, (ii) emulsions that can be added to water, often as part of a hydroseed mix, and (iii) blocks which dissolve into flowing water.

**Figure B2-24:** Turbidity reduction in water sample following treatment with a flocculant. Before on the left and after on the right.

**Chitosan** | Chitosan is a cationic biodegradable biopolymer that is produced from a renewable source – chitin – which is found mainly in the exoskeletons of crustaceans and insects and the cell walls of certain fungi. Chitosan is biodegradable and derived from a renewable source. While chitosan is widely used in many commercial products and ingestible dietary supplements, its cationic nature may mean higher toxicity to aquatic organisms relative to an anionic polymer. While toxicity varies among products, in practice chitosan is often used in ways that eliminate the risk of having residual chitosan in treated water released to natural features. One common example is chitosan-enhanced sand filtration, where sand filters are used at the end of a treatment train (often an active treatment system) as a polishing step which removes any flocculated sediment that remains in suspension. Chitosan residual can also be tested with portable kits that can be useful where effluent discharges directly to a natural feature.




**For specific and detailed guidance on using anionic polyacrylamide on construction sites, see Toronto and Region Conservation Authority's *Anionic Polyacrylamide Application Guide for Urban Construction in Ontario* (TRCA, 2013).**

**The Guide is available in the Sustainable Technologies Evaluation Program Resource Library at:**

**sustainabletechnologies.ca**

## Application

Polymer flocculants are best applied to enhance sediment settling when:

- Treatment is required for short-term pumping activities, such that taking the time to construct a BMP with similar sediment removal capacity (e.g. sediment control pond) would be impractical;
- A high sediment removal rate is required but the area available for treatment is too small to accommodate a sediment control pond;
- Water being treated contains a large proportion of fine sediments (e.g. clay) since these are difficult to settle out of suspension
- Water being treated contains certain contaminants of concern that require removal through specific chemical and/or physical processes;
- Site specific policy requirements define more stringent effluent water quality standards than are typical and/or achievable when applying other conventional BMPs; or
- Other conventional sediment control measures have failed to achieve the necessary removal rates.

## Design and installation

Product selection

- Selecting a flocculant and determining dosing rates should be carried out in consultation with the product supplier. Dosing rates vary according to the dosing method, product type and its physical form.
- Selection of a flocculant should be based on demonstrated sediment settling performance during bench scale testing using soil and water samples from the site.
- For any flocculants to be used, toxicity data must be available to demonstrate that the product is non-toxic at the intended dosing/application rate. Evidence of this should be available in the product's Material Safety Data Sheet (MSDS) and/or toxicity reports. As a minimum, acute and chronic toxicity data, based on testing by an accredited third party, should be available for the following aquatic

organisms: fathead minnow (Pimephales promelas), rainbow trout (Oncorhynchus mykiss) and water flea (Daphnia magna). The LC-50 concentrations (the concentration of polymer that is lethal to 50% of the sample population) listed in toxicity reports should significantly exceed the maximum anticipated release rate of the product based on the intended use.

- The use of any cationic polymer flocculant for treatment of construction runoff that is being discharged to a natural feature is subject to approval by the local municipality and CA and other agencies involved in regulated discharges from the site. Approval is based on product toxicity data and the intended application method and dosing rate.
- Ensure product labelling and/or packaging is available for the flocculant, which specifies the following:
  - product expiry date
  - use and maintenance instructions
  - safe handling, storage and disposal information
- Any applications of anionic PAM-based products should meet the criteria detailed in *Anionic Polyacrylamide Application Guide for Urban Construction in Ontario* (TRCA, 2013).

**Polymers are not a magic bullet**

Polymer flocculants can be an important ESC tool, but to be effective they have to be thoughtfully integrated as part of a ***treatment train*** that provides opportunity for ***dosing, mixing and settling.***

System design

- Any flocculant-based construction runoff treatment system should be designed by a qualified individual with knowledge of, and experience with, polymer flocculants.
- A construction runoff clarification system incorporating a polymer flocculant can come in a variety of configurations – such as an open ditch / channel or an active treatment system with tanks – but should always be designed to provide opportunity for the following key system functions:
  - **Dosing:** The flocculant is dissolved into the water being treated at a dosing rate determined based on manufacturer guidance. The dosing rate will vary based on several factors, such as product, type, the flow rate of water and water temperature.
  - **Mixing:** Physical mixing of the flocculant and water will increase opportunity for sediment particles to react and bind together. Passive mixing can be accomplished by allowing the water to flow through barriers that will create turbulence (e.g. rock check dams, baffles). Mixing time required should be determined based on manufacturer guidance.
  - **Settling:** Providing an area for sediment settling following mixing ensures that flocs (i.e. agglomerated particles) will settle out within the treatment system rather than in the downstream area or feature receiving the treated discharge.
  - **Final filtration:** Filtering effluent at the end of the system can provide assurance that flocs that have not settled out of suspension are removed before the effluent is discharged to the receiving area. Suitable filters may include geotextile fabric (e.g. sediment bag) or sand filters depending on the polymer flocculant used and the specific system design.
- Ensure the system discharges to a well stabilized area, with flow dispersion and interruption devices placed as needed. Consider the entire flow path to the receiver and apply stabilization measures along the path as needed.

- Consider air and water temperatures experienced during active use of the system and confirm that the product will be effective at the planned dose temperatures. Some polymer flocculants become less effective at colder temperatures. As a result the dosing rate may need to be increased or an alternative flocculant or treatment method may be required.
- Ensure pumping rates do not shift substantially from the rates estimated during flocculant and system selection and sizing, as the flocculant and filters may be less effective at different flow rates.
- For a multi-barrier approach, always incorporate final filtration for discharge and apply stabilization and energy dissipation in the downstream flow path.
- Keep a spill response kit near the polymer flocculant water clarification system and ensure staff are aware of spills response and reporting protocols.

System siting

- Flocculant based clarification systems should never be sited in natural areas, terrestrial or aquatic features. Where effluent from the system will be discharged to a natural water feature, the distance between the system outlet and the water feature should be at least 30 metres.
- Where siting 30 m away is not possible, consult with the local CA for guidance on siting and monitoring efforts that can be applied to mitigate risk.
- For large installations, like active treatment systems with weir tanks, ensure placement on a stabilized ground surface and consider accessibility by vehicles transporting system components.

## Inspection and maintenance

- For systems where water is being pumped, such as in active treatment, inspect daily during active use and keep a record of the inspection. Guidance on active treatment systems is provided in the following section.
- Where flocculants are used in a passive way (e.g. in an interceptor swale), inspections should be carried out on a weekly basis as well as before and after significant rainfall or snowmelt events.

**Figure B2-25:** Polymer flocculant in gel-block form

- Carry out routine effluent monitoring to verify performance and ensure that effluent quality meets any applicable standards. If contaminant removal performance declines, investigate each system component – dosing, mixing, settling, filtration – to identify the potential source of the problem. If the system is treated pumped water that is being discharged to a natural water feature, cease pumping until performance issues can be resolved.
- The following components should be inspected, if applicable:
  - **Dosing area.** Ensure dosing is occurring as intended. Where solid block forms are used, ensure they are not being coated with sediment, as this can compromise their capacity to dissolve into the water. Also consider block positioning to ensure good contact so that water isn't short circuiting the dosing area.

  - **Filters.** Regular inspection is required to ensure filters remain effective. Where geotextile bags are used for final filtration, close monitoring is required to ensure that bags are replaced as needed. Because they can fill up quickly when used as part of a polymer system, caution should be exercised to prevent rupture.
  - **Sediment settling area(s).** Sediment accumulation should be removed at the appropriate trigger (e.g. 30% height of a sediment retention barrier).

- For ditch / swale systems, inspect for evidence of excessive sediment accumulation and / or erosion, and clean out or re-stabilize as needed.
- Ensure the flocculants are being stored and maintained as specified in guidance from the supplier / manufacturer to ensure ongoing efficacy.
- Ensure staff overseeing the use of the system have a thorough knowledge of proper maintenance.
- Where there is evidence of erosion at the discharge point or along the flow path downstream of the discharge locations, re-consider whether stabilization is adequate to protect against erosion based on the flows.
- Keep MSDS sheets and toxicity reports related to the flocculant used in an easily accessible location on the site.
- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact.

### Decommissioning

- Ensure flocculant-treated sediment and any leftover flocculant are properly disposed of.
- Where polymer flocculants left over are suitable for reuse elsewhere, ensure proper handling and storage in accordance with supplier / manufacturer guidance.

## ACTIVE TREATMENT SYSTEMS

Active treatment systems incorporate weir tanks, flocculants and filters in order to achieve a high contaminant removal rate while occupying a relatively small footprint (Figure B2-26).

They differ from a passive flocculant-based treatment train in that they are more sophisticated, offering more precise control of the treatment processes, such as flocculant dose metering and filter backwashing capabilities. They may also incorporate hydrodynamic processes for physical separation of floatables and suspended particles from the water. Flocculants are often incorporated in the treatment process to promote sediment particle binding and settling, and filters (e.g. sand) are included as a final 'polishing' step before water leaves the system.

**Figure B2-26:** Active water treatment system for construction site runoff

Active treatment systems are highly customizable and can range from simple to complex, depending on the components included, the types of contaminants being removed and the removal rate required. Product suppliers typically rent out the system components for the desired duration and often provide installation and other operations support to ensure the system performs effectively.

### Application

Active treatment systems should be considered for removing contaminants during pumping of construction site stormwater when:

- Treatment is required for short-term pumping activities, such that taking the time to construct a BMP with similar sediment removal capacity (e.g. sediment control pond) would be impractical;
- A high sediment removal rate is required but the area available for treatment is too small to accommodate a sediment control pond;
- Water being treated contains certain contaminants of concern that require removal through specific chemical and/or physical processes;
- Site specific policy requirements define more stringent effluent water quality standards than are typical and/or achievable when applying other conventional BMPs; or
- Other conventional sediment control measures have failed to achieve the necessary removal rates.

### Design and installation

- Selection of system and sizing should be done in consultation with the system supplier. Consider what treatment level is needed and what contaminants should be removed in order to find the right system to achieve those goals.

- Typical system components may include:
  - Flocculant and associated dosing system (e.g. injection into water stream, passive dosing by allowing water to flow over and around water soluble flocculant blocks);
  - Detention tank with weirs or baffles to allow mixing and sediment settling; and
  - Filters with or without backwashing capability.
- Determine the location where the system will be placed based on consideration of the following:
  - Placement at least 30 m from any natural water feature in order to minimize risk of a spill into the feature. Where siting 30 m away is not possible, consult with the local CA for guidance on siting and monitoring efforts that can be applied to mitigate risk.
  - Placement on a stabilized ground surface.
  - The location must be accessible to the vehicles transporting the system components. Consider whether the largest component that will be brought on site can be transported and placed in the intended area.
- Where flocculants are used, refer to flocculant guidance. The proposed use of any cationic flocculant is subject to approval by the local municipality and CA, as well as any other agencies involved in regulating discharges for the site.
- Selection of a flocculant should be based on demonstrated sediment settling performance during bench scale testing using soil and water samples from the site.
- For any flocculants to be used, toxicity data must be available to demonstrate that the product is non-toxic to aquatic organisms at the intended dosing/application rate.
- Ensure pumping rates do not shift substantially from the rates estimated during flocculant and system selection and sizing, as the flocculant and filters may be less effective at different flow rates.
- Ensure the system discharges to a well stabilized area, with flow dispersion and interruption devices placed as needed. Consider the entire flow path to the receiver and apply stabilization measures along the path as needed.
- For a multi-barrier approach, add a sediment control barrier around the area where the active treatment system is placed. This will provide added protection in the event of any pipe leaks.
- Keep a spill response kit near the active treatment system and ensure staff are aware of spills response and reporting protocols.

## Inspections and monitoring

- Inspect daily during active use of the system and keep a record of the inspection. Inspection of specific system components may be the responsibility of the supplier, depending on the terms of the contract. As a minimum the onsite inspector should look monitor sediment accumulation in the tank and effluent quality.
- Carry out routine effluent monitoring to verify performance and ensure that effluent quality meets any applicable standards.

**Figure B2-27:** Treated water from an active treatment system

- Ensure system is monitored daily during active pumping and that staff overseeing the use of the system have a thorough knowledge of proper operation.
- Where there is evidence of erosion at the discharge point or along the flow path downstream of the discharge locations, re-consider whether stabilization is adequate to protect against erosion based on the flows.
- Keep MSDS sheets and toxicity reports related to the flocculant used in an easily accessible location on the site.
- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact.

## VEHICLE TRACKING CONTROL
### (a.k.a. track out control, mud tracking control)

Vehicle tracking control is an umbrella term for a variety of practices that are applied at construction site entrances to control vehicles tracking mud offsite. Tracking controls can also be applied within a site where there is a need to minimize sediment transport from active construction areas to other areas that area being protected (e.g. LID features, developed areas of the site). For example, during building construction, tracking controls can be applied at the lot exit so that vehicles don't track mud onto the roads and ultimately into storm drains.

Preventing vehicle mud tracking helps to keep sediment out of storm drains, end-of-pipe controls and natural features, and reduces the risk of dust pollution. Vehicle tracking controls generally fall into the following categories:

- **Mud mats** | Mud mats include rock/stone pads underlain with geotextile fabric or pre-fabricated products in various designs. They are used primarily for stabilizing site entrances, but some pre-fabricated mud mat products may also encourage some mud removal by providing an uneven or bumpy surface that digs into the mud caked onto the tires.
- **Shaker racks / grates / ridges** | These racks or grates are pre-fabricated products that are designed to (i) provide a stable entrance and (ii) dislodge mud from tires as vehicles bounce slightly while driving over the uneven surface. As their ability to remove mud relies on the bouncing/shaking action, they need to be long enough – at least one full tire rotation – to provide opportunity for dislodgment.
- **Wheel washers** | A well installed vehicle wheel washing system can provide the highest level of protection from offsite mud tracking. These types of devices are designed to spray water onto tires as the vehicle drives through them, essentially pressure washing mud from the tires. They typically include or are installed with a rack through which water drains and an area for capturing of dirty wash water, which is directed towards a sediment control measure. Wheel washers come is a wide variety of designs and configuration. Wheel washing can also be less sophisticated, such as passive washing – where the vehicle is simply driven through a pool of wash water in a contained area – and manual washing carried out with a hose by on site staff.

**Figure B2-28:** Vehicle tracking controls. From top to bottom: mud mat, shaker rack, vehicle wheel washer.

## Application

Vehicle tracking controls should be applied when:

- The site is greater than one hectare in size;
- There will be grading and filling operations in close proximity to construction site entrances; or
- Weather and site conditions will result in saturated, muddy soils;

Wheel washing should be used as the vehicle tracking control if:

- Mud tracking is an ongoing issue and simpler vehicle tracking controls are not providing effective mitigation;
- Other tracking controls cannot be constructed due to site constraints
- The site contains contaminated soils; or
- The local municipality makes it a requirement.

## Design and installation

### Mud mats

The following are recommended design specifications for mud mats constructed with rock pads:

| Design attribute | Specifications |
|---|---|
| Length | ≥ 20 m |
| Width | Full width of the entrance |
| Rock / stone layer thickness | 450 mm |
| Rock / stone details | For the first 10 m in from the road: 50 mm diameter clear stone<br>Remaining length: 150 mm diameter clear stone |
| Bottom layer type | Non-woven geotextile fabric or graded aggregate filter |

- See mud mat design detail in Figure B2-29.
- For pre-fabricated mud mat products, adhere to manufacturer specifications for design and installation.
- Where constructed over top of a culvert or ditch, a sediment control barrier (e.g. sediment fence, filter sock) should be installed along the edges of the pad to prevent sediment from being washed into the area below.
- Ensure that drainage from the mud mat is conveyed to a sediment control measure for removal of suspended sediment.

Shaker racks / grates / ridges

- For pre-fabricated products, adhere to manufacturer specifications for design and installation.
- Ensure that the device installed is long enough to allow for at least one full tire rotation so that the vehicle will bounce enough to dislodge mud.
- Ensure device installed is wide enough to accommodate the passage of any construction vehicle on site.
- The rack should be installed with space below to allow for sediment deposition.
- Install rock pads on either side of the shaker rack.
- Convey drainage from the shaker rack to a sediment control measure.
- Where constructed over top of a culvert or ditch, a sediment control barrier (e.g. sediment fence, filter sock) should be installed along the edges of the installation to prevent sediment from being washed into the area below.

Wheel washing

- Where a full proprietary system is used, ensure that product selection, placement and installation is consistent with guidance provided by the manufacturer / supplier of the product.
- The particular model of wheel washing system needed should be determined based on the number of vehicles cleaned daily and the amount of mud that needs to be removed from each vehicle
- Ensure all dirty wash water will be drained into a containment area below and then conveyed to a sediment control measure for removal of suspended sediment.

## Inspection and maintenance

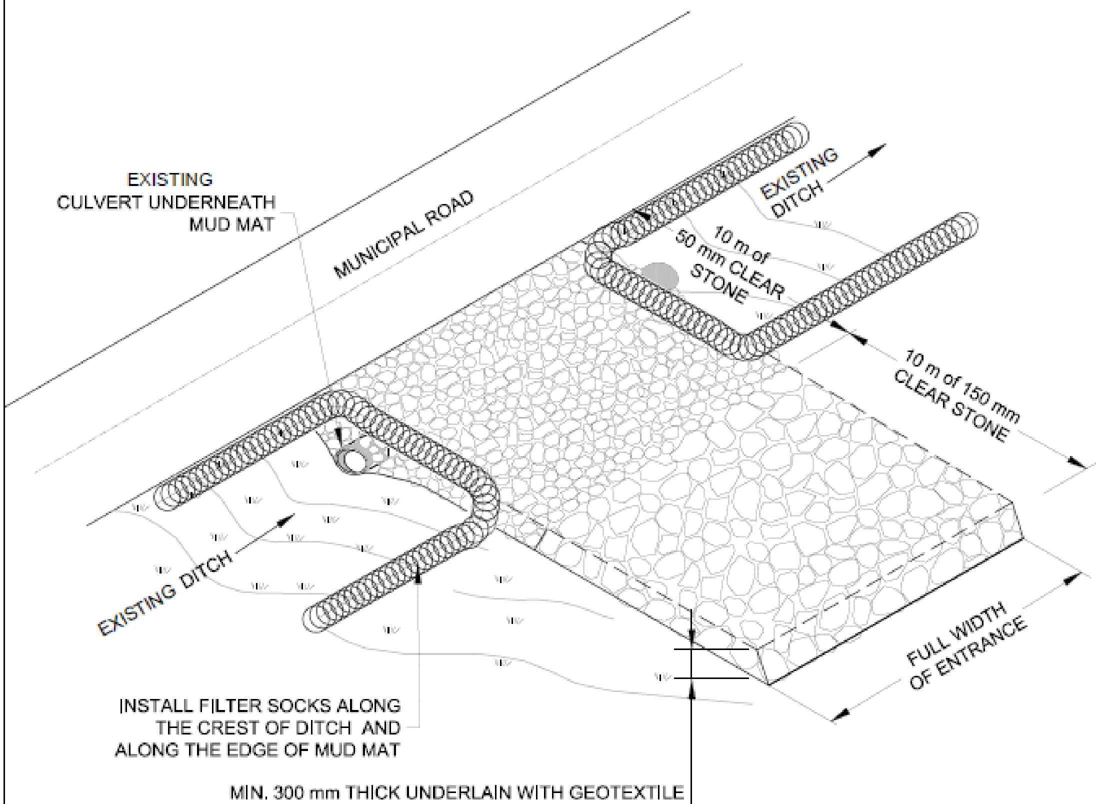
- Inspect vehicle tracking controls weekly, and before and after significant rainfall (see definition in Section 10.1.2) or snowmelt events, and keep a record of the inspection.
- Inspect mud mats for excessive sediment accumulation. For rock pads look for signs that the voids have been filled with sediment and replace granular material as needed.
- Clean up any sediment tracked onto public roads at the end of each day.
- Ensure the installation of storm drain inlet protection for inlets in roads that will be subject to street sweeping, since this can sometimes cause additional sediment to be swept into storm drain inlets.
- Any repair or maintenance needs identified should be repaired within 48 hours or sooner if natural receptors are at imminent and foreseeable risk of adverse impact.

## Decommissioning

- Ensure all components are removed with minimal disturbance, and that waste materials are properly disposed of.
- Grade and restore the area as per the final stabilization plans.

MUD MAT DETAIL NOTES:

1. MUD MAT TO BE UNDERLAIN WITH A GEOTEXTILE CLOTH
2. SEDIMENT WILL BE CLEANED FROM PUBLIC RIGHT OF WAYS AS REQUIRED
3. STORM INLETS IN CLOSE VICINITY TO MUD MAT TO BE PROTECTED WITH INLET CONTROL MEASURES




NOTE: THIS DETAIL REPRESENTS AN IDEAL SCENARIO. SITE CONDITIONS VARY AND EROSION AND SEDIMENT CONTROL MEASURES SHOULD BE TAILORED FOR EACH SITE AND PROJECT

| Toronto and Region Conservation Authority | TRCA ESC DESIGN DETAIL | SCALE: N.T.S. | REV: 1 | DATE: MARCH 2019 |
|---|---|---|---|---|
| | DRAWING TITLE: MUD MAT | | | DWG NO: 05 |



**Figure B2-29:** Design detail for mud mat for construction site vehicle access

# APPENDIX C:

# BEST MANAGEMENT PRACTICES FOR IN AND NEAR WATER WORKS

# BMPs for in and near water works

In-water works should be avoided if possible, and may be viewed as a last resort. The rationale behind this is to minimize potential ecological impacts, as in-water works are intrusive to aquatic habitats and considered high risk. Where possible, selecting construction methods that avoid disturbance of water features, such as trenchless crossing methods for installing pipes, cables and other underground services, should be employed.

When it is necessary to carry out works in or adjacent to water features, preventing the release of sediment into the waterbody requires careful design and effective implementation of measures that isolate the work area from the rest of the feature. One of the best approaches to reduce the risk of sediment release into the waterbody is to phase the work such that the area of work is isolated to small sections that can be stabilized at the end of each work day. Planning of in water construction activities should always consider methods that minimize the construction footprint and duration of work, and are scheduled to ensure completion outside of spawning times in order to mitigate long-term negative impacts to the feature and aquatic ecosystem.

## Construction timing

All in water and near water works should be scheduled such that works are completed outside of the restricted activity timing windows listed in Table C1. The regions defined in Table C1 are delineated in the map shown in Figure C1. These timing windows ensure pollution is minimized and aquatic habitats are protected during critical life stages, such as spawning, juvenile stages and migration. If the proposed works cannot be completed outside of the indicated spawning times, the work may need to be phased in over more than one year, or approval to work during the restricted activity timing window is required. In Ontario, MNRF and DFO should be consulted for permission to carry out any in or near water works during the restricted activity timing windows.

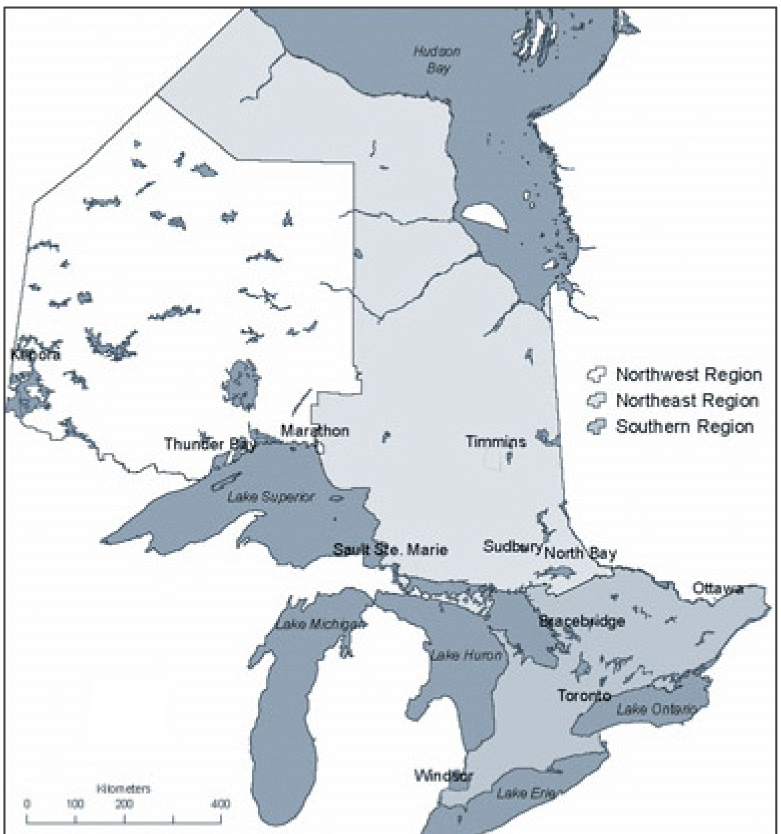



**Figure C1:** Ontario's Northwest, Northeast and Southern Region boundaries for determining application of restricted activity timing windows. Source: Fisheries and Oceans Canada, 2013

If species listed under the Endangered Species Act (S.O. 2007) or Species at Risk Act (S.C. 2002) could be impacted by the construction activities, additional approvals may be required prior to initiating any in or near water works. The local conservation authority, MECP or DFO and their respective websites should be consulted to determine site specific requirements.

**Table C1:** Ontario restricted activity timing windows for protection of fish and fish habitat during in water and near water works (source: Fisheries and Oceans Canada, 2013)

| | Fish Species | Northwest Region | Northeast Region | Southern Region |
|---|---|---|---|---|
| Spring spawning species | Walleye | April 1 to June 20 | April 1 to June 20 | March 15 to May 31 |
| | Northern Pike | April 1 to June 15 | April 1 to June 15 | March 15 to May 31 |
| | Lake Sturgeon | May 1 to June 30 | May 1 to July 15 | May 1 to June 30 |
| | Muskellunge | May 1 to July 15 | May 15 to July 15 | March 15 to May 31 |
| | Large/ Smallmouth Bass | May 15 to July 15 | May 15 to July 15 | May 1 to July 15 |
| | Rainbow Trout | April 1 to June 15 | April 1 to June 15 | March 15 to June 15 |
| | Other/Unknown Spring Spawning Species | April 1 to June 15 | April 1 to June 15 | March 15 to July 15 |
| Fall spawning species | Lake Trout | Sept. 1 to May 31 | Sept. 1 to May 31 | Oct. 1 to May 31 |
| | Brook Trout | Sept. 1 to June 15 | Sept. 1 to June 15 | Oct. 1 to May 31 |
| | Pacific Salmon | Sept. 1 to June 15 | Sept. 1 to June 15 | Sept. 15 to May 31 |
| | Lake Whitefish | Sept. 15 to May 31 | Sept. 15 to May 15 | Oct. 15 to May 31 |
| | Lake Herring | Oct. 1 to May 31 | Oct. 1 to May 31 | Oct. 15 to May 31 |
| | Other/Unknown Fall Spawning Species | Sept. 1 to June 15 | Sept. 1 to June 15 | Oct. 1 to May 31 |

**Table C2:** Common best practices for protecting natural water features during in-water construction

| Practices | | Description | Page |
|---|---|---|---|
| Sediment / turbidity curtains | | Geotextile material vertically suspended in water to enclose an in-water work area and contain sediment transport to a limited area within the disturbed water body. Implemented around construction activities occurring "in the wet", meaning the area where construction is occurring is not being dewatered. The sediment curtains act as a filter baffle and isolate/protect an important or sensitive in-water feature. Sediment curtains are also applied to enhance sediment settling in temporary or permanent detention ponds. | C-4 |
| Temporary stream crossings via temporary bridge or culvert(s) | | Steel plate or other timber crossing placed above top of bank and anchored, or a raised stone embankment constructed across a watercourse to allow passage of construction vehicles. Water conveyance through the embankment is provided via culvert(s) incorporated within the stone. Temporary crossings are intended to allow access to both sides of a watercourse at a stable concentrated point thereby limiting disruption and erosion impacts to a smaller area. | |
| **Construction in the Dry** | Waterproof Isolation Barrier (WIB) | A sealed structural barrier applied to block the passage of water into and out of an in water construction area. The WIB, also known as a cofferdam, can be applied in any natural water feature to maintain a waterproof separation that prevents sediment from the work area from being transported into the larger water feature. WIBs that are designed to extend across the length of the watercourse to block all flows must be applied with one of the watercourse diversion or bypass methods described in this Appendix. | C-10 |
| | Diversion / bypass channel | A secondary channel alongside the work area to passively divert flows around it and allow for work within the existing channel to proceed in dry conditions. Typically applied with temporary waterproof barriers / dams to keep flows out of the existing channel and route them into the bypass. All methods of temporary diversion help maintain water quality by containing sediment in the dry, isolated work area. | C-15 |
| | Flume bypass | A passive watercourse diversion that concentrates flows to a pipe or chute where gravity then conveys them, unimpeded, around or through the work area. All methods of temporary diversion help maintain water quality by containing sediment in the isolated, dry work area. Isolation of work area is typically achieved by blockage of flow upstream and downstream with WIBs or other waterproof barriers / dams. Where dewatering of the work area is necessary, appropriate discharge treatment is required to remove suspended sediment prior to discharge. Flumes may not be suitable for sensitive streams. | C-17 |
| | Bypass pumping | An active watercourse diversion method in which an electrical or fuel-powered generator is used to pump flows around the work area in order to create dry work area. All methods of temporary diversion help maintain water quality by containing sediment in the dry, isolated work area. Pump intakes are fitted with fish screens to prevent fish entry, and fish collection and relocation (with the appropriate permits) is often necessary as this method does not allow for fish passage. Bypass pumping may not be suitable for sensitive streams and is only appropriate for short duration projects. | C-20 |
| | Dewatering | The removal of water within the immediate construction area to facilitate working in the dry. Dewatering effluent should be treated and released a minimum of 30 metres from any surface water feature, where possible. The discharge location and flow path should be well vegetated or otherwise stabilized so that erosion of soil does not occur at the discharge point, and treated water does not pick up any additional sediment along the flow path back to the receiver. | C-9 |

## SEDIMENT CURTAIN

**(a.k.a. turbidity curtain)**

Sediment (or turbidity) curtains consist of a weighted, permeable or impermeable material that is secured and vertically suspended in water using a floatation device. While work is being conducted in the wet, the curtain keeps sediment contained to the area between the curtain and the bank and also slows the movement of water in the isolated area. Over the duration of the work, sediment settles out of suspension to the bottom of the water body.

### Potential permitting requirements

- As work will be conducted in the wet, there is the possibility that work will negatively impact aquatic life present within the contained area of the curtain. Prior to construction, the proposed in-water works should be reviewed with the local CA, Fisheries and Oceans Canada and applicable provincial ministries.
- If necessary, obtain permits / authorizations to collect and relocate fish and other wildlife from the isolated work area.

Use sediment curtains in ***calm*** and ***predictable*** water bodies with relatively ***uniform water depths***.

### Planning

- Plan works to occur outside of the restricted activity timing windows (spawning times) in Table C1.
- Consult the manufacturer of the sediment/turbidity curtain to determine the appropriate dimensions, curtain type, anchoring materials and buoyancy requirements for each application.
- Be aware that dynamic watercourses (like urban rivers) have the higher potential for changes in water velocities and levels which can displace the curtain.
- Avoid the times of year when there’s a higher potential for debris, like ice, in the watercourse.
- Remember that periods of fluctuating water levels and seasonal changes will make installation difficult and can result in failure of the curtain.
- Consult with aquatic biologist or equivalent expert if fish rescue / relocation activities are necessary to carry out the work.
- Keep spill kit and spill response plan on-site in the event deleterious substances enter the water body.

### Design

- Suspend geotextile curtains in the water with floatation devices/buoys and affix the base of the water body with an anchoring system (chains, concrete blocks, anchor, etc.).
- Ensure a freeboard of more than 50 mm above the floatation device.
- Customize the length of the sediment curtains for the job.
- Vary the anchors that weigh the curtain down to facilitate its contact with the water bottom for different bed materials (ex. muddy, sandy, rocky, uneven, etc.)
- Refer to Figures C3 and C4 – Ontario Provincial Standard Drawings for Turbidity Curtains (Nov. 2015) for design details.

**Figure C2:** Sediment curtain installed in a lake

## Installation

- Refer to the manufacturer's installation instructions.
- It may be helpful to roll out the length of curtain on land before guiding into the water.
- When guiding the curtain into the water, ensure it does not become twisted and avoid sharp objects.
- Position the curtain at least 5 m outside of the perimeter of the work area.
- Hold the curtain parallel to the bank using cable or rope moorings affixed to the shore, typically at the upstream and downstream ends.
- Overlap curtains to form a continuous barrier.
- Attach t-bars to curtains and embed into the water bottom (if possible) to provide structure.

## Inspection and maintenance

- Conduct daily inspections prior to starting work to ensure that the sediment curtain is functioning as intended and that it is not damaged.
- Look for turbid water outside of the area enclosed by the curtain, especially at the upstream or downstream limits where the curtain may not be properly secured to the native bank.
- Ensure that the floatation boom is visible and there's no evidence of overtopping.
- Remove any debris (logs, branches, garbage, etc.) that may be caught in or on the curtain.
- Malfunctioning components and damages should be repaired within 48 hours or sooner if environmental receptors are at imminent and foreseeable risk of adverse impact.
- Physical disruption of the curtain may result in the re-suspension of sediment in the water column and care should be taken to avoid hitting the curtain.

## Decommissioning

- Proper and careful removal of the curtain and its components following the completion of construction activities is very important in order to prevent the re-suspension of sediment. Refer to manufacturer's instructions for proper removal procedures.
- Consult with regulatory agencies permitting the works to consider solutions to address accumulated settled sediment.
- Restore all disturbed areas using native plant species.

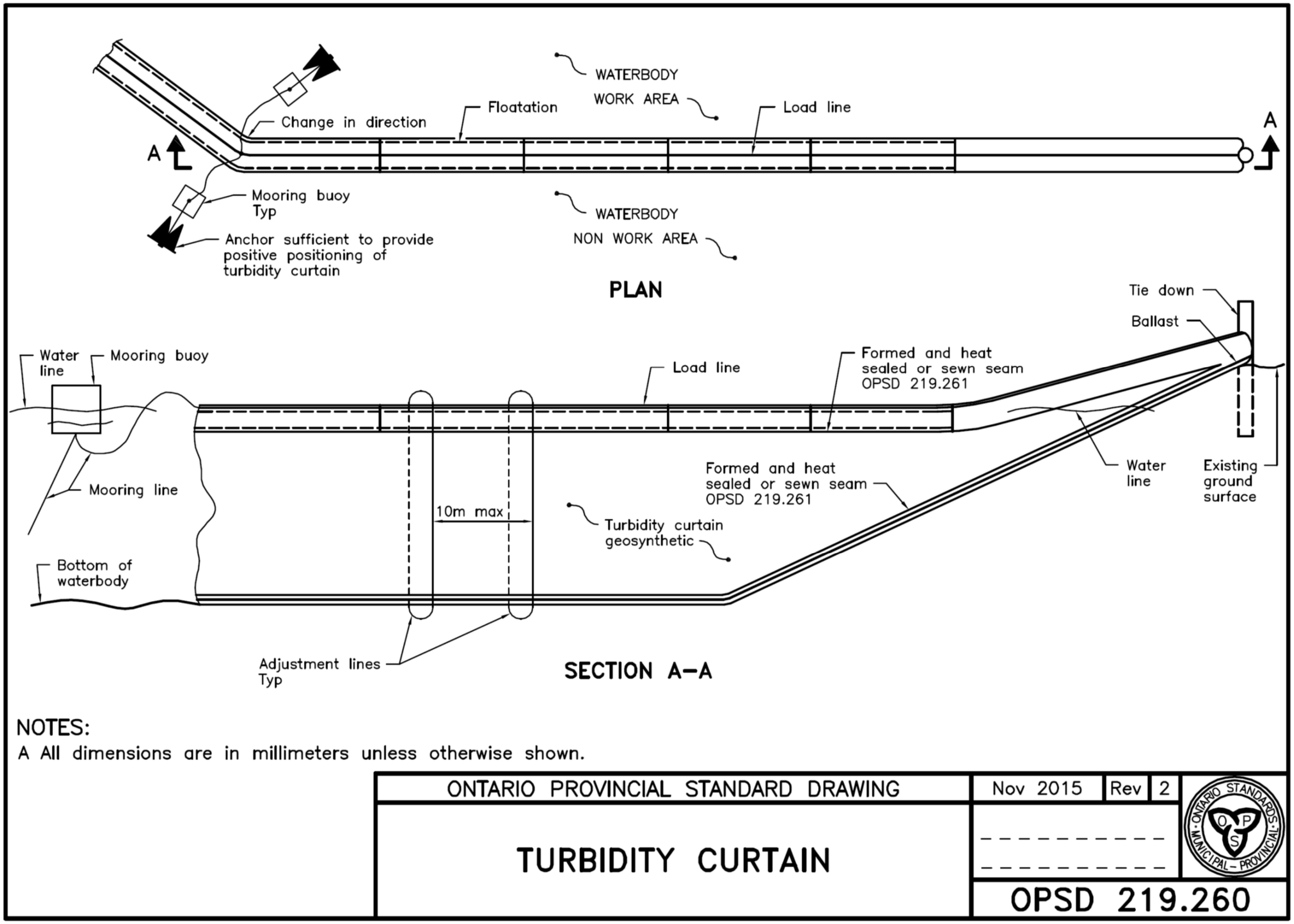
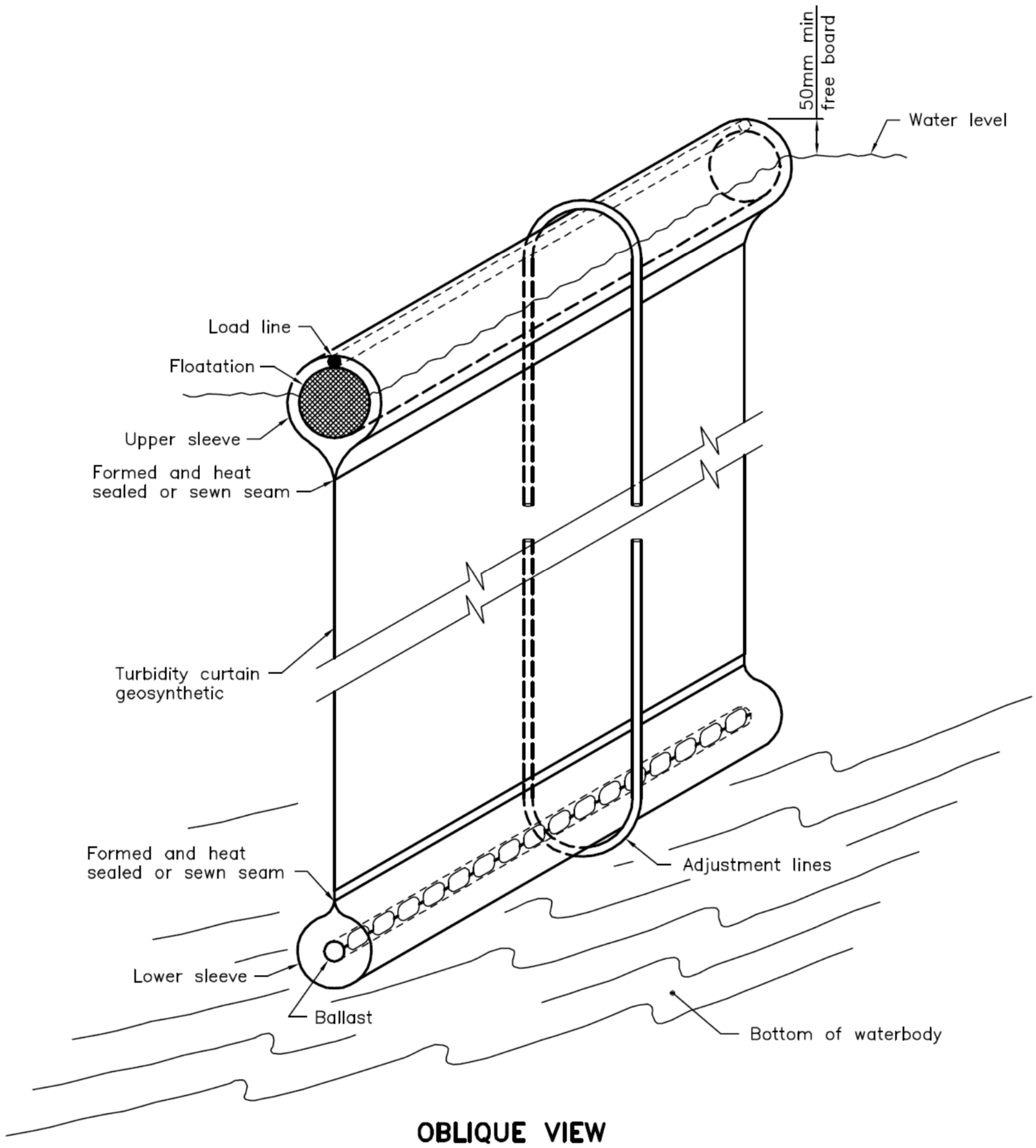



**Figure C3:** Ontario Provincial Standard Drawing for turbidity curtain in a water body




**OBLIQUE VIEW**

NOTES:

A All dimensions are in millimeters.

| ONTARIO PROVINCIAL STANDARD DRAWING | Nov 2015 | Rev 2 |
|---|---|---|
| **TURBIDITY CURTAIN**<br>SEAM DETAIL | | |
| | **OPSD 219.261** | |

**Figure C4:** Ontario Provincial Standard Drawing for turbidity curtain in a water body - seam detail

## DEWATERING AN ISOLATED WORK AREA

The removal and discharge of water from a work area to create dry working conditions is a necessity on many construction sites within waterbodies or where the water table is high and groundwater is anticipated. When sediment-laden water is being removed from the work area, the water must be treated using appropriate sediment control measures before it can be released into the environment (outside the work area). As the treated water is released, erosion mitigation measures must be in place to ensure the flows do not erode the discharge area or the flow path to the ultimate receiving water feature. Refer to Section 6.4 and Appendix B2 for additional guidance on dewatering best practices.

Please consider the following in conjunction with the in-water isolation measures described in this Appendix.

**Check out Fisheries and Oceans Canada's *Freshwater Intake End-of-Pipe Fish Screen Guideline* (1995) for best practices related to fish screens during pumping activities.**

- If necessary, obtain permits / authorizations to collect and relocate fish and other wildlife from the isolated work area (e.g. License to Collect Fish for Scientific Purposes, Wildlife Scientific Collector's Authorization). For species at risk sites, additional permits or authorizations may also be required through the MECP.
- Install, operate and maintain a pump intake with a fish screen in advance of the initial drawdown and in accordance with the requirements from pertinent governing agencies.
- Treat pumped water if required using a BMP described in Section 6.4 of the Guide or Appendix B2 (e.g. sediment bag). Refer to ESC Design Detail drawings #1 and 2 (Figures B2-16 and B2-17) for depictions of a dewatering treatment train system incorporating a sediment bag.
- Ensure the water is ultimately discharged to a well-vegetated located at least 30 m, if possible, from any waterbody, and that the flow path is stabilized. See Figure C7 (ESC Design Detail #9) for site isolation schematic, including dewatering details.
- Once initial drawdown is complete, create a filtered sump in the work area by digging a small pit below design elevations where water can collect and the pump intake can be situated.

# WATERPROOF ISOLATION BARRIERS (WIB)

**(a.k.a cofferdams)**

Waterproof isolation barriers (WIB) are constructed structures applied on a temporary basis to block the passage of water into and out of an in water construction area. They can be applied in any natural water feature to maintain a waterproof separation that prevents sediment from the work area from being transported into the larger water feature. These barriers can be composed of a variety of materials but are often constructed with pea gravel filled bags and a waterproof sheet membrane.

## Potential permitting requirements

- A License to Collect Fish for Scientific Purposes and/or Wildlife Scientific Collector's Authorization are required from the MNRF in order to carry out any collection and relocation of fish or wildlife stranded in the isolated area to the waterbody prior to dewatering, every time the isolation barrier is breached and/or when aquatic species are visible.
- The proposed works should be reviewed with the local CA and applicable permitting agencies, which may include DFO, MNRF and MECP (for species at risk sites or if water movement activities involved trigger permit to take water requirements).

## Planning

- Plan works to occur outside of the restricted activity fish timing windows (Table C1).
- Phase works to ensure that disturbed areas can be stabilized at end of day.
- Stabilize or cover disturbed areas if left exposed and inactive longer than 3 days, and in anticipation of precipitation or snow melt events.
- Use hydraulic modeling to determine the height at which the WIB should be constructed. Refer to Appendix A for the specified flood risk calculation, which can be used to determine the design storm for sizing of WIBs, based on consideration of service life (i.e. how long the WIB will be in place) and the acceptable level of risk, which should be no greater than 5%. **As a minimum, WIBs should be sized to hold back flows from the 2 year event with some freeboard, unless otherwise approved by the relevant regulatory agency.**
- Have the impact to the local channel section assessed by a qualified person if more than one third of a watercourse is to be isolated during the planned work.
- Include a contingency or emergency response plan documenting which flows will overtop the WIB and outline the steps to take in the event that high flows breach the barrier.
- Keep spill kits and a spill response plan on-site in the event deleterious substances enter the water body.

## Design

- Refer to ESC design detail for "Meter bag waterproof isolation barrier" in Figure C6 and "Site isolation layout" in Figure C7, which shows the set up for use of a WIB for partial stream isolation to facilitate work in the dry.
- Use meter bags made of durable material and capable of being moved at least twice for the installation and removal.

- Using sand to fill bags that are part of a WIB should be avoided, as sand, if released, will fill small voids in the substrate of the water feature and thereby compromise invertebrate habitat. Pea-gravel fill is recommended.
- Key in a waterproof membrane that overtops the isolation barrier to minimize leaks where a water-tight seal is difficult to achieve.
- Design the barrier using a double lined wall with a layer of impermeable liner secured in-between (refer to Figure C6).
- For construction during winter, consider substituting plastic bags for a more durable material, as the plastic is more likely to tear when frozen.

**Figure C5:** Waterproof isolation barrier (cofferdam)

## Installation

- Use the dewatering techniques as described in Section 6.4 and Appendix B2 (see Figures B2-16 and B2-17 for dewatering treatment train) when pumping water out to establish and maintain a dry work area.
- Fill bags to varying capacities depending on site conditions and where they will be placed.

- Ensure that bags are not overfilled to allow for some malleability during barrier construction, and also to prevent the fill from falling out of the bag into the feature.
- Avoid excessive amounts of relocation as it increases the risk of the bag tearing.
- Ensure that the bottom of the barrier is in complete and continuous contact with the bed of the water feature.
- Use different sizes of bags in areas where there are irregularities in the water bottom, where the barrier needs to tie into native bank, and where voids within the barrier need to be filled. For example, gaps between meter bags may need to be filled with smaller pea gravel bags.
- Construct the WIB from the top of bank, where possible, and in sequence from upstream to downstream.

## Inspection and maintenance

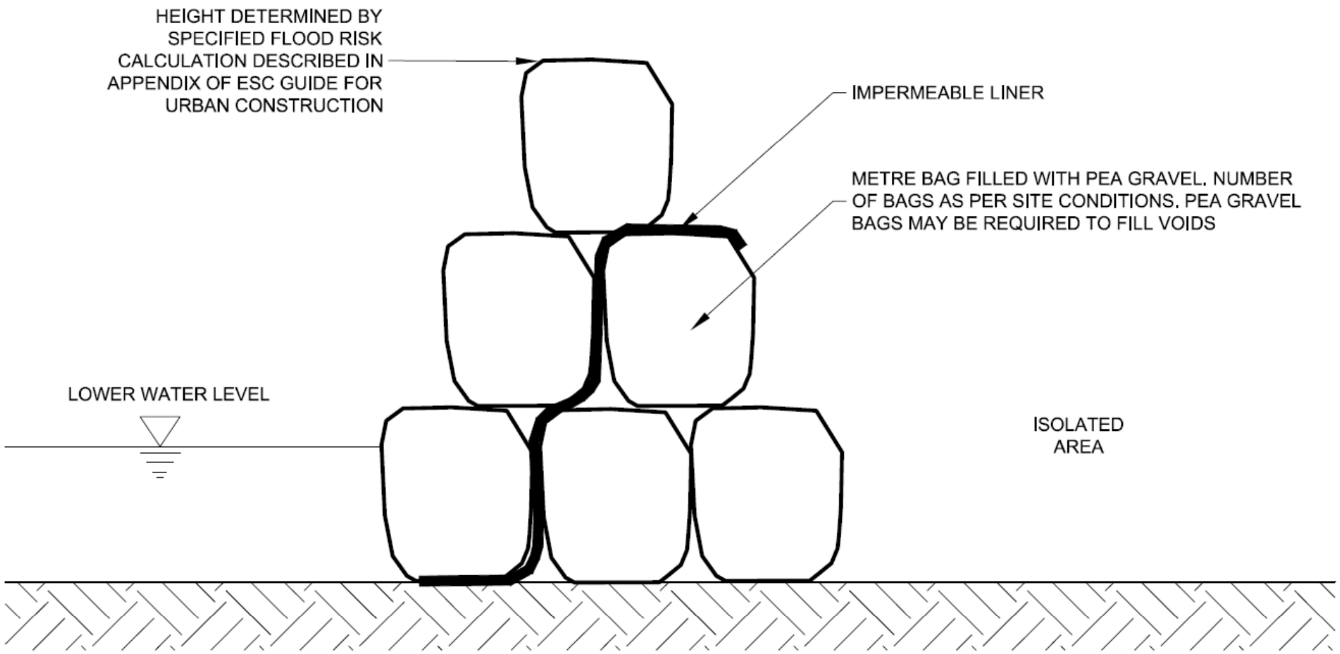
- Conduct an inspection of the WIB at the start of each day and document the findings.
- Repair leaks, holes, torn areas, etc. within 48 hours or sooner if environmental receptors are at imminent and foreseeable risk of adverse impact.
- Monitor the forecast as storm events, floating debris, ice, etc. can displace the isolation barrier or parts thereof.
- When possible, keep a surplus of materials (meter bags, pea gravel, etc.) on-site so that repairs and maintenance can be performed quickly.
- Dewater the site when barrier is breached and ensure the dewatering system is inspected and maintained in good working condition regularly.
- Avoid placing / storing fuel or other potential aquatic contaminants in the floodplain.

## Decommissioning

- Remove all excess material, accumulated sediment and debris from the dry, isolated work area before removing the isolation barrier.
- Follow sequencing shown on the construction drawings for the decommissioning of the isolation barrier and in an upstream to downstream direction.
- Remove the isolation barrier carefully to minimize disturbance to the channel.
- Restore all disturbed areas using native plant species.

***Consider sustainability and reuse***

**Meter bags filled with pea gravel can be transported to different work locations if they are in good condition.**

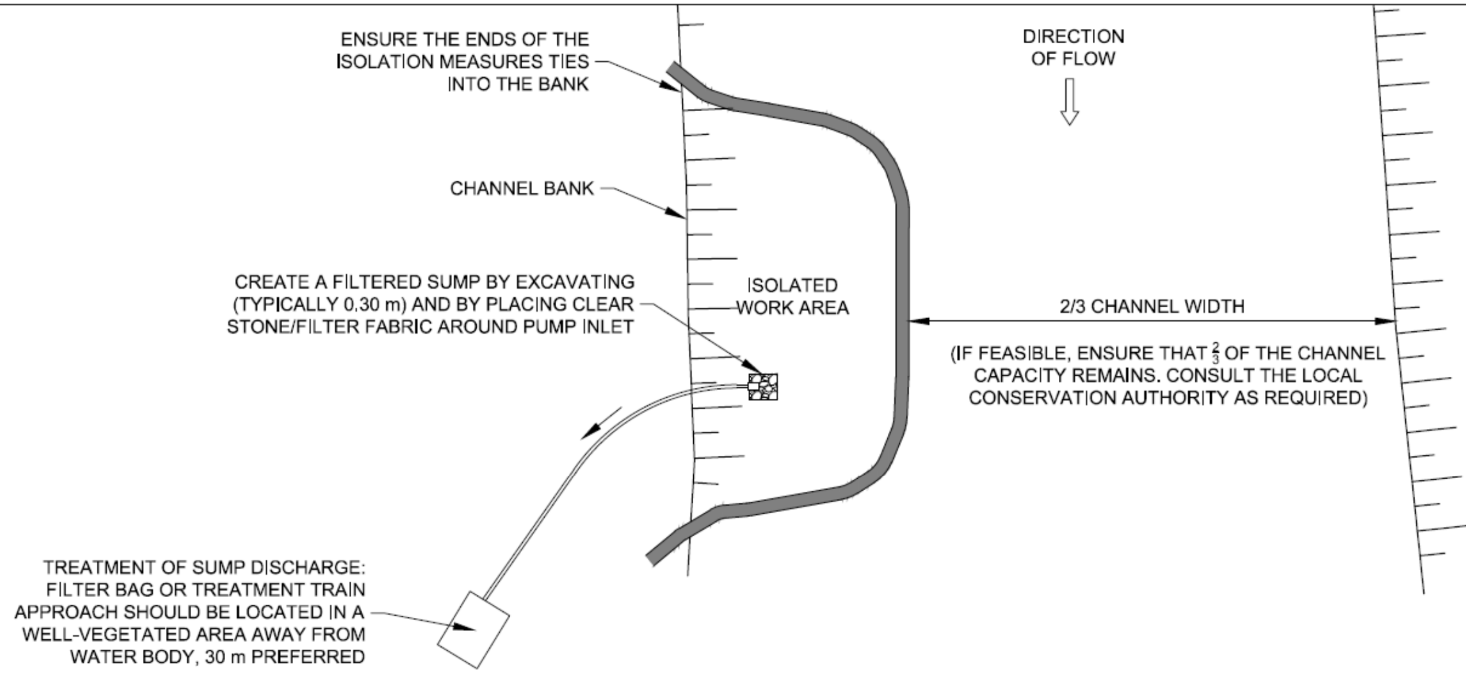



NOTE:
THIS DETAIL REPRESENTS AN IDEAL SCENARIO. SITE CONDITIONS VARY AND EROSION AND SEDIMENT CONTROL MEASURES SHOULD BE TAILORED FOR EACH SITE AND PROJECT

| Toronto and Region Conservation Authority | TRCA ESC DESIGN DETAIL | SCALE N.T.S. | REV 1 | DATE MARCH 2019 |
|---|---|---|---|---|
| | DRAWING TITLE METRE BAG WATERPROOF ISOLATION BARRIER | | | DWG NO 07 |



**Figure C6:** Design detail for waterproof isolation barrier constructed using metre bags




NOTES:

1. DETAILS FOR WATERPROOF ISOLATION BARRIER (WIB) SHOULD BE PROVIDED SEPARATELY
2. THE WIB SHOULD BE SIZED USING THE FLOOD RISK CALCULATION
3. EXCAVATION SHOULD NOT BE REQUIRED FOR THE INSTALLATION OF THE WIB
4. ENSURE THAT THE DOWNSTREAM AND UPSTREAM ENDS OF THE WIB CREATE A CONTINUOUS BARRIER WITH THE EROSION AND SEDIMENT CONTROL MEASURES ON THE TABLELAND
5. WIB SHOULD ONLY BE REMOVED ONCE THE ISOLATED AREA HAS STABILIZED
6. ALL PUMP INTAKES SHOULD BE FITTED WITH A FISH SCREEN IF THERE IS THE POTENTIAL FOR FISH OR OTHER AQUATIC WILDLIFE ENTRAPMENT

NOTE:
THIS DETAIL REPRESENTS AN IDEAL SCENARIO. SITE CONDITIONS VARY AND EROSION AND SEDIMENT CONTROL MEASURES SHOULD BE TAILORED FOR EACH SITE AND PROJECT

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| Toronto and Region Conservation Authority | TRCA ESC DESIGN DETAIL | SCALE N.T.S. | REV 1 | DATE MARCH 2019 |
| | DRAWING TITLE SITE ISOLATION LAYOUT | | | DWG NO 09 |



**Figure C7:** Design detail for partial watercourse isolation using a waterproof isolation barrier (coffer dam)

# TEMPORARY WATERCOURSE DIVERSION – BYPASS CHANNEL

A bypass channel is a secondary channel alongside the work area to passively divert flows around it and allow for work within the existing channel to proceed in dry conditions. All methods of temporary diversion help maintain water quality by containing released sediment to the dry, isolated work area.

## Potential permitting requirements

- A License to Collect Fish for Scientific Purposes and/or Wildlife Scientific Collector's Authorization are required from the MNRF in order to carry out any collection and relocation of fish or wildlife as part of in water works.
- The proposed works should be reviewed with the local CA and applicable permitting agencies, which may include DFO, MNRF and MECP (for species at risk sites or if water movement activities involved trigger Permit to Take Water requirements).

## Planning

- Plan works to occur outside of the restricted activity fish timing windows (Table C1).
- Chose the temporary watercourse diversion that will have the least amount of disturbance to the waterbody and the surrounding area.
- Sequence the work to minimize the length of channel that will be bypassed.
- Use hydraulic modeling to determine the size and shape of the bypass channel. Refer to Appendix A for the specified flood risk calculation, which can be used to determine the design storm for sizing of WIBs and bypass channels, based on consideration of service life and the acceptable level of risk, which should be no greater than 5%. **A temporary bypass channel should, as a minimum, be sized to convey the 2 year event, unless otherwise approved by the relevant regulatory agency.**
- Include a contingency plan on the drawings documenting which flows will overtop the system, the steps to take in the event of a breach and a plan to remove the equipment and other material from the floodplain.
- Keep spill kits and a spill response plan on-site in the event deleterious substances enter the water body.

## Design

- Ensure watercourse diversion allows for fish passage.
- Store the material removed for the construction of the bypass channel 30 metres away from the water body where possible and contain the stockpile with sediment control measures.
- Tie the downstream end of the bypass channel into the existing channel beyond the work area.
- Protect the bypass channel from erosion prior to receiving flows using erosion netting/blankets/matting/geotextile fabric with an anchoring system, suitably sized riprap, or established vegetation.
- Ensure that there is no increase in the velocity of the flows in the bypass channel.

## Installation

- Install the temporary bypass channel before starting other construction work.
- Sequence the construction of the bypass channel in a downstream to upstream manner while maintaining berms at both ends until ready to receive diverted flows.
- Install waterproof isolation barriers, if required, at the upstream and downstream ends of the work area to prevent water from entering the work area.

## Inspection and maintenance

- Inspect the bypass channel weekly, after every rainfall and significant snowmelt event and keep a record of the inspection.
- Repair localized slope failures and erosion concerns within 48 hours of being identified or sooner if environmental receptors are at imminent and foreseeable risk of adverse impact.

## Decommissioning

- Stabilize the new channel prior to the return of flows so as to minimize sediment released.
- Ensure any stranded fish or wildlife are collected and relocated in accordance with licenses / permits.
- Follow sequencing shown on the construction drawings.
- Restore all disturbed areas using native plant species.

# TEMPORARY WATERCOURSE DIVERSION – FLUME BYPASS

A flume bypass is a passive type of watercourse diversion that concentrates watercourse flows to a point where they enter a pipe or chute for conveyance, by gravity, around or through the work area. All methods of temporary diversion help maintain water quality by containing released sediment to the isolated, dry work area.

## Potential permitting requirements

- A License to Collect Fish for Scientific Purposes and/or Wildlife Scientific Collector's Authorization are required from the MNRF in order to carry out any collection and relocation of fish or wildlife as part of in water works.
- The proposed works should be reviewed with the local CA and applicable permitting agencies, which may include DFO, MNRF and MECP (for species at risk sites or if water movement activities involved trigger Permit to Take Water requirements).

## Planning

- Plan works to occur outside of the restricted activity fish timing windows (Table C1).
- Choose the temporary watercourse diversion that will have the least amount of disturbance to the waterbody and the surrounding area.
- Sequence the work to minimize the length of channel that will be bypassed.
- Use hydraulic modeling to determine the size and shape of the flume bypass. Refer to Appendix A for the specified flood risk calculation, which can be used to determine the design storm for sizing of WIBs and flumes, based on consideration of service life and the acceptable level of risk, which should be no greater than 5%. **A temporary flume bypass should, as a minimum, be sized to convey the 2 year event, unless otherwise approved by the relevant regulatory agency.**
- Include a contingency plan on the drawings documenting which flows will overtop the system, the steps to take in the event of a breach and a plan to remove the equipment and other material from the floodplain.
- Keep spill kits and spill response plan onsite in the event deleterious substances enter the water body.

## Design

- See example of site set up in Figure C8 and "Flume Bypass" design detail in Figure C9.
- Ensure flume allows for fish passage.
- Install WIB at the inlet and outlet of the flume to prevent the entry of water into the work area.
- Install the outlet of the flume such that it facilitates the gradual and safe re-entry of fish into the watercourse or, alternatively, install a ministry-approved fish screen at the inlet so as to prevent fish from entering the flume.

**Splash pads *dissipate energy* and *reduce erosion potential* at discharge locations.**

**They can be as simple as a patio stone, just don't forget to remove during decommissioning!**

- Attempt to minimize erosion and turbidity at the outlet by installing a splash pad.
- Ensure that the designer / engineer documents any deviation from the approved design and keeps the documented changes on site.


**Figure C8:** Application of a flume bypass to divert stream flows around a dry work area

## Installation

- Secure the pipe at intervals based on its length and size.
- Install the WIB starting from the banks working inwards towards the center of the channel.
- Ensure a tight seal where the pipe and the WIB meet.

## Inspection and maintenance

- Inspect the flume system weekly after every rainfall and significant snowmelt event and keep a record of the inspection.
- Immediately remove any debris collected at the upstream end of the system.
- Repair concerns, any displacements or failures within 48 hours of being identified, or sooner if environmental receptors are at imminent and foreseeable risk of adverse impact.

## Decommissioning

- Stabilize the new channel prior to the return of flows so as to minimize sediment released.
- Follow sequencing shown on the construction drawings.
- Restore all disturbed areas using native plant species.

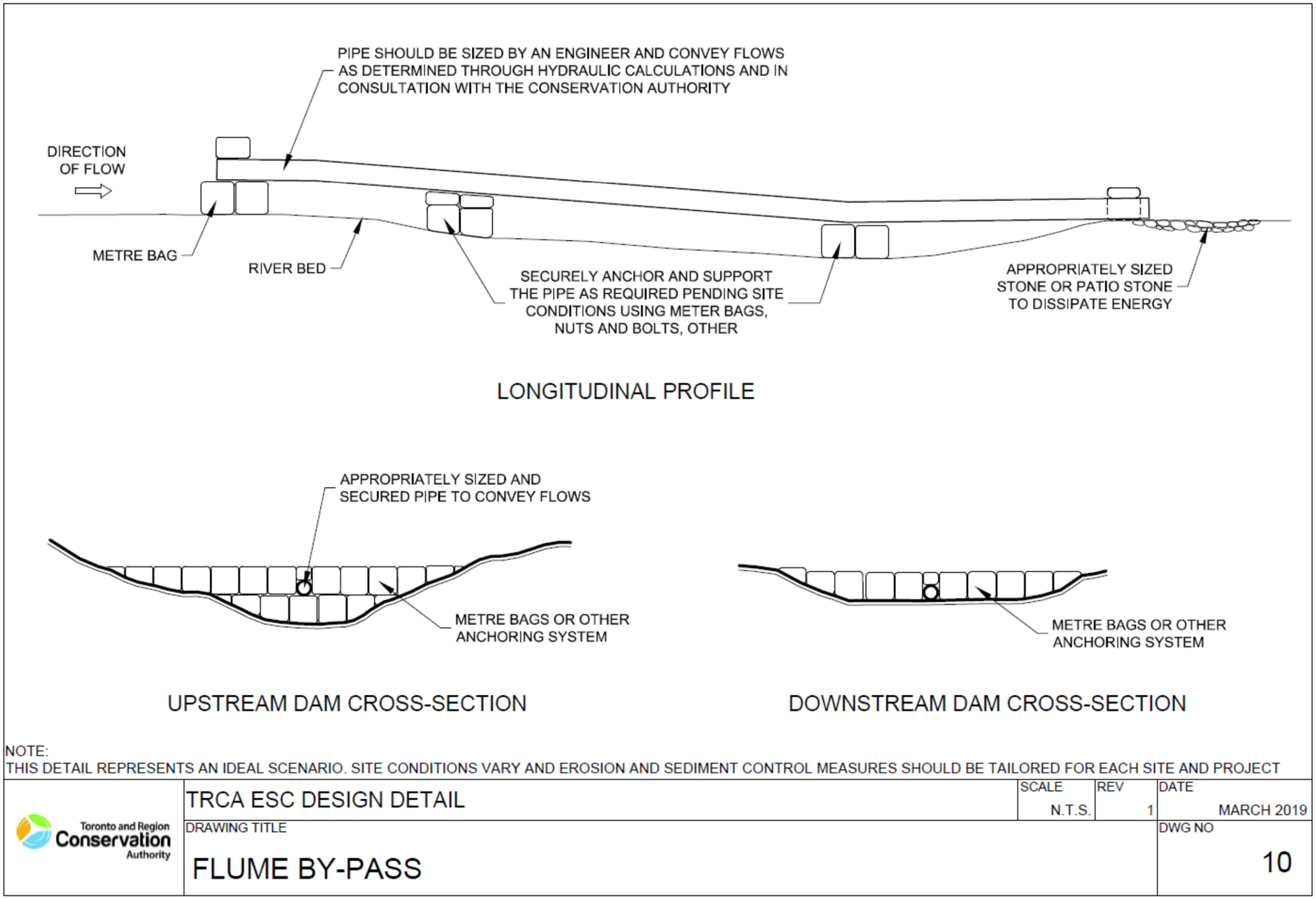


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**Figure C9:** Design detail for application of a flume bypass to divert watercourse flows around a dry work area

# TEMPORARY WATERCOURSE DIVERSION – BYPASS PUMPING

Bypass pumping is a type of temporary watercourse diversion that uses an electrical or fuel-powered generator to pump flows around the work area in order to create dry work area. All methods of temporary diversion help maintain water quality by containing sediment in the dry, isolated work area. Bypass pumping does not allow for fish passage and is most appropriate for short duration construction projects.

## Potential permitting requirements

- Because this method does not allow for fish passage, fish collection and relocation activities are often necessary.
- A License to Collect Fish for Scientific Purposes and/or Wildlife Scientific Collector's Authorization are required from the MNRF in order to carry out any collection and relocation of fish or wildlife as part of in water works.
- The proposed works should be reviewed with the local CA and applicable permitting agencies, which may include DFO, MNRF and MECP (for species at risk sites or if water movement activities involved trigger Permit to Take Water requirements).

## Planning

- Plan works to occur outside of the restricted activity fish timing windows (Table C1).
- Choose the temporary watercourse diversion that will have the least amount of disturbance to the waterbody and the surrounding area. Because bypass pumping does not allow for fish passage, it may not be appropriate in sensitive streams and should only be applied for short duration projects.
- Sequence the work to minimize the length of channel that will be bypassed.
- Use hydraulic modeling to determine the pump size and other system requirements. Refer to Appendix A for the specified flood risk calculation, which can be used to determine the design storm for sizing WIBs and determining capacity of pumps used during bypass pumping. The specified flood risk calculation is based on consideration of service life and the acceptable level of risk, which should be no greater than 5% for in water BMPs. **A temporary bypass pump system should, as a minimum, be sized to accommodate the 2 year event, unless otherwise approved by the relevant regulatory agency**.
- Include a contingency plan on the drawings documenting which flows will overtop the system, the steps to take in event of a breach and a plan to remove equipment and other material from the floodplain.
- Keep spill kits and a spill response plan on-site in the event deleterious substances enter the water body.

## Design

- Refer to Figures C10 and C11 for examples of bypass pumping applications, and Figure C12 for a design detail for bypass pumping.
- The design should attempt to minimize erosion and turbidity at the outlet by installing a type of splash pad or by turning the discharging water upwards.

- In a fish-bearing stream, the pump intake must have a fish screen installed, operated, and maintained. Guidance on fish screens is available in Fisheries and Oceans Canada's *Freshwater Intake End-of-Pipe Fish Screen Guideline* (1995).
- Ensure that the designer / engineer documents any deviation from the approved design and keeps the documented changes on site.

## Inspection and maintenance

- Back-up pumps may need to be on-site in the event of a pump failure.
- Pumps should be monitored regularly when they are running. If pumps are running continuously, a technician should be assigned to monitor the pumps – remotely or on site – after normal working hours.
- Any deficiencies should be rectified within 48 hours or sooner if environmental receptors are at imminent and foreseeable risk of adverse impact.

## Decommissioning

- Ensure sediment removal and stabilization of work area is complete before the return of flows so as to minimize sediment released downstream.
- Follow sequencing shown on the construction drawings.
- Restore all disturbed areas using native plant species.

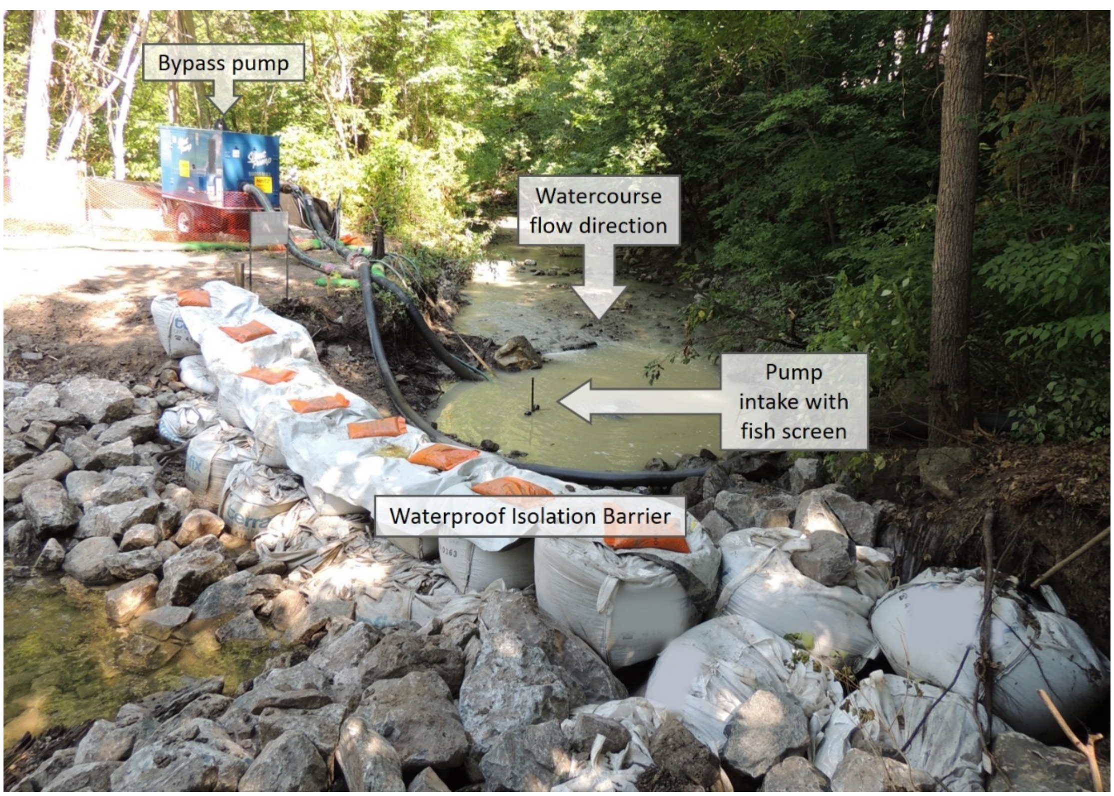
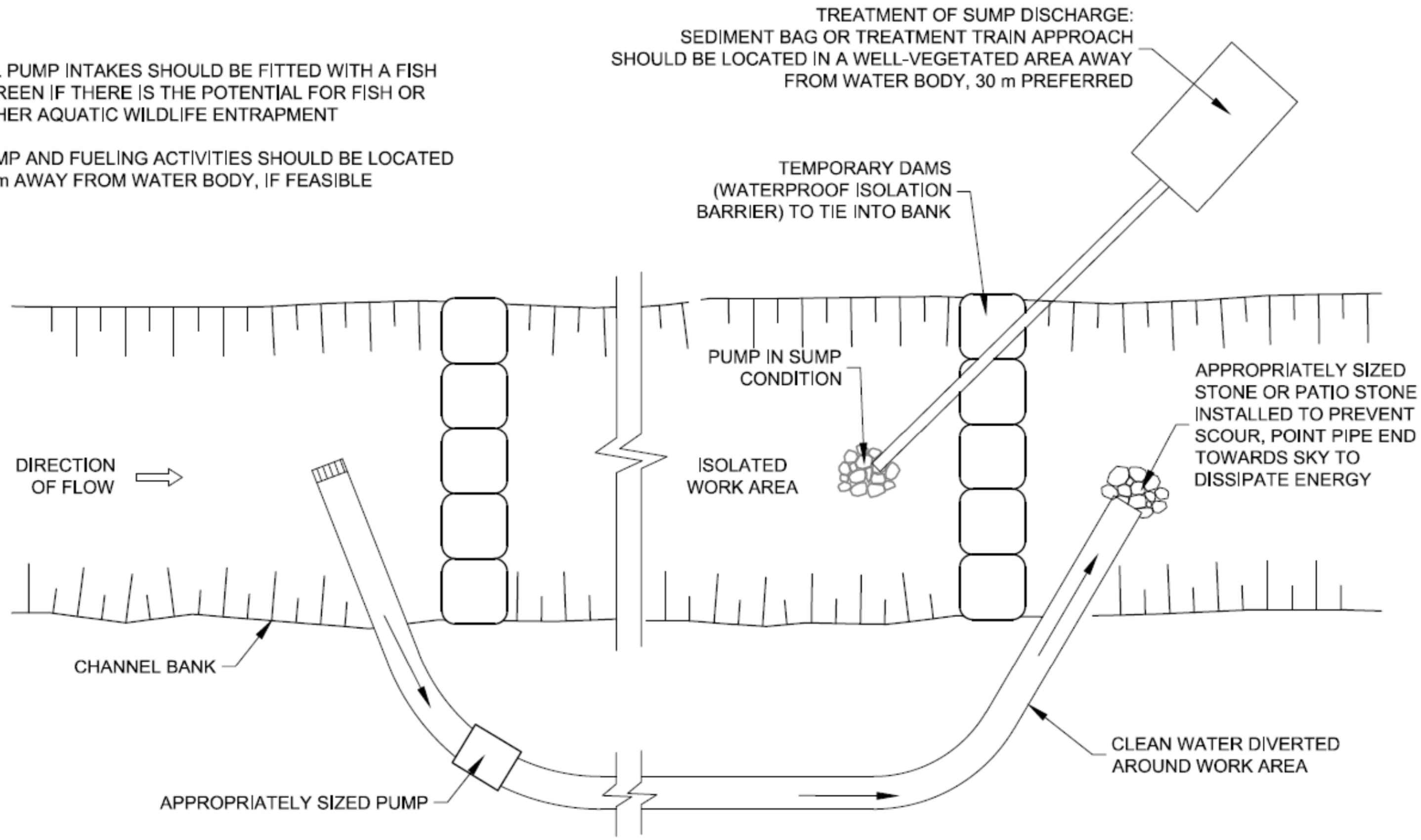



**Figure C10:** Bypass pumping to divert stream flows around an isolated work area


**Figure C11:** Energy dissipation at pump discharge location during bypass pumping

NOTES:

1. ALL PUMP INTAKES SHOULD BE FITTED WITH A FISH SCREEN IF THERE IS THE POTENTIAL FOR FISH OR OTHER AQUATIC WILDLIFE ENTRAPMENT
2. PUMP AND FUELING ACTIVITIES SHOULD BE LOCATED 30 m AWAY FROM WATER BODY, IF FEASIBLE




NOTE:
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|---|---|---|---|---|
| | DRAWING TITLE BY-PASS PUMPING | | | DWG NO 08 |



**Figure C12:** Design detail for watercourse diversion using bypass pumping and dewatering to maintain a dry isolated work area

# SHEET PILE ISOLATION WALL

Steel sheet piles can be driven into the ground at the perimeter of an in-water work area to isolate it from the water body. Often times, sheet pile walls are used when major excavation is required such as for the construction of bridge abutments, piers and open cut installation. They are also installed when they will remain part of the structure and in smaller water bodies when the impacts of the installation and removal are predictable and there will be minimal disturbance.

## Potential permitting requirements

- A License to Collect Fish for Scientific Purposes and/or Wildlife Scientific Collector's Authorization are required from the MNRF in order to carry out any collection and relocation of fish or wildlife as part of in water works.
- The proposed works should be reviewed with the local CA and applicable permitting agencies, which may include DFO, MNRF and MECP (for species at risk sites or if water movement activities involved trigger Permit to Take Water requirements).

## Planning

- Plan works to occur outside of the restricted activity fish timing windows (Table C1).
- Use hydraulic modeling to determine the height of the wall. Refer to Appendix A for the specified flood risk calculation, which can be used to determine the design storm for sizing the wall, based on consideration of service life and the acceptable level of risk, which should be no greater than 5%. **A sheet pile isolation wall should, as a minimum, be sized to hold back flows from the 2 year event with some freeboard, unless otherwise approved by the relevant regulatory agency.**
- Include a contingency plan on the drawings documenting which flows will overtop the wall, the steps to take in the event of a breach and a plan to remove the equipment and other material from the floodplain.
- Anticipate a large staging area to stage the sheet piles, the wall components and the heavy machinery used to install it.
- Undertake a geotechnical investigation, if necessary, of the subsurface soil conditions and groundwater level elevations.
- Keep spill kits and spill response plan on-site in the event deleterious substances enter the water body.

## Design

- See application of a sheet pile isolation wall in Figure C13.
- Consider using a brace on the inside depending on the height of the wall above grade and how deep the sheets will extend into the ground.

## Installation considerations

- Ensure that the sheets are installed perpendicular to the ground.
- Use sheets that are in good condition.

**Figure C13:** Sheet pile isolation wall

- Confirm that the use of a vibratory hammer attachment is permitted as adjacent utilities or geotechnical constraints may prevent its use.
- Avoid pulling up or re-driving the sheets as this may compromise their shape.
- Ensure that the designer / engineer documents any deviation from the approved design and keeps the documented changes on site.
- Work from the top of bank and install in an upstream to downstream manner.

## Inspection and maintenance

- Anticipate leaks if there were difficulties fitting sheets together.
- Inspect the sheet pile wall weekly, after every rainfall, significant snowmelt and during ice-out and keep a record of the inspection.
- Repair failures or breaches of the wall within 48 hours of being identified, or sooner if environmental receptors are at imminent and foreseeable risk of adverse impact.
- Keep additional erosion and sediment control measures on site.

***Consider sustainability***

Sheet piles can typically be reused on other projects, resulting in a significant reduction in waste generated on your project.

## Decommissioning

- Remove the sheet piles in a downstream to upstream manner.
- Restore all disturbed areas using native plant species.

# WATER-FILLED BLADDERS

**(a.k.a. water-filled cofferdams, inflatable bladder dams)**

Water-filled bladders are temporary barriers filled with available, on-site water that are placed within a water body to create a dry, isolated work area. They are best suited for use where flow velocities are low and water levels are not subject to large fluctuations.

## Potential permitting requirements

- A License to Collect Fish for Scientific Purposes and/or Wildlife Scientific Collector's Authorization are required from the MNRF in order to carry out any collection and relocation of fish or wildlife as part of in water works.
- The proposed works should be reviewed with the local CA and applicable permitting agencies, which may include DFO, MNRF and MECP (for species at risk sites or if water movement activities involved trigger Permit to Take Water requirements).

## Planning

- Plan works to occur outside of the restricted activity fish timing windows (Table C1).
- Use hydraulic modeling and manufacturer's recommendations to determine the size of the bladder. Refer to Appendix A for the specified flood risk calculation, which can be used to determine the design storm for sizing of water-filled bladders, based on consideration of service life and the acceptable level of risk, which should be no greater than 5%. **A water-filled bladder should, as a minimum, be sized to hold back flows from the 2 year event with some freeboard, unless otherwise approved by the relevant regulatory agency.**
- Use where flow velocities are low and water level fluctuations are predictable and insignificant.
- Provide a contingency plan on the drawings documenting which flows will overtop the barrier and outline the steps to take in the event of a breach including a plan to remove the equipment and other material from the floodplain.
- Keep spill kits and a spill response plan on-site in the event deleterious substances enter the water body.

## Design

- See application of a water filled bladder shown in Figure C14.
- Adhere to design guidance provided by the product supplier.

## Installation

- Install according to the manufacturer's recommendations.
- Ensure water bottom is level, free of debris or other material that may cause punctures or displacements prior to positioning.
- Fill any gaps with pea gravel bags to ensure a complete waterproof seal.

- Ensure that only one end of the bladder is anchored to the bank or shoreline at a higher elevation than the top of the bladder so that it doesn't obstruct flows during a high-flow event.
- Ensure there's room for water to expand if bladders are used during freezing conditions.


**Figure C14:** Work area isolation using water-filled bladders

## Inspection and maintenance

- Inspect the effectiveness of the bladder prior to the commencement of works and thereafter weekly, after every rainfall and significant snowmelt event and keep a record of the inspection.
- Repair any displacements or failures within 48 hours of being identified, or sooner if environmental receptors are at imminent and foreseeable risk of adverse impact.
- Keep additional erosion and sediment control measures on site.
- Immediately remove any debris that has collected in front of the bladder.

## Decommissioning

- Avoid releasing the water directly into the watercourse so as to avoid altering the temperature of the water body. Gradual release to an adjacent vegetated area is recommended in order to mitigate thermal impacts.
- Restore all disturbed areas using native plant species.

# PORTABLE DAM SYSTEM

A portable dam system is comprised of a reinforced, impermeable liner anchored over top of a series of steel A-frames that are placed in the watercourse at pre-determined intervals. Through hydrostatic pressure, the system is held in place and a dry, isolated work area can then be created.

## Potential permitting requirements

- A License to Collect Fish for Scientific Purposes and/or Wildlife Scientific Collector's Authorization are required from the MNRF in order to carry out any collection and relocation of fish or wildlife as part of in water works.
- The proposed works should be reviewed with the local CA and applicable permitting agencies, which may include DFO, MNRF and MECP (for species at risk sites or if water movement activities involved trigger Permit to Take Water requirements).

## Planning

- Plan works to occur outside of the restricted activity fish timing windows (Table C1).
- Use hydraulic modeling and manufacturer's recommendations to determine the height of the portable dam system. Refer to Appendix A for the specified flood risk calculation, which can be used to determine the design storm for sizing of portable dams, based on consideration of service life and the acceptable level of risk, which should be no greater than 5%. **A portable dam system should, as a minimum, be sized to hold back flows from the 2 year event with some freeboard, unless otherwise approved by the relevant regulatory agency.**
- Provide a contingency plan on the drawings documenting which flows will overtop the structure and outline the steps to take in the event that high flows breach the barrier including a plan to remove equipment and other material from the floodplain.
- Keep spill kits and a spill response plan on-site in the event deleterious substances enter the water body.

## Design

- See application of a portable dam shown in Figure C15.
- Adhere to design guidance provided by the product supplier.

## Installation

- Install according to the manufacturer's recommendations.
- Ensure water bottom is mostly level and free of debris or other objects that may cause displacements. Generally the portable dam system is flexible enough to seal over irregular surfaces.

## Inspection and maintenance

- Inspect the effectiveness of the portable dam system prior to the commencement of works and thereafter weekly, after every rainfall and significant snowmelt event and keep a record of the inspection.

- Repair any displacements or failures within 48 hours of being identified, or sooner if environmental receptors are at imminent and foreseeable risk of adverse impact.
- Keep additional erosion and sediment control measures on site.

### Decommissioning

- Decommission according to the manufacturer's recommendations.
- Restore all disturbed areas using native plant species.

**Figure C15:** Work area isolation with a portable dam system

# APPENDIX D:

# SUMMARY OF LEGISLATION RELEVANT TO EROSION AND SEDIMENT CONTROL

# APPENDIX D: SUMMARY OF LEGISLATION RELEVANT TO ESC

The following subsections describe the primary federal, provincial and municipal legislation relevant to ESC during urban construction projects and how they regulate, or otherwise impact, sediment management activities. The list provided herein is not exhaustive, and additional legislation may apply to specific geographic areas or the regulation of certain activities occurring over the course of a construction project (e.g. fish collection during in-water projects).

## Federal

### *Fisheries Act (R.S.C 1985)*

The Fisheries Act is administered by the Federal Department of Fisheries and Oceans and has broad applicability to various activities that can impact fisheries and fisheries waters that (i) provide fish habitat or (ii) support fish habitat opportunities at any life stage. Canadian fisheries waters include "all waters in the fishing zones of Canada, all waters in the territorial sea of Canada and all internal waters of Canada." The Act was subject to significant changes in 2019, which resulted in the re-instatement of previously removed protections for all fish and fish habitat. The amended act also restored the prohibition of any harmful alteration, disruption or destruction of fish habitat (HADD), which had been removed in the last amendment to the Fisheries Act in 2013.

The Act requires that fish and fish habitat are protected during construction. With respect to construction activities and sediment management, some of the key sections of the Act are summarized below.

- **Section 34.4(1):** This section states that no person shall carry on any work, undertaking or activity, other than fishing, that results in the death of fish

- **Section 35(1):** This section states that no person shall carry on any work, undertaking or activity that results in the harmful alteration, disruption or destruction of fish habitat

The Act lists several exceptions to the prohibitions in sections 34(1) and 35(1), for example, section 35(2)(b) which allows the harmful activity to occur if it has been authorized by the Minister.

- **Section 36(3):** This section states: "No person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance that results from the deposit of the deleterious substance may enter any such water." Deleterious substance is defined as follows:

    a) "any substance that, if added to any water, would degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water, or

    b) any water that contains a substance in such quantity or concentration, or that has been so treated, processed or changed, by heat or other means, from a natural state that it would, if added to any other water, degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water"

Construction site runoff could fall in line with this definition of deleterious substance if the concentrations of sediment and other adsorbed compounds (e.g. heavy metals, nutrients) were high enough to cause detriment to fish or fish habitat.

- **Sections 38(4) and 38(5).** These sections describe duties to notify the appropriate authority of any serious harm to fish – a violation of Section 35(1) – and any deposit of a deleterious substance – a violation of Section 36(3). The duty to notify applies to a person who owns, manages or has control of the work or a person who caused or contributed to the harm.

- **Section 38(6).** This section requires any person responsible for the harm in Section 38(4) or the deposit of deleterious material in Section 38(5) to take all reasonable measures to prevent the occurrence or to counteract, mitigate or remedy adverse effects resulting from the occurrence.

- **Section 78(6)**. This section describes the due diligence defence, stating "no person shall be convicted of an offence under this Act if the person establishes that the person (a) exercised all due diligence to prevent the commission of the offence; or (b) reasonably and honestly believed in the existence of facts that, if true, would render the person's conduct innocent. The concept of due diligence and a discussion of how it can be exercised is provided in Chapter 5.0 of the Guide.

Common construction activities that have the potential to result in violations of Sections 35(1) and 36(3) of the Act include:

- Realignment or intrusion into a stream channel;
- Restrictions to fluvial processes;
- Impacts to riparian corridors;
- Infilling of habitats, wetlands and coastal marshes;
- Channelizing and piping headwater inputs;
- Discharges of deleterious substances from construction sites, and
- Dewatering operations

For construction projects involving in or near water works, determining whether a Fisheries and Oceans Canada review and/or authorization is required must be done through an online self-screening process. This is discussed in Chapter 10.0.

### *Species At Risk Act (S.C. 2002)*

Canada's Species At Risk Act (SARA) was created to "prevent wildlife species from being extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity, and to manage species of special concern to prevent them from becoming endangered or threatened." Environment and Climate Change Canada is responsible for the overall administration of SARA, however the Act gives Fisheries and Oceans Canada responsibility for the protection of aquatic species and habitat at risk.

The provisions in the Act that protect endangered, threatened or extirpated species apply automatically on federal lands and waters. On provincial, territorial or privately owned land, SARA applies only to the aquatic species and migratory birds (if also included in the Migratory Birds Convention Act) that are listed in Schedule 1 as endangered, threatened or extirpated. The Act does allow for other Schedule 1 species to be protected on non-federal lands in cases where there is no provincial or territorial legislation in place that protects them, but it would require that an order be issued, which would require a public consultation process.

In addition to the protection of the individual species, SARA also contains provisions that protect their habitat. These provisions would apply to construction activities, and in water works in particular, occurring on sites that are known habitat for species at risk. The applicable provisions that protect habitat are:

- **Section 33.** No person shall damage or destroy the residence of one or more individuals of a wildlife species that is listed as an endangered species or a threatened species, or that is listed as an extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada.
- **Section 58(1).** No person shall destroy any part of the critical habitat of any listed endangered species or of any listed threatened species — or of any listed extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada — if:

  a) the critical habitat is on federal land, in the exclusive economic zone of Canada or on the continental shelf of Canada;
  b) the listed species is an aquatic species; or
  c) the listed species is a species of migratory birds protected by the Migratory Birds Convention Act, 1994.

In the Act, critical habitat is defined as: “the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species’ critical habitat in the recovery strategy or in an action plan for the species.”

Fisheries and Oceans Canada has online mapping available that identifies aquatic species at risk habitat, and which can be used to determine whether a development site would be subject to SARA prohibitions. Where a development project requires the undertaking of activities prohibited under Sections 33 and 58(1) of SARA, approval is required from Fisheries and Oceans Canada. Construction activities that are being carried out in or near water can be screened using Fisheries and Oceans Canada’s online screening process in order to establish whether permits and/or authorizations under SARA or the Fisheries Act are required. The self-screening process should be undertaken prior to application for a SARA permit.

### *Environmental Protection Act (S.C. 1999)*

Administered by Environment and Climate Change Canada and Health Canada, the Environmental Protection Act is defined as “an Act respecting pollution prevention and the protection of the environment and human health in order to contribute to sustainable development”. The Act also recognizes the importance of pollution prevention, and the management and control of toxic substances and hazardous waste, in reducing threats to Canada's ecosystems and biological diversity.

Section 64 of CEPA states:

“A substance is toxic if it is entering or may enter the environment in a quantity or concentration or under conditions that:

a) Have or may have an immediate or long-term harmful effect on the environment or its biological diversity;

b) Constitute or may constitute a danger to the environment on which life depends; or

c) Constitute or may constitute a danger to human life or health in Canada."

### *Navigation Protection Act (R.S.C. 1985)*

The Navigation Protection Act regulates any interferences with navigation in Canada's navigable waters. Administered by Transport Canada, the Act was previously known as the Navigable Waters Protection Act until amendments came into effect in April 2014. Navigable water is defined as:

"A canal and any other body of water created or altered as a result of the construction of any work means a body of water, including a canal or any other body of water created or altered as a result of the construction of any work, that is used or where there is a reasonable likelihood that it will be used by vessels, in full or in part, for any part of the year as a means of transport or travel for commercial or recreational purposes, or as a means of transport or travel for Indigenous peoples of Canada exercising rights recognized and affirmed by section 35 of the Constitution Act, 1982, and

(a) there is public access, by land or by water;

(b) there is no such public access but there are two or more riparian owners; or

(c) Her Majesty in right of Canada or a province is the only riparian owner."

They are waterways that are able to be navigated by the public as a highway. When considering whether a waterway is navigable water, the Ministry takes into consideration its specific characteristics (e.g. whether it can accommodate a vessel based on size and dimensions) and any evidence that the waterway is, has been, or will be used for navigation by the public.

In the Act, some provisions are specific to navigable waters listed in the schedule, including lakes, rivers, riverines and parts of oceans that are known to be the busiest in Canada with respect to navigation. Works carried out in the water bodies listed in the schedule, require the Minister's approval if, after screening, it is determined that they will substantially interfere with navigation. In the Act, 'work' is defined as "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."

Water bodies not listed in the schedule do not require approval under the NPA, nor do works classified as 'minor works'. Minor works, which are defined in the Minor Works Order, are referred to as 'designated works' in the NPA. These projects may proceed without approval, even in scheduled water bodies, provided that the work is carried out in accordance with the legal requirements in the Order.

Under the Act, any construction activities that would interfere with navigation within scheduled navigable waters, and which cannot be classified as 'minor works', would require a 'Notice to the Minister' (of Transportation). The Ministry screens these projects to determine whether they should be allowed to proceed, whether they will require an approval, and what terms and conditions should be tied to the approval. The key sections of the Act that are the most relevant to construction site sediment management are provided below. The Act is most applicable to in water construction works, since these activities can directly interfere with navigation.

**Section 3.** It is prohibited to construct, place, alter, repair, rebuild, remove or decommission a work in, on, over, under, through or across any navigable water that is listed in the schedule except in accordance with this Act or any other federal Act.

**Section 21.** No person shall throw or deposit or cause, suffer or permit to be thrown or deposited any sawdust, edgings, slabs, bark or like rubbish of any description whatever that is liable to interfere with navigation in any water, any part of which is navigable or that flows into any navigable water.

**Section 22.** No person shall throw or deposit or cause, suffer or permit to be thrown or deposited any stone, gravel, earth, cinders, ashes or other material or rubbish that is liable to sink to the bottom in any water, any part of which is navigable or flows into any navigable water, where there is not a minimum depth of 36 metres of water at all times, but nothing in this section shall be construed so as to permit the throwing or depositing of any substance in any part of a navigable water if it is prohibited by or under any other federal Act.

**Section 23.** No person shall dewater any navigable water.

For construction activities that may interfere with navigable water, online self-screening through Transport Canada should be undertaken in order to determine if the works are permitted or whether they will require the issuance of a Navigation Protection Program approval.

## Provincial

### *Water Resources Act (R.S.O. 1990)*

The Ontario Water Resources Act (OWRA), administered by the Ontario Ministry of the Environment, Conservation and Parks (MECP), is the province's most significant legislation that regulates water quality and quantity. Its purpose, as stated in the Act itself is "to provide for the conservation, protection and management of Ontario's waters and for their efficient and sustainable use, in order to promote Ontario's long-term environmental, social and economic well-being".

The Act prohibits the discharge of polluting material in Section 30(1), which states:

"Every person that discharges or causes or permits the discharge of any material of any kind into or in any waters or on any shore or bank thereof or into or in any place that may impair the quality of the water of any waters is guilty of an offence."

To determine what is meant by impairment of the water, it is necessary to refer to Section 1(3) of the Act, which explains the circumstances under which water will be deemed to be impaired. It states:

"For the purposes of this Act, the quality of water shall be deemed to be impaired by the discharge of material if the material or a derivative of the material enters or may enter the water, directly or indirectly, and,

> (a) the material or derivative causes or may cause injury to or interference with any living organism that lives in or comes into contact with, (i) the water, or (ii) soil or sediment that is in contact with the water;

(b) the material or derivative causes or may cause injury to or interference with any living organism as a result of it using or consuming, (i) the water, (ii) soil or sediment that is in contact with the water, or (iii) any organism that lives in or comes into contact with the water or soil or sediment that is in contact with the water;

(c) the material or derivative causes or may cause a degradation in the appearance, taste or odour of the water;

(d) a scientific test that is generally accepted as a test of aquatic toxicity indicates that the material or derivative, in diluted or undiluted form, is toxic;

(e) peer-reviewed scientific publications indicate that the material or derivative causes injury to or interference with organisms that are dependent on aquatic ecosystems; or

(f) the material or derivative has a prescribed characteristic or is a prescribed material."

This definition is directly applicable to construction projects, since sediment and associated contaminants discharged from the site can cause injury to, and interference with, aquatic organisms and also cause degradation in the appearance of the water. The Act also requires, in Section 30(2), that the Ministry be notified when material that may impair the quality of the water escapes or is discharged.

The OWRA (section 34) also governs water taking/movement, which is a common occurrence during constructions projects, particularly when groundwater dewatering is required. Chapter 9.0 provides additional information on permits for water taking under the OWRA and when they are required.

### *Lakes and Rivers Improvement Act (R.S.O. 1990)*

The Ontario Lakes and Rivers Improvement Act (LRIA) is administered by the Ontario Ministry of Natural Resources and Forestry. The Act regulates the management, protection, preservation and use of Ontario waters and the lands under them. It also provides for the management, perpetuation and use of the fish, wildlife and other natural resources dependent on lakes and rivers. One of its key focuses is the regulation of dams.

The LRIA requires an approval for the construction of a dam in any lakes and rivers in the province. As stated in Section 14(1), "No person shall construct a dam in any lake or river in circumstances set out in the regulations without the written approval of the Minister for the location of the dam and its plans and specifications."

This provision is highly relevant to in-water construction works which often require isolation of work areas through the damming and diversion of water in lakes and rivers. Because this approval requirement overlaps with the requirements for a Conservation Authority permit (see Chapter 10.0), the MNRF has determined that areas of the province that are within the jurisdiction of a CA do not have to apply for an LRIA section 14 approval. In areas of the province that are not CA jurisdiction, these kinds of projects would require Section 14 approval obtained directly form the MNRF.

The other LRIA provision that is relevant to construction activities is 36(1), which states: "No person shall throw, deposit, discharge or permit the throwing, depositing or discharging of any substance or matter in a lake or river, whether or not the lake or river is covered by ice, or on the shores or banks of a lake or river under circumstances that conflict with the purposes of this Act." Based on the stated purposes of the Act, which are primarily to protect and preserve lakes and rivers, the discharge of elevated concentrations of sediment and associated contaminants from construction sites could be considered a violation of this section of the LRIA.

### *Environmental Protection Act (R.S.O. 1990)*

The Ontario Environmental Protection Act (EPA), administered by the MECP, is one of the primary pieces of pollution control legislation in the province. It addresses various aspects of environmental protection, ranging from waste management to renewable energy. The EPA provisions that are most relevant to construction site sediment management are those that prohibit discharges of contaminants into the environment and those that address spills. The applicable provisions are:

**Section 14(1).** Subject to subsection (2) but despite any other provision of this Act or the regulations, a person shall not discharge a contaminant or cause or permit the discharge of a contaminant into the natural environment, if the discharge causes or may cause an adverse effect.

**Section 92(1).** Every person having control of a pollutant that is spilled and every person who spills or causes or permits a spill of a pollutant shall forthwith notify the following persons of the spill, of the circumstances thereof, and of the action that the person has taken or intends to take with respect thereto,

> (a) the Ministry;
>
> (b) any municipality within the boundaries of which the spill occurred or, if the spill occurred within the boundaries of a regional municipality, the regional municipality;
>
> (c) where the person is not the owner of the pollutant and knows or is able to ascertain readily the identity of the owner of the pollutant, the owner of the pollutant; and
>
> (d) where the person is not the person having control of the pollutant and knows or is able to ascertain readily the identity of the person having control of the pollutant, the person having control of the pollutant.

There are also several other provisions related to spills, including duties to have spills prevention plans – Section 91.1 – and to mitigate adverse effects arising from the spill and restore impacted areas - Section 93(1). Guidance on spills response and control plans is provided in Section 7.7.

### *Ontario Conservation Authorities Act (R.S.O 1990)*

The Conservation Authorities Act, administered by the MNRF, was first passed in 1946 at which time it authorized the creation of Conservation Authorities (CAs) throughout Ontario. Under the Act, individual regulations have been passed for each CA entitled “Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses” (Ontario Regulations 42/06 and 146/06 to182/06). The regulations are meant to control flooding and to prevent property damage, erosion, pollution and loss of life. They allow CAs to regulate development and other activities taking place within valley and stream corridors, wetlands and associated areas of interference, and the Lake Ontario waterfront. These areas are often referred to collectively as the ‘regulated area’. The regulations made under the Act prohibit, regulate and require permission 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.

- Development, if in the opinion of the authority, the control of flooding, erosion, dynamic beaches or pollution or the conservation of land may be affected by the development.

As such, construction activities that take place in an area regulated under the CA regulations require a permit, since these activities by their nature involve the movement and/or placement of fill and alteration of drainage patterns. These activities can have significant impacts on flooding risk, erosion, pollution and the conservation of land. Discharging stormwater into the regulated area may also require a CA permit even if the development itself is not being constructed in the regulated area, as these activities can increase risks of pollution, flooding and erosion.

Section 28(3) of the Conservation Authorities Act states that CAs, under their regulations, may issue permission that is subject to conditions that must be met, or the permit can be cancelled. Some examples of conditions that are typically applied include: the use of phased ESC plans, the implementation of inspections and maintenance programs, and adherence to construction timing windows.

Chapter 9.0 provides additional guidance on CA permits and regulated areas.

### *Ontario Endangered Species Act (S.O. 2007)*

The Ontario Endangered Species Act (ESA) is administered by the MECP. Its purpose is to identify and protect species at risk and their habitats, and to promote recovery of these species and stewardship activities that will assist in their protection and recovery. Unlike the federal SARA, the Ontario ESA applies to any land – public or private – that contains, or provides habitat for, endangered species. Two regulations have been created under the Act: a general regulation under the ESA (O.Reg. 242/08) and the Species at Risk in Ontario List (O.Reg. 230/08). The latter lists all extirpated, endangered, threatened and special concern species in the province.

In the Act, the provision in Section 10 protects the habitat of species at risk, stating “No person shall damage or destroy the habitat of, (a) a species that is listed on the Species at Risk in Ontario List as an endangered or threatened species; or (b) a species that is listed on the Species at Risk in Ontario List as an extirpated species, if the species is prescribed by the regulations for the purpose of this clause.”

In Ontario development applications are screened to determine whether there are any at risk species on the site. If at risk species are believed to be on the site and/or have been observed on the site, the activities planned may require an Endangered Species Act permit or authorization. Permits and authorizations issued will often be subject to conditions and requirements based on MECP recommendations on procedures and protection measures that will best safeguard the species from harm.

In an effort to enhance the protection of aquatic species-at-risk during construction activities, the MNRF, in partnership with the Credit Valley Conservation Authority, MECP, and Fisheries and Oceans Canada, released a protocol titled *Silt Smart: Erosion and Sediment Control Effectiveness Monitoring and Rapid Response Protocol for Large Urban Development Sites (version 1.2)*. It outlines a consistent effectiveness monitoring methodology to protect the health of sensitive streams and habitats in areas undergoing large urban development. Based on this protocol, which was released in 2012, sensitive streams include those that support species-at-risk and coldwater species such as the provincially endangered Redside Dace, Atlantic Salmon and Brook Trout.

### *Planning Act (R.S.O. 1990)*

The Planning Act, administered by the Ministry of Municipal Affairs and Housing, sets out the ground rules for land use planning in the province. It defines the parties who can control land use and how they can do so. It provides the basis for, among other things, preparing official plans, regulating and controlling land uses through zoning bylaws and minor variances, and dividing land into separate lots for sale or development through a plan of subdivision or a land severance. CAs are "public commenting bodies" under the Planning Act, which requires that they be notified regarding municipal policy documents and planning and development applications under the Act. As such, CAs provide comments to the municipality/planning approval authority on these documents and applications. The planning/development applications CAs are required to review and comment on often include ESC plans.

Section 3 of the *Planning Act* enables the province to issue policy statements on land use planning matters of provincial interest.  The current Provincial Policy Statement (PPS), released in 2014, details several provincial interests that are relevant to ESC and environmental protection during land development in general.  These include Natural Heritage (Section 2.1), Water (Section 2.2), and Natural Hazards (Section 3.1). Under each of these categories, the PPS lays out how these interests  - the protection of natural heritage and water features and the protection of human health and infrastructure from natural hazards – must be addressed. All planning/land use decisions are required to be consistent with the PPS and provincial plans such as the Niagara Escarpment Plan (2017), the Oak Ridges Moraine Conservation Plan (2017), the Greenbelt Plan (2017), and the Growth Plan for the Greater Golden Horseshoe (2017).

Conservation authorities have been delegated the responsibility of representing the provincial interest on natural hazards encompassed by Section 3.1 of the PPS. As such, they are required to review and provide comments on municipal policy documents (e.g. Official Plans) and applications submitted pursuant to the Planning Act.

## Municipal

Section 142 of the Municipal Act (S.O. 2001) grants municipalities the power to regulate "site alteration", and pass associated bylaws for activities and undertakings that disturb the natural ground conditions and alter soil sediment distribution. This section is comprehensive and proactive in controlling land-disturbing activities early in the development process. Bylaws require permits to be secured for site alterations that routinely require environmental assessments and as a condition of approval erosion and sediment control plan and/or Environmental Control Plan.

Each municipality has its own process to allow earthworks and the construction process to be initiated either through a top soil bylaw, tree removal bylaw, site alternation permit or pre-servicing agreements. The ESC plan forms a key component of this process and the land owner is required to meet the conditions of the identified municipal approval process. The conditions of the approval generally include a letter of credit for a predetermined percentage of the cost to implement, maintain and decommission the ESC plan.

# APPENDIX E:

# EROSION RISK ASSESSMENT APPROACHES

# APPENDIX E: EROSION RISK ASSESSMENT APPROACHES

## Revised Universal Soil Loss Equation (RUSLE) approach

A number of methods have been established to assess potential erosion (soil loss) within a defined geographic area, but the most common is the Revised Universal Soil Loss Equation (RUSLE). RUSLE evolved from the Universal Soil Loss Equation (USLE) - an empirical model which was developed in the 1960s by Walter H. Wischmeier and Dwight D. Smith. The revised version of USLE, released in 1992, is a computerized version of the model that incorporated improvements in many of the factor estimates.

RUSLE is used to calculate soil loss based on the five contributing factors described below, which are explained in detail in *Revised Universal Soil Loss Equation for Application in Canada (RUSLE FAC): A Handbook for Estimating Soil Loss from Water Erosion in Canada* (Wall et al., 2002). Guidance on performing RUSLE calculations for construction projects, including examples, are available in the City of Calgary Water Resources *Erosion and Sediment Control Guidelines* (2017).

The equation is:

$$A = R \times K \times LS \times C \times P$$

The factors/variables shown in the equation are defined as follows:

**Soil loss (A)** | Average annual soil loss for the defined geographic area, expressed as a weight per unit area (i.e. tonnes/hectare). This is the product of the other five factors described below.

**Soil erodibility (K factor)** | A quantifiable measure of how susceptible a soil is to erosion based on characteristics such as texture, structure, permeability, organic matter content, and the way the soil is affected by seasonal changes.

**Slope (LS factor)** | Based on site topography, this factor considers drainage patterns and the length, steepness and shape of the slopes in the study area.

**Rainfall and runoff (R factor)** | This factor considers the erosivity of rainfall and runoff, taking into account rainfall intensity and the volume of overland flow generated during the event. This factor also encompasses seasonal variations in the erosivity of rainfall events (e.g. high erosivity summer thunderstorms, high runoff generation during rain on frozen soils).

**Crop and vegetation management factor (C factor)** | Sometimes referred to as the 'cover' factor, this is a measure of how effective a given ground cover is at preventing erosion. While agricultural applications are primarily concerned with crop/vegetative cover, C factors have now been established for ground covers used in construction applications, like erosion control blankets.

**Support practice factor (P Factor)** | This factor considers practices applied to prevent soil loss by reducing runoff volumes and flow rates. In construction applications, support practices can be considered sediment control practices, particularly those that result in alterations of flow rates and pathways. Once potential soil loss is calculated based on the four factors above, the support practices are incorporated (as part of ESC plan development) in order to determine the extent to which they can help mitigate that anticipated soil loss.

Once soil loss is calculated for a defined geographic area using RUSLE, the values can be compared with those in Table E1 below from RUSLE FAC (2002). This allows for evaluation of the extent of soil loss/erosion expected and how it compares to the maximum tolerable soil losses defined in the document. Based on the outcome of that assessment, additional support practices may need to be added if predicted erosion levels are too high. Alternatively, the C factor could be adjusted by increasing cover on bare soil areas to make them less vulnerable to erosion.

**Table E1**: Potential soil erosion classes

| Soil erosion class | Potential soil loss (tonnes/ha/year) |
|---|---|
| Very low | < 6 |
| Low | 6 - 11 |
| Moderate | 11 - 22 |
| High | 22 - 33 |
| Severe | > 33 |

Source: RUSLE for Application in Canada: *A Handbook for Estimating Soil Loss from Water Erosion in Canada* (Wall et al., 2002)

## Ministry of Transportation's qualitative risk assessment approach

The Ontario Ministry of Transportation (MTO) has developed a qualitative approach to erosion risk assessment as part of their *Environmental Guide for Erosion and Sediment Control During Construction of Highway Projects* document (MTO, 2015). The approach is based on some of the factors defined in RUSLE and includes the following items:

i. An overview of the risk of a broad study area; and
ii. A detailed assessment of the construction project.

### *Overview risk assessment:*

The overview risk assessment for erosion and sediment control is a general classification that can be applied to larger study areas or areas identified as having sensitive downstream receiving features. The overview risk assessment involves separating the study area into areas (polygons) of similar erosion potential and assigning an erosion potential risk rating (low, moderate or high) to each. The base map used to select polygons should be developed at a scale suitable to the size and topography of the study area. The scale should be sufficient to discern areas with different erosion risk levels. Polygon sizes between 0.5 and 10 ha are recommended. The method MTO outlined also involves determining a consequence rating for each polygon, which involves estimating the risk (low, moderate or high) of consequences occurring in the event of ESC failure within that polygon. The consequence rating is based on potential ecological, legal or project consequences. The assessment results are reported in a table where polygons are numbered and their associated erosion risk and consequence ratings are listed along with a brief justification for the ratings.

An overview report is also completed in support of the risk assessment and includes the following items:

i. Site Description
ii. Existing Conditions
iii. Anticipated Project Activities
iv. Considerations for ESC Plan Development

Additional guidance on how to establish polygons of like erosion potential is provided in Section 5.2 and Appendix B of MTO's *Environmental Guide for Erosion and Sediment Control During Construction of Highway Projects (2015)*.

### *Detailed assessment:*

A detailed assessment is the final step within MTO's Risk Assessment and is done to determine the overall level of risk from construction activities and specifies the appropriate level of effort that is required as it relates to erosion and sediment control onsite. The detailed assessment is typically documented within a technical memo in support of the proposed construction activities.

## Hybrid qualitative ERA approach

The approach detailed in this section represents a hybrid of the MTO approach and the RUSLE method described in Appendix E. While qualitative like the MTO approach (described in the 2015 *Environmental Guide for Erosion and Sediment Control During Construction of Highway Projects*), it differs in that it does not consider risk classification of consequences and is instead focused solely on estimating erosion risk. The hybrid approach involves the following steps:

1) Dividing the site into polygons of like erosion potential that are delineated by using topographical and soils maps and aerial photographs. The base map used to select polygons should be developed at a scale suitable to the size and topography of the study area. The scale should be sufficient to discern areas with different erosion risk levels. Polygon sizes between 0.5 and 10 ha are recommended.
2) For each polygon, compile data on soil characteristics (K factor), topography (LS factor), and anticipated ground cover, if any (C factor).
3) Using the risk classification tables provided in section 6.2.3 of the *ESC Guide for Urban Construction* (2019), rate each polygon as having a high, moderate, or low risk of erosion.
4) Select best practices most appropriate for mitigating erosion based on the estimated risk. See BMP selection guidance in table 6.6 of the Guide.
5) Prepare ESC plan, specifying best practices for each polygon based on what is determined through the hybrid ERA approach.
6) Repeat this process for each construction stage with a distinct ESC plan, e.g. topsoil stripping & grading, site servicing, building construction.

# APPENDIX F: ESC INSPECTION REPORT TEMPLATE

# ESC INSPECTION REPORT TEMPLATE

Date:________________________________ Weather/Time:________________________________

Project Site:____________________________ Reason for Visit:________________________________

Inspector Name:________________________________________

Recipients:

*List of report recipients and e-mail*

ACTION ITEMS:

| Item Number | Location | Description | Date | Completion Date | Weeks Recurring |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

*a table listing active/ongoing maintenance, repair and replacement requirements can be used to summarize a detailed report. This can provide quick reference "Checklist/To Do" for the contractor.*

Detailed ESC Report to Follow:

Item #:

*Clear and concise description of what should be done…action item including a representative date stamped photo of the concern.*

*This should be done for each item every inspection.*

MAP – *attach a site plan/drawing and note the action items (new and recurring) that appear on the corresponding inspection report to ensure locations of corrective/actions items are clear. This is particularly useful for large projects.*

Signature_________________________________ Date____________________________

# APPENDIX G:

# RESTORATION GUIDELINES

# APPENDIX G: RESTORATION GUIDELINES

## A. Restoration Planning, Implementation and Monitoring

Through the planning and/or permitting of a project, areas are often identified for restoration to mitigate development impacts or to enhance the natural heritage system. These areas include sites outside the existing natural features including the buffer and sites within the natural heritage system where construction disturbance was deemed unavoidable. The goal of restoration work is to establish natural self-sustaining vegetation that contributes to the surrounding ecosystem function and provides valuable habitat. Many resources go into the design and implementation of restoration projects and these projects require thoughtful planning, proper implementation as well as post-construction monitoring and maintenance.

### 1. Planning

It is critical to the success of any restoration project that the site conditions are well understood by the designers and that appropriate plants are selected. Existing habitat conditions must be considered as well as post-development conditions which may affect plantings. Drawings must include a plan view showing planting locations, species (common and scientific names) and numbers. Soil preparation requirements, the type of planting stock, the appropriate timing of planting and seed application as well as any relevant planting details should also be included.

Plant selection and project design should be completed based on the following:

i. Soil type should be determined and the health of the soils should be assessed to properly plan for soil amendments or any site preparation that will be required. TRCA's *Preserving and Restoring Healthy Soil: Best Practices for Urban Construction* is a valuable resource regarding the creation a healthy soil environment following construction.
ii. As soil compaction from construction activities is a key limiting factor to the success and establishment of restoration plantings, the remediation of compaction must be considered at the design stage and outlined on the plans.
iii. Plants should be native species and suitable given the soil, moisture, and light conditions of the site as well as any site specific stressors. Cultivars of native species are generally not acceptable and invasive species are not permitted. Rare species should be avoided as well as species that are often mislabeled including *Viburnum trilobum* and *Celastrus scandens*.
iv. Planting plans should be based on natural vegetation communities found in the region and plant groupings should be selected accordingly. Designers should consider the natural features on the site and in the adjacent areas as well as have an understanding of existing vegetation communities and the landscape context. Plants should be arranged in a layout that mimics natural conditions.
*v.* A range of early successional plants should be used to provide the biodiversity necessary to support the development of a future natural self-sustaining community. Late successional species should be included in areas where a source of seed does not exist in order to promote succession but should not make up the majority of species in the plant list.
vi. Where possible, native species can be salvaged from the area to be developed and used as part of the restoration planting. If the area is composed of native plant species, it may also be possible to salvage sod mats as a source of seed and an effective erosion control measure.
vii. Planting densities should achieve full coverage of the site with shrubs planted at 1 metre on centre and trees planted at 5 metres on centre. Higher densities are required for live stake plantings and lower densities or nodal plantings may be acceptable depending on the targeted community and the size of the area to be restored.
viii. Predation and herbaceous competition can limit the growth and survival of planted material,

especially in the initial years following planting. The need for mulch and rodent guards must be assessed in order to protect young tree stems. In some cases, larger planting stock may be the only way to outcompete and ensure planting success.

ix. In areas where invasive species are a particular problem, eradication of these species may become a component of the restoration initiative.

x. To inhibit the establishment of invasive species within a restoration area, all exposed soils should be stabilized with a native seed mix that includes a nurse crop.

## 2. Implementation

Even with good design, proper implementation is necessary to ensure long-term success of the planted material.

i. Following construction, soil conditions should be reassessed prior to planting to evaluate the amount of soil compaction and/or the need for soil amendments. Soil compaction remediation as well as the addition of fertile soil or amendments will be needed if the area to be restored was part of the active construction site.

ii. The location of restoration work and the type of plant material will determine the timing of the planting. The following should be considered when scheduling the restoration work:
   - Bareroot stock and live stakes should only be installed while dormant in spring or after leaf fall in autumn.
   - Planting during wetter months (May and September) is ideal. Balled and burlapped as well as container-grown stock can be installed at any time during the growing season, if adequate water is supplied.

iii. Seeding should occur as soon as possible following the completion of work. Seed mixes should not be applied during the drought-prone season (i.e. June through August), unless adequate irrigation can be supplied. Works occurring during the summer and winter months should specify interim erosion control measures.

## 3. Post-Construction Monitoring and Maintenance

While properly selected native plant material will become resilient to climatic variations, all newly planted plants are sensitive until sufficient root growth has developed. Because planting is stressful on the plant material, a certain amount of mortality is expected in any restoration project. Monitoring and maintenance are integral to a successful project.

i. After seed has been applied to a restoration site, a follow-up monitoring visit should be conducted to ensure that the seed has been effective at stabilizing the site. Reseeding should be completed at this point, if required.

ii. While balled and burlapped or container-grown stock can be planted throughout the planting season, weather conditions must be monitored to ensure adequate rainfall once the planting is complete. Watering should be planned for any dry periods until plants become established. Plants are most susceptible in the first growing season but remain sensitive for the first 2-3 years after planting.

iii. The levels of invasive species should also be monitored. If invasive species begin to dominate the site or limit plant survivorship, invasive species control should be implemented.

iv. A two-year plant warrantee is standard at nurseries but is ineffective without monitoring of the restoration site. The restoration site should be monitored several times a year during the plant warrantee period and any dead stock replaced before the two year period expires.

## B. Seed Mix Selection

An important part of almost all restoration work is the selection of an appropriate seed mix to stabilize the ground, deter the introduction of persistent invasive species and to contribute to the future biodiversity of the area being restored. Without proper stabilization of a site, adjacent natural areas may be negatively affected through sedimentation as well as through the invasion of aggressive exotic species. Proper stabilization immediately following construction will also limit erosion and promote slope stability.

**Factors to consider in seed selection:**

i. Seed mixes generally must be comprised of native species. Persistent non-native invasive species are not acceptable (see table below).
ii. Species should be compatible and complementary to the existing vegetation communities in the surrounding area. In urban areas or areas where invasive species are pervasive, the seed mix composition should include species that are able to establish quickly and outcompete unwanted vegetation.
iii. The seed mix must contain species that are suitable to the local soil type, moisture, and light conditions.
iv. An annual nurse crop that germinates easily and will not persist on the site should be selected to ensure quick soil stabilization.

The following species are aggressive exotic species and seed mixes containing these species should not be selected. Please note that this list does not represent all problem g species and species not listed here may also be deemed unacceptable. Contact the local CA for a list of species native to the area.

| Scientific Name | Common Name | Scientific Name | Common Name |
|---|---|---|---|
| *Agrostis gigantea* | red top | *Poa pratensis ssp. pratensis* | Kentucky blue grass |
| *Bromus inermis ssp. inermis* | smooth brome grass | *Setaria faberi* | giant foxtail |
| *Carex spicata* | spiked or European meadow sedge | *Setaria glauca (S. pumila)* | yellow foxtail |
| *Dactylis glomerata* | orchard grass | *Setaria italica* | foxtail millet |
| *Elymus repens (Agropyron repens; Elytrigia repens)* | quack grass | *Setaria verticillata var. verticillata* | bristly foxtail |
| *Festuca rubra* | (creeping) red fescue | *Setaria viridis* | green foxtail |
| *Glyceria maxima* | giant or rough manna grass | *Trifolium arvense* | rabbit-foot clover |
| *Juncus compressus* | round-fruited or compressed rush | *Trifolium aureum (T. agrarium)* | hop-clover |
| *Linum perenne* | perennial flax | *Trifolium campestre* | large hop-clover |
| *Linum usitatissimum* | common flax | *Trifolium hybridum* | alsike clover |
| *Lotus corniculatus* | bird's foot trefoil | *Trifolium incarnatum* | crimson clover |
| *Melilotus alba* | white sweet clover | *Trifolium medium* | zig-zag clover |
| *Melilotus officinalis* | yellow sweet clover | *Vicia cracca* | cow, tufted, or bird vetch |
| *Phalaris arundinacea* | reed canary grass | | |

# APPENDIX H: REFERENCES LIST

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