CIELAP BRIEF ON **SEDIMENT CONTROL**

Lake Ontario Water Quality: Is it affected by Contaminant Transfer by Soil Erosion and Sediment Transport from Construction Sites?

CANADIAN INSTITUTE FOR ENVIRONMENTAL LAW AND POLICY

L'INSTITUT CANADIEN DU DROIT ET DE LA POLITIQUE DE L'ENVIRONNEMENT

Since/depuis 1970

Sediment Control Workshop
Wednesday May 7, 2003

Lake Ontario Water Quality: Is it affected by Contaminant Transfer by Soil Erosion and Sediment Transport from Construction Sites?

Satya P. Mohapatra and Anne Mitchell

Canadian Institute for Environmental Law and Policy
130 Spadina Avenue, Suite 305
Toronto, ON M5V 2L4

SUMMARY

Soil erosion, although a natural process, is accentuated by improper land management practices. Urban sprawl type development in the Greater Toronto area is a major contributor of soil erosion and increase in storm water runoff in the area. The eroded soil and sediments could carry and eventually deposit pollutants in to streams and rivers resulting in deterioration of water quality in addition to causing silt and sediments to build up in lakes and streams. Most of the pollutants are transported in the particulate form and concentrations of these chemicals are characterized by high concentrations of suspended solids in the flowing water.

In Toronto and region, most of the contaminants ultimately reach the Lake Ontario, which is the main source of drinking water and recreation in the region. The situation is aggravated during heavy storms when the municipalities using the combined sewer system are not able to manage the overflow and untreated sewage enters the water streams along with the storm water. These discharges may drastically affect the health and quality of a waterway, and untreated storm water runoff can pollute recreational waters and kill aquatic life.

The risk of erosion during construction depends on soil properties, ground contours, drainage patterns and exposure to wind, rain or snow. It is, therefore, essential to plan and implement correct management practices in order to reduce soil erosion and sedimentation. True costs of potential pollution must be assessed and the benefits of better environmental performance determined. Joint studies need to be undertaken by the government and the industry to quantify the amount of contaminant load from the construction industry and monitor soil erosion maintenance as well as water quality. We also suggest that the local governments take urgent measures to improve land and sewer management so as to meet the water quality objectives set by the province in order to ensure safety and health of people in the region.

INTRODUCTION

The Construction Industry is one of the major industries in Canada. It contributes about 12% to the country's GDP (CCA, 2003). There has been a steady growth in this industry in recent years in almost all sectors, residential, non-residential buildings, airports, roads and highways, gas and oil facilities, mining and communication etc. The growth in the industry has been facilitated by growth of population, industrial and economic activities and resultant urban sprawl. This is particularly true for Toronto and region, which accounts for almost half of the population in Ontario.

Although construction is an essential element of development, this is often accompanied by harmful effects on the environment. Air pollution and loss and fragmentation of natural areas, woodlands, farmlands and wildlife habitat are few examples. Nevertheless, soil erosion and sedimentation is the most important environmental concern associated with the construction industry.

Soil erosion by water occurs in three phases, particle detachment, sediment transport and sedimentation or sediment deposition. In the first phase, soil particles are detached from the parent soil mass by the forces of falling raindrops or by the sheer forces of runoff. In the second

phase, particles are moved down the slope. The ability of the runoff to transport the detached particles is a function of the velocity of runoff. The third phase of the erosion process, i.e. sedimentation occurs when the velocity of the runoff is reduced and the load carrying capacity decreases, causing some or all of the sediment to deposit. In general, the larger and heavier particles deposit first with the finer, smaller particles depositing further down the slope.

Development within urban and agricultural areas changes the runoff characteristics of streams and increases the availability of sediment material. High suspended sediment concentration in streams, rivers and lakes can increase costs of water treatment and detract aesthetically from the water body. The deposition of sediment in water bodies can lead to the exertion of large oxygen demands on the water, burial of habitat for benthic aquatic life and alteration or destruction of the aquatic ecosystems.

Development is also responsible for introduction of contaminants in to the system, which has become a major concern associated with erosion and sedimentation (Persaud and Jaagumagi, 1995). Many chemicals are used in the construction industry, which are not only toxic to the workers during use, but also pose a threat to the water quality by being carried away along with the eroded soil and sediments through absorption and adsorption in to the water bodies. These pollutants may consist of nutrients, pesticides, PCBs, toxic metals and other industrial compounds.

Affects of Construction Sediments on Water Quality

Sediment transport affects the quality of water bodies in two ways:

1. Sediments introduce chemicals sorbed to the soil particles in to the aquatic environment
2. Sediments make additional surface area available for absorption/adsorption of chemical pollutants already present in water

Thus, sediment transport and sedimentation contribute to accumulation and persistence of contaminants in the water bodies. Finer sediment particles, by virtue of their greater surface area to volume ratio, absorb relatively greater quantity of pollutants compared to large sediment particles. Sediments also enhance the cost of water treatment plants, reduce the capacity of water reservoirs and clog the river mouth and harbour. Sediments act as reservoir of chemical contaminants, which are interchanged within the water-sediment system. The accumulated contaminants affect the aquatic biota through bioaccumulation and biomagnification. Recent studies have shown that sediments could even act as a reservoir of pathogenic bacteria and release them later to overlying water (Crabill C. *et. al*., 1999).

In Toronto and region, most of the contaminants ultimately reach Lake Ontario, which is the main source of drinking water and recreation in the region. The situation is aggravated during heavy storms when the municipalities using the combined sewer system are not able to manage the overflow and untreated sewage enters the water streams along with the storm water. As a result, the lake becomes a depository of chemicals and other contaminants quite contrary to the expectations of the Great Lakes Water Quality Agreement.

Table 1. Chemicals Used in Construction Industry and Associated Health Effects

Name	Product Usage/Source	Probable Health Hazard
A. Inorganic Chemicals		
Hydrochloric Acid	Cleaners, Concrete ethers	Corrosive
Nitric Acid	Cleaners, Concrete ethers	Corrosive
Arsenic	Wood preservatives, Paints	Carcinogenic, Damage immune system
Cadmium	Pipe lining, Paint, Pigment, Wall Paper, Glue	Toxic to central nervous and respiratory systems, kidneys and intestines
Chromium	Wood preservative	Carcinogenic, Kidney and lever damage
Lead	Pipe lining, Paint, Pigment, Wall Paper, Glue, Fuel additive	Toxic to central nervous system, kidney damage, high blood pressure
Mercury	Pipe lining, Paint, Pigment, Wall Paper, Glue	Toxic to central nervous and respiratory systems, Brain and kidney damage
B. Organic Chemicals		
Benzene	Construction solvent, Stain removers, Paints, Fuel additive, Adhesives	Carcinogenic, Damage to immune system
Propoxur (Baygon)	Pesticide	Liver problems
Malathion	Pesticide	Toxic
Polyvinyl Chloride	Pipe, Electrical wire, Cable, Home furnishings, Packaging	Carcinogenic
Polychlorinated Biphenyls (PCBs)	Old transformers, Refrigerators, Fluorescent light fixtures	Carcinogenic, Immune deficiency, Reproductive and Nervous system trouble
Pentachlorophenol	Wood preservative	Carcinogenic, Liver and Kidney problems
Dioxins and Furans	Found in Chlorinated organic solvents, Pesticides, Wood preservatives, Herbicides	Carcinogenic
Methylene Chloride	Solvent for resins, Paints, Thinners, Adhesives, Foams, Printed Circuit Boards	Carcinogenic
Methyl Ethyl Ketone	Cleaning Solvent	Neurotoxic
Trichloroethylene	Degreesing metal parts, Paint removers, adhesives	Carcinogenic
Name	Product Usage	Health Hazard
C. Other substances		
Asbestos	Fireproofing, Insulation	Carcinogenic
Oil and Grease		

Chemicals Used in the Construction Industry

Construction industry uses many chemicals in several of its operations (Alexander, 1997; Persaud and Jaagumagi, 1995. These are heavy metals like lead or mercury, acids and organic chemicals like pesticides and PCBs including other organic chemicals that are used as solvents and wood preservatives. While some of these chemicals are volatile, e.g. methyl ethyl ketone, and therefore, would not get carried away along with sediments, many organic chemicals used in the construction industry are likely to be sorbed on the sediment particles and subsequently reach the water bodies. Some inorganic chemicals like acids used in the industry may cause some problem due to spill, however, they are not likely to reach the water courses or affect the water quality. In addition to these chemicals, many other substances like asbestos, silica and fiberglass are used in the construction industry, the dusts of which could contaminate the soil and eventually get drained along with run-off.

Most of the chemicals used in the construction industry have potential health hazards and a few of them are known carcinogens. A list of some chemicals and other substances having known health effects that are used in the construction industry is given in Table 1.

Policies Governing Water Pollution from Construction Industry in Ontario

Discharge of pollutants in to the aquatic ecosystem in Ontario is controlled mainly by the Environmental Protection Act and the Ontario Water Resources Act. The Environmental Protection Act forbids discharge of any contaminant to the natural environment in amounts, concentrations or levels exceeding the limits prescribed by legislation. Ontario Water Resources Act regulates use of water and also discharge of wastewater in to water bodies. There are also a few other regulations (e.g. regulations 347 and 362) to manage the chemical waste produced by the industry. The Ministry of Environment and Energy also produced a set of guidelines for the construction industry to prevent sediment and erosion control (Persaud and Jaagumagi, 1995). The guidelines include

- Stockpiles should be located away from the water courses and stabilized against erosion
- Vehicles should leave at a designated point and minimum material should be tracked off the site.
- Sediment/debris must not get in to the municipal sewer system
- There should be on-site and/or down-stream detention facilities
- After completion of work, accumulated sediment, debris and other material should be removed and disposed off.
- Exposed surfaces should be protected to control run-off.

The guidelines also suggested filtering and impoundment using detention ponds.

Provincial Water Quality Objective

Provincial Water Quality Objectives (MOE, 1994) suggest criteria for different chemical and physical indicators representing a satisfactory level for surface waters. Criteria for some substances that are used in the construction industry are given in Table 2.

Table 2. Ontario Provincial Water/Sediment Quality Objectives

Name	Maximum Concentration Objectives (ug/L)
Arsenic	100.0
Cadmium	0.2
Chromium	100.0
Lead	1.0-5.0
Mercury	0.2
Benzene	100.0
Propoxur (Baygon)	Not Specified
Malathion	0.1
Vinyl Chloride	400.0
Polychlorinated Biphenyls (PCBs)	0.001
Pentachlorophenol	0.5
Dioxins and Furans	Not Specified
Methylene Chloride	100.0
Trichloroethylene	20.0

Role of Local Governments

Municipalities are entrusted with the responsibility to enact by-laws for topsoil preservation, erosion and sediment control. A study by TRCA also recommended adoption of such by-laws by the municipalities and carrying out monitoring to ensure compliance with the by-laws as far back as 1993 (TRCA, 1993). While some municipalities have enacted by-laws for the purpose, many municipalities in the province have yet to formulate one. In the absence of such by-laws it is difficult to regulate the loss of soil and sediment from the construction sites and, therefore, to arrest the chemical contamination of water bodies through sediment transport.

Conclusions

The need to have an erosion and sediment control plan for any construction project can hardly be overemphasized. Development should be designed in a way appropriate to soil type and topography of the area as the risk of erosion during construction depends on soil properties, ground contours, drainage patterns and exposure to wind, rain or snow. It is, therefore, essential to plan and implement correct management practices in order to reduce soil erosion and sedimentation. Even in the presence of existing laws and guidelines, we fail to protect the environment because true costs of potential pollution are not assessed and the benefits of better environmental performance are not determined.

It is heartening that many construction companies in Ontario have adopted the principle of 3Rs – Reduce, Reuse and Recycle. However, we suggest, for better environmental performance by the construction industry, that the government and the industry jointly take up studies to:

- Quantify the amount of contaminant load from the construction industry
- Monitor soil erosion maintenance
- Monitor surface water quality near major construction projects
- Evaluate the potential of ground water pollution due to impoundment facilities

We also reiterate that all the local governments develop by-laws for soil erosion and sedimentation and take urgent measures to improve land and sewer management so as to meet the water quality objectives set by the province in order to ensure safety and health of people in the region.

REFERENCES

Alexander R. 1997 Toxic Exposures in the Construction Industry. Consumer Law Page, Alexander, Hawes & Audet, LLP, San Jose, California
http://consumerlawpage.com/article/construction-toxics.shtml

Crabill C., Donald R., Snelling J., Foust R. and Southam G., 1999. The impact of sediment fecal coliform reservoirs on seasonal water quality in Oak Creek, Arizona. Wat. Res. 33:2163-2171

CCA 2003 Canadian Construction Association Overview
http://www.cca-acc.com/overview/overview.html

MOE 1994 Water management, Policies, Guidelines and Provincial Water Quality Objectives, Ontario Ministry of Environment and Energy, July 1994

Persaud D. and Jaagumagi R. 1995 Guidelines for Evaluating Construction Activities Impacting Water Resources, Ontario Ministry of Environment and Energy, January 1995

TRCA 1993 Clean and Clear: Keeping Soil on Construction Sites and Out of Streams, A Joint Study by Toronto Region Conservation Authority and the Ministry of the Environment, January 1993