CHAPTER 6
WATER QUALITY

INTRODUCTION

Gig Harbor is the City's centerpiece water body. There are homes, businesses, parks, recreational and educational activities that surround and revolve around the harbor. The harbor is also habitat to various fish and wildlife. With the Endangered Species Act listing of the Chinook salmon as threatened it is important to protect and improve the water quality of the various water bodies in the City.

Commercial fishing and boat building has been associated with the City for over 100 years. The City has preserved this history and has continued to celebrate their relationship with Gig Harbor through various events, such as the Donkey Creek Chum Festival. This festival was initiated by the Gig Harbor Commercial Fishermen's Club and provides an opportunity to raise the awareness of the community in regards to the importance of the harbor. Various environmental groups work with the Fishermen's Club to incorporate educational aspects into the event. Information and activities related to fishing, salmon and protection of the harbor are offered at the festival.

Community involvement and education becomes much more important in the protection of the harbor and the City's waterways as growth and development occurs. "Big box" developments such as Costco attract customers from not only within the City limits, but also the unincorporated surrounding area as well. The Tacoma Narrows Bridge project completed in 2007 has improved access to the City. The combination of development and road improvement projects has and will continue to increase the number of vehicles, visitors, businesses, employees and residents to the City. These activities, including construction, can impact the quality of the City's natural water bodies if surface water runoff is not properly managed.

Protection of the harbor is dependent on proper management of the shorelines as well as the protection of the tributary creeks.

The following are the City's four main creeks within the City limits with their receiving water body in parenthesis:

- Donkey Creek (Gig Harbor)
- Crescent Creek (Gig Harbor)
- McCormick Creek (Henderson Bay)
- Wollochet Creek (Wollochet Bay)

There are also a number of tributaries to these creeks including North Creek which is a tributary of Donkey Creek.

Within the Urban Growth Area there are two other creeks Garr Creek and Goodnough Creek. Garr Creek is a tributary of Wollochet Creek. Goodnough Creek is a tributary to Henderson Bay. The Urban Growth Boundary extends to the northwest adjacent to Henderson Bay, to the east side of Gig Harbor and to the south along Puget Sound. It is possible that in the future, the City will be responsible for regulating and protection of the entire shoreline of Gig Harbor, and parts of the shoreline of Henderson Bay and the Puget Sound.

Proper management of stormwater is an integral part of the preservation of the water quality of the harbor, bays and the surrounding streams.

As it rains, water falls on a variety of surfaces. In the City there are still trees taller than the highest building and there are undeveloped areas with good tree canopies. In the areas with good tree canopy, rain is either captured by the trees, evaporates or falls to the understory vegetation below. Below the trees, the rainwater is used by the plants, or falls to the ground and is taken by the roots or possibly infiltrate into the soils or runoff in its natural course. In these areas the amount water runoff is naturally reduced.

In areas that have been cleared and developed, the amount of water runoff will increase as the trees and vegetation is removed and the ground is compacted and impervious materials are placed. The increase in runoff affects the quantity and quality of water. As the water flows across impervious or compacted surfaces it will collect and transport pollutants to the storm system and discharge into its receiving water. These pollutants include oils and greases from roads and fertilizers and pesticides from lawns and gardens. These pollutants will lead to poor water quality and degrade the health of the water body. This will negatively affect the fish and wildlife that use the water body as habitat and possibly create a health hazard.

It is required by the City's Municipal Code that all new development collect the stormwater runoff and provide detention and treatment. These facilities will provide some mitigation towards the stormwater runoff. Regular inspection and maintenance is very important for these facilities to function properly. The facilities have limited volume available and if they are not maintained properly, they will overflow and cease to provide any benefit towards the protection of the City's waters.

As discussed in Chapter 2 Stormwater Regulations, the Clean Water Act regulates the discharges of pollutants to waters of the United States and makes it unlawful for any person to discharge any pollutant from a point source into waters of the United States. The NPDES permit requires agencies to have a stormwater program that identifies and documents their storm system and contributors, addresses water quality impacts and reduces pollutant discharges. In accordance with the permit, the City is required to address illicit discharge detection and elimination. Training must be provided to staff and the public must be educated of their responsiblity to report any spills or illicit discharges.

WATER QUALITY IMPACTS

Stormwater has been shown to increase pollutant loads in receiving waters and sediments, as well as to increase water temperatures, thereby affecting riparian habitat (*Stormwater Management Manual for Western Washington*, Ecology). Research in Western Washington has shown that the concentrations of many pollutants found in stormwater from residential, commercial and industrial areas exceed water quality standards. Development, and activities on developed areas, results in changes to the natural environment. These changes can adversely impact the natural environment by release of hydrocarbons, fertilizers, pesticides, bacteria, and other contaminants as discussed below.

The *National Water Quality Inventory Report to Congress* (EPA, 1986) concluded that diffuse sources of water pollution, including runoff from urban areas, are the leading cause of water quality impairment. In 2005, Ecology updated Washington's Water Quality Management Plan to Control Nonpoint Sources of Pollution. The Plan identified typical nonpoint sources of pollution, developed a strategy for protecting and improving water quality and describes methods for monitoring and evaluating progress.

Parameters of Concern

Many substances that are transported by stormwater impact the receiving water bodies. Typical parameters of concern include: temperature, dissolved oxygen, pH, sediment/turbidity, nutrients, metals, pesticides and herbicides, petroleum hydrocarbons, and bacteria. The impact of stormwater on the natural environment is a function of the structural components installed to control flow and preserve water quality, the density and type of development, maintenance of the storm drainage system and the day to day best management (housekeeping) practices. The following discussion provides a brief description of the parameters mentioned above.

- **Temperature -** Temperature can affect the life process of salmon and other fish from spawning to migration. Increases in stream temperatures are identified as a barrier to salmon migration. Other aquatic species are also impacted by temperature increases. As described below, temperature also affects the amount of dissolved oxygen in the waters.

- **Dissolved oxygen -** Dissolved oxygen (DO) is necessary in water to maintain life. Biological activity, water temperature and the quality of the water tributary to the stream cause natural variations in the levels of DO. Dissolved oxygen is used by fish and bacteria for respiration and in the decomposition of organic matter. When the rate of oxygen utilization exceeds the rate of replenishment, DO levels will drop. In some cases the DO can become depleted and the concentration in the water may go to zero. Oxygen demand is greater at higher temperatures due to the increased biological activity, however the maximum concentration of DO in water is inversely related to water temperature; i.e. warmer water has a lower saturation level than colder water. The saturation concentration at 8°C is approximately 11.5 milligrams per liter (mg/L) and at 20°C it is 9.5 mg/L. Thus during the summer months, when stream flows are low and water temperatures are elevated, DO is less available to aquatic life. Variations in DO may also be caused naturally by the water source. For example, groundwater and water draining bogs and marshes may have a low DO concentration.

- **pH -** Chemical and biological systems occurring in natural waters cause changes in the pH of water. Changes in pH affect the toxicity, reactivity, and solubility of many compounds. For example the solubility and toxicity of zinc, a common parameter in stormwater runoff, is impacted by changes in pH.

- **Sediment/turbidity -** Erosion of the land surface may cause sediment to enter streams with runoff. The greatest risk of sedimentation occurs during construction when the ground surface has been stripped and soil is exposed. Erosion and sediment transport can be controlled through the implementation of good construction practices including the installation of proper erosion control measures. Excessive sediment input to streams can plug the gravels restricting the flow of water through them. Reduced flow through streambed gravels can inhibit the transfer of oxygen from the water to fish eggs and lead to their destruction.

- **Bacteria -** Fecal coliform bacteria in surface waters have historically been used as an indicator of water-borne pathogenic bacteria or viruses. Therefore, fecal coliform is used as indicators for public health concerns. High levels can indicate failing septic systems, poor livestock management practices, poorly operated wastewater treatment systems and other point or non-point sources.

- **Nutrients -** Nutrients stimulate the growth of algae and water plants. Typical human sources of nutrients include detergents, fertilizers and septic system effluent. Primary nutrients of concern are nitrogen and phosphorous. Phosphorus is often the controlling nutrient for algae growth in fresh waters. In marine waters nitrogen is usually the nutrient in shortest supply and therefore limits algae growth. Forms of nitrogen include ammonia, nitrite, and nitrate that are components of fertilizers and septic system effluent. Typical nutrient concentrations in stormwater runoff are usually sufficient to stimulate the growth of algae and plant species. Increased algal activity resulting from the elevated nutrient concentrations may cause a decrease in DO and an increase in surface algal scums, water discoloration, odors, and overgrowth of plants.

- **Toxics -** Toxics criteria have been developed to directly address aquatic life protection and human health protection from consuming water and fish/shellfish. Toxics standards are different than conventional water quality standards such as pH, temperature, and dissolved oxygen. The toxics standards contain criteria on compounds such as metals, pesticides, and other organic compounds found in the environment.

- **Metals -** Metal concentrations are generally elevated in stormwater relative to background concentrations. Zinc is a typical surrogate used to assess the impact of stormwater on the receiving water. Zinc originates from the wear on automobile brakes. If metals concentrations are sufficiently elevated they can impair, or in some cases be lethal to, aquatic life. Lead concentrations historically were elevated in runoff and in sediment. However since the banning of leaded gasoline, lead concentrations have decreased.

- **Pesticides/Herbicides -** Pesticides and herbicides, by design, are targeted to kill insects and undesirable weeds. In many cases they may have adverse effects on aquatic biota. For example herbicides may kill aquatic plant life. Many pesticides attack the central nervous system of fish. If pesticides or herbicides are applied improperly, the impacts on aquatic life can be dramatic.

- **TPH -** Total Petroleum Hydrocarbons (TPH) are associated with urban and industrial stormwater runoff. TPHs originate from minor drips, leaks and exhaust from automobiles, the servicing of engines and from road construction.

WATER QUALITY STANDARDS

Water Quality Criteria

WAC Chapter 173-201A establishes the water quality standards for protecting and regulating the quality of surface waters in Washington. Protecting surface water will maintain public health and public enjoyment of the waters, fish, shellfish and wildlife.

According to WAC Chapter 173-201A-612, Gig Harbor, Wollochet Bay and Henderson Bay are classified as extraordinary quality (Class AA) for marine aquatic life uses. Any fresh surface waters that are tributaries to extraordinary quality marine waters must satisfy the extraordinary quality (Class AA) for freshwater aquatic life uses water quality criteria. This includes Donkey Creek, McCormick Creek, Wollochet Creek and Crescent Creek.

Water quality criteria, for fresh or marine waters, are developed to provide protection for the various designated uses. They are applied alongside the designated use associated with every waterbody in the state. The Water Quality Standards contain numeric (i.e., not to exceed some concentration) and narrative criteria for both marine and fresh waters. Table 6-1 shows the water quality standards.

Table 6-1 Water Quality Criteria

Parameter or Type	Freshwater Criteria	Marine Criteria
Temperature	Not to exceed 16°C (60.8°F)	Not to exceed 13°C (55.4°F)
Dissolved Oxygen	Exceeds 9.5 mg/L	Exceeds 7.0 mg/L
Total Dissolved Gas	Not to exceed 110 percent of saturation at any point of sample collection.	No Marine Criteria for Total Dissolved Gas
pH	pH shall be within the range of 6.5 to 8.5, with a human-caused variation within the above range of less than 0.2 units.	pH must be within the range of 7.0 to 8.5 with a human-caused variation within the above range of less than 0.2 units.
Turbidity	Turbidity shall not exceed: • 5 NTU over background when the background is 50 NTU or less; or • A 10 percent increase in turbidity when the background turbidity is more than 50 NTU.	Turbidity must not exceed: • 5 NTUs over background when the background is 50 NTU or less; or • A 10 percent increase in turbidity when the background turbidity is more than 50 NTUs.
Bacteria	Fecal coliform organism levels must not exceed a geometric mean value of 50 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 100 colonies/100 mL.	Fecal coliform organism levels must not exceed a geometric mean value of 14 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 43 colonies /100 mL.
Toxic, radioactive, or deleterious material	Concentrations must be below those which have the potential, either singularly or cumulatively, to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health.	
Aesthetic	Values must not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste	

WATER QUALITY MONITORING

Existing water quality surveys are related to the permitting requirements for the City of Gig Harbor wastewater treatment facility. For the most part, the data collected was in the harbor. However, some data was collected from Crescent Creek and Donkey/North Creek, the two major tributaries into Gig Harbor.

The City does not currently have a formal water quality monitoring program and no locations are monitored on a regular basis. The City collects water samples if there are unidentified spills or there is notification of any observations of polluted waters. Water samples are delivered to a lab for analysis.

Water quality sampling of the City's water bodies have been performed in the past as part of the City's Wastewater Treatment Facility permit requirements (late 1990's) and the Gig Harbor Basin Plan completed by Pierce County (early 2000's). The last sampling was done in 2002 for the Gig Harbor Basin Plan. Table 6-2 shows the data results from the sampling for the Wastewater Treatment Facility. Table 6-3 shows the data results from the Gig Harbor Basin Plan. The Gig Harbor Basin Plan was developed as a part of the Pierce County Basin Planning Program in 2005. This program developed a surface water management plan for each of the County's major basins evaluating water quality, flooding and habitat issues.

It is difficult to make conclusions based on the collected data due to the gaps in collection periods and unknown sampling locations. Different sampling locations will produce different results. Samples taken in an upstream undeveloped area may produce results that satisfy the State's criteria whereas a site downstream of a shopping center may not. In general, based on the most recent data, during the spring it appears that the creeks satisfy the DO requirement, but during the summer as temperatures increase the DO falls below the criteria. Majority of the Fecal Coliform samples exceed the requirement. The pH appears to be within the required range. Sampling must be done regularly over a period of time to develop a baseline and to make an assessment of the water quality.

Related to water quality monitoring the following tasks are required by the NPDES Phase II permit:

- Receiving waters shall be prioritized for visual inspection by February 15, 2010. (S5.C.3.c.ii)
- Field assessments must be conducted for three high priority water bodies by February 15, 2011. (S5.C.3.c.ii)
- Annual field assessments must be conducted on at least one high priority water body. Required annually after February 15, 2011. (S5.C.3.c.ii)

TABLE 6-2 Historical Water Quality Data

Date	DO (mg/l)	Fecal Coliform (MPN/ml)	PO_4-P (mg/l)	SiO_4-Si (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	NH_4-N (mg/l)	Data Source
Crescent Creek								
3/31/91	11.79	<0.3	0.074	24.254	1.935	0.004	0.0002	Spr 91 Rpt
3/28/92	11.79	<0.3	0.101	18.097	3.699	0.018	0.097	Spr 92 Rpt
6/11/92	10.45	2.3	0.066	31.136	0.828	0.004	0.012	Sum 92 Rpt
8/11/97	10.74							S-12
8/22/97	10.02		0.029	11.045	0.725	0.003	0.021	S-12
8/28/97	10.09		0.019	9.644	0.067	0.003	0.014	S-12
9/11/97	10.05		0.016	9.945	0.693	0.005	0.051	S-12
9/18/97	9.37		0.018	5.167	0.775	0.006	0.027	S-12
North Creek								
8/11/97	7.00							S-12
8/22/97	7.18	2.3	3.361	17.110	7.288	1.438	10.374	S-12
8/28/97	7.55		3.037	15.948	8.204	1.622	8.316	S-12
9/11/97	6.76		3.534	15.707	10.859	0.965	10.301	S-12
9/18/97	6.81		2.512	9.99	6.697	0.964	10.136	S-12
Gig Harbor – Northerly Station (#3 – Shallow depth)								
3/31/91	10.65	<0.3	0.218	6.400	1.371	0.001	0.001	Spr 91 Rpt
3/28/92	9.40	<0.3	0.241	5.218	1.438	0.020	0.015	Spr 92 Rpt
7/1192		0.4	0.223	4.655	0.973	0.023	0.009	Sum 92 Rpt
8/11/97	14.69							S-12

TABLE 6-2 Historical Water Quality Data (continued)

Date	DO (mg/l)	Fecal Coliform (MPN/ml)[1]	PO_4-P (mg/l)	SiO_4-Si (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	NH_4-N (mg/l)	Data Source
Gig Harbor – Northerly Station (#3 – Shallow depth) – (continued)								
8/15/97			0.058	0.873	0.070	0.0124	0.103	S-12
8/22/97	7.48		0.056	1.048	0.220	0.004	0.015	S-12
8/28/97	8.42		0.078	1.923	0.202	0.017	0.154	S-12
9/11/97	12.01		0.026	0.887	0.024	0.002	0.029	S-12
9/18/97	5.51		0.089	1.942	0.307	0.013	0.131	S-12

Notes:
[1] Most Probable Number per milliliter

Sources:
S12 Receiving Water Quality Monitoring Program - Cosmopolitan Engineering Group
Gig Harbor Water Quality Study Summer Report 1992 – Raven Services Corporation
Gig Harbor Water Quality Study Spring Report 1992 – Raven Services Corporation

TABLE 6-3 Gig Harbor Basin Plan Water Quality Data

Date	Temp. (deg. C)	DO (mg/L)	Turbidity (NTU)	pH	Fecal Coliform (CFU/100 ml)	Nitrate (mg/L)	Total Phosphorous	Phosphate (mg/L)	Conductivity
Goodnough Creek									
6/1/2000	10.8	7.9	3	7.7	180	1.7	0.06	ND	(3)
7/31/2001	13.2	(1)	(1)	7.5	50(2)	1.86	0.02	0.01	(3)
3/15/2002	5.6	12.9	1	5.6	84	0.98	1.7	ND	95.5
6/11/2002	10.4	8.82	1.9	7.52	0	(3)	0.05	(3)	101.2
10/1/2002	11.5	N/A	1.1	6.92	60	2.51	0.07	ND	186.0
McCormick Creek									
6/1/2000	11.1	7.8	0	7.9	150	0.25	0.06	ND	(3)
7/31/2001	13.3	(1)	(1)	7.5	174	0.26	0.03	0.03	(3)
3/15/2002	6.6	11.0	2	7.2	14	0.33	1.70	ND	92.3
6/11/2002	11.6	7.61	1.7	7.5	130	(3)	0.05	(3)	96.6
10/1/2002	10.7	N/A	1.3	6.73	190	0.286	0.06	ND	130.4
Wollochet Creek									
6/1/2000	12.8	9.8	3	7.9	50	0.34	0.07	ND	(3)
7/31/2001	13.9	(1)	(1)	7.3	118	0.39	0.02	0.02	(3)
3/15/2002	6.9	10.5	2	6.9	34	0.52	1.10	ND	65.0
6/11/2002	12.7	9.62	1.7	7.82	10	(3)	0.07	(3)	72.0
10/1/2002	10.1	N/A	0.3	7.13	70	0.384	0.05	ND	154.3

TABLE 6-3 Gig Harbor Basin Plan Water Quality Data (continued)

Date	Temp. (deg. C)	DO (mg/l)	Turbidity (NTU)	pH	Fecal Coliform (CFU/100 ml)	Nitrate (mg/l)	Total Phosphorous	Phosphate (mg/l)	Conductivity
Donkey Creek									
6/1/2000	10.8	8.4	6	7.9	90	0.23	0.10	0.03	(3)
7/31/2001	13.6	(1)	(1)	7.4	220(2)	0.68	0.07	0.05	(3)
3/15/2002	5.9	12.4	1	6.7	72	0.28	2.60	ND	101.9
6/11/2002	10.5	9.23	1.6	6.88	210	(3)	0.08	(3)	101.2
10/1/2002	11.4	N/A	1.1	6.61	40	0.189	0.11	ND	129.3
Crescent Creek									
6/1/2000	11.5	8.0	5	8.2	440	0.72	0.07	0.04	(3)
7/31/2001	13.3	(1)	(1)	7.5	124	0.68	0.04	0.03	(3)
3/15/2002	5.9	12.6	1	7.1	56	0.69	1.70	ND	89.1
6/11/2002	11.2	8.45	1.5	7.6	100	(3)	0.06	(3)	92.3
10/1/2002	10.1	N/A	0.7	7.24	540	0.725	0.1	ND	140.9

Source: Pierce County, Gig Harbor Basin Plan Volume 1, August 2005
Notes: (1) No data due to equipment malfunction.
(2) Data estimated.
(3) Data not provided.
ND – Not Detectable.
N/A – Not Available.

SECTION 303(D)/TOTAL MAXIMUM DAILY LOAD

Section 303(d) of the Clean Water Act (CWA) established the Total Maximum Daily Load (TMDL) or Water Quality Improvement Project process. Federal law requires states to identify sources of pollution in waters that fail to meet state water quality standards, and to develop Water Quality Improvement Reports to address those pollutants. The Water Quality Improvement Project establishes limits on pollutants that can be discharged to the waterbody and still allow state standards to be satisfied.

In January 1998, Ecology, EPA, Northwest Environmental Advocates, and Northwest Environmental Defense Center agreed to a cleanup schedule directing how Washington State will improve the health of nearly 700 water segments. Ecology's Memorandum of Agreement outlines a plan and schedule to improve polluted waters while expanding public involvement in Water Quality Improvement Reports.

The terms water quality plan, water cleanup plan, and total maximum daily load (TMDL) are all used to describe the same thing - a process undertaken with local organizations and citizens to reduce water pollution. These plans describe the type, amount, and sources of water pollution in a water body; how much the pollution needs to be reduced to meet water quality standards; and targets to control the pollution. They also include suggested activities to improve water quality.

Ecology has not notified the City of any water bodies within the City that have been identified and proposed to be included in the 303(d) list or require a TMDL. Since Ecology has not identified a waterway or water body within the City that will require a TMDL study, the City does not have TMDL requirements at this time.

POLLUTANT SOURCES

Pollutant sources are classified as point and nonpoint sources. A point source is where the pollutant can be traced back to a single origin or source such as a discharge from a sewage treatment plant or an industrial site.

Nonpoint source pollution is where the pollutant source cannot be traced back to a single source. For example, stormwater runoff picks up oils, greases, metals and other pollutants from the road surface, but the actual car(s) that discharged the pollutant will be difficult to find. Nonpoint source pollution is the leading cause of water pollution. Typical pollutants such as fecal coliform bacteria, pesticides, sediments, and nutrients can come from a point source or nonpoint source.

The EPA and Ecology regulate stormwater discharges through the stormwater permitting program (i.e. NPDES Phase II, see Chapter 2) to prevent point source pollution and reduce nonpoint source pollution.

The water quality data collected in past studies is not sufficient to clearly define if and where major inputs of stormwater contaminants are to the natural system. Typically, this is assessed through a sampling program designed to evaluate both dry weather and wet weather flows at several key locations in the natural and man-made storm drainage system.

Major sources of non-point source pollution in Gig Harbor are likely related to urban development and marine activities. Other important sources of non-point pollution may include illicit connections to the storm drain system, on-site sewage systems and improper waste storage and disposal practices.

Urban Development

Development in the City continues. As stated previously "Big Box" development has recently arrived and Costco, Target and others have opened stores in the City. Other commercial and residential developments continue to be constructed. These developments include fast food restaurants, full-service restaurants, large grocery stores, hardware stores, dry cleaners, and other small, service-oriented businesses. Also found at these locations are gas stations, automotive service centers, and automotive parts stores. There is also an automobile sales center and a large lumber yard along Point Fosdick Drive Northwest just north of the Harbor Plaza. The business establishments along Harborview Drive and in the Downtown corridor are primarily related to the tourist industry and include small restaurants and clothing and gift shops. The shopping area along Judson Street includes a large grocery store, an automotive parts store, an automotive service center and other miscellaneous businesses. In the surrounding area of the City, there are golf courses, sand and gravel pits and contractors.

Potential sources of contaminants from these developments include:

- Oil, grease, suspended solids, general automotive fluids and metals from the parking lots and car related services areas.
- Increased bacterial loads and garbage from possible improper waste storage and disposal practices at grocery stores and restaurants.
- Food waste, containers and cooking oils/greases from the restaurants.
- Chemicals and cleaning solvents from the dry cleaners.

- Oil, grease, petroleum hydrocarbons from gas stations, automotive parts stores and service centers .

- Sediment from sand and gravel pits.

- Pesticides, herbicides and fertilizers from landscaping and golf courses.

Throughout the City, undeveloped land is being converted to residential and commercial use. The construction related activities of land clearing and site preparation can be significant sources of stormwater pollution. Areas that have been cleared of vegetation are prone to erosion and can significantly increase sediment loading to nearby drainage courses and bodies of water. Sediment can become deposited in natural and manmade channels thereby reducing hydraulic capacity. The efficiency and capacity of associated stormwater control structures such as culverts, pipes and detention facilities will also be affected by the deposition of sediment. The City has been experiencing sediment problems at the 38th Avenue NW culvert. This has been identified as a CIP project. Sediment has also been observed at Donkey Creek's outlet to Gig Harbor. The sediment has increased the size of the estuary at the outlet and decreased the capacity of the outlet. The City has a CIP project to remove the culvert and restore Donkey Creek at this location. For both of these projects, it is recommended that an investigation be completed to determine the source of sediment. It may be possible to resolve this problem at the source through a stabilization project or improvements to the conveyance system. Detention requirements in this basin could also be increased to decrease the flow and velocity in the area of the erosion.

The amount of stormwater runoff also increases during construction activities as vegetative cover is removed. Leaf interception and infiltration provide a natural detention benefit while plant roots generally improve a soil's water holding capacity. When vegetation is removed from an area and replaced with impervious surfaces such as roads and rooftops, the total volume and peak rate of runoff increases. Erosion of slopes, streambanks and accelerated channel scouring from increased flow rates and volumes can damage property, destroy riparian habitat and degrade water quality. For these reasons, it is imperative proper construction erosion control techniques are specified and utilized in all projects. There are steep slopes along Gig Harbor and within the City. It is important to protect these slopes by limiting the number of outfalls in these areas requiring developments to provide proper detention and slope protection or have the discharge pipe be connected or outlet to the system at the bottom of the slope. In addition to soil erosion, building activities can generate other pollutants. Pesticides, fertilizers, petroleum products, cleaning solvents, paints, asphalt by-products, acids, and salts, as well as solid wastes, are potential sources of stormwater pollution if improperly handled on a construction site. Construction erosion control programs should include provisions for waste handling and disposal.

Urban development can severely impact wetlands in several ways. Development often includes filling in wetlands or changing the hydrologic characteristics of areas draining to wetlands. When increased stormwater flows due to development are directed to a wetland area, the hydrological regime of the wetland may be altered which may lead to major alterations or even destruction of the biology of the wetland. Nutrient pollution from urban development may impact wetlands by promoting the growth of nuisance plants and pesticide, herbicide or fertilizer pollution from urban development may destroy wetland plants. Organic pollution from urban development may increase the oxygen demand in wetlands that may lead to destruction of existing ecosystems. Inadvertent diversion of flows can lead to a decrease in wetland area and opportunity for water quality treatment. In 2005, the City contracted with Adolfson and Associates to complete a wetland inventory. This study can be used as a baseline for wetland monitoring. Any changes should be documented and investigated. Adolfson was not granted access to private property therefore additional wetlands may exist. As development occurs and wetland reports are submitted, the identified wetlands should be included in a GIS wetland inventory map. Date and source of information should be in the GIS database.

Volume IV, Chapter 3 of the 2008 Pierce County Surface Water Design Manual has recommended best management practices for various single family residential activities. These could be provided to homeowners as an education and outreach effort.

Marine Activities

In addition to the risk of pollutants due to high volumes of boat traffic that Gig Harbor receives during summer months, there are some high risk areas along the waterfront that could introduce pollution into the harbor. Near the corner where Soundview Drive turns from north to west was a large fueling station that was closed in 1999. This site had three large vertical tanks for fuel storage, a fuel pit with several overhead fueling pipes and numerous drums and oil storage locations. The Gig Harbor marina no longer has a fueling station and the tanks have been removed from the site. There have been discussions of a new fueling station, but none have been submitted.

Boat repair and maintenance occurs at this site and could contribute significant amounts of oil/fuel, particulate and chemical pollution to the nearby waters. Boat maintenance including bottom sanding and painting, varnishing, fiberglass repairs and engine work appear to occur in open air, parking lot style conditions. Residues from these activities can contribute to localized air pollution as well as contaminated runoff during rainfall events. Volume IV, Chapter 4 of the 2008 Pierce County Surface Water Design Manual has recommended best management practices for various commercial and industrial activities. These could be provided to the owners of these facilities as an education and outreach effort.

County and State Highways

Stormwater runoff from state and county highways, as well as city arterials and residential streets can contain elevated concentrations of metals, suspended solids and organic compounds such as petroleum hydrocarbons. Studies have shown that pollutant loading is directly related to the amount of vehicle traffic during the storm (Horner and Mar, 1982). Major highways with high vehicle use, such as State Route 16, can be significant sources of non-point pollutant loading. Sanding in the winter further contributes sediment to the drainage system. The City has a street sweeping program that includes a regular sweeping schedule for the City streets. Soon after the snow and ice melts the streets are swept and the storm system is inspected. If needed the catch basins are cleaned with the City's vactor truck. The City works with WSDOT any time there are water quality problems in the area of State Routes.

GENERAL CONSIDERATION IN URBAN STORMWATER QUALITY AND QUANTITY CONTROL

Each of the issues discussed above for stormwater quantity and quality problems present stormwater management issues. Stormwater management solutions to alleviate the stormwater problem areas must be sound from an engineering viewpoint and must comply with the stormwater regulations as discussed in Chapter 2.

As the consequences of uncontrolled urban runoff have become more widely recognized and better understood, and as the alternatives available for control have increased, the complexity of stormwater management has grown. Several general considerations may provide a framework for issues that may affect the City of Gig Harbor's stormwater management program. The considerations are briefly discussed in the following paragraphs and include:

- Stormwater quality and quantity control,
- Construction phase and long-term site operations,
- Structural and nonstructural controls,
- Source control and downstream treatment,
- Control in new and existing development, and
- Sensitive area considerations.

Stormwater Quality and Quantity Control

Stormwater management has traditionally been concerned with control of runoff quantities for the purpose of preventing flooding. Accordingly, most regulations prior to 1990 and engineering design procedures address this concern. Recently, runoff water quality control has become an added concern as it has been recognized that water quality goals often cannot be realized through control of point sources of water pollution alone.

Efforts at quantity and quality control are confronted with the same basic task, predict the amount of runoff resulting under various conditions and provide sufficient storage capacity and treatment to achieve control objectives. In the case of quantity control, the objective is to release storm runoff at a rate that does not increase the runoff, due to development, from a site. For ease in regulating this objective, design storms and various assumptions regarding runoff from soil are used. These assumptions are standardized and do not always provide sufficient protection to streams. Stormwater detention can also provide water quality protection by providing sufficient holding time for the effective operation of gravity settling or biochemical removal of pollutants. Thus, storage may benefit both stormwater quantity and quality.

Low Impact Development (LID) methods such as vegetated swales, rain gardens, porous materials and pavers have been shown to reduce stormwater flows through infiltration and also provide water quality treatment. LID is discussed in Chapter 2 Stormwater Regulations.

Construction Phase and Long-term Site Operation Phase

In general, the types of potential water quality problems differ sufficiently between construction and the operation of a developed site that these periods should be treated separately in stormwater management planning. During construction, the major concern is the movement of sediment with stormwater runoff. Proper temporary erosion and sediment control must be used during construction. This must be inspected daily and if there is any indication that the controls are not functioning properly, they must be repaired immediately. After the site is constructed and the soil stabilized, the sediment movement decreases. However, the contaminant concentration can increase. For example, homeowner use of pesticides, herbicides and fertilizer typically has an impact downstream. Water quality treatments installed for the construction phase can be converted to permanent service. For example, sediment detention ponds are routinely converted to long term stormwater detention facilities upon the completion of construction. Educating the public and business owners will help in the reduction of pollutants from their site.

Structural and Non-structural Control

Control of water pollution relies to a large extent on both structural and non-structural devices. For example, grassy swales, oil/water separators, and wet ponds could all be considered structural stormwater treatment devices. Nonstructural approaches may include enhanced maintenance programs, regulations, public involvement, land use controls and other measures. Effective stormwater quality programs use a mix of structural and non-structural alternatives.

Source Controls and Downstream Treatment

Source control generally provides pollutant removal at or close to the location of pollutant generation; downstream treatment is removed from the source. Source control measures include proper handling of all potential contaminants to minimize the potential for release to the environment. Downstream treatment includes detention ponds, swales and filters.

Stormwater Control in New and Existing Development

New developments offer greater opportunities to apply stormwater management techniques than do existing developments. Retroactively installing structural controls in existing developments is generally difficult and expensive due to the lack of space. In older developments, space for detention and treatment of stormwater was generally not set aside. Structural measures often occupy the space of two or more building lots and this land may not be available for a detention facility at a cost effective rate in developed areas. Possible alternatives in this scenario include vault type detention under roadways, or the purchase of land for regional detention facilities. The cost effectiveness of stormwater controls will likely influence the placement of these controls. Additionally, the costs of stormwater controls installed as part of new development are generally borne by private developers whereas the cost of installing a stormwater system retroactively is generally a public cost.

Sensitive Area Considerations

Areas sensitive to the potential impacts of urban stormwater include lakes and estuaries that are poorly flushed. Special consideration needs to be given to areas upland of these types of water bodies. Regulations in these areas may target nutrient removal through enhanced water quality treatment.

STORMWATER MANAGEMENT ALTERNATIVES

Stormwater management includes the use of both structural and non-structural methods. Structural methods are those actually physically constructed to detain, infiltrate or treat stormwater runoff. Non-structural methods are those applied by homeowners, businesses and municipalities to reduce the impacts of stormwater through daily practices, maintenance, and creative design of new facilities and by regulations.

Structural Alternatives

Structural alternatives typically include storage and release facilities or infiltration systems. Other less obvious but effective measures include: swales and filter strips, minimization of directly connected impervious area and porous pavement and parking blocks. Structural alternatives are to be designed to the City's adopted surface water requirements.

Storage and Regulated Release

Storage and regulated release of stormwater is currently practiced in the City of Gig Harbor. New developments in the City are required to install detention or infiltration systems to insure that the rate of stormwater runoff leaving the site for a particular design storm event does not change as a result of development. The intent, as discussed above, is to reduce or eliminate the impact of development on streams.

Detention basins typically consist of: 1) a permanent structure (i.e. pond, vault or tank), 2) an overlying zone in which the design volume temporarily increases as a result of storm events and 3) a flow control restrictor. During storms, runoff replaces "treated" waters that were detained within the permanent facility since the previous storm. Thus the permanent water storage volume is critical for water quality treatment of stormwater. Wet detention ponds are often used in series with swales to provide additional treatment. If properly designed and maintained, wet detention ponds can provide not only effective flood and water quality protection, but also ancillary benefits, such as enhanced aesthetics and wildlife habitat.

The removal of stormwater pollutants in a wet detention system is accomplished by a number of physical, chemical and biological processes. Gravity settling removes particles through the physical process of sedimentation. Chemical flocculation occurs when heavier sediment particles overtake and coalesce with smaller, lighter particles to form still larger particles. Biological removal of dissolved stormwater pollutants includes uptake by aquatic plants and metabolism by phytoplankton and microorganisms that inhabit the bottom sediments.

Swales and Filter Strips

Swales and filter strips are among the oldest stormwater control measures, having been used alongside streets and highways for many years. A swale is a shallow trench that has the following characteristics:

- Side slopes are flatter than three feet horizontally to one foot vertically,

- Contains contiguous areas of standing or flowing water only during and immediately after rainfall events, and
- Planted with or contains vegetation suitable for soil stabilization, stormwater treatment, and nutrient uptake.

A filter strip is simply a strip of grass covered land across which stormwater from a street, parking lot, rooftop, etc., sheet-flows before entering adjacent receiving waters.

Maintenance of both swales and filter strips is essential to their proper operation. A healthy stand of grass must be maintained for the expected performance of the swale to be achieved. Proper mowing and removal of grass clippings is critical to promote healthy grass growth and to ensure that the grass does not lay over reducing the filtering.

Erosion Control

Control of erosion during construction can be accomplished by many methods. All of the local stormwater manuals (for example Kitsap County, King County and Ecology) have similar and stringent requirements to control the offsite migration of sediment. There are two basic principles utilized in the application of temporary erosion and sediment control measures.

The first and most effective principle is to keep sediment from moving at all. Typical methods employed here are plastic covering, hydroseeding and mulching. A relatively new development to help stabilize soil is to spray the exposed soil with a polyacrylimide tackifier that actually holds the soil in place. Although the tackifier degrades over time it lasts sufficiently long to allow hydroseed or other measures to take root. Both methods discussed above, polymer clarification and polyacrylimide application, require the addition of chemicals and are considered experimental by the Department of Ecology.

The second principle is to stop the offsite migration of sediment. Typical structural methods applied to stop sediment movement are silt fences, hay bales, sedimentation ponds and gravel filters. All of these methods are designed to capture sediment after it has been dislodged and has migrated from its original location. A new development in the capture of sediment is polymer assisted clarification. This requires the application of a flocculation chemical to stormwater in a sediment pond. The flocculation chemical promotes rapid settling of the sediment. By maintaining side by side sedimentation ponds and performing batch treatment on the ponds, stormwater can be released from the site essentially free of sediment.

Low Impact Development

Low Impact Development (LID) best management practices (BMP's) are recommended by the City. BMP's such as rain gardens, biofiltration swales, pervious asphalt/concrete and concrete pavers allow water to infiltrate on site and reduce runoff to the City storm system. The City has participated in the review of Volume VI of the 2008 Pierce County Surface Water Design Manual that discusses LID.

Infiltration systems

Infiltration systems intercept runoff and allow it to infiltrate into the ground and recharge the ground water table. Infiltration systems should be preceded by water quality treatment to remove particulate material that may clog the infiltration gallery. If the soil and groundwater conditions allow, infiltration should be used if at all possible. Proper infiltration recharges the ground water table, provides stable low flows to the streams in the summer, reduces high intensity surface water runoff to streams during storm events, and provides for water quality treatment.

Non-structural Alternatives

Non-structural stormwater management alternatives are those which do not directly require construction. They include a wide range of items such as regulatory requirements for stormwater detention that ultimately leads to structural controls, or education that seeks to teach homeowners about the use of fertilizers. As discussed in Chapter 2, the City is required to satisfy the NPDES Phase II permit requirements. The permit has specific programs and a schedule for tasks within each program. During the next five years the City will be incorporating these programs and completing tasks. These programs all relate to water quality. The main programs are as follows, details are in Chapter 2:

- Public Education and Outreach
- Public Involvement
- Illicit Discharge Detection and Elimination
- Control Runoff from New Development and Redevlopment Construction Sites
- Municipal Pollution Prevention, Operation and Maintenance.

Facilities Maintenance

The objective of a stormwater maintenance program is to assure the reliability and dependability of the stormwater system for conveyance, detention and water quality. Maintenance programs include cleaning catch basins, pipes and open ditches, maintaining a facilities inventory, maintenance scheduling, budgeting, and record keeping.

In order to perform maintenance at a high level, a budget, staff and priority schedule needs to be established. The budget should include annual inspection of catch basins and conveyance facilities before the wet season to assure that debris has not blocked a channel or taken up capacity in a manhole. If the City's Stormwater Utility budget permits, the catch basins should be cleaned of sediment on an annual basis. The City's Maintenance Program is discussed in Chapter 7.

Changes to Municipal Codes and Regulations

The federal, state and local rules, regulations and guidelines that govern stormwater have been discussed in Chapter 2 of this document.

The City will adopt the 2008 Pierce County Surface Water Design Manual after it has been reviewed and approved for equivalency by Ecology. Adoption of this manual provides the City with a comprehensive technical support document for implementing erosion and sedimentation control facilities on development sites, establishment of technical requirements for best management practices (BMPs), and design criteria for structural stormwater management facilities and Low Impact Development BMPs.

Site Design

Site design should attempt to minimize impervious area. Minimization of impervious area reduces the need for and cost of stormwater detention facilities and increases open space. Town houses, for example, create less impervious area than detached single family residences.

In addition to minimization of impervious area is the "connectivity" of the impervious areas. The more the impervious areas are disconnected from each other the more opportunity there is for dispersion and infiltration of rain water. A simple way to decrease the connectivity is the use of splash blocks at the bottom of roof down spouts rather than tightlining the downspouts into the storm drain system. Splash blocks force the roof runoff to flow overland, leading to dispersion and infiltration, before entering the stormwater system. Volume VI of the 2008 Pierce County Surface Water Design Manual includes Low Impact Development best management practices that can be used in the design of residential and commercial developments.

Best Management Practices

The treatment of stormwater runoff prior to discharge to surface water or prevention of non-point pollution in stormwater should be accomplished by using Best Management Practices (BMPs). The 2008 Pierce County Surface Water Design Manual, Volume IV contains BMPs for single family residences and commercial and industrial activities. BMPs can be placed into two general groups: source control BMPs, and runoff treatment BMPs. Source control BMPs keep a pollutant from ever coming in contact with stormwater. Treatment BMPs such as biofiltration swales, wetponds, sand filters, and others are discussed in Volume V of the 2008 Pierce County Surface Water Design Manual. Source control BMPs are preferred as they are generally less expensive and frequently are very effective in eliminating the source of pollution prior to its entry into runoff.

CONCLUSION

Water quality is a local and regional issue. Drainage basins do not follow a jurisdictional boundary which is why it is important to work with neighboring agencies to protect the water bodies. The City should continue to develop their relationships with Pierce and Kitsap Counties and work with other groups as discussed in Chapter 2. By following the requirements of the NPDES Phase II permit, the City will develop a stormwater program that will address water quality issues. The City has already implemented various sections of the permit into the current program. Activities such as the Donkey Creek Chum Festival provide community education and involvement in the preservation of Gig Harbor and the other streams. The City has worked with Pierce County on the storm system and sensitive area inventories. The City is considering the adoption of the 2008 Pierce County Surface Water Design Manual which includes design requirements and best management practices for homeowners, commercial and industrial activities. The Design Manual also has a volume on Low Impact Development. All of these actions will improve the City’s water quality program.