The Cecelia Creek Project

Environmental Technology Co-op Team

September, 1998

Camosun College Co-op Team-Veins of Life Watershed Society

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Prepared For: *The Veins of Life Watershed Society,Victoria BC*

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EXECUTIVE SUMMARY

The Camosun College Co-op Team has conducted a detailed assessment of the industrial presence within the Cecelia Creek drainage area. The purpose of the study was to identify industrial practices and non-point source pollution inputs to this modified watercourse. Cecelia Creek is one of the most polluted creeks within the Capital Regional District, as it drains a large impervious area spanning 900 hectares. The waters from Cecelia Creek enter the second largest mudflat in the Gorge Waterway.

The Cecelia Creek Project had the following objectives:

- delineate the watershed boundary;
- determine industrial practices and non-point source pollution inputs;
- evaluate private catch basin maintenance;
- determine industrial presence;
- public education;
- identify prevalent chemicals potentially entering the storm drain system; and
- investigate the feasibility of wet detention ponds in Cecelia Ravine.

The approach to addressing these objectives was as follows:

- create a database of businesses within the study area;
- conduct on-site interviews with each business to assess:
    - business practices
    - chemical usage
    - chemical recycling
    - catch basin maintenance schedule
    - level of impact on storm water quality
    - use of best management practices
- create digital maps representing industrial usage of lots and business rating system; and
- develop a database of common industrial chemicals.

Out of 119 businesses in the study area, 101 were interviewed and assessed. The automotive industry was determined to be the most predominant business type within the study area, totaling 58% of all businesses. On site interviews were conducted and it was noted that there was a wide range of practices within this industry type. The automotive industry was further divided into subcategories to enable a more detailed review of this industry. A summary of detrimental practices resulting from inadequate on-site treatment and the potential release of contaminated effluent into the storm drain system is as follows:

Auto Body

- washing of the shop floor
- vehicles are pre and post washed using toxic products

Auto Repair

- engine shampooing, parts rinsing, transmission or radiator flushing
- unconfined spraying of solvents onto engines and engine parts
- auto parts are removed from alkaline soak bins and rinsed clean on the lot
- floor and vehicle washing

Auto Detailing

- complete vehicle cleaning, often with toxic cleaners i.e. wheel rim cleaners are primarily hydrochloric and phosphoric acid
- engine washing with strong degreasers
- products function as spray on/wash off products and carried no warnings as to their toxicity to water bodies

Auto Dealerships

- fall-out treatment of every new vehicle, a dilute acid wash was applied and rinsed off to eliminate paint impurities upon arrival
- washing of lot vehicles and shop floors

Auto Rental

- fleet washing and general service repairs

Fleet Washing

- four companies with large vehicle fleets were power washed on site by a mobile wash company every week

Gas Stations

- pressure washing of lot surfaces with water and solvents

Towing

- vehicle repairing and washing on site

Furniture Refinishing

- rinsing of furniture stripping solvents directly into a floor drain which was connected to the storm drain system

Food Distribution

- forklifts contributed oily residues onto the workplace floor surfaces
- power washing of workplace floor surfaces could cause contaminated wash waters to enter the storm drain system

Business Ratings

A rating system was developed based on discharges of potentially contaminated effluent into the storm drain system. The rating system parameters used to define the four categories are discussed within the report. The business rating results are as follows:

Business Rating	Number of Businesses
Poor	27
Suspect to Satisfactory	27
Negligible to Good	47
Not Interviewed	18

Conclusions

There were some identifiable trends within the industrial sector that produced contaminated effluent that was entering the storm drains. Despite this commonality, there was also a broad range of business conduct that made each facility unique. The high concentration of automotive shops in the study area and the associated operational practices may have the potential to negatively impact Cecelia Creek. It is clear that several of the practices witnessed in this study contravene Municipal By-laws for storm water quality, Provincial Regulations and the Federal *Fisheries Act*.

The maintenance of catch basins varied from business to business within the study area. All of the catch basins mentioned in the study are private catch basins unless stated otherwise. In total there were 67 catch basins identified in the study area. 42% of which were never maintained and 22% which were maintained only once a year. In regard to auto-related businesses, catch basin maintenance was generally scarce. It was common to pump out the basin when it became full or well after its ability to operate effectively had been reached.

The diverse business practices within the study area will largely dictate the selection of an individual and specific catch basin maintenance schedule. The performance of the catch basin will depend on the frequency of maintenance. As the frequency of catch basin maintenance in the study area was generally poor so will the ability of the catch basin to function properly.

Oil-water separators have the potential to diminish the amount of pollutants entering Cecelia Creek. Their implementation and appropriate scheduled

maintenance within the study area could have positive repercussions on the water quality of Cecilia Creek.

The implementation of wet detention ponds in Cecelia Ravine could slow the flow of water and subsequently allow settling out of certain contaminants from the base flow. This bioremediation technique along with additional vegetation to treat the newly created sediment could aid in the removal of contaminants from the waters of Cecelia Creek and their deposition into the marine environment.

While the Municipalities may have insufficient funding to perform a business participation program such as the one in Bellevue, other cost-effective measures could be considered. For example, education geared towards generating local awareness within the industrial sector may alleviate some unnecessary discharges.

Most of the foreshore along the Victoria waterway has been greatly altered by hardened shorelines, with the Cecelia Estuary one of the few remaining unconsolidated shoreline areas. Archipelago Marine Research Ltd. states that, “These remaining areas should be conserved and further foreshore and intertidal modifications restricted to measures which remediate or enhance habitat values. Catchments adjacent to valued habitats should have high priority for contaminant source control, which would include discharge 641” (1996) (641 is the number of the storm drain system that flows into Cecelia Creek). The future management of Cecelia Creek must consider both the reduction of contaminant input and the remediation of present contamination.

Recommendations

The following recommendations are based on the priority to eliminate and/or mitigate contaminated wastewater effluent from entering Cecelia Creek and subsequently the receiving marine environment.

1. Ensure Municipalities adopt adequate and appropriate By-laws for the protection of storm drains and water courses;
2. Enforce Municipal By-laws, Provincial Regulations and Federal Legislation;
3. Delegate catch basin maintenance responsibility;
4. Install appropriate storm water treatment technology for all businesses within the study area;
5. Investigate handling and disposal alternatives for catch basin sediments;
6. Implement bioremediation techniques such as wet detention ponds and associated phytoremediation techniques in Cecelia Ravine;
7. Review Bellevue Project for the purpose of implementing relevant sections;
8. Adopt and enforce Best Management Practices for industrial activities;
9. Continue and expand follow-up studies; and
10. Initiate public education programs throughout the community.

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INTRODUCTION

The Veins of Life Watershed Society is a non-profit organization focused on the restoration of the Gorge Waterway, Portage Inlet, and Selkirk Waters. This includes all sources of input into these waters via the combined watersheds of the surrounding Municipalities. It is the Society's goal to conserve and restore this habitat for future use by the community and wildlife, with the hope of reintroducing juvenile salmonids and increasing the presence of waterfowl. In recent years the Watershed Society has succeeded in transforming the Gorge into a riparian green space, habitable for wildlife and of pleasing aesthetics, to the extent that it has restored pride within the Gorge community.

The Camosun College Co-op Team was made up of four Environmental Technology students. The 13 week research project focused on the urban watershed surrounding Cecelia Creek and the various industrial inputs entering this modified watercourse. The Cecelia Creek Project Report inventories the business sectors within the study area, the associated contaminants and the potential for each sector to contribute contaminated effluent to storm water. It is an assessment of the status of Cecelia Creek, and emphasizes the industrial activities and their practices within the study area. Furthermore, the Cecelia Creek Project Report illustrates the variance that exists in the practices of businesses within the same sector, as well as illustrating trends that exist within the individual sectors. It should be noted that all catch basins mentioned in this study are private, unless specifically stated as being otherwise.

Included in the report are digital maps representing the demographic coverage of industrial businesses within the study area. It also provides the locale of each business categorized by industrial sector, along with a rating of activities with respect to effluent discharge entering the storm drain system developed from on-site surveys and interviews. Conducting these on-site surveys and interviews provided the opportunity to educate businesses in regards to storm water quality

issues, the status of Cecelia Creek, applicable By-laws and the use of best management practices.

2.0 CECELIA CREEK

2.1 Watershed Boundary & Drainage Area

Cecelia Creek drains a large urban area of about 900 hectares spanning two jurisdictions. This area consists of mixed industrial, commercial and residential land uses and it is estimated that 90% of the watershed contains impervious surfaces. "The highest elevation (over 80 meters) and two-thirds of the watershed lies within the Municipality of Saanich" (Stallard *et al*., 1998). The City of Victoria possesses the only unculverted section of the creek (approximately 130 meters in length), which flows into the Gorge Waterway and is inundated by tidal waters for as much as ¼ of its length on a daily basis" (Stallard *et al*., 1998). The watershed boundary for Cecelia Creek encompasses both storm drain systems 641 C and 641 D. Figure 1 illustrates these two storm drain outfalls where they daylight in Cecelia Ravine. The present watershed boundary of Cecelia Creek is not outlined by natural topography; it is bound by these storm drain systems (Figure 2).

Figure 1: Outfalls 641 C (right) & 641 D (left)
Figure 2: Cecelia Creek Storm Drain System 641 C & 641 D

2.2 History of Cecelia Creek

Over the past century, the lands adjacent to Cecelia Creek gradually urbanized, causing a series of intense modifications to the Creek.

> "Cecelia Creek originally branched just south of Burnside Road with watercourse tributaries that probably continued up the hillside where Tolmie and Glasgow Avenues now intersect. However, by 1890 the City maps illustrated culverting of sections of the creek along its longer tributary. In 1907, City maps revealed the continuing disappearance of Cecelia Creek as development progresses and with the construction of the Selkirk Trestle in 1917. Victoria City atlases show that the modification of the Cecelia Creek estuary and the reduction of Cecelia Creek to 200 meters in length was complete by 1919."
> (Stallard *et al*. 1998)

2.3 The Present Status of Cecelia Creek

The Selkirk Waters area contains the region between the Bay Street Bridge to the Selkirk Overpass as well as Cecelia Creek and the adjacent intertidal mudflats (Emmett *et al*., 1996). The Cecelia Creek estuary, which contains a fringe of salt marsh vegetation and a tree-shaded embankment, is the second largest estuarine mudflat in the entire Gorge Waterway, comprising 3.75 ha (Stallard *et al*., 1998).

Cecelia Ravine Park is located on both sides of the creek between Burnside Road and the Gorge, and includes the only accessible portion of the creek. "In 1992 the Capital Regional District Parks Department created the Galloping Goose Regional Trail, a multi-use pathway which passes over and adjacent to the creek, through Cecelia Ravine Park" (Stallard *et al*., 1998). The creek has fecal coliform counts well over the acceptable level for swimming, and high levels of metals such as mercury, zinc, and cadmium. The creek is riddled with oils, solvents and has trash discarded along its banks (Cleverley, 1998). The following figure illustrates the turbidity and high sediment levels of Cecelia Creek.

Figure 3: Upstream View of Cecelia Creek

2.4 The Pollutants Present in Cecelia Creek

Storm drains are the major routes for contaminants to the harbours from non-point sources. LGL Limited Ltd. states that "Contamination from industrial sites will be conveyed in the water and sediment that passes down these drains. The contaminants in each drain will reflect the sources within the drain catchment" (1995).

Chemicals found in excess of the CRD adopted Marine Sediment Quality Guidelines (MSQG) for sediment samples in the drainage area of Cecelia Creek are: cadmium, lead, zinc, copper, mercury, arsenic and heavy and light polycyclic aromatic hydrocarbons (LPAHs and HPAHs) (Emmett *et al*., 1996). According to

Municipal Storm Water Quality By-laws listed in Appendix 4, uncontaminated water is the only substance allowed to enter storm drains.

Drainage 641 D was noted as contributing a notably higher amount of chemical contaminants than would be regarded as average (Emmett *et al.*, 1996), while drainage 641 C was comparable to other storm drains, and was found to have only zinc in excess of MSQGs (Emmett *et al.*, 1996). When comparing the urban demographics for both catchment areas, the land use within the area of 641 C is mainly residential. Alternatively, the land use within the 641 D catchment area is largely industrial and commercial, with a high concentration of automotive shops, electrical shops, paint retailers and mall outlets. During a survey of the upper Victoria Harbour and Selkirk Waters conducted by Archipelago Marine Research, water from storm drain 641 D had the "lowest" quality sample based on visual observations and odour levels (Emmett *et al.*, 1996).

2.5 Areas that Exceed the Marine Sediment Quality Guidelines

All of the tests conducted during a CRD sampling program were of sediment samples. The sediment samples were extracted where they naturally occurred, either in drainpipes, manholes or catch basins. Two sampling locations in particular were cited for MSQG exceedences: two separate catch basin and manhole sediment tests on Tolmie Lane, situated on the Saanich/Victoria Municipal boundary, and a catch basin in the middle of Beta St. (Emmett *et al.*, 1996).

The catch basin on Tolmie Lane exceeded MSQGs for the following chemicals: cadmium, copper, lead and zinc. The manhole test on the same lane also exceeded MSQGs for arsenic, cadmium, copper and zinc. A sediment test further upstream from this location also exhibited chemical exceedences for lead (Emmett *et al.*, 1996). Other manholes further upstream were also noted to be in excess for cadmium, copper, lead and zinc (Emmett *et al.*, 1996).

The Beta St. catch basin (surrounded by automotive shops) exceeded MSQGs for HPAHs and LPAHs, as well as arsenic and cadmium. (Emmett *et al.*, 1996). Both the Beta and Tolmie test sites are near the end of the cumulative drainage of 641 D. Sites further upstream may provide indication of potential contaminant sources. Sediment test sites that exhibited MSQG exceedences are illustrated in the following figure.

Figure 4: Sediment Test Sites in Excess of Marine Sediment Quality Guidelines

The CRD "Stormwater Quality Survey Core Area" (1997) includes drainage 641 which flows into Cecelia Creek. In 1997 Drainage 641 is cited for a high public health rating. In 1996 it was cited high for both public health and contaminant rating. In 1997 it received a moderate contaminant rating, however the outfalls of the 641 C and D discharge pipes are listed as a high contaminant rating. A contaminant rating is based on the level of contamination present, whereas a public health rating is based on the need for mitigative measures, the level of fecal coliforms present and the public use of the shoreline (Miller *et al*., 1995). In addition, the average fecal counts for Cecelia Creek are well above "primary contact criteria" as 641 functions as a combined sewer overflow associated with a sewage pumping station (Miller *et al*., 1995).

Two manhole sediment tests were conducted upstream in the drainage area: one on Tolmie Lane (within 641 D) and one on Cloverdale Avenue (within 641 C). The 641 D test had a moderate rating due to zinc and PAHs, and the 641 C test had a high rating due to high PAHs (Miller *et al*., 1995).

Sediment testing of both 641 C and 641 D storm drain systems were in excess of MSQGs for HPAHs. Two samples exhibited exceedences for mercury and zinc. High measurements were also recorded for cadmium, lead, and LPAHs. Drain outfall 641 C had an excessive reading for zinc, while 641 D outfall tests had high readings for zinc and HPAHs, and additional high readings for LPAHs and mercury (Miller *et al*., 1995).

3.0 DETERMINING NON-POINT SOURCE POLLUTION INPUTS

3.1 Chemicals Used by Each Business Type

To assess which industries could potentially be contributing contaminated effluent into Cecelia Creek, a baseline of products related to the business types within the study area was determined. A list of potentially contaminating processes related to pollutant by-products is as follows:

Table 1: Contaminants and Their Sources

Contaminant	Source
Cadmium	metal cleaning (caustic solutions), soldering for aluminum, photo processing (photo finishing and ink), printing, batteries, paint, oil spills and tire wear
Lead	radiator repair, automotive/gas stations, photo processing/printing, exterior and road marking paints and tire wear particles
Zinc	automotive repair (fuel, oil, brake fluid, antifreeze, radiator flush), pigments and preservatives, gas stations (fuel leaks, radiator repair), tire and pavement wear particles, exterior and road marking paints, atmospheric deposition, and automobile exhaust
Copper	pipe corrosion (brass & copper), sewage treatment plant effluent, brake lining wear particles, asphalt and radiator repair
Mercury	latex paints, home detergents/bleaches, fluorescent and mercury vapor lamps, and dental wastes
Arsenic	fossil fuels, production of iron, steel, copper, nickel and zinc
PAHs	petroleum products - automotive industry, metal cleaning - caustic de-rusting solutions, - formulation solvents, motor oil, tire wear particles, exhaust, erosion of road surfaces, contaminated oil and atmospheric fallout

(Miller *et al*., 1998) Only processes pertaining to activities within the drainage were extracted from the source material.

A standard chemical inventory that represented the industries in the study area was developed prior to conducting on-site business surveys and interviews. The chemical inventory was acquired by obtaining Material Safety Data Sheets from the Workplace Hazardous Material Information System from the trades section at

the Interurban Campus of Camosun College. This inventory proved to be a valuable guide to the study team when developing the appropriate questions for each business type. In addition, interviews were conducted with tool shop attendants to further determine commonly used chemicals that had a high potential to enter storm drains or sanitary sewer systems. 17 categories of industry were surveyed.

3.2 Businesses within the Cecelia Creek Drainage

To determine sources of potential contamination, comprehensive ground truthing was used to ascertain what businesses and activities were within the study area. Some businesses in the study area were excluded, such as office, retail, or wholesale sites that were determined not to have a significant impact on storm water quality. In addition, some businesses were excluded because they lacked private and/or municipal storm drain access. Some businesses were included because of the potential for contaminated wastewater effluent to enter the sanitary sewer; regardless of their negligible direct impact on storm water quality in the study area. Figure 5 represents the type and amount of businesses and figure 6 illustrates the location of the business sites within the study area.

Figure 5: Business Types within the Cecelia Creek Study Area

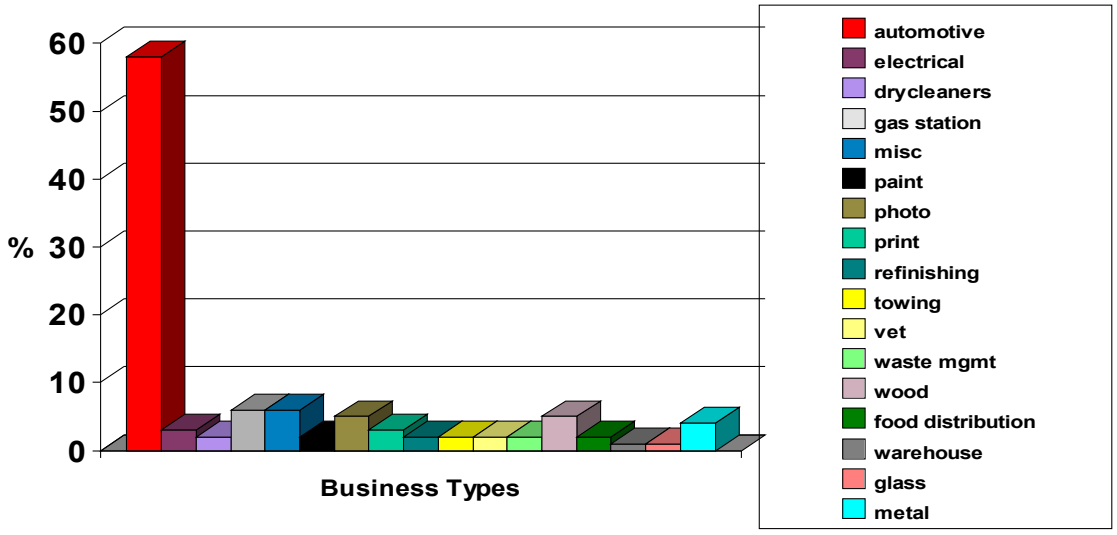
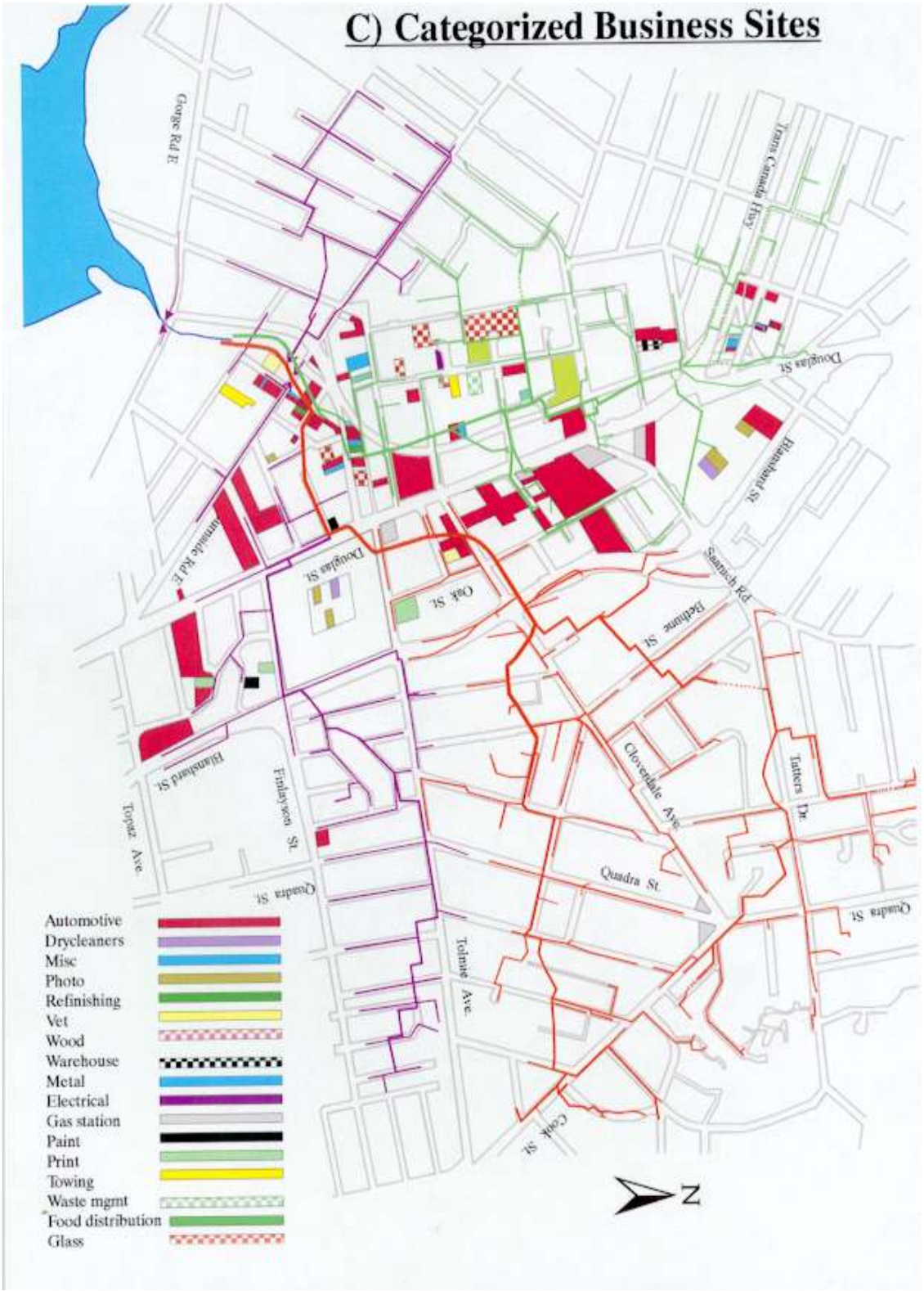


Figure 6: Illustration of Business Sites within the Study Area



Archipelago states that high contaminant input via storm drains correlates with industrial activity within drainage areas. Non-industrial sites such as parking areas and residential streets do not appear to significantly contribute to such high contamination (Emmett *et al.,* 1996). This suggests that 641 D and its corresponding high level of industrial activity could directly impact the study area. The figures below compare the amounts and types of businesses within 641 C & D. They illustrate the high concentration of potentially polluting business sites within 641 D, as it covers half the area of 641 C.

Figure 7: Businesses within Storm Drain Region 641 C

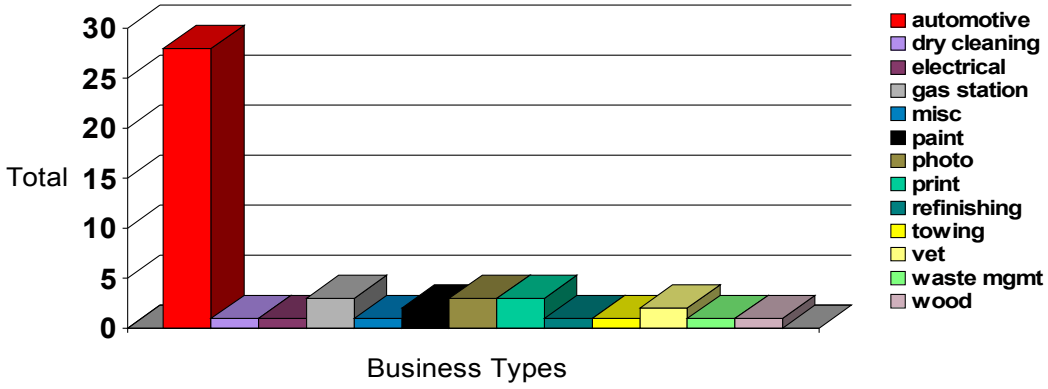
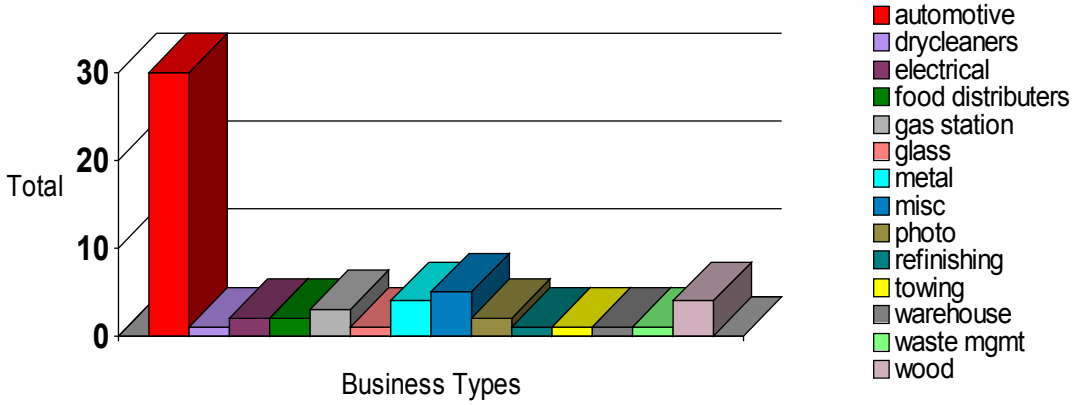


Figure 8: Businesses within Storm Drain Region 641 D

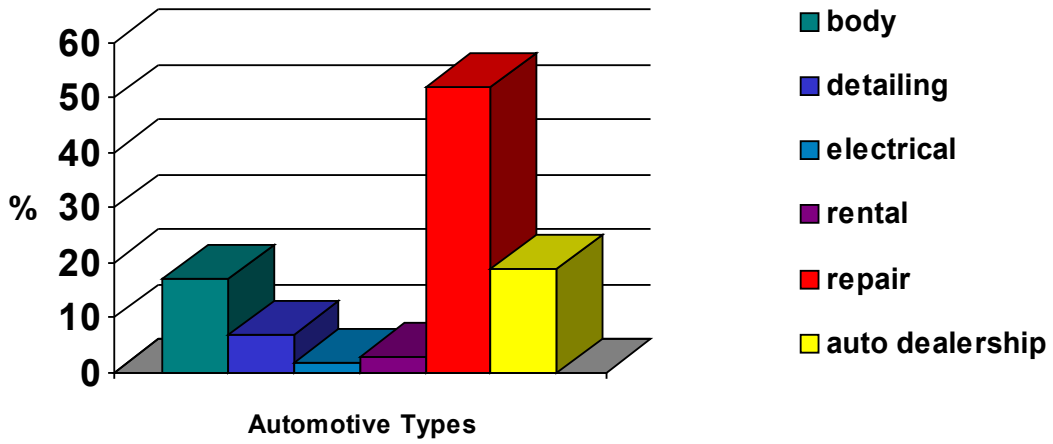


4.0 CURRENT BUSINESS PRACTICES

4.1 Automotive Industry

Out of 119 businesses 101 were interviewed and assessed. After developing a database with all of the relevant businesses, on-site surveys and interviews were conducted. Based on these surveys it was apparent that there was a wide range of practices within one industry type. This was particularly apparent within the automotive sector, where the number of businesses was disproportionately high totaling 58% of all businesses. The automotive industry was further divided into several different sectors with distinct practices and therefore different potential impacts. The figure below illustrates the breakdown of the entire automotive industry. As illustrated, automotive repair dominates this category with the highest percentage of businesses.

Figure 9: Automotive Related Business types in the Cecelia Creek Drainage



The following information details the breakdown of the automotive sector and the corresponding practices:

4.1.1 Auto Body

Most of their materials and chemicals used by the auto body facilities were self-contained. The paints were applied in down drafts facilities, which filter the paint

particulate and discharge treated air. Paint gun solvent was also recycled into closed drums and containers. Chemical stripping was not practiced, as most was done via dry sanding. However, some shops stated they performed some wet sanding (<10%).

Wet washing of these shops was not a common practice. Auto body shops did however pre and post wash the vehicles they service. The cleaners used to pre-wash the vehicles were strong, as their purpose was to rid the vehicle of tough dirt and to condition the surface. The post-wash used milder cleaners to remove any excess paint particulate. All of these facilities did not use on-site treatment and all wastewater from vehicle washing was entering storm drains.

4.1.2 Auto Repair

Repair shops within the study exhibited some variation. A general summation of standard detrimental practices would be the unconfined engine shampooing, engine parts rinsing, transmission or radiator flushing, and car washing. Repair shops often washed all the vehicles they serviced. The other practices were dependent on the type of repair shop. Some of the shops washed vehicle engines, but it was noted that several refused to do so. Some businesses would employ other automotive shops to perform this service, such as auto detailing shops.

Radiator and transmission flushing, was not practiced within all of the shops, however, some specialized. The range of practices for changing radiator fluid varied from the completely self-contained Wynn recycling system to drain-bin changes. All auto repair shops recycled their anti-freeze. One auto shop repaired radiators as a sole specialty, and would service radiators from other auto shops in the region. The majority of the radiators were pre-drained before arrival. Radiator repair involved the use of a soak bin for radiator cleaning Although this soak bin is self-contained, it was common to rinse the radiator parts

with water into a nearby storm drain. There were rust trails observed, leading from a radiator shop into a Municipal storm drain.

Another shop was noted for soaking large vehicle parts and diesel engines for other automotive shops. The wastewater from parts rinsing was entering the sanitary sewer. This finding was confirmed through their building plans as the discharge pipe from the soak tank was connected to a sanitary pipe originally designed to function as a washroom. The pH of the solvents used in the soak bins ranged from 12.2 to 13.5 post dilution. These soaks utilized alkaline solvents, which reacted on the engine build-up. The engine residue was then removed by rinsing the part with a power washer.

Many shops changed oil and antifreeze, but avoided transmission and radiator flushes. Oil, antifreeze and solvent storage did not appear to be causing an impact on storm water quality in the study area. However, it was common to overfill waste oil holding tanks when they reached capacity, causing ground spillage under the tank. It was common that floor residues caused by such spills were removed by wet washing the surface with a solvent.

Another practice that had the potential to contribute contaminated effluent to the storm drain system was the unconfined spraying of solvents onto engine parts and engines on the lot, as the rinse waters were entering the storm drain system. For example, at one shop it was a standard practice to clean an engine by spraying it with brake cleaner, then wash it into the storm drain. It was also a standard procedure to spray clean an engine using a pressure washer to find an oil leak, and the same practice is performed for engine washes. Nine auto repair shops were found to be washing engines using degreasing solvents with a pH range of 12 to 14.

Forklifts require a significant amount of hydraulic lubricant and if leaking they can produce oil waste residues on impervious ground surfaces. The facilities that utilized or repaired diesel forklifts had very oily floors or ground surfaces.

A general concern with auto repair shops was the frequency of shop floor washing. How often a shop washed its floors and with what products would be key to the contribution of potentially contaminated effluent into the storm drains. The majority of shops washed their floors, and some with strong solvents. Washing with a cleaner was noted at seven auto repair shops, with a cleaning schedule ranging from daily to once every three months. While most shops used mild detergents, one shop washed their floor daily using a cleaner with a pH of 12.

4.1.3 Auto Detailing

Auto detailing shops were responsible for complete car washing including engines and wheels. The volume of wastewater effluent containing solvents coming from a detailer was visibly high as their wash waters were entering the storm drain system. Auto detailers also used some very strong cleaners, such as wheel rim washes, which are primarily hydrochloric and phosphoric acid. Every detailing shop reviewed performed engine shampooing using alkaline solvents in a spray on/wash off procedure.

4.1.4 Auto Dealerships

General practices for dealerships included all of the concerns for auto body, auto repair, and auto detailing, plus individual lot practices. All of the car dealerships washed their display vehicles frequently, and most operated a repair, detailing, and even auto body shop.

One car dealership washed their display vehicles with water only. This dealership also operated a separate, self-contained oil sump in their repair shop. In comparison, another shop washed all the display vehicles with a cleaner twice

a week. This dealership also washed all vehicles serviced by both the auto repair and auto body shop. The floor of the auto repair shop was washed with a 2 in 1 degreaser (pH=12.2) once per week, and parts rinsing (post solvent treatment) was performed outside on the lot. Wheel and wheel rim washing of test driven vehicles was also performed. The lot catch basins were not maintained and the wastewater effluent from auto detailing and post repair vehicle washing was entering a Municipal storm drain.

A practice that was unique to dealerships was the fall-out treatment of new vehicles. Fall-out treatment was used to remove a protective wax coating on the new vehicles. This procedure involved the application of a dilute acid wash, which was applied and rinsed off to eliminate paint impurities of all new vehicles upon arrival.

4.1.5 Auto Rental

The primary wastewater producing practice related to rental facilities was regular fleet washing. Additionally, all auto rental facilities within the study area operated auto repair shops which did not contain any on-site wastewater treatment facilities.

4.1.6 Fleet Washing

Several companies in the study area employed large vehicle fleets and they cleaned their vehicles off-site. However, a mobile wash company that fleet washes is servicing others on site in the study area. The wastewater from this company's operation was entering the storm drain system. The survey uncovered four companies in the study area with large vehicle fleets that used this service.

One facility, which included twenty-nine vehicles, including buses, washed and maintained their vehicles on the lot. During the on-site tour a bus was observed being power washed with a strong detergent into the lot storm drain.

4.1.7 Gas Stations

All of the gas stations in the study area did not change oil or antifreeze, and the majority pressure washed their lot with water only. Some of the stations washed the lot with a solvent once a year.

Two of the gas stations surveyed in the study provided car-washing facilities. One station's wash drains were hooked up to the sanitary sewer system, and wastewater at the other facility was continuously recycled. These facilities pre-wash the vehicles by hand with a car wash detergent to rid any stubborn spots and these wash waters were entering the storm drain system.

4.1.8 Towing

All of the towing companies stated that they were not conducting any vehicle washing, maintenance or part disassembly at their facilities. However, source complaints and witnessed accounts of their activities contradicts the previous statement.

4.2 Automotive Summary

The main concern with the auto-related businesses in the study area was the lack of catch basin maintenance. It is common to pump out the basin when it becomes full or well after its ability to operate effectively has been reached. The high concentration of automotive shops in the study area and their common practices can be attributed to cumulative effluent wastewater entering the storm drain system.

4.3 Other Practices Within the Drainage

The remaining businesses have a smaller presence within the study area and are not automotive related.

4.3.1 Dry Cleaning Dry cleaning did not appear to affect storm water quality, since none of the facilities surveyed had storm drains access on-site.

4.3.2 Electrical The electrical facilities encountered performed contract work at the job site and did not store hazardous materials.

4.3.3 Paint Only one of the two retail paint shops was surveyed. They did not clean their paint mixers and did not have storm drain access within their facility.

4.3.4 Photo The only two photo development shops were located within Mayfair Mall. The janitorial attendants of Mayfair Mall stated that there are no storm drain outlets inside the mall. A manager and staff person from one of the photo processing outlets said that undiluted non-recyclable waste developing solvents were being discarded down the toilet.

4.3.5 Print A print shop was observed rinsing their blanket and roller solvent from the off-set printers into the workshop sink. The solvents that were discarded were activator and stabilizer solutions from the Silver Image Master Maker.

4.3.6 Wood Primary mill shops did not produce any waste waters as the only waste produced were wood wastes. Most utilized vacuum filtration systems for collecting sanding wastes.

4.3.7 Furniture Refinishing Two sites were reviewed for their practices related to furniture restoration and refinishing. Both facilities performed furniture stripping, however only one shop had storm drain access from within the shop. This facility was using a four-inch floor drain within the workshop for a post furniture strip and rinse procedure. The furniture stripping residue and thinner on the furniture piece was post washed into the storm drain using laundry detergent. This was a standard procedure for all furniture stripping at this location. The

second location dry stripped manually, by scraping or sanding the residuals off and water was not used in their processes. The waste was then swept up and disposed of as hazardous waste.

4.3.8 Veterinary One Veterinary facility utilized a filtration system on its storm drain that was enforced by the City of Victoria and subsequently implemented. The Municipality of Saanich recently inspected the second facility prior to the on-site visit.

4.3.9 Metal Due to the ingredients that are in fluxes and solders, it was a consideration that welding could be contributing heavy metals to storm water. Without exception none of the shops interviewed used fluxes for welding, unless they were inclusive in the solder product and none of the shops had storm drain access within their facilities.

The interior of one steel fabrication shop was covered with red steel primer particulate. All of the primer painting was conducted inside and the shop was dry swept daily. There was a visible dry red stain leading down to the storm drain located outside of the shop, however during the on-site tour a stream of particulate was not evident.

4.3.10 Food Distribution The food distribution facilities within the survey area had large vehicle fleets that were cleaned weekly by a mobile washing company. The fleet at one site included four large refrigerated trucks, and the other distribution facility had over thirty trucks ranging from vans to semi trailer trucks.

One site operated a forklift in the refrigeration area of the facility. The floor was visibly streaked with oily floor residues and was washed on a bimonthly basis using a heavy cleaner with a pH of 13.0-13.5. Because the facility lacked inside drains all wastewater from the power washing of floor surfaces was hosed out of the loading dock and into two sump drains in their parking lot. Upon

examination, these catch basins were full of dark colored waste water and contained what can best be described as grease curds.

Another distribution facility washed its floors daily with the aid of a vacuum system. The wastewater from this equipment was discharged into the sink. This site also contained tertiary processing plants for fish, cheese, and vegetable produce. The five floor drains in the cheese and produce processing areas were capped to stop the entry of food particles into the drain system. These tertiary-processing areas were washing daily with diluted bleach.

4.3.11 Appliance Repair Appliance repair includes the servicing of large restaurant and other assorted appliances. The power-washing of the appliances with detergents on the lot was observed and this practice was contributing effluent wastewater discharges into the storm drain system.

4.3.12 Warehouses The warehouses in the study area employed vehicle fleets. However, the vehicles were owner operated and were washed off site by the individual owners.

The following table illustrates the amount and overall percentage of businesses that receives on-site surveys and interviews.

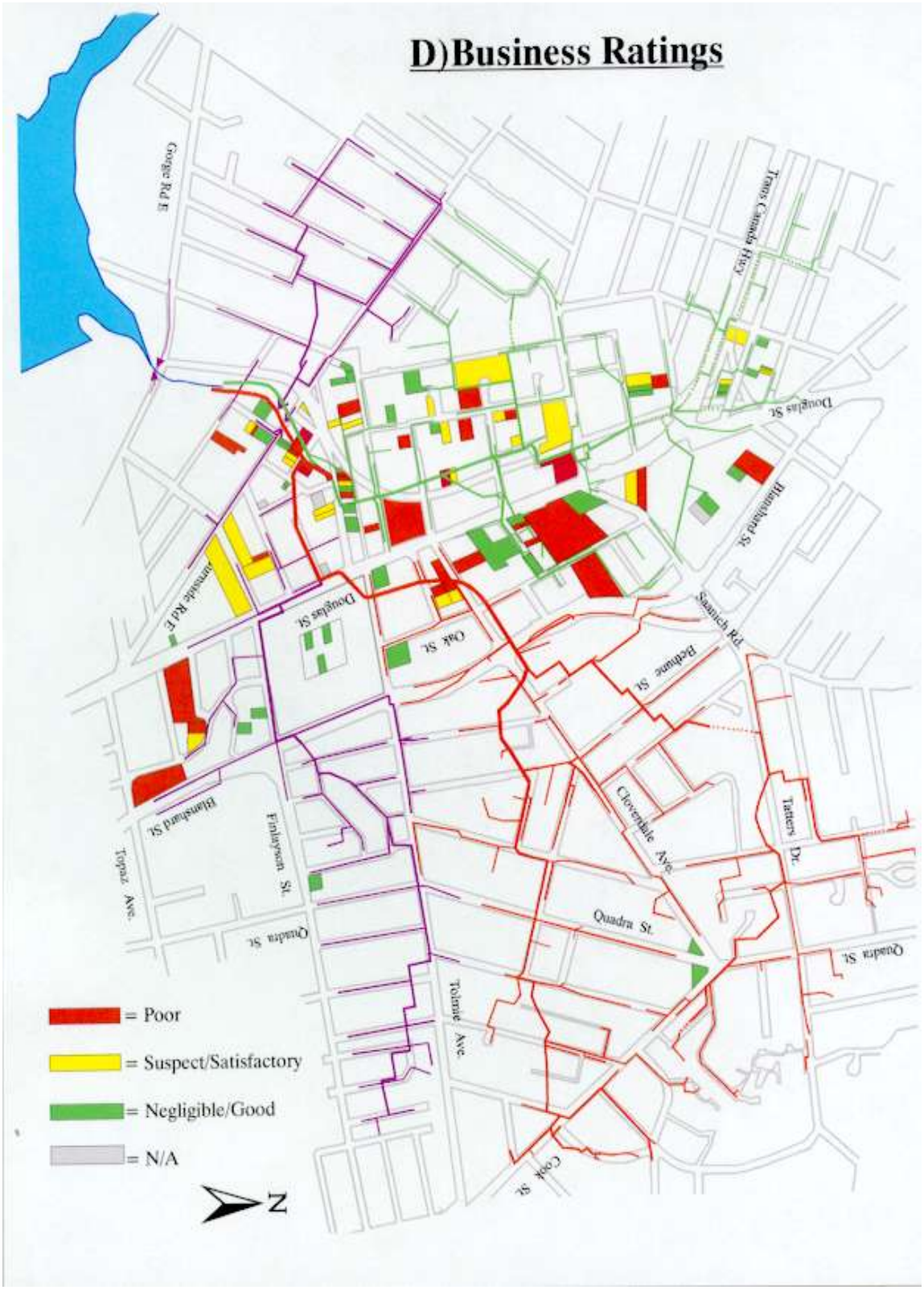
Table 2: Businesses that Received On-Site Surveys and Interviews

Business Type	Total Interviewed	%	Business Type	Total Interviewed	%
Automotive	48/58	83	Paint	1/2	50
Dry Cleaning	2/2	100	Photo	4/5	80
Electrical	3/3	100	Print	3/3	100
Food Distributors	2/2	100	Furniture Refinishing	2/2	100
Gas Station	6/6	100	Towing	2/2	100
Glass	1/1	100	Veterinarian	2/2	100
Metal	3/4	75	Warehouse	2/2	100
Miscellaneous	4/6	67	Waste Mgmt	2/2	100
Wood	5/5	100			

4.4 Business Rating System

The rating system is as follows: red for poor, yellow for satisfactory to suspect, green for good to negligible and grey for not visited. The system operates purely with respects to contaminant effluent discharges into storm drains. This system was based on the on-site visits and observed practices. The rating system does not target catch basin maintenance per se, as a table has already been formulated for their maintenance to demonstrate that it is infrequent and generally poor. This rating system operates purely with respects to effluent discharges into storm drains. For example, the furniture refinishing company that was discharging furniture stripping residue and detergents into the storm drain system received a poor rating. An auto repair business may have received a satisfactory to suspect rating because the company washed the vehicles that it serviced and a paint company may have received a green rating as it did not have any storm drain access within the building or nearby lot space. The study team realized that this system was not flawless as it is difficult to rate observations and conversations from the on-site visits, however, this was a best attempt to determine and consider relative toxicity of different source pollutants and practices. The following figure illustrates the disbursement of business ratings within the study area.

Figure 10: Illustration of Business Ratings



5.0 WASTE MANAGEMENT

According to one company that removed catch basin sediment from businesses within the study area, a permit was needed to dispose of catch basin sediment. A contact from the Hartland Landfill confirmed that the Environmental Services Group from the CRD must approve the waste and issue a permit before it can be disposed of. The sediment is deposited into a liquid waste disposal facility, and the suspended sediment is settled out and landfilled. The wastewater is collected and travels out of the landfill as leachate to the Clover Point sewage outfall.

The CRD is working with Municipalities to begin sampling and analysis of catch basin wastes to ensure that practices are in accordance with relevant By-laws. They are developing a handling and disposal plan for each Municipality in order to better protect the environment. The wastes will be categorized into street sweeping wastes, liquid and solid catch basin wastes, and liquid and solid storm water wastes.

5.1 Businesses with Oil Interceptors or Treatment Facilities

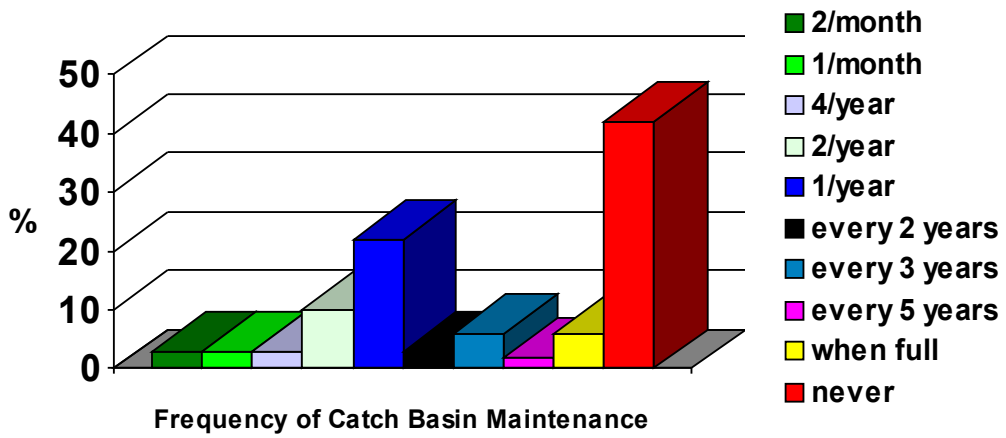
There were five businesses utilizing an oil interceptor within the study area. One auto repair shop used an absorbent sac, placed into the catch basin to soak up waste oils. The sac changed colour when full therefore signaling when it should be replaced, however, the end disposal site for the absorbent sac was unknown.

5.2 Maintenance Schedule-Catch Basin Care

Throughout the survey it was noted that there was a wide range of practices regarding catch basin maintenance. Many shops were highly cognizant of the need to maintain their catch basins, while others were unaware if they had any. In total there were 67 catch basins identified throughout the business survey. All

of the catch basins in the study are privately owned unless stated as otherwise. The following figure represents the level of catch basin maintenance within the study area. As illustrated, 42 % of which were never maintained, and 22% were maintained only once a year.

Figure 11: Frequency of Catch Basin Maintenance



T&E Consultants verifies that it is important to "Routinely maintain and monitor the performance of catch basins to determine their adequacy and what additional measures may be needed to manage the quality and quantity of water and sediment discharges to the storm drain system" (1996). Catch basins are effective as a source of treatment and storage of stormwater contaminants, however they do have a limited capacity to do so. T & E Consultants states that "The removal of sediments is a method of intercepting some of the heavy metals, oils, and bacteriological contaminants that are absorbed and concentrated in these materials. If the tributary areas to the catch basin are inadequately swept, or if cleaning of the catch basin is not frequent enough, the quality of these sediments may degrade to a point where they must be handled as a Controlled or Special Waste" (1996).

The City of Bellevue Utilities Department has implemented a proactive program that addresses storm water quality issues. The following information regarding catch basin maintenance was

> "If you own or maintain a business site, check your catch basins at least twice a year to see if they need cleaning. If you wait any longer, debris may accumulate in the outlet pipe and will be time-consuming and considerably more expensive to clean. Cleaning should be done in the spring and again before the rainy season begins. Catch basins should be cleaned out before deposits fill 60% of the area below the outlet pipe."

It is critical to maintain catch basins regularly, however, it is apparent that a catch basin maintenance schedule will vary greatly between business sites. Even within one industry type the maintenance schedule will vary. For example, within the automotive sector the frequency of catch basin maintenance ranged from twice per month to never. The Bellevue Utilities Department stated that the frequency of catch basin should be about twice a year. However, the diverse business practices within the study area will largely dictate the selection of an individual and specific catch basin maintenance schedule.

The performance of the catch basin will directly depend on the frequency of maintenance. It can be concluded that within the study area the frequency of catch basin maintenance and subsequently their ability to perform appropriately was generally poor

6.0 BEST MANAGEMENT PRACTICES

Archipelago Marine Research Ltd. supports the implementation of Best Management Practices (BMPs) in industrial areas. Their data suggests that industrial areas are a major contributing source of storm water sediment contamination. Archipelago also states that "Source control programs should

incorporate the development, adoption and enforcement of BMPs for industrial activities, particularly ship yard, scrap metal, recycling and auto related industries (1996)."

BC Environments definition of BMPs is as follows:

> "BMPs are practices which are currently regarded to improve the quality of urban stormwater runoff, including source control BMPs and treatment BMPs. Source control BMPs are designed to prevent pollutants from contacting rainfall and runoff waters. Treatment BMPs are constructed facilities that store, infiltrate, and/ or treat urban runoff to reduce flooding and erosion, replenish groundwater reserves, remove pollutants, and provide other amenities."
> (1992)

BC Environment states that, "Source Control BMPs can reduce the loadings of pollutants which threaten priority receiving water uses" (1992). T&E Consultants Ltd. state that, "If Source Control BMPs have been implemented, and stormwater quality improvement is still inadequate, treatment BMPs should apply. The range of options available as treatment BMPs is wide and they include physical, biological and chemical mechanisms to remove stormwater contaminants. Specific chemical contaminants of concern, and site conditions will largely dictate selection of the treatment BMP" (1996).

6.1 Oil-Water Separators

The purpose of an oil/water separator is to allow oils to collect on the surface and sediments to settle on the bottom. This allows unpolluted wastewater to flow into the storm drain system. There are a variety of oil/water separators available and the implementation of a specific oil/water separator will depend on the situation with which it is to function. BC Environment states the following regarding the structure and purpose of oil/water separators.

> "The key to any oil/water separator is to give the oil droplets enough time to float the surface as the water continuously moves through the separator. The bigger the separator, the more time the oil droplets have to rise to the surface. Oil is usually in the form of discrete oil droplets. Oil droplets that are very small may form an emulsion of oil and water. It may be too long for the small droplets to reach the surface before the water has left the separator. For this reason a three-chambered separator is recommended. The first chamber is the largest, and most of the oil will be removed from the effluent at this point. Oil, which is dissolved, will no longer form discrete droplets. Dissolved oil in water with more than 15 parts per million of total extractable hydrocarbons will require additional treatment."
> (1995)

BC Environments "Summary of Environmental Standards & Guidelines for Fuel Handling, Transportation and Storage" (1995) states the following procedures in regards to the implementation and effective maintenance of oil/water separators.

Initial Collection:

- Area is constructed with a cement pad and a sump for the collection of mud and spilled fuel or oil;
- Along the top third of the sump, water drains to the oil/water separator;
- Initial compartment should be large enough to collect oily waste and any accumulated mud/sand;
- The following two compartments separate oil and water;
- Access to mud sump collection area, to allow regular maintenance.

Oil/Water Separation:

- The ratio of depth to width should be approximately equal to 0.3.
  $\frac{\text{depth}}{\text{width}} = 0.3$
- The length should be approximately three times the width.
- The greater the surface area of the separator the more effective the separation.
- The bottom should be sloped to allow mud to settle to one side.
- The initial compartment should be the largest to allow as much oil as possible to be collected in one chamber.

- Minimum capacity of separator should be approximately 220 gallons (1,000 litres) to prevent the discharge of an accidental spill.

Final Discharge:

- Effluent must not exceed levels of 15 mg/litre of total extractable hydrocarbon[37] and 10 mg mineral, oil and grease. [16]
- No observable sheen may be detectable on the effluent.
- Shut off valve at final discharge pipe to prevent the discharge of an accidental spill.
- During extended periods of freezing temperatures, the operator may convert the separator to a spill interceptor by emptying the separator and closing the discharge valve.
- The final discharge effluent may enter the environment if all the criteria are met.

Maintenance:

- Dip tank regularly to monitor oil levels;
- Pump out, store and dispose of oily waste regularly in a manner approved by BC Environment;
- Remove and dispose of sludge and sediment regularly in a manner approved by BC Environment.

Other Options:

- Coalescing oil/water separators
- Activated carbon filters (charcoal filters)
- Air assisted liquid phase separators

According to the BC Environment “it is good practice to install flow control facilities upstream of oil-water separators where possible, to prevent flushing out of accumulated pollutants by major storms” (1992). It is also stated that emulsifying agents, such as detergents and antifreeze should not enter any oil-water separators. “Sources of emulsifying agents such as car washes and industries which utilize detergents should be identified, and runoff from these sites should be prevented form entering storm drains” (1992). The performance of the oil-water separator will directly depend on the frequency of maintenance. “Weekly inspection of oil-water separators is recommended, with cleaning as

required; separators should always be cleaned before the onset of the rainy season, and again after the first significant storm" (1992). It is also required that oil-water separators are cleaned immediately after a spill.

6.2 Bioremediation

The preservation of the estuarine mudflat habitat located at the mouth of Cecelia Creek is essential, as it is an integral part of the marine habitat of the Gorge and Selkirk Waterway.

Figure 12: The Cecelia Creek Estuary

This mudflat is the second largest within the Selkirk waterway and its attributes should be a priority for remediation measures. Archipelago Marine Research Ltd. states the following:

> "Source control in this catchment area should focus on sub areas within the catchment where high levels of stormwater drain sediment contamination have been observed. This discharge is unusual in that it is an open creek for the last few hundred meters, which, with the increased recreational use of the area associated with the opening of the Galloping Goose spur, will increase a growing degree of human contact. Stormwater management

> measures should be considered for this discharge. Such measures might include oil-water separation at the discharge outfall, and/or bioremediation to reduce the load of contaminated sediment, which reaches the adjacent estuary. Bioremediation measures could include modification of the creek to slow the more contaminated base flow, combined with addition of vegetation to partially treat the water and sediment"
> (1996)

6.3 Design of Wet Detention Ponds

A bioremediation technique recommended in this study for implementation in Cecelia Ravine is the construction of wet detention ponds and the use of phytoremediaton. Wet detention ponds and phytoremediation would function to minimize the amount of contaminants found in the storm water. Appendix 3 outlines the overall design of wet detention ponds and associated phytoremediation recommendations.

7.0 PUBLIC EDUCATION

A requirement for a successful source control program is the development of a comprehensive public awareness program. An important part of implementing source control is the development of projects that focus on education, technical assistance, financial incentives, and enforcement on specific geographical areas where source controls offer the greatest potential benefits (Archipelago 1993).
BC Environment states that, "Public and private sector education should be a major element of any source control program. Education programs should emphasize that the effects of contaminated urban runoff accumulate over time, and that pollutants are generated by a large number of individually insignificant sources" (1992).

7.1 On-Site Visits

On-site visits and interviews were used as an opportunity to inform the various industries with respect to the storage of chemicals, non-toxic alternatives, appropriate schedule for catch basin maintenance and a general introduction to Cecelia Creek.

7.2 Pamphleteering

On-site visits and interviews were accompanied by a stormwater quality pamphlet to further discuss the importance of storm water quality. This pamphlet included a section on Cecelia Creek, its present status and its location. By-laws pertaining to storm water for both the City of Victoria and Municipality of Saanich were summarized. In addition, the pamphlet identified general BMPs and phone numbers of importance (Appendix 2).

7.3 Business Partners for Clean Water-Bellevue Project

The City of Bellevue in Washington State is leading the field of urban runoff quality control. The Bellevue Storm and Surface Water Utility, which was formed in 1974, undertake Stormwater management in Bellevue. BC Environment states that, “The mission of the drainage utility is to manage the storm and surface water system in Bellevue, to maintain a hydrologic balance, to prevent property damage, and to protect water quality, for the safety and enjoyment of the citizens and the preservation and enhancement of wildlife habitat” (1992).

Bellevue has implemented a program that involves businesses in the protection of water quality within their community. The City of Bellevue Utilities Department states, “The program is designed to give businesses the information they need to comply with water quality laws and to recognize businesses that take voluntary steps to protect local streams and lakes” (1993). It also allows businesses to

take responsibility within their community. This program is taking positive steps to ensure strong water quality protection in the Bellevue area.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Conclusions

There were some identifiable wastewater producing trends within the industrial sector. Despite this commonality, there was also a broad range of business conduct that made each facility unique. The high concentration of automotive shops in the study area has the potential to negatively impact storm water quality. It is clear that several of the practices witnessed contravene Municipal By-laws for storm water quality, Provincial Regulations and the *Fisheries Act*.

The diverse business practices within the study area will largely dictate the selection of an individual and specific catch basin maintenance schedule. The performance of the catch basin depends on the frequency of maintenance. As the frequency of catch basin maintenance in the study area was generally poor so will the ability of the catch basin to function properly.

Oil-water separators have the potential to diminish the amount of pollutants entering Cecelia Creek. Their implementation and appropriate scheduled maintenance within the study area can have positive repercussions on the water quality of Cecilia Creek. Through out the study, sixty-seven catch basins were identified amidst industrial activities

The implementation of wet detention ponds in Cecelia Ravine could slow the flow of water and subsequently allow to settling out of certain contaminants from the base flow. This bioremediation technique along with additional vegetation to treat the newly created sediment could aid in the removal of contaminants from the waters of Cecelia Creek and their deposition into the marine environment.

While the Municipalities may have insufficient funding to perform a business participation program such as the one in Bellevue, other cost-effective measures

could be considered. For example, education geared towards generating local awareness within the industrial sector may alleviate unnecessary discharges.

Most of the foreshore along the Victoria waterway has been greatly altered by hardened shorelines, with the Cecelia Estuary one of the few remaining unconsolidated shoreline areas. Archipelago Marine Research Ltd. states that, "These remaining areas should be conserved and further foreshore and intertidal modifications restricted to measures which remediate or enhance habitat values. Catchments adjacent to valued habitats should have high priority for contaminant source control, which would include discharge 641" (1996).

Once contaminants reach the bottom sediments of the Selkirk Waterway, remedial actions become more complex and expensive. Additionally, there is little point in conducting costly remedial measures in the receiving environment if contaminants continue to enter the harbour. Therefore the process of ensuring that contaminants are controlled at their originating sources should be emphasized. The future management of Cecelia Creek must consider both the reduction of contaminant input and the remediation of present contamination.

Recommendations

The following recommendations are based on the priority to eliminate and/or mitigate contaminated wastewater effluent from entering Cecelia Creek and subsequently the receiving marine environment.

1. Ensure Municipalities adopt adequate and appropriate By-laws for the protection of storm drains and water courses;
2. Enforce Municipal By-laws, Provincial regulations and Federal Legislation;
3. Delegate catch basin maintenance responsibility;
4. Install appropriate stormwater treatment technology for all businesses within the study area;
5. Investigate handling and disposal alternatives for catch basin sediments;
6. Implement bioremediation techniques such as wet detention ponds and associated phytoremediation in Cecelia Ravine;
7. Review and implement relevant sections of the Business Partners for Clean Water-Bellevue Project;
8. Adopt and enforce Best Management Practices for industrial activities;
9. Continue and expand follow-up studies; and
10. Initiate public education programs throughout the community.

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APPENDIX 1
CHEMICAL DATABASE

Industrial Use	Product	Notable Chemicals	Hazards	Suppliers
Distributer-floor cleaner	Industrial Bleach	Sodium Hypochlorite 12%, Sodium Hydroxide 0.7%, Sodium Chloride 8.5%	severe to skin, eyes, pulmonary edema -do not allow chemical to enter sewers or waterways	Prairie Chem Inc. #5516-40th St.SE Calgary AB T2C 2A1
Distributer-Heavy Duty Liquid Stripper/ Degreaser	Regain	2-Aminoethanol <7%, Ethylenediaminetetraacetic acid, tetrasodium salt (3 ppm), Alcohols C10-15 ethoxylated Sodium metasilicate, 2-butoxy ethanol (25 ppm) All <5%	pH:13.0-13.5 -don't mix with acids, chlorinated detergents -contact can cause burns to skin, eyes -Hazardous by WHMIS standards- spills should be disposed of as hazardous materials -prevent large spills from entering sewers or waterways.	Ecolab Food & Beverage Division (Klenzade) 5105 Tomken Rd. Mississauga, ON L4W 2X5 Tel: (905) 238-0171
Auto-Truck and Trailers Vehicle Washing	PDR 202 Truck and Trailer Wash	Nitrilotriacetic acid, Trisodium salt, Monohydrate (20-30%), Sodium carbonate (20-30%) (15 mg/m3 dust limit), Sodium metasilicate <10%	WHMIS Health 2/4 -chronic hazard flush -corrosive to eyes and skin-can result in blindness - severe overexposure can cause lung damage, choking, unconsciousness or death -one of the ingredients at high oral doses caused cancer in lab animals	ZEP Manufacturing Co. of Canada 10916 -#119 Street Edmonton, AB T5H 3P4 Tel: (403) 453-5800
Auto-Engine Washing	Foamy Engine Brite (Aerosol)	Aromatic Petroleum Distillate <12% (100 ppm), Amine Alkylaryl Sulfonate <6%, 2-Butoxyethanol <5% (25 ppm), Isobutane/propane <8%	WHMIS Class A,D1A,D2B -aerosol -chronic exposure in high concentrations may cause liver and kidney damage -fatal if swallowed -absorbs through skin -dermatitus	GUNK-Radiator Specialty Co. 1900 Wilkinson Blvd. Charlotte, NC 28234-6080 Tel: 1-888-827-4865
Auto-Shop Floor Cleaning	J-Shop 600 Cleaner	2-Butoxyethanol <12% (25 ppm), Sodium Hydroxide <3% (2 mg/m3), Sodium silicate <4%, Alkylphenoxy polyethoxyethanol <4%, Sodium xylene sulfonate <5%,	Health 3/4, pH:12.0 - use respirator if poor ventilation, gloves, goggles, protective footwear. Section 13:Preventative Measures was ommitted from this MSDS Sheet, so no avoidance of sewers was mentioned	SC Johnson & Son Ltd. 1 Webster St. Suite 100 Brantford, ON N3T 5R1 Tel: 1-800-257-7259

Industrial Use	Product	Notable Chemicals	Hazards	Suppliers
Auto-Post Auto Body Vehicle Wash	Multi-Wash Cleaner Hard Surface (8360) - GM Multi Wash	Sodium tripolyphosphate <7%, Potassium hydroxide <1% (2 mg/m3), Fatty Acid Diethanolamine 5%, Diethanolamine 5% (15 ppm ceiling), Phosphoric acid <5% (5 ppm ceiling), organic phosphate ester, ethoxylated nonyl phenol	WHMIS Class D Div 2 SDiv B - pH 9.75 - Health Hazard-Low -Inhalation not a hazard - spill should be picked up with an inert absorbent and then flushed - recommends wearing neopropene gloves and gogles, rubber apron for spill clean-up	Supplier - GM of Canada, Oshawa Manufacturer: Drew Chemical Ltd. 1 Drew Court, Ajax, ON L1S 2E5
Appliance Repair-Appliance Washing	Fantastic All Purpose Spray Cleaner/Dow All Purpose Cleaner Fantastic	Dow: Quaternary Ammonium Compounds <.3%, Butyl propasol <5%, Nonionic surfactants <5% Spray: 2-Butoxyethanol <5% (25 ppm -skin), Sodium silicate <2%, Sodium Hydroxide <1% (2mg/m3-ceiling)	Health-1/4 -dike large spills and use absorbent pH-12.4	See SC Johnson & Son, Ltd. - different tel: (800) 725-6737 US Manufacturer: (800) 725-6737 MSDS was sent by Lisa Toutant, Safety, Health & envr. Dep. (414) 260-2777 fax: (414) 260-4320
Auto-All Purpose Auto floor cleaner including parts cleaning	Autopar Concrete Floor Cleaner & Degreaser ID: UN1759	Sodium carbonate (Carbonic acid) <60%, Sodium metasilicate (silicic acid) < 60%, Benzenesulfonic acid <5%, Methyl alcohol <5% Diethanolamine <5% (0.46 ppm), Sodium Hydroxide <10% (2mg/m3)	WHMIS Class D2A, E - pH: 12.2 -materials to avoid: water - can burn skin and chronic exposure can perforate nasal septum, cause bronchial irritation	Chrysler Canada Service and Parts Ops. (MSDS -Ina Dugan (519) 973-3302) General Office, 2450 Chrysler Centre, Windsor, ON N9A 4H6 fax: (519) 973-2929
Auto-Tire cleaner - Auto Detailing -	T-7 All Purpose Dressing	Mineral Spirits (Stoddard's Solvents) <38%	No Health rating - Flammability 2/4 -non-soluble in water	Granitize Products, Inc. 11022 Vulcan St. South Gate, California 90280-0893 Tel: (562) 923-5430
Auto-Concrete Cleaner - Auto repair	AMWAY Concrete Floor Cleaning Compound	Sodium metasilicate <70%, Sodium Carbonate <60%, Detergent Ranges Alcohol ethoxylate <5%	pH (2% aqueous sol) = 12.8 -product can burn skin -inhalation may cause respiratory injury -prevent environmental release of spill	Amway of Canada Ltd. 375 Exeter Rd. London, ON N6A 4S5 Info tel: (519) 685-7882

Industrial Use	Product	Notable Chemicals	Hazards	Suppliers
Auto-Car wash detergent	Mint Condition Car Wash Concentrate	Cocamide Dea <5%, Ethanol <5%, Alcohol ethoxysulfate salt <10%, Sodium Lauryl ether sulfate <10%, Sodium dodecylbenzene sulfonate <5%	pH=6.8 - contain dike spill to prevent environmental release -inhalation exposures to ethyl alcohol 100 ppm	See Amway of Canada Ltd.
Auto-Auto Detailing Wheel Rim Cleaner	Foaming Aluminum Brightener	Hydroflouric acid <10% (2.5 mg/m3), Phosphoric acid <10% (1 mg/m3)	Health rating:4/4, pH=2 -liquid and vapor can cause severe burns that are not immediately visible -cannot contact clothing , paint or glass -neatralize spills with alkali =-prevent run-off from entering sewer or waterway	Production Car Care Products 1000 E. Channel St. Stockton, CA 95205 (209) 943-7337
Auto-Large engines/parts soak	Okite Dynadet (Biodegradable, Dustless)	Sodium hydroxide 45-55% (2 mg/m3), Tetrasodium pyrophosphate 20-30% (5 mg/m3), Nonylphenoxy polyethoxy ethanol <5%, Dipentene <5%	pH (post dilute):>13 - HMIS 3 0 1 J - overexposurecauses severe irritation of nose, mouth, and respiratory tract - chemical pneumonitis, severe skin burns - in case of spill neutralize with mild acid then flush with water- this substance erodes some metals	Okite Products, Inc. 50 Valley Rd. Berkeley Heights, NJ 07922
Auto-Large engines/parts soak -	Okite TurboDet -Heavy Duty Low Foamer for Spray Washers	d-Limonene <5%, Sodium carbonate <60%, Sodium metasilicate <20%, Tetrasodium pyrophosphate <15% (5 mg/m3), Diethylene glycol butyl ether <10%, Ethoxylated alcohol <5%	pH (post dilution)= 12.2 at 5.3 oz/gal - HMIS Code 2 0 1 I - inhalation of dust or mist may cause respiratory irritation-prolonged or repeated contact to skin may cause burns-spills should be placed in dry containers for disposal (powdered concentrate)	Okite Products of Canada Ltd. 115 East Dr., Bramalea, ON L6T 1B7 Tel: (800) 526-4473, (908) 464-6900, fax: (908) 464-4658
Auto-Vehicle Parts solvent	Standard Solvent 350	Saturated Hydrocarbons 82-88% Aromatic hydrocarbons 12-18%	do not allow to enter waterways, sewers, storm drains	Chevron Canada Ltd. #1500-1050 W. Pender St. Vancouver, BC V6E 3T4 Info on product:1-800-582-3835 Chevron Envr. Health Center

Industrial Use	Product	Notable Chemicals	Hazards	Suppliers
Auto-Vehicle Wash	Tunnel Express Car Wash Soap	Diethanolamine (3 ppm), two types of surfactant, Isopropanol (400 ppm), Monoethanolamine (3 ppm) -proportion of ingredients were not listed	Health=1/4 ph=9-10 - prevent runoff into sewer or surface water - over exposure causes irritation to eyes and dermatitis-skin	C/EZ-1, Inc. 1000 E. Channel St5. Stockton, CA 95205 Tel: (209) 948-1133
Auto-Auto Reconditioning	Radiant C007	VM&P Naptha 60-100% (300 ppm)	Health=2/4 - central nervous effects as in Blue Dressing -prevent runnoff (in case of spill) into sewers, streams or water bodies	See Car Brite
Auto-Car Washing Auto Detailing	OK Car Soap	Sodium Lauryo ether sulfate <7%, Cocamidopropyl hydroxysultaine <5%	pH=8.5 Health=1/4 - mild irritation - can cause dermatitus	See Car Brite
Auto-Automotive reconditioner Heavy cleaner, degreaser	Blue Max E004 pH=>13	2-butoxyethanol <7% (25 ppm), Nonylphenoxypolethoxyethanol <5% (1 ppm), Dodecylbenzene sulfonic acid <5% (2 ppm), Sodium tripolyphosphate <5% (15 mg/m3), Sodium xylene sulfonate <5%, Phosphoric acid <5% (5 mg/m3),	Health=3/4 -corrosive to eye tissue -can cause chemical burns to skin -prolonged exposure can cause irreversible destruction to skin surface -heavy inhalation can burn repiratory tract tissues -chronic overexposure can result in kidney or liver damage	See Car Brite
Auto-Fall out Treatment of paint impurities on all new cars	Liquid Fallout Remover	Ethanedioic acid <13% (1 mg/m3), Nonylphenoxypolyethoxyethanol <5%	pH=1 Health=2/4 - may cause chemical burns to skin - corrosive to eyes - chronic exposure may cause liver/kidney damage -treat and dispose spills with an absorbent	See Car Brite

Industrial Use	Product	Notable Chemicals	Hazards	Suppliers
Auto-mild engine/parts degreaser	Special Blue Degreaser F001D	Mineral Spirits 66/3 30-60% (100 ppm), Aromatic petroleum distillate <30% (100 ppm), Nonoisopropylamine-dodecylbenzene sulfonate <13%	Health=2/4 - causes dermatitus to skin, inhalation -headache, nausea, irritation and possible narcotic effects -absorb spill	See Car Brite
Auto-auto shop washing	BOWES Concrete Cleaner	Sodium metasilicate <40% (2mg/m3), Sodium carbonate <60%, Akyl phenol ethoxylate <5%, Petroleum naptha < 5% (100 ppm)	Health=2/4 -states that it is a highly alkaline chemical but no pH given - product is stated as fully biodegradable-spill residue to be washed down sewer. Can burn skin and the respiratory tract (dust inhalation)	Bowes Industries Inc. 5902 E. 34th St. PO BOX 18802 Indianapolis, Indiana 46218 Tel: (317) 547-5245
Auto-car wash	BOWES Concentrated Car Wash	Alkyl Aryl Sulfonate <50%, Fatty Alcohol <10%, ether sulfate -no ceiling exposures established	no pH listing, no health rating. -says to avoid mixture with strong acids, bases.- can cause dermtitus, gastrointesinal problems irritation of nasal passages - sewer should be flushed with lots of water (waste disposal method)	See Bowes Industries Inc.
Auto-car wash	Car Brite Converter F002A	Kerosene 30-60% (400 ppm), 30-60% Aromatic petroleum distillates (100 ppm), Nonylphenoxylpolyethoxyethanol <13% (1 ppm), ethanol <7% (1000 ppm)	Health=2/4 - chronic exposure (lab animals) causes liver abnormalities, anemia, damage to kidney, lung, eye, spleen and nervous system - collect spill with absorbent for disposal	Car Brite Inc. 1910 South State St. Indianapolis, IN 46203 Tel: (317) 788-9925 Call US Collect: 1-202-483-7616
Auto-automotive reconditioning	Blue Dressing C003D	Mineral spirits 30-60% (100 ppm), VM&P Naptha 30-60% (300 ppm)	Health=2/4 - overexposure to this product has been suggested to cause central nervous system effects -related to inhalation - prevent runoff into streams, sewers and other water bodies	See Car Brite

Industrial Use	Product	Notable Chemicals	Hazards	Suppliers
Appliance Repair-Cleaner - large appliances and parts	FP1 Numero Uno Cleaner & Degreaser B	Polyethylene Glycol ether 5-10%, Alkyl dimethyl benzyllammonium chloride <5%, Sodium metasilicate <5%, Potassium hydroxide <5% (2 mg/m3)	WHMIS Class: D2B, E Health=2/4 pH=13.4 - solubility in H2O-excellent -may cause chronic irritation of eyes, skin and respiratory tract-may burn skin-severe burns to eyes -spills-use inert absobent-dry disposal	Avmor Ltd. 433 Ste. Helene Montreal, QC H2Y 2L1 Tel: (514) 849-8074 Fax: (514) 844-3114
Auto-parts and engine degreaser -	SLAM 1 Cleaner & Degreaser	Sodium hydroxide (2 mg/m3 ceiling), 2-butoxyethanol (25 ppm skin)	Health=3/4 pH=12-14 -corrosive alkaline - attacks certain metals -aluminum chrome zinc brass- respiratory exposure can lead to severe pneumonitis-burns eyes,skin on contact-deep ulcerations and scarring to skin- prevent runoff to sewer or surface water.	Production Car Care Products, 1000 East Channel St. Stockton, CA 95205 Tel: (209) 943-7337 Sales Rep: Tony, 599 Cromar Rd. RR#1, Sidney, BC V8L 5M5 Tel:(604) 655-8806 fax: 655-5053
Auto-Auto Detailing-All Purpose Cleaner & Degreaser	DucaSol	Propylene glycol monoethyl ether <5%, Isopropyl alcohol <5% (400 ppm), Trisodium phosphate <5%, Potassium hydroxide <5% (2 mg/m3), Sodium gluconate <5%, Nitriiotiacetic acid <5%	pH=12.7 - completely soluble in water. Nitriiotriacetic acid is listed by NTP as an anticipated human carcinogen -neutralize large spills with dilute acid -contain with dike - can cause burns to skin	Ducan Sales Inc. 1920 Broadway St., Port Coquitlam, V3C 2N1 Tel: (604) 942-0722
Auto-Auto Detailing-Industrial Cleaner & Degreaser	DuroSolv	Kerosene 60-100%, Ethylene glycol monobutyl ether 3-7%, Trichloroethylene <3%	WHMIS Class: D1B, B3C - prevent spills from entering sewers or waterways - causes dermatitus - prolonged exposure at high concentrations may have liver and kidney effects - trichloroethylene is listed as a potential carcinogen by NTP and IARC	See Ducan
Auto-Car Wash	Car Clean	unknown -below disclosure limits	pH unknown - inhalation causes irritation to mucous membranes, skin effects dermatitus - prevent spills from entering surface waterways.	See Ducan

Industrial Use	Product	Notable Chemicals	Hazards	Suppliers
Auto-Car Wash	Wash & Wax	unknown -below disclosure limits	pH=7.5-8.5 - Same warning as Car Clean	See Ducan
Auto-Wheel washing	A-50 Aluminum Brightener	100% Hydrochloric acid 10-30% (5 ppm), 100% Phosphoric acid 5-10% (3 ppm), Hydrofluoric acid 5-10% (3 ppm)	WHIMS Class:E D1A - pH=<1 - can cause severe irritation of the respiratory tract, pulmonary inflamation, fumes very corrosive to tissue, permanent visual damage - neutralize apill with soda ash and lime	See Ducan
Auto-Car Wax	D-Wax	Kerosene 60-100% (14 ppm/4h), Ethylene glycol monobutyl ether 3-7% (450 ppm/4h), Trichloroethane 3-7% 12500 ppm/4h)	WHMIS Class: D1B, B3C -irritation caused by inhalation, skin exposure, eye contact - fatal if swallowed. Chronic effects on liver, kidneys - prevent spills from entering sewers, waterways, or soil	See Ducan
Auto-vinyl/leather restoration	ST Dressing	Isoparrafinic naptha 60-100% (5900 ppm/4h)	Same warning as Car Wax	See Ducan
Auto-vinyl/rubber restoration	Vinyl Care	unknown - below disclosure limits	ph=7.0-8.5 - flush spill with water once picked up by absorbent - irritation to eyes	See Ducan

Industrial Use	Product	Notable Chemicals	Hazards	Suppliers
Auto-Vehicle washing	Blue Magic (0356)	unknown - ingredients not subject to WHMIS disclosure	pH= 7-8, 6.5-7.5 post dilution Health Rating 1/4 - may irritate eyes, skin -No known effects from chronic exposure -recommend use of neopropene gloves, glasses - clean up spill with inert material	See ZEP
Auto-Car Wash	Jet Clean - Concentrated Truck and Trailer Wash	Alpha Olefin Sulfonate, Sodium Salt 20-30%, Sodium silicate 5-15%, Nitrilotriacetic acid, Trisodium salt 10-20%	pH (concentrate)=12.0-13.0 -may be corrosive to eyes, mucous membranes, possible skin irritant. Spill should be picked up and disposed.	See ZEP
Auto-Engine Shampoo	Mopar Engine Shampoo (0VU01070)	Aromatic Solvent 30-60% (50 ppm), Stoddard Solvent 30-60% (100 ppm), Benzene <0.1% (1 ppm), Ethylene glycol 1-5% (25 ppm), Potassium hydroxide 0.1-1.0% (2 mg/m3)	pH=8.4 WHMIS Class B3, D2A -high concentrations (inhalation) produce lung irritation, chemical pneumonitis, skin and eye irritant - absorb spill with inert material	See Chrysler Canada
Print-Roller Cleaner & Blanket Wash	OffSet Roller Cleaner & Blanket Wash	Hydrocarbon Mixture-Petroleum Naphtha 100%	Hazard Index Rating: Health-2/4 Flammability-2/4	A.B. Dick Co. (Emergency Tel: (312) 763-1900
Print-Stablizer	Mitsubishi SLM-ST Stablizer	Monopotassium Phosphate <5%, TTHA <5%	Health=1/4 pH=5.8 -prevent spill from entering sewer or waterways	See FRC

Industrial Use	Product	Notable Chemicals	Hazards	Suppliers
Furniture-Refinishing-To strip varnish	Methylene Choride MSDS #LA1629	100% methylene chloride (odour threshold 214 ppm)	WHMIS Codes: D.1B D.2A D.2B - possible carcinogenic effects, very dangerous in case of skin or eye contact, toxic to kidneys, lungs, the nervous system, liver, cardiovascular system -do not outch spills, prevent from entering sewers	See Van Waters & Rogers Ltd. Tel:(604) 273-1441
Furniture-Refinishing-To remove applied stripper	Van Blend VWR LP 611 Lacquer Thinner	Toluene <100% (100 ppm), Methanol <30% (200 ppm ceiling) Methyl ethyl ketone <30% (200 ppm ceiling, Ethyl acetate <5% (400 ppm)	WHMIS Codes: B.2 D.1A D.2B - very hazardous in case on skin or eye contact, inhalation -substance is toxic to blood, kidneys, the nervous system, liver -chronic exposure -accumulates in organs -prevent entry inot sewers in case of spill -avoid TLV limits	See Van Rogers & Waters Ltd.
Metal-Solder	50/50 Solder	Tin (Sn) 49.5%, Lead (Pb) 49.5%, Antimony (Sb) 0.12%	Solders can be an Ingot, Bar, Wire, Tape, or Foil	The Canada Metal Company Ltd. NO ADDRESS LISTED on MSDS
Auto-Engine Cleanser	Caustic Soda	Sodium Hydroxide	Health-3/4 -complete protective equipment required for spills including breathing apparatus - keep out of sewers	Van Waters and Rogers Ltd. 9800 Van Horne Way Richmond, BC V6X 1W5 Etel: Chemtrec at 1-800-424-9300
Carburetor degreaser	Cleaner/ degreaser	Chlorinated solvents 20-45%, Glycol ether 5-10%, Aromatic hydrocarbon solvent 5-15% Phenol derivative,cresylic acid 10-25%, methyl alcohol <5%, Potassium Oleate soap <5%	No WHMIS Classification or hazard rating given, causes many health problems upon exposure, including (Chronic) pulmonary edema, intravascular hemolysis, nausea, dizziness, accelerated respiration, hemoglobin in urine	See Kleen-Flo

APPENDIX 2
PAMPHLET: STORM DRAINS TO STREAMS

Best Management Practices (BMP's)

In order to reduce the amount of pollutants that may be entering the storm drains in your area, implementing Best Management Practices will help protect, restore and enhance receiving waters.

BMP's

- Keep residue such as paint chips from entering storm drains.
- Keep paints, solvents, chemicals, waste containers, and solid rags stored in containers & covered from the rain
- Prepare for and clean up spills
- Minimize waste & properly dispose of or recycle all wastes
- Fix any oil leaks in equipment
- Clean catch basins every 6 months (end of summer & early spring)
- Install oil interceptors
- Repair fluid leaks in vehicles
- Recycle used oil & antifreeze
- Use alternative, non-toxic products
- Properly handle, store & dispose of hazardous products
- Sweep pavement & roofs rather than pressure washing

Where is Your Storm Water Going?

The runoff waters in your area drain through an elaborate set of storm sewers. These waters flow through Cecelia Creek & are deposited into the Gorge waterway.

About Cecelia Creek

Cecelia Creek drains a large urban area of about 900 hectares. This area consists of mixed industrial, commercial & residential land uses. The creek has sewage counts 75 times the acceptable level for swimming & high levels of metals such as mercury, zinc & cadmium. It is also riddled with oils, solvents and trash discarded along its banks.

Worth Taking a Closer Look

We invite you to take a tour of Cecelia Creek. The creek runs along the left side of the Galloping Goose trail as you near the Selkirk overpass. The tour will only take you a few minutes, since the creek is only 175 meters long.

You can also go to the SPCA along Burnside Rd, turn up Napier Lane & park at the Napier Lane/Cecelia Rd intersection. Follow the footpath that runs through the park down to the creek.

Volunteer Opportunities & Memberships

Veins of Life Watershed Society
Contact: John Roe
Ph/fx: 383-2086
E-mail: volws@islandnet.com

Phone Numbers of Importance

Spill Reporting:
1-800-663-3456

CRD Recycling Hotline:
360-3030

Regent Recycling:
388-7226

References

Cleverley, B. (June-1998) Cecelia Creek to be Cleaned up. Times Colonist-Local A3, Victoria BC.

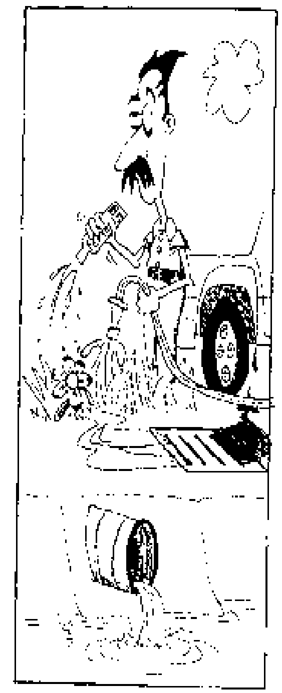
Waste Management Group. (1992) Urban Runoff Quality Control Guidelines for British Columbia. Municipal Waste Reduction Branch.

Woodward Clyde Consultants, et al. (1993) Water Quality Protection for Bellevue Businesses. City of Bellevue Utilities Dept.

ILLUSTRATIONS BY:
CHRIS RICHARDSON

Veins of Life Watershed Society
RPO Box 44107 Tillicum Mall
V9A 7K1
Victoria BC
Phone/Fax: 383-2086

FROM STORM DRAINS TO STREAMS



Veins of Life Watershed Society
RPO Box 44107 Tillicum Mall
V9A 7K1
Victoria BC
Phone/Fax: 383-2086

Streams

Small streams are all around us, flowing though our parks & backyards, near our work or beside our roads.

We sometimes take them for granted, but we might be surprised to know how important they are to fish, wildlife, & to us.

Healthy streams, even small ones, are a neighborhood asset. Streams provide habitat for more than 85% of our wildlife species. Healthy streams can also provide valuable spawning & rearing areas for several fish species including salmon & trout. Fish are sensitive to pollution & to habitat changes, so their presence is a good indicator of stream health

Urban Runoff

In a natural stream, water runs over the surface of the land, it seeps into the soil to become ground water. As it descends it is absorbed & cleansed by soil, plants & bacteria. Groundwater & surface runoff feeds our streams, rivers & marine habitat.

Whatever is washed down a storm drain eventually reaches our water resources without any benefit of treatment

Urban areas have large impermeable surfaces of cement & asphalt that block the absorption of water into the soil. As the water runs over surfaces it picks up any pollutants covering these surfaces, including oils, toxic metals & wastes. Virtually anything on the ground surface can become a water pollutant, since storm water runoff collects pollutants as it travels. During heavy rains this flows into our coastal water bodies. The flow is called *urban runoff*

Ways You May be Polluting

Most people know that it is illegal to dump toxic chemicals or other pollutants down the storm drain. But you are also polluting if you allow pollutants to be washed into the storm drain with rain or wash waters.

For example, you may be polluting if you:

- Rinse wash water from a dirty car, greasy engine, or grimy roof vent down the storm drain
- Spill antifreeze on your parking lot without cleaning it up
- Allow materials or wastes stored outside to leak

Storm Drains

means a sewer constructed for carrying only storm water & drainage water

Discharges to Storm Drains

The only allowable deposits into storm sewers are:

- storm water (resulting from natural precipitation)
- cooling water & condensate drainage from refrigeration & air conditioning equipment
- cooled condensate from steam heating systems

(Bylaw number 92-15 City of Victoria)
(Bylaw number 7501 Municipality of Saanich)

Working Together for Clean Water

Pollution prevention depends on steps taken by each Greater Victoria resident. A good first step in water quality protection is to identify the drains on your business site & where they go. How many storm drains do you have on your property? Look at your activities. Do you maintain your catch basins? What goes down those drains?

Together we can keep our streams, lakes & waterways clean!

APPENDIX 3
WET BASIN DESIGN & PHYTOREMEDIATION

WET DETENTION PONDS

Wet detention ponds (also referred to as wet basins) are designed to provide quantity and quality control of stormwater runoff. The purpose of a wet pond is to retain a permanent pool of water for a particular period of time in order for pollutants to accumulate in the sediment. After a runoff event, the pond level subsides at a controlled rate allowing for phytoremediation (a technology that harnesses the natural ability of plants to degrade or remove chemicals found in soil, ground water and surface water) to take place. The controlled rate of outflow also aids in the reduction of scouring and erosion of sediments by dissipating the inflow energy of water. Functional wet basin design is essential to the proper functioning of wet pond and phytoremediation processes.

Wet Basin Design

The following information was extracted from Scheuler, (1987) Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs:

The pollutant removal capacity of wet ponds depends on the size of the pond relative to the catchment area. Areas with high development (greater impervious surface) require a large wet pond whereas areas with small development (less impervious surface) require a smaller wet pond. BC Environment states that "It has been recommended that the ratio of pond surface area to catchment area for wet ponds in the Pacific Northwest should be greater than 1% for an urbanized catchment" (1992).

Rv- {Runoff Coefficient}

Rv is a measure of site response to rainfall events, and is calculated as:

Eq: $Rv = r/p$ where r = storm runoff (inches)
p = storm rainfall (inches)

The Rv for a site depends on the nature of the soil, topography, and cover. This equation for the relation of watershed imperviousness to Rv was based on the best fit developed in the monitoring of forty-seven small urban catchments.

Eq: $Rv = 0.05 + 0.009 (I)$

where I = the percent of site imperviousness

(Adj. R2 = 0.71)

(Scheuler, 1987)

I is determined by summing up the total area of the site covered by structures, sidewalks, driveways, parking lots, roads, and other impermeable site areas, and dividing it by the total site area (Scheuler, p. 1.11). These equations only predict storm runoff volumes. They do not predict baseflow as a component. For that reason it is suggested that for anything above one square mile, baseflow should be accounted for. It is also suggested that 10% of the annual rainfall volume is so slight that no appreciable run-off is produced (Pj) (A.8 – Section 6). The runoff coefficient can serve as a reliable estimator of runoff volumes, given an initial estimate of rainfall volume (Scheuler, A.8 - Section 6).

Determining Long Term Sediment Accumulation in a Wet Pond

The following is taken from Scheuler:

EXAMPLE: A planner wants to know how much storage volume will eventually be lost due to sediment deposition in a 7500 cubic yard wet pond, draining a 106 acre, 55% impervious watershed over a twenty year period. Assume that:

1) the average sediment removal of the pond is 60%;
2) one ton of sediment eroded from the watershed is in poor condition;
3) the average annual rainfall is 40 inches.

SOLUTION: the expected mean sediment concentration for a 100 acre watershed in poor condition is about 280 mg/l. The post-development storm runoff coefficient (Rv) will be 0.55 (See Figure A.2). Therefore, the annual

sediment load during a normal year of rainfall can be obtained by solving the general equation:

$$L = [(P)\ (Pj)\ (Rv)/12]\ (C)\ (A)\ (2.72)$$

Where P = rainfall depth over the desired time interval

Pj = factor that corrects P for storms that produce no runoff

Rv = runoff coefficient, which expresses the fraction of rainfall that is converted into runoff

C = flow weighted mean concentration of the pollutant in urban run-off (mg/L) (refer to Table A.1**(photocopy or scan) or own pollutant data)

A = area of the development site (acres)

12 is a conversion unit factor from inches to feet

2.72 is a conversion unit factor used for pound/acre/interval, derived from using Discharge (Q) = cubic feet/second/day and R = runoff depth in acre-feet

Q= (R) (43 560 sq. ft)(day/24 hr)(hr/60 min)(min/60 s)

Q= (R) (0.504) (p. 1.19)

Given the mean concentration for a pollutant (C, mg/l or ppm.) and the discharge rate, the load over any interval (L, in pounds) is given by:

$$L = (C)\ (Q)\ (5.39)$$ where 5.39 is a conversion factor

By combining the terms, the general equation for estimating urban run-off loads (Expressed in pounds/acre/interval) is provided by:

$$L = [(P)\ (Pj)\ (Rv)/12]\ (0.504)\ (C)\ (5.39)$$

$$L = [(P)\ (Pj)\ (Rv)/12]\ (C)\ (2.72)$$ (A.1 Section 1)

SOLUTION: L = [(40) (0.9) (.55)/12] (280) (106) (2.72) = 133 200 pounds
(67 tons/year)

If the pond is 60% efficient in trapping sediment, the total load delivered over twenty years would be:

(67 tons/yr.) (20 yr.) (0.6) = 800 tons

The trapped sediment load would fill up about 800 cubic yards, or about 11% of the pond's total stormwater storage capacity. Wet Basin efficiency at trapping sediment can be estimated using Figure A.2, once VB/VR ratio is determined (p.1.19).

Baseflow Correction

The following is taken from Scheuler:
Baseflow can be accounted for if Baseflow quantity and quality are known. (Can be obtained from the difference between the annual and storm runoff coefficients.) Baseflow pollutant concentrations can be inferred from regional or local dry-weather quality monitoring data.

Calculated as:

$$L = [(P)(Rva) - (P)(Pj)(rv)]/12\ [(Cb)(A)(2.72)]$$

Where Rva = Annual runoff coefficient (From Figure A.2)
Cb = average dry-weather pollutant concentration (mg/l)
All other parameters as defined previously
(A.9 Section 6)

BMP Recommendations

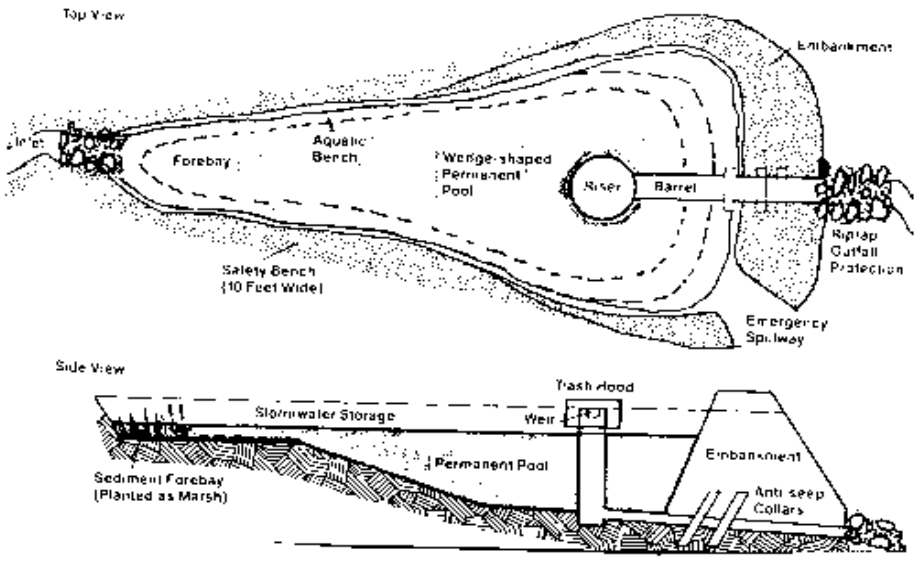
The following is taken from Scheuler:
A wet extended detention pond and wet pond operate at optimum level only if they are draining an area of 20 acres or more. They are not feasible on an area of less than 10 acres and marginal in between. (p. 2.5)

Optimum soil class for a wet detention pond ranges from loam to clay. Sandy loam/loamy sand is marginal; sand is not feasible. It is recommended that pond soils not be permeable and to avoid fractured bedrock. Drawdowns can be minimized by installing an impermeable layer of clay soil, filter fabric or by compacting available soils. Other features of wet pond design that may preclude their usage are; proximity to bedrock, space, depth requirements, and thermal impacts (not really an issue in our case). High sediment input is also and important factor which may eliminate a wet basin as an option unless carefully designed for. (p. 2.5)

For wet basins, the proximity of the bedrock cannot exceed the required depth of excavation for proper wet basin storage. The recommended depth for a wet pond is not in excess of 8 ft., or stratification during the summer will create low oxygen conditions that will re-release toxins from the sediments. (p. 2.7)

It is also stated that wet basins are ineffective in reducing runoff volume, and only retain runoff for a short period of time before releasing it downstream (p. 2.9). Modifying the design by providing accommodating bank depths for peak flows can probably surmount this.

Figure 4.1



Peak Discharge Control: Must define stormwater storage needs by reservoir routing (SCS TR-20 and SWMM models for example – Maryland Soil Conservation Service. (1981, 2) Standards and Specifications for Ponds. Practice Code No. 378. – TR-20 model). It is thought that control of the 2-year and 10-year design storm is sufficient to adequately control the entire spectrum of expected flood frequencies. However in an impermeable watershed, peak flows equivalent to a 2-year storm may occur as often as six times a year. Small frequent storms have to be controlled. This can be achieved by extending the detention time of run-off within the pond from 24 to 40 hours (p. 4.9).

Volume control is generally achieved only after droughts and minor storms during summer. A wet basin at the base of a drainage may actually increase peak discharge if it detains stormwater long enough to coincide with the arrival of the upstream peak. It is advisable to perform detailed watershed modeling to evaluate the cumulative impact of wet ponds on the total watershed hydrograph, and adjust release rates accordingly (p. 4.9) (TR-20).

Ponds should be designed to maximize the distance between the pond inlet and outlet (causes maximum or proper displacement of old water by new stormwater) with minimum length to width ratios of 3:1 or greater. Irregular shaping is also a plus. The pond should have a depth variation of 3-6 feet. Less than 2 feet causes re-suspension, whereas depths exceeding 8 feet cause stratification and the re-release of toxins into the sediment. Shallow ponds have higher removal efficiency (p. 4.9).

The sizing recommendations can be based on five different rules. These rules are designed to maximize biological uptake. The larger the pool the better the uptake, but once a threshold is reached, the difference attributed to size is negligible (above 4xs).
The minimum volume of the permanent pool should be equivalent to:

- Rule 1: ½ inch of runoff distributed over the contributing watershed area
- Rule 2: ½ inch of runoff distributed over the impervious portion of the contributing watershed
- Rule 3: volume of the permanent pool equivalent to a variable depth of runoff distributed over the contributing watershed, depending on land use
- Rule 4: 2.5xs the volume of runoff generated from the mean storm over the watershed area
- Rule 5: see above.

Table 4.1: Summary of Wet Pond Sizing Rules

SIZING RULE	Sediment Removed	Phosphorus Removed	Extra Storage (compared to 2 yr. dry pond)	Extra Cost
RULE 1: 0.5 in. runoff per acre	60-90%	35-90%	35-200%	20-90%
RULE 2: 0.5 in. runoff per impervious acre	60%	35-40%	90%	20-25%
RULE 3: 0.1-0.8 in. depending on land use	55-80%	30-50%	30-70%	20-40%
RULE 4: 2.5xs the runoff of the mean storm	75%	55%	75%	40-50%
RULE 5: 4.0xs the runoff of the mean storm (≅2 week retention)	85-90%	65%	200-250%	80-100%

Structural Recommendations

The following is taken from Roesner *et al*, 1989, but was quoting a presentation by Scheuler and Helfrich, Design of Extended Detention Wet Pond Systems:

- The recommended slope gradient around a wet pond is no more than 3:1 (h:v), with 10:1 being recommended as the optimum for wildlife utilization. Gradual inclines are also better for mowing.

- The stream channel immediately below the pond outlet should be lined with large stone riprap to prevent scouring and have a slope close to 0.5% (p. 4.10).

- Recommend hoods or trash racks be installed on both the low flow pipe and design storm orifices. The low flow orifice pipe should be negatively sloped so that it draws water at least one foot below the surface of the permanent pool.

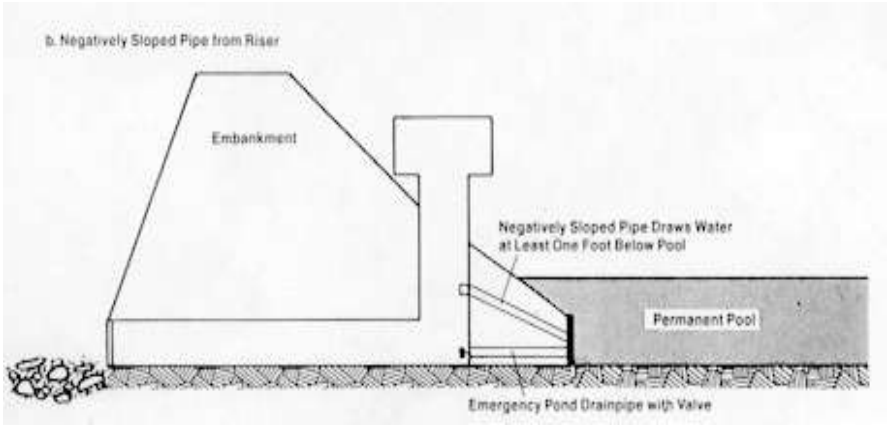


Figure 3.3b

- Recommend use of reinforced concrete pipes, barrels and risers (50-75 yrs), which have a substantially longer life than corrugated metal (25 yrs.).

- Riser should be located within or on the face of the embankment rather than in the middle of the pool, easing maintenance and inspection. Also riser should be designed to withdraw water from the bottom of the pool where water will be cooler to prevent thermal discharges.

- Use anti-seep collars around the barrel to prevent seepage. Surge stone placed in a bottom releasing designed barrel will re-aerate low O2 bottom waters that are discharged.

- Aerators or fountains can be placed in pool to maintain dissolved O2 levels

- All ponds should have an emergency drain (with the pipe sized to drain the entire pond in less than 24 hrs), to allow access for repairs and sediment removal.

- Maintain access with a right of way with a min of 10 ft and maximum slope of 5:1. Access route should never cross the emergency spillway.

- Recommend volume specific on-site sediment disposal location.

- Sediment forebay to trap incoming sediments. Less dredging is involved. Vegetated with emergent and aquatic plants, increases wet basin efficiency. Minimum volume required for a sediment forebay can be ascertained by:
  1) Using the "Simple Method" Formula to determine long-term sediment load from watershed.
  2) Estimate wet pond-trapping efficiency from Figure A.2
  3) Compute volume of sediment trapped in pond, assuming one ton = one y^3 of wet sediment.
  4) Solve for area (used for determining on site disposal size - assume a 12 in depth of wet sediment per unit area).

  (p. 4.15)

Vegetative Design

The following is taken from Scheuler, 1987:

Zone 1: Deep water - aquatic plants

Zone 2: Shallow Water - emergent aquatic vegetation, usually only grow at less than one ft water depth. Shallow bench should be 10-20 ft wide and extend around at least half the pond's perimeter. Plant at least two primary wetland species that are hardy and rapid colonizers and aggregate in 3 or 4 monospecific stands. Up to three secondary non-aggressive species should also be planted and distributed in clumps around the perimeter.

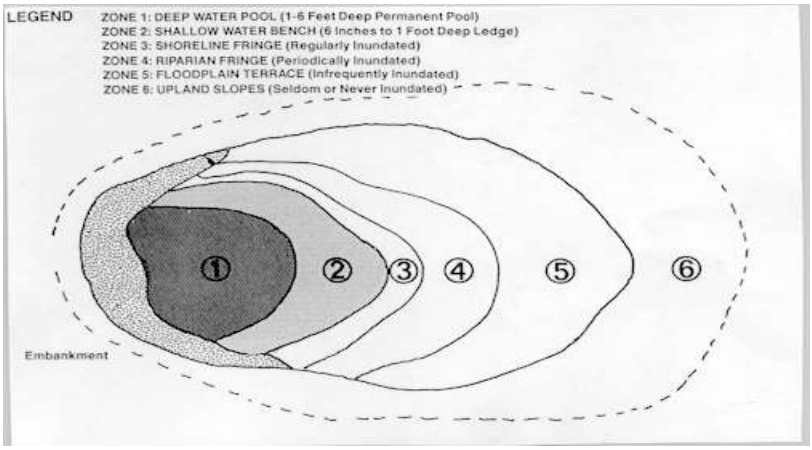
Zone 3: Pond Shoreline, species must be capable of withstanding periodic drying during summer months.

Zone 4: Riparian Fringe Area -N/A

Zone 5: Floodplain Terrace. Infrequent periodic inundation plants prefer moist or slightly wet soil conditions. Trees, shrubs and species that can tolerate exposure, compacted soils and have minimal maintenance requirements.

Zone 6: dependent on local conditions.

Figure 9.4



TIPS:

a) Trees with rootballs bigger than 30 inches should never be planted on pond embankments.

b) Due to compaction during construction, larger holes must be dug and backfilled with uncompacted soil for trees, shrubs, etc.

a) Shade and wind prone species should be avoided in initial planting.

d) Use regionally native species.

e) Extra maintenance (mulching, weeding fertilizing, watering) is required during the first few years.

(p. 9.12)

Wet Basin Costs

<u>The following was taken from Scheuler:</u>

Wet ponds are most cost effective when used for larger, more intensive developed sites.

A Planning estimate of the base construction cost for a wet pond of less than 100 000 cubic feet can be approximated using the MWCOG equation (Weigand, *et al*., 1986).

$C = 6.1Vs^{0.75}$ where C = construction cost in 1985 dollars

Vs = Volume of storage (cubic ft) of the pond up to the crest of the emergency spillway, including the permanent pool. (Stormwater storage + Permanent pool)

At larger than 100 000 ft, costs can be derived using the same formula:

$$C = 34Vs^{0.64}$$

Costs are increased by the amount of excavation required. Land costs are excluded in this equation due to variability, as are permit costs. Overseeing construction can be added by a general rule of thumb that these costs generally add 25% to the base construction cost (C). Wet pond construction costs are largely determined by volume. Choice of the sizing rule will strongly affect permanent pool cost (p. 4.12).

Wet Basin Maintenance

The following was taken from Schueler:
Mowing of side-slopes, embankment, emergency spillway should be performed at least twice a year to 14 times a year. Use of native and hardy, slow growing, drought tolerant grasses are recommended.

Inspections are to be annual to insure proper functioning, preferably when it's raining as well. Check embankment for subsidence, erosion, cracking and tree growth. Check the emergency spillway and drain for sediment accumulation, clogging of the barrel and outlet, effectiveness of downstream/upstream erosion protection measures, and overall modifications.

Debris and litter must be removed from the pond surface, especially around the riser and outlet. To control erosion, repair of riprap, embankment, side slopes and emergency spillway must occur regularly.

Nuisance control for pond problems may include insects, weeds, odors and algae. Not an issue if pond is properly sized and vegetated. Recommend biological control. (p. 4.13)

Non-Routine

Structural Repairs and Replacement of water works tend to constitute 25% of the construction costs, so their replacement is a significant expense.

Sediment Removal:
Approximately 1% of the storage volume capacity is lost annually. A clean out cycle of 10-20 yrs is recommended and operations in excess of 100 000 dollars are not uncommon. Average is 14$/y3 (in 1986) and shallower, smaller ponds are cheaper (<10$/y3). The shallower the pond, the more that can be dug out with a front-end loader, as opposed to dredging. Transportation of dredge materials is also a very significant cost, as well as, dredging and reclamation of the site.

Mixing and Residence Times

The following has been extracted from, Mixing and Residence Times of Stormwater Runoff in a Detention System a presentation by E.H. Martin, which was part of the compilation by Roesner *et al*.:

Five tracer runs were performed on a detention pond and wetlands system to determine mixing and residence times in the system. The data indicate that at low discharges and with large amounts of storage, the pond is moderately mixed

with residence times not much less than the theoretical maximums possible under complete mixing. At higher discharges and with less storage in the pond, short-circuiting occurs, reducing the amount of mixing in the pond and appreciably reducing the residence times. The time between pond outlet peak concentrations and wetlands outlet peak concentrations indicate that in the wetlands, mixing increases with decreasing discharge and increasing storage.

The following information was extracted from Design of Extended Detention Wet Pond Systems, the presentation by Scheuler and Helfrich:

Pond Specifications to Assure Longevity:

- Avoid copper metal pipe
- Reversed slope ed. pipe allows for least clogging.
- Both the pond drain and the R. Slope ed. Pipe should be equipped with adjustable gate valves. Gives option of fine tuning the release rates in order to target extended detention times.

Access:

- Easement off road or private roadway – min width of 20 ft. – max slope of 5:1.

PHYTOREMEDIATION

"Phytoremediation is a technology that harnesses the natural ability of plants to degrade, transform, remove or provide a barrier control of selected chemicals found in soils, groundwater and surface water environments" (Catherine Barnard, 1997). This technology is used on rural/urban sites and wet detention basins contaminated with mercury, lead, arsenic, cadmium, copper, zinc, LPAH's, PAH's, silver and chromium. The plants take up the toxic metals through their roots and transport them to stems or leaves, where they can be easily removed by harvesting (Barnard 1997). Drying, ashing or composting easily and safely processes the harvested plant material rich in accumulated contaminants. As a result the toxic waste and cost are much less than with any other remediation

method. Some of the metals can even be reclaimed from the ash, which in turn generates recyclable material and reduces the cost. The plants are planted around the perimeter, within the wet basin. Plants aid in the control of water flux into and out of the contaminated area and control soil erosion (Barnard 1997).

There are two types of phytoremediation. "Phytoextraction is when high biomass metal accumulating plants and appropriate soil procedures are used to transport and concentrate metals from the soil into above ground shoots, which are then harvested. Rhizofiltration is when plant roots grown in water, precipitate and concentrate toxic metals from polluted effluent" (http://aesop.rutgers.edu/~halpern/phyto.html, 08/12/98, p. 1)

Plants that are excellent for pytoremediation are hyperaccumulator plants. Hyperaccumulators are plants that can accumulate high levels of heavy metals in their tissue without being harmed (Barnard, 1997). The only issue with this is that metal hyperaccumulator plants are relatively rare taxa and often only occur in remote areas, or being of very restricted distribution in areas often threatened by devastation. In some cases plants contain 1000 times more metal than the soil in which they live in.

This is a list of plant genus' s and species, which naturally degrade pollution:

- *Aradopsis* (mercury)
- *Bladder campion* (zinc and copper)
- *Brassica juncea* (lead, cadmium, zinc and copper)
- *Poplar* (pesticides)
- *Thalaspi caerulescens* (zinc, cadmium and lead)
- Tomato (lead, zinc and copper)
- *Sobertia acuminata* (chromium)

Yet to be found is a plant that will deal specifically with lead, one of the most common pollutants.

Hyperaccumulator species:

- *Thlaspicaerulescens*
- *T. ochroleucum*
- *Alyssum murale*
- *A. tenium*
- *A. lesbiacum.*

(Barnard, 1997)

Metal thresholds for sediment accumulation:

	MSQGs	Special Wastes
• Mercury	.41	100
• Lead	450	N/A
• Arsenic	57	100
• Cadmium	5.1	100
• Copper	390	N/A
• Zinc	410	N/A
• LPAH's	5.2	N/A
• PAH's	12.0	N/A
• Silver	6.1	N/A
• Chromium	260	N/A

(T & E Consultants Ltd. 1996)

Hartigan states that wet detention basins require two to seven times more storage than extended dry detention basins and are two to four times the cost for non-point source pollution control. The average cost per acre of wet drainage basin area is $3080.00 (1989). It is least cost effective where nutrient loading is not a concern. It is also more attractive, with less frequent clean-outs.

APPENDIX 4
SUMMARY OF CURRENT LEGISLATION

a) THE FEDERAL GOVERNMENT

The Federal Government relies on the **Fisheries Act** to set specific stormwater discharge standards. Miller states that "The **Fisheries Act** prohibits the deposit of deleterious substances into waters frequented by fish. The federal government, provincial government, or a third party could technically charge whoever owns the drainage system at the point where deleterious substances in the stormwater drainage system enters fish-bearing waters (Miller *et al*.,1995)." The Department of Fisheries and Oceans (DFO) implements the strategy of 'no net loss' of fish under this act. This strategy requires that both stormwater flow controls and quality controls be enacted within their development plans (Miller *et al*., 1995).

The DFO's goal, as stated at their Internet site is "To manage Canada's oceans and major waterways so that they are clean, safe, productive and accessible, to ensure sustainable use of fisheries resources, and to facilitate marine trade and commerce. Five objectives further define this Mission:

- manage and protect the fisheries resource;
- manage and protect the marine freshwater environment;
- understand the oceans and aquatic resources;
- maintain maritime safety; and
- facilitate maritime trade, commerce and ocean development.

b) THE PROVINCIAL GOVERNMENT

Provincial legislation that best deals with stormwater management includes the **Municipal Act**, the **Waste Management Act**, the **Health Act** and the **Water Act** (Miller *et al*., 1995). Under the guidelines set by the **Spill Reporting Regulation,** the municipalities are required to respond to and clean up spills when unauthorized substances are being discharged into the storm drains in conjunction with the **Provincial Emergency Program** (Miller *et al*., 1995).

Ministry of Environment Lands and Parks

"Pollution loadings from non-point sources, such as stormwater runoff from urban and industrial areas are the major continuing source of pollution to receiving waters. Non-point source pollution is often the limiting factor in improving or maintaining surface water quality. Consequently, stormwater which historically has not been a regulatory priority, has now become an area of focus as local governments develop and implement liquid waste management plans."

"Under the **Water Act**, the Ministry continues to regulate the installation of stormwater facilities which have potential to alter a water course. Under the **Waste Management Act**, and through the implementation of liquid waste management plans by local governments, the Ministry has increased its level of control over the quality of the stormwater discharges (Miller *et al*., 1995)."

WASTE MANAGEMENT ACT

Province of British Columbia

(The following includes parts of the Act that are relevant to this study)

Part 2 -- Prohibitions and Permits

Waste Disposal -- Strict Liability

3 (1) For the purposes of this section, the conduct of an industry, trade or business includes the operation by any person of facilities or vehicles for the collection, storage, treatment, handling, transportation, discharge, destruction or other disposal of waste.

(2) Subject to subsection (5), a person must not, in the course of conducting an industry, trade or business, introduce or cause or allow waste to be introduced into the environment.

(3) Subject to subsection (5), a person must not introduce or cause or allow to be introduced into the environment, waste produced by any prescribed activity or operation.

(4) Subject to subsection (5), a person must not introduce waste into the environment in such a manner or quantity as to cause pollution.

(5) Nothing in this section or in a regulation made under subsection (3) prohibits any of the following:

(a) the disposition of waste in compliance with a valid and subsisting permit, approval, order or regulation, or with a waste management plan approved by the minister;

(f) the use of pesticides or biocides for agricultural, domestic or forestry purposes in compliance with the Pesticide Control Act, the Pest Control

Products Act (Canada) and any other Act and regulation governing their use;

(k) the disposal of waste by a person other than a municipality

(i) by means of a system of waste disposal lawfully operated by a municipality or other public authority, and

(ii) in compliance with the rules and regulations that apply to that system;

Special Wastes-Confinement

4 (1) A person who produces, stores, transports, handles, treats, deals with, processes or owns a special waste must keep the special waste confined in accordance with the regulations.

(2) Except to the extent expressly authorized by a permit, approval, order, waste management plan or the regulations, a person must not release a special waste from the confinement required by subsection (1).

(3) If a special waste is released from or escapes from the confinement required by subsection (1), it is, for the purposes of this Act, deemed to have been introduced into the environment.

Special Wastes -- Disposal Facilities

(5) A person must not construct, establish, alter, enlarge, extend, use or operate a facility for the treatment, recycling, storage, disposal or destruction of a special waste except in accordance with the regulations.

Powers of Lieutenant Governor in Council

(6) (1) If the Lieutenant Governor in Council considers it to be necessary in the public interest, the Lieutenant Governor in Council has and may exercise, in respect of wastes, all the powers that a director or district director may exercise under this Act in respect of wastes, and without limiting that power, the Lieutenant Governor in Council may, after any consultations the Lieutenant Governor in Council considers desirable, issue permits for the construction and operation of facilities for the management, treatment, disposal, recycling, storage and destruction of wastes or for the introduction of wastes into the environment.

(2) In acting under this section, the Lieutenant Governor in Council may act in a manner the Lieutenant Governor in Council considers to be in the public interest and is not limited to the considerations that would be taken into account by a director, district director, officer or manager.

Spill Prevention and Reporting

12

(1) In this section, "polluting substance" means any substance, whether gaseous, liquid or solid, that could, in the opinion of the minister, substantially impair the usefulness of land, water or air if it were to escape into the air, or were spilled on or were to escape onto any land or into any body of water.

(2) If a person has possession, charge or control of any polluting substance, the minister may, if the minister considers it reasonable and necessary to lessen the risk of an escape or spill of the substance, order that person

(a) to undertake investigations, tests, surveys and any other action the minister considers necessary to determine the magnitude of the risk and to report the results to the minister,

(b) to prepare, in accordance with the minister's directions, a contingency plan containing information the minister requires, and

(c) to construct, alter or acquire at the person's expense any works, or carry out at the person's expense any measures that the minister considers reasonable and necessary to prevent or abate an escape or spill of the substance.

(3) If an escape or spill occurs of a substance for which a contingency plan was prepared, a manager may order any person having possession, charge or control of the substance at the time it escaped or was spilled, or the person who prepared the plan or all of them to put the contingency plan into operation at their expense.

(4) The minister may order a person who prepared a contingency plan to test the plan.

(5) If a polluting substance escapes or is spilled or waste is introduced into the environment other than as allowed or authorized by :

(a) section 3,

(b) a bylaw under section 24,

(c) a waste management plan approved by the minister, or

(d) a permit, approval or order, the person who had possession, charge or control of the substance or waste immediately before the escape, spill or introduction must, immediately after he or she learns of the escape, spill or introduction, report the escape, spill or introduction in accordance with the regulations.

(6) In a prosecution for a contravention of subsection (5), it is presumed that the accused knew of the escape, spill or introduction at the time of the alleged contravention and the burden of proving that he or she did not know is on the accused.

(7) The minister may amend or cancel an order made under this section.

PROVINCIAL EMERGENCY PROGRAM

Environmental Emergency Program

Environmental emergencies include: spills, discharges, emissions, as well as dyke and dam failures, debris flows and floods. The environmental emergency reporting is by telephoning the 24 hour toll-free number 1-800-663-3456.
This number is located in the front cover of all BC Telephone Company phone-books. A special, international marine spill reporting number for the Pacific west coast - 1-800-OILS-911.

Of the over 4,000 environmental emergencies reported annually, the most common are spills of oil and hazardous materials (about 95% of all events). The type of substance and reportable amounts are listed in a schedule to the Spill Reporting Regulation of the BC Waste Management Act. A person who had possession, charge or control of a substance must, within a reasonable time, report the spill (or pending spill),

PART 3 – MUNICIPAL WASTE MANAGEMENT

Province of British Columbia

(The following includes parts of Municipal Waste Management that are relevant to this study)

Definitions for Part

(17)In this Part:

"sewage facility" means works operated by a municipality that gather, treat, transport, store, utilize or discharge sewage;

"waste management plan" means a plan that contains provisions or requirements for the collection, transportation, handling, storage, treatment, utilization and disposal of recyclable material or waste or a class of wastes in all or a specified part of a municipality or the municipalities.

Waste Management Plans

18 (1) A municipality, alone or with one or more other municipalities, may submit for approval by the minister a waste management plan respecting the management of municipal liquid waste.

(3) Despite any other requirement of this Act, the minister may, by notice in writing,

(a) direct a municipality to prepare or revise a waste management plan and submit it to the minister on or before a date specified by the minister, or

(b) specify a date by which a municipality must furnish proof, in a form satisfactory to the minister, of the progress that the municipality is making to comply with this section.

(4) If the minister considers it to be in the public interest and is satisfied that a municipality is making efforts in good faith to complete a waste management plan in accordance with this Act and the regulations, the minister may, on

conditions specified by the minister, grant an extension of a date specified under this section.

(5) If a waste management plan is approved by the minister, a manager may
(a) issue an operational certificate to a municipality or to any person who is the owner of a site or facility covered by the waste management plan, and
(b) attach conditions to the operational certificate, and the operational certificate forms a part of the waste management plan.

(6) Despite subsection (5), an operational certificate must be issued in accordance with an approved waste management plan and must not conflict with the waste management plan in any substantive fashion.

(7) The minister may, at any time, with or without conditions, approve all or any part of a waste management plan or an amendment to a waste management plan.

(8) The minister may, by order, amend or cancel a waste management plan and, if cancelled, the waste management plan ceases to have force or effect.

(9) Despite anything in the Municipal Act, if a waste management plan is required under subsection (2) or (3) (a) or a waste management plan has been approved by the minister under this section, a bylaw adopted by a municipality for the purpose of preparing or implementing the waste management plan does not require the assent of the electors, a petition, an initiative plan or consent on behalf of the electors referred to in that Act.

(10) Nothing in a waste management plan prevents the exercise of rights conferred by a permit or approval subsisting on the date the waste management plan is approved unless the permit or approval is suspended or cancelled by the minister under section 36 (1).

(11) Despite subsection (10), if a permit or approval contains any provision that conflicts with a requirement of an approved waste management plan, that provision of the permit or approval that conflicts does not apply after the waste management plan is approved.

(12) Despite subsection (10), if an operational certificate is issued in respect of a site or facility for which a permit or approval was previously issued for the discharge of waste in the jurisdiction covered by an approved waste management plan, the permit or approval is cancelled.

c) CAPITAL REGIONAL DISTRICT

The Capital Regional District (CRD) in consultation with the Municipalities has taken a coordinating role in the development of programs for the management of stormwater quality in the Liquid Waste Management Plan area (Hull *et al*., 1998). Hull states, that the "Regional responsibilities include stormwater quality monitoring, technical assistance to the municipalities, public education, coordination of watershed management and promotion of best management practices. The CRD does not have authority to implement any type of mitigative measures or programs, this is the responsibility of the individual Municipalities (Hull *et al*., 1998).

Source Control programs and Best Management Practices (BMPs) are the primary tools that the CRD promotes to better manage the quality of stormwater discharges (T & E Consultants, 1996,). T & E Consultants Ltd. states that "the CRD encourages Municipalities to develop and broadly apply stormwater BMPs to include residential land-use areas and their own operations (1996).

d) MUNICIPALITIES

The municipalities are guided by water quality criteria and restrictions set by the senior levels of government (CRD). Miller states that "the Municipal Act, sections 966 and 976(5) enable municipalities to enact bylaws to control surface runoff according to impervious area, local surficial geology and groundwater conditions, and to provide a range of environmental protection measures for a variety of hazards, natural features and environmental sensitivities (1995)." It provides the necessary tools that the municipalities can use to protect their storm water quality (CRD). All jurisdictions within the LWMP have programs to control contamination of stormwater, these programs vary from one municipality to another in detail, and the level of protection provided (CRD). Miller states that "The Official Community Plans and development permits can be effective ways for municipalities to address discharges to storm sewers and watercourses. Municipalities can also work with the Federal and Provincial governments to ensure that all senior level requirements such as the Fisheries Act are being met (1995)."

e) A BYLAW OF THE CITY OF VICTORIA
NO. 92-15

(The following includes parts of the By-law that are relevant to this study)

1. A person shall not deposit or cause or permit the deposit of any substance into a storm sewer except:

   (a) storm water;

   (b) drainage water with impurity levels that will not be harmful to health, including but not limited to

   (i)cooling water and condensate drainage from refrigeration and air conditioning equipment, and

   (ii) cooled condensate from steam systems.

3. For greater certainty, but without limiting the generality of Section 2, a person shall not deposit or cause or permit the deposit of the following substances into a pipe, main, conduit, opening for workers' access, street inlet, gutter or other opening of a storm sewer except with the permission of the Council:

   (a) oil, gasoline, benzene, naphtha, alcohols or other flammable or explosive

   liquid, solid or gas;

   (b) ashes, cinders, sand, mud, straw, grass clippings, insoluble shavings, metal, glass, rags, feathers, tar, asphalt, creosote, plastic, wood, animal paunch contents, offal, blood, bones, meat trimmings and waste, fish or fowl heads, shrimp, crab or clam shells, entrails, lard tallow, baking dough, chemical residue, cannery waste, bulk solids, hair and fleshing, spent grain and hops, whole or ground paper dishes and cups, whole or ground food and beverage containers, underground garbage and paint residue or any solid viscous substance which is capable of obstructing flow or interfering with the operation of any part of the storm sewer;

   (c) a noxious or malodorous gas or substance which either by itself or by

interacting with another waste is capable of creating a public nuisance or harm

to health;

(d) material from a cesspool or septic tank;

(e) radioactive material unless it is within the limits permitted by license issued by the Atomic Energy Board of Canada;

(f) poisons, herbicides, pesticides, detergents and residue from carpet cleaning.

f) THE CORPORATION OF THE DISTRICT OF SAANICH BY-LAW NO.7501 FOR THE REGULATION AND PROTECTION OF NATURAL WATER COURSES, DITCHES, AND DRAINS

(The following includes parts of the By-law that are relevant to this study)

6. Discharges to Storm Sewers and Watercourses

(a) No person shall discharge or allow or cause to be discharged into a storm sewer or watercourse any domestic waste, trucked liquid waste or prohibited waste.

(b) Notwithstanding the prohibition contained in subsection 6(a), a person may discharge into a storm sewer or watercourse water resulting from domestic activities customarily incidental to a residential use of land including:

(i) water resulting from natural precipitation, and drainage of such water

(ii) water resulting from garden and lawn maintenance, non-commercial car washing, building washing and driveway washing; and

(iii) uncontaminated water.

(c) Notwithstanding the prohibition contained in subsection 6(a), a person may discharge into a storm sewer or watercourse water resulting from the following non-domestic activities:

(i) street, hydrant and water main flushing; and

(ii) firefighting activities.

7. Oil and Grease Interceptor

(a) Where a paved or impervious motor vehicle parking lot is constructed as part of any development, other than a single family dwelling or duplex, the developer shall install an in-line oil and grease interceptor to intercept the

stormwater run-off from the parking lot before it reaches the municipal drainage system.

(c) The owner of the lands shall keep the oil and grease interceptor in good operating condition and shall maintain and repair the device at least once per year from the date of completion of the interceptor. At the request of the Manager, the owner of the lands shall provide satisfactory proof of service by a qualified contractor.