Silt Smart

Erosion and Sediment Control Effectiveness Monitoring and Rapid Response Protocol for Large Urban Development Sites

Version 1.2
March 2012

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1.0 BACKGROUND

Urban development projects involving activities such as topsoil stripping, site grading, infrastructure installation and watercourse alteration can dramatically alter pre-development erosion and sedimentation processes. If construction activities are not effectively managed to limit soil exposure and contain runoff, the mobilization and transport of water-borne sediments may result in water quality degradation, destabilization of naturally occurring fluvial processes and interference with wetland and aquatic habitats. These environmental concerns together with ongoing urban expansion pressures lead to development of the Greater Golden Horseshoe Conservation Authorities Erosion and Sediment Control Guidelines for Urban Construction (GGHCA 2006).

While the land development industry has taken important steps toward improving its erosion and sediment control practices, deficiencies still exist. Recurring problems include lack of proper follow-through in implementing approved ESC plans, inadequate inspection and ongoing maintenance of ESC measures, illicit pumping, and failure to report sediment spills. Due diligence in erosion and sediment control requires a standing commitment from developers, engineering consultants and contractors that is premised on the reality that sediment releases, such as those attributable to rainfall events, can happen at any time of the day and any day of the week. Rapid response is important in minimizing adverse impacts particularly where sensitive species and their habitats are at risk.

The larger scale and extended nature of urban development activities across many parts of the GTA is challenging the capacity of the development industry and regulatory agencies to adequately evaluate ESC effectiveness and promptly identify and respond to problems as they arise. Real-time turbidity monitoring sensors along with remote data logging and transmission technologies can offer a practical solution to this dilemma. These systems provide developers and site managers with an early detection system and the ability to rapidly respond when sediment releases threaten the natural environment.

2.0 PURPOSE

This protocol has been developed with input from Fisheries and Oceans Canada (DFO), Ontario Ministry of Natural Resources (MNR), Ontario Ministry of Environment (MOE), Credit Valley Conservation Authority (CVC) and reviewed by Toronto and Region Conservation Authority (TRCA). It also draws on experiences in other jurisdictions where real-time turbidity monitoring is being increasingly used to assist in preventing and mitigating adverse environmental impacts of land development activities (NRSI 2010; YSI 2010; DNR 2006).

The primary purpose of this protocol is to outline a consistent effectiveness monitoring methodology to protect the health of sensitive streams and habitats in areas undergoing large urban development. Sensitive streams include those that support species-at-risk and coldwater species such as the provincially endangered Redside Dace, Atlantic Salmon and Brook Trout. Ultimately, it will result in the protection of water quality and drinking water resources.

The objective is to ensure that large construction activities such as topsoil stripping, rough grading, installation of infrastructure and build-out associated with large development proposals are continuously and proactively monitored in a manner that prevents harmful impacts of deleterious sediment and silt getting into local receiving streams. The protocol is not intended to replace applicable regulatory tools and processes such as municipal bylaws, provincial and Conservation Authority permits and approvals, and spills reporting. It is a mechanism to identify

deficiencies in Erosion and Sediment Controls (ESC) measures and practices and trigger a rapid response to remediate the situation. In other words, the focus of the protocol is a preventative mitigation measure rather than an enforcement tool.

Site Inspections are a critical component of the ESC plan, particularly on large sites. Most site inspections focus on sediment control functioning and may not include assessing impacts on watercourses and fish habitat. Site inspection effectiveness is dependent upon the frequency of monitoring and the immediacy and robustness of actions taken to address any failure of an ESC measure. It is recognized that there is need for continuous monitoring with more immediate notification to the contractor, proponent and agencies. Utilizing real-time monitoring to notify proponents, contractors and agencies of ESC problems will assist in ensuring ongoing protection of sensitive watercourses.

3.0 PROTOCOL APPLICATION

Approvals and permits for activities relating to large construction sites are issued by a number of agencies. This protocol applies to large construction sites that are within the catchment of sensitive streams including those that support species-at-risk and coldwater species such as the provincially endangered Redside Dace, Atlantic Salmon and Brook Trout.

Large Construction Projects include:

1) Single or contiguous development sites where total development area will be larger than 25 ha
2) Other sites due to their location and type of construction (e.g. high risk of sediment release due to soil type, slope, duration and extent of in stream works)

Sensitive Streams include:

1) Redside Dace Habitat
2) Spawning and Nursery Habitat for Coldwater Species

Implementation of this protocol can be achieved through the existing planning and regulatory framework. For example, MNR may facilitate implementation through permits and/or approvals of mitigation plans associated with Redside Dace under the Endangered Species Act. Conservation Authorities may facilitate implementation through permits associated with their regulation or Fisheries Act reviews through enhancement of the ESC plan. Municipalities may implement the protocol through development permits. The MOE may implement through Permit to Take Water (PTTW) applications. Throughout the planning and permitting process agencies will ensure a consistent approach, which sufficiently addresses all required approvals.

4.0 EROSION & SEDIMENT CONTROL EFFECTIVNESS MONITORING

The implementation of this protocol includes development of a monitoring plan, installation of monitoring equipment, response to specific in-stream turbidity alert levels and completion of mitigation actions and reporting requirements.

Total suspended solids (TSS) and turbidity both indicate the amount of solids suspended in the water, but the measure different things. The test for TSS measures the actual weight of material per volume of water, while turbidity measures the amount of light scattered from a sample (more suspended particles cause greater scatterings). TSS can only be measured through lab analysis of a sample. Turbidity can easily be measured in the field using insitu sondes that are placed in stream.

For the purpose of this protocol, continuous real-time turbidity monitoring is to be deployed using insitu sondes to detect migration of silt and sediment from active construction sites to the receiving watercourse. Real-time monitoring is designed using equipment and web-based technology that allows data to be remotely accessed. The system is configured to send alerts to Contact Groups made up of proponents, municipalities and review agencies when trigger levels, based on the difference between upstream and downstream readings, are exceeded. This allows for a rapid response to repair and/or supplement erosion and sediment controls.

Monitoring stations are based on an assessment of potential pathways by which silt and sediments from large sites may be released into receiving streams. At minimum, two real-time turbidity monitoring stations are required within each sensitive stream**.** Additional monitoring stations may be selected based on sensitivity of the receiving body, site-specific environmental conditions and the type and scale of construction. It is understood that background erosion in a stream is a natural process. Background, for the purposes of triggering alert levels, will be established through simultaneous monitoring at a prescribed upstream reference site. Other methods to establish 'background' conditions can be used if approved by all parties. The frequency of turbidity measurements will be set at fifteen-minute intervals.

A detailed site-specific monitoring plan will be submitted to agencies for approval. The plan should include an equipment list, installation plan, mapping of monitoring locations and site-specific monitoring details. An example of the type of equipment that could be included in the equipment list is found in Appendix A.

Personnel involved in ESC management must possess the training and experience required to effectively undertake their duties and responsibilities. Appropriate accreditation includes registration and/or certification through Professional Engineers Ontario (PEO), Association of Professional Geoscientists of Ontario (APGO) and/or Certified Inspector in Sediment and Erosion Control (CISEC).

5.0 ALERT LEVELS AND RESPONSES

Erosion from large development sites has the potential to contribute large quantities of silt and sediment to watercourses. The severity of impacts from increased suspended sediment levels is a function of the concentration of sediments in the water correlated to the duration of exposure (Newcombe MS1986; OMNR 1992). The supporting science recognizes there are various tolerance thresholds across fish species as well as across their life stages. Studies have shown that in general, however, TSS concentrations above 25 mg/L will begin to impact fish as summarized in the figure below (Kerr 1995; Newcombe MS1986; Newcombe and Macdonald 1991).

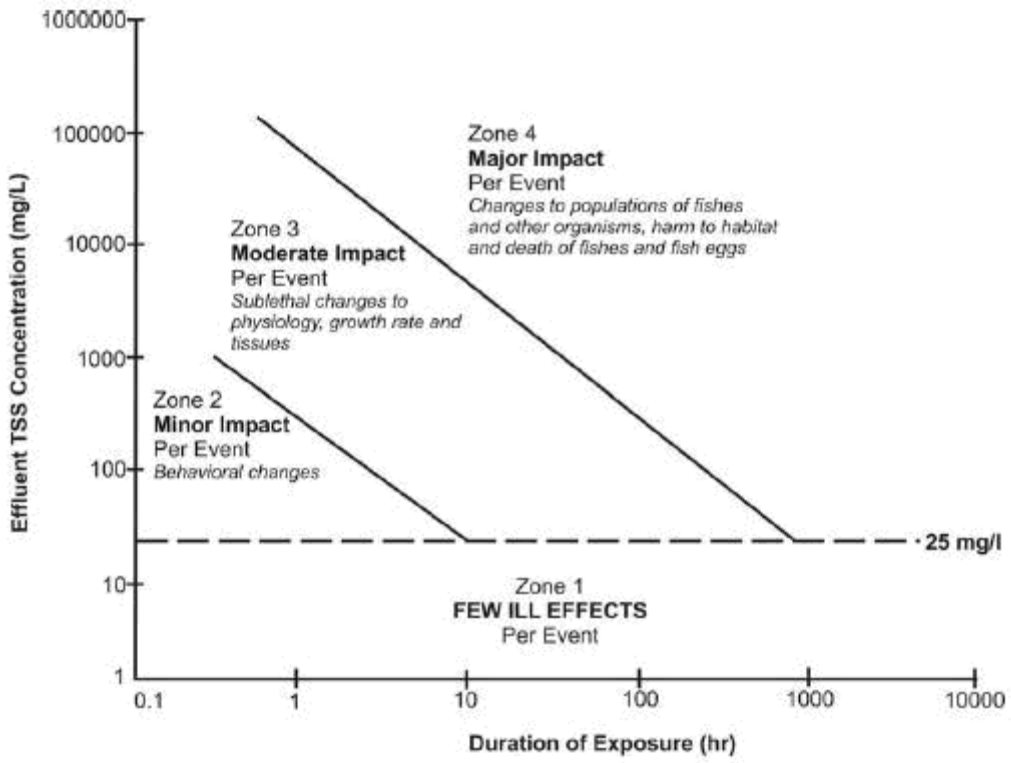

Figure 1: Relationship between sediment concentration and duration of exposure on fish health and habitat (modified from Newcombe 1986)

Turbidity (NTU) measurements are often used as a surrogate for measuring suspended solids as recognized by the federal Canadian Council of Ministers of the Environment guidelines (CCME, 2002). The Canadian Water Quality Guidelines for protection of aquatic life specify a maximum increase of 8 NTUs from background levels for short-term exposure (e.g. less than 24 hrs). This benchmark is used as the alert threshold for Occurrence Scenarios one and two of this protocol. The third Occurrence Scenario has an alert threshold of 330 NTUs based on the severity of impacts to fish health and habitat resulting from short-term exposure to an elevated sediment concentration of approximately 1000mg/L (Newcombe, 1986). It is recognized that there is no standard relationship between TSS and turbidity measurements, as it is stream specific. As a result, flexibility with the alert thresholds is considered throughout the project and is based on site-specific conditions and adequate baseline monitoring data.

An alert response, referred to in the Occurrence Scenarios outlined in Table 1 below, must include a site inspection from the certified inspector to confirm that the ESC plan is being implemented as approved. If deficiencies in ESC measures or in the ESC plan are identified, remedial actions must be taken immediately to ensure the receiving stream is protected. If long-term changes are made to the ESC plan as a result of an investigation, a newly stamped plan should be included with the Final Assessment Report (see Section 7.0 - Reporting). Members of Contact Groups referred to below in the Occurrence Scenarios table receive alerts and reports and are to be defined during the development of a site-specific monitoring plan.

Table 1: Occurrence Scenario Alerts and Actions

	Occurrence Scenario 1	Occurrence Scenario 2	Occurrence Scenario 3
Occurrence	Two consecutive turbidity measurements of **8 NTUs** above background	Turbidity is **8 NTUs** above background for **10 hours or more**	Two consecutive turbidity measurements greater than **330 NTUs** above background
Alert	Alert is sent to **Contact Group One** The alert is repeated every 2 hrs until the turbidity decreases to below target	Alert is sent to **Contact Group Two** The alert is repeated every 2 hrs until the turbidity decreases to below target	Alert is sent to **Contact Group Three** The alert is repeated every 2 hrs until the turbidity decreases to below target
Response	All deficiencies in ESC design and maintenance as identified through inspection will be rectified as soon as possible and not later than 24 hours of notice.		
Preliminary Report	Preliminary Assessment Report is required within 10 hours after first light.		
Final Report	A Final Assessment Report, stamped by a qualified professional, is required within 48 hours of the end of the occurrence.		

6.0 REPORTING REQUIREMENTS

Standard ESC maintenance inspections and reports are required as per Erosion and Sediment Control Guideline for Urban Construction (2006). Furthermore and notwithstanding the provisions of this protocol, conditions may exist where a silt or sediment release to a watercourse constitutes a 'spill' requiring the inspector to report the spill occurrence to the MOE Spills Action Centre (1-800-268-6060). Part *X* of the Environmental Protection Act defines a 'spill' as:

> *a discharge of a pollutant [includes silt and sediment] that occurs (a) into the natural environment, (b) from or out of a structure, vehicle or other container, and (c) that is abnormal in quality or quantity in light of the circumstances of the discharge.*

Further to the above and in addition to the aforementioned document titled *Greater Golden Horseshoe Conservation Authorities Erosion and Sediment Control Guideline for Urban Construction document, a third existing document is useful for proponents. An Inter-Jurisdictional Compliance Protocol for Fish Habitat and Associated with Water Quality* developed by the Compliance Working Group of the multi-agency Aquatic Resource Management Advisory Committee (ARMAC) includes information about roles and responsibilities as well as a "first on the scene" decision matrix (ARMAC 2007).

For the purposes of this protocol, Preliminary and Final Assessment Report templates can be found in Appendix B. For each occurrence, an electronic Preliminary Assessment Report will be sent to the appropriate Contact Group within 10 hours (after first light) of the alarm to notify of SEC issues, remedial actions taken and further remedial actions recommended, including time frames.

Additionally, for each occurrence, an electronic and hardcopy Final Assessment Report stamped by a qualified professional is sent to the appropriate Contact Group within 48 hours of the end of the occurrence. The report will include: scale and duration of occurrence, identification of cause(s), description of remediation measures required, time that remediation measures were undertaken, and confirmation that remedial measures are complete and functioning. If remedial actions include long-term changes to the approved ESC plan, an updated ESC plan is submitted with the Final Assessment Report.

7.0 REFERENCES

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8.0 APPENDICES

A) Example Monitoring Equipment List
B -1) Template Reporting Form – Preliminary Assessment Report
B- 2) Template Reporting Form – Final Assessment Report

Appendix A

Table 1: Turbidity Real-time Station Equipment List

This protocol does not limit the equipment to those listed blow. Equipment selection will be discussed and finalized during approval of the site-specific monitoring plan.

Equipment	Equipment Type	Supplier
Data logger	Campbell Data Logger	Campbell Scientific
	Sutron 9210 Data Logger	Hoskin Scientific
	New Sutron GPRS-Link with Modem	Hoskin Scientific
	Onset Data Logger with Modem	Hoskin Scientific
	Solar Stream Data Logger with Modem	Hoskin Scientific
Water turbidity sensor	Campbell Turbidity Sensor	Campbell Scientific
	Global Turbidity Sensor	Hoskin Scientific
	YSI 600OMS with Water Depth, Level, & Temp	Hoskin Scientific
	Hydrolab with Water Depth, Level, & Temp	Campbell Scientific
Water temperature sensor	Hobo Temp Smart	Hoskin Scientific
	Sutron Temp Sensor	Hoskin Scientific
Water level sensor	OTT Pressure Level Sensor	Campbell Scientific
	PS9800 Pressure Transmitter	Hoskin Scientific
Modem	Campbell Modem	Campbell Scientific
	Solar Stream Modem (Data Garrison)	Campbell Scientific
Antenna	Modem Antenna	Campbell Scientific
	Included with Modems from Hoskin	Hoskin Scientific
Solar panel	30 watt Solar Panel with Mount and 10ft cable	Hoskin Scientific
	20 watt Solar Panel with Mount	Campbell Scientific
Charging regulator	3 amp regulator	Hoskin Scientific
Battery	Deep Cycle Marine Batter	Canadian Tire
Software	Campbell Loggernet Software	Campbell Scientific
	Software for Hobo Loggers	Hoskin Scientific
	Software for Sutron Loggers	Comes with Sutron
Enclosure	Fibreglass	Campbell Scientific
	For Hobo System	Hoskin Scientific
	Nema 4X Enclosure	Hoskin Scientific

APPENDIX B-1

Erosion and Sediment Control
Effectiveness Monitoring and Reporting Protocol for Large Urban Development Sites

Preliminary Assessment Report

Project Name:	
Permit Number(s):	
Project Location:	
Site area (ha):	
Receiving Water (i.e., creek, lake):	
Prime Contractor:	
Certified Inspector:	
Stage of Construction:	
Construction Activities on Site:	
Heavy Equipment on Site:	
Are in-stream works taking place?	
Are in-stream works within the timing window?	
Are dewatering activities taking place?	
Occurrence Scenario Number	
Occurrence Scenario Contact Group:	**CVC**
	MNR
	MOE
	DFO
	Municipality
	Proponent
Date and Time of Alert:	
Date and Time of Inspection:	
Current Weather Conditions: **Rainfall amount (mm):** **Rainfall duration (hours):** **Snowmelt amount (mm):**	
Previous Weather Conditions: **Rainfall amount (mm):** **Rainfall duration (hours):** **Snowmelt amount (mm):**	
Date of Last Inspection:	
Current status of the Occurrence	**Ongoing** **Ceased**
Turbidity Reading(s):	
Reading Location(s):	
Time of Reading(s):	

Erosion Prevention Practices on site: **(Check all measures used)**	
Rock Check Dam **Straw Bales** **Rip Rap** **Sod** **Hydro/terra-seeding** **Mulch**	**Vegetated Filter Strip** **Re-vegetative System** **Erosion Control mat/net/blanket** **Riparian Preservation** **Scarification**

	Yes/No	**Location of deficiency and action required**
Are erosion controls installed to project specification?		
Are straw bales staked and trenched?		
Are erosion controls in good condition?		
Do erosion controls cover the areas of concern?		
Are exposed ditches properly protected?		
Has excessive sediment accumulated behind check dams?		
Are the slopes stabilized?		
Are stockpiled materials properly isolated and stored?		
Do erosion controls appear effective?		

Sediment Control Practices on site: **(Check measures used)**		
Silt Fence **Straw Logs** **Silt Bag** **Vegetative Strip** **Mud Mat** **Sediment Trap**	**Turbidity Curtain** **Settlement Basin** **Interceptor Swale** **Berm** **Bulkhead within Storm Sewer** **Other**	
	Yes/No	**Location of deficiency and action required**
Are sediment controls installed to project specifications?		
Are sediment fences properly trenched?		
Are sediment controls installed at the specified location?		
Is runoff from exposed areas fully contained?		
Are sediment controls free of rips and tears?		
Is there excessive sediment build-up?		
Is sediment contained within ponds/basins below the design storage volume?		
Is effluent relatively clear?		
Are storm sewers protected from sediment entry?		
Do sediment controls appear effective?		

In-Stream Works on site: **(Check measures used)**		
Augering and/or Directional Drilling **Sediment and/ or Turbidity Curtains** **Temporary Stream Crossing via Culvert** **Dry Flume**	**Cofferdam** **By-pass or Full Diversion** **Dewatering** **Other**	
	Yes/No	**Comments**
Does the contractor have a dewatering permit?		
Are dewatering volumes being monitored and recorded?		
Does the contractor have a valid in-water work permit?		
Are cofferdams functional?		
Is pumping from entry or receiving pit(s) being filtered prior to release?		
Are any deleterious substances entering any watercourse? (Originating from the site)		
Does the contractor have a spill response kit?		

Preliminary Inspection Results
Occurrence Scenario Summary Results

Date and Time of Alert:	
Current status of the Occurrence	**Ongoing Ceased**
Turbidity Reading(s):	
Reading Location(s):	
Time of Reading(s):	
Summary of Inspection Results: (Notes from inspector)	
Remedial action taken?	
Further remedial action required?	
Expected timeline for completion of further remedial action?	
Next steps:	
Further investigations required?	
Does the ESC Plan require revisions?	
Expected timeline of the Final Assessment Report?	

Additional Comments/Observations:
Name of ESC Inspector:

Appendix A. Reference Site Map
Appendix B. Photo Log

APPENDIX B-2

Erosion and Sediment Control
Effectiveness Monitoring and Reporting Protocol for Large Urban Development Sites

Final Assessment Report

Project Name:	
Permit Number(s):	
Project Location:	
Site area (ha):	
Receiving Water (i.e., creek, lake):	
Prime Contractor:	
Certified Inspector:	
Stage of Construction:	
Construction Activities on Site:	
Heavy Equipment on Site:	
Are in-stream works taking place?	
Are in-stream works within the timing window?	
Are dewatering activities taking place?	
Occurrence Scenario Number	
Occurrence Scenario Contact Group:	**CVC**
	MNR
	MOE
	DFO
	Municipality
	Proponent
Date and Time of Alert:	
Date and Time of Inspection:	
Current Weather Conditions: **Rainfall amount (mm):** **Rainfall duration (hours):** **Snowmelt amount (mm):**	
Previous Weather Conditions: **Rainfall amount (mm):** **Rainfall duration (hours):** **Snowmelt amount (mm):**	
Date of Last Inspection:	
Current status of the Occurrence	**Ongoing** **Ceased**
Turbidity Reading(s):	
Reading Location(s):	
Time of Reading(s):	

Erosion Prevention Practices on site: **(Check all measures used)**	
Rock Check Dam **Straw Bales** **Rip Rap** **Sod** **Hydro/terra-seeding** **Mulch**	**Vegetated Filter Strip** **Re-vegetative System** **Erosion Control mat/net/blanket** **Riparian Preservation** **Scarification**

	Yes/No	**Location of deficiency and action required**
Are erosion controls installed to project specification?		
Are straw bales staked and trenched?		
Are erosion controls in good condition?		
Do erosion controls cover the areas of concern?		
Are exposed ditches properly protected?		
Has excessive sediment accumulated behind check dams?		
Are the slopes stabilized?		
Are stockpiled materials properly isolated and stored?		
Do erosion controls appear effective?		

Sediment Control Practices on site: **(Check measures used)**		
Silt Fence **Straw Logs** **Silt Bag** **Vegetative Strip** **Mud Mat** **Sediment Trap**	**Turbidity Curtain** **Settlement Basin** **Interceptor Swale** **Berm** **Bulkhead within Storm Sewer** **Other**	
	Yes/No	**Location of deficiency and action required**
Are sediment controls installed to project specifications?		
Are sediment fences properly trenched?		
Are sediment controls installed at the specified location?		
Is runoff from exposed areas fully contained?		
Are sediment controls free of rips and tears?		
Is there excessive sediment build-up?		
Is sediment contained within ponds/basins below the design storage volume?		
Is effluent relatively clear?		
Are storm sewers protected from sediment entry?		
Do sediment controls appear effective?		

In-Stream Works on site: **(Check measures used)**		
Augering and/or Directional Drilling **Sediment and/ or Turbidity Curtains** **Temporary Stream Crossing via Culvert** **Dry Flume**	**Cofferdam** **By-pass or Full Diversion** **Dewatering** **Other**	
	Yes/No	**Comments**
Does the contractor have a dewatering permit?		
Are dewatering volumes being monitored and recorded?		
Does the contractor have a valid in-water work permit?		
Are cofferdams functional?		
Is pumping from entry or receiving pit(s) being filtered prior to release?		
Are any deleterious substances entering any watercourse? (Originating from the site)		
Does the contractor have a spill response kit?		

Final Inspection Results
Occurrence Scenario Summary Results

Date and Time of Alert:	
Date and Time of end of occurrence	
Turbidity Reading(s):	
Reading Location(s):	
Time of Reading(s):	
Summary of Inspection Results: (Notes from inspector)	
Remedial action taken or ongoing	
Expected timeline for completion of remedial action?	
Has the ESC Plan bee revised?	**No** **Yes**

Additional Comments/Observations:
Name of ESC Inspector:

Appendix A. Reference Site Map
Appendix B. Photo Log
Attachment C. Revised ESC Plan