CHAPTER 5

NONPOINT SOURCE POLLUTION ANALYSIS

5.1 INTRODUCTION

Friday Harbor's natural beauty and rich heritage are a significant part of the Town of Friday Harbor and San Juan Island's popularity with tourists. Tourism is a major contributor to the area's economy. Without proper management, stormwater runoff may cause substantial degradation to the harbor's natural resources.

Stormwater is defined as the runoff from residential, commercial, and other urban areas. As rain falls and runs off of urban surfaces, pollutants associated with the urban environment are transported to surface waters where they may damage aquatic organisms and reduce the aesthetic value of the water body.

Nationwide, approximately 30 percent of water quality problems have been attributed to stormwater runoff. Many sources of stormwater pollution are uncontrolled. Sources of nonpoint pollution are numerous, varied and hard to detect, but their cumulative effect on water quality and habitats in Puget Sound can be significant.

5.2 IMPACTS TO WATER QUALITY

Pollutants discharged in stormwater are largely uncontrolled. In Puget Sound, stormwater has been estimated to contribute about 7 percent of the total flow from all point and nonpoint sources but about 60 percent of the total lead, 30 percent of the total zinc, and nearly all of the total fecal coliform bacteria. Research in western Washington has shown that the concentrations of many pollutants found in stormwater from residential, commercial, and industrial areas exceed water quality criteria.

The National Water Quality Inventory, 1986 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.

The Nationwide Urban Runoff Program (NURP), (EPA, 1983), included extensive field monitoring throughout the United States to characterize urban runoff flows and pollutant concentrations. Listed below are the conclusions reached in the NURP Study:

1. Heavy metals (especially copper, lead, and zinc) are the most prevalent priority pollutant constituents found in urban runoff. End-of-pipe concentrations exceed EPA ambient water quality criteria and drinking water standards in many instances. Some of the metals are present often enough, in high enough concentrations, to be potential threats to beneficial uses.

2. The organic priority pollutants were detected less frequently and at lower concentrations than the heavy metals.

3. Coliform bacteria are present at high levels in urban runoff and can be expected to exceed EPA water quality criteria during and immediately after storm events in many surface waters, even those providing high degrees of dilution.

4. Nutrients are generally present in urban runoff, but with a few individual site exceptions, concentrations do not appear to be high in comparison with other possible discharges to receiving water bodies.

5. Oxygen demanding substances are present in urban runoff at concentrations approximating those in secondary treatment plant discharges.

6. Total suspended solids (TSS) concentrations in urban runoff are fairly high in comparison with treatment plant discharges. Urban runoff control is strongly indicated where water quality problems associated with TSS, including build-up of contaminated sediments, exist.

   The effect of the pollutants listed above in the receiving water are site specific, however, the following generalities can be assumed:

7. Frequent exceedances of heavy metals ambient water quality criteria for freshwater and marine aquatic life are produced by urban runoff.

8. Although a significant number of problem situations could result from heavy metals in urban runoff, levels of aquatic life use impairment suggested by the magnitude and frequency of ambient criteria exceedances were not observed.

9. Copper, lead, and zinc appear to pose a significant threat to aquatic life uses in some areas of the country. Copper is suggested to be the most significant of the three.

10. Organic priority pollutants in urban runoff do not appear to pose a general threat to aquatic life.

11. The physical aspects of urban runoff, e.g., erosion control and scour, can be a significant cause of habitat disruption and can affect the type of fishery present.

12. Several projects identified possible problems in the sediments because of the build-up of priority pollutants contributed wholly or in part by urban runoff.

13. Coliform bacteria are present at high levels in urban runoff and can be expected to exceed EPA water quality criteria during and immediately after storm events in most rivers and streams. Coliform bacteria discharges in urban runoff have a significant negative impact on the recreational uses and shellfish rearing and spawning.

14. Domestic water supply systems with intakes located on streams in close proximity to urban runoff discharges are encouraged to check for priority pollutants which have been detected in urban runoff, particularly those in the organic category.

15. Nutrients in urban runoff may accelerate eutrophication problems and severely limit recreational uses, especially in lakes. However, NURP's lake projects indicate that the degree of beneficial use impairment varies widely, as does the significance of the urban runoff component.

16. Adverse effects of urban runoff in marine waters is highly specific to the local situation. Though estuaries and embayments were studied to a very limited extent in NURP, they were not believed to be generally threatened by urban runoff. Coliform bacteria present in urban runoff is the primary pollutant of concern, causing direct impacts on shellfish harvesting and beach closures. It is also known that metals may accumulate in shellfish, thereby posing a threat to people that consume shellfish.

17. Groundwater aquifers that received deliberate recharge of urban runoff do not appear to be imminently threatened by this practice at the two locations where it was investigated.

5.3 WATER QUALITY STANDARDS

The following discussion focuses on the criteria used to evaluate water quality contaminants, and sources most common in runoff. In Section 5.5, potential problems in the Town of Friday Harbor are identified. Appropriate strategies for addressing problem areas and reducing adverse impacts are then summarized.

Stormwater runoff constitutes the primary transport mechanism for nonpoint pollution. Pollution problems associated with land utilization and development encompass the common use of potential pollutants such as pesticides, fertilizers, petroleum products, and numerous others. A further problem stemming from residential, commercial, and industrial land uses is the higher volume of runoff because of the higher percentage of impervious area. In developed areas, certain pollutants are more prevalent that in undeveloped areas. Pollutants accumulate in surficial soils and on paved surfaces from vehicular emissions, atmospheric deposition, spills, leaks, improper waste storage/disposal practices, and fertilizer/pesticide application. They are then washed off the land surface during subsequent storm events and transported via stormwater runoff to nearby water bodies or infiltrated to shallow groundwater supplies.

Nonpoint pollutants can also be discharged directly to surface waters via atmospheric deposition, spills, leaks, recreational boating, or improper waste disposal practices. Although these types of nonpoint pollution can be attributed to an individual source, their intermittent nature makes it difficult to identify and control these discharges. For the purposes of this report, these direct discharges have been considered nonpoint pollution sources. Parameters, which define nonpoint pollution, are discussed below in terms of state standards and potential sources.

5.3.1 PARAMETERS OF CONCERN

Water quality parameters affecting stormwater comprise a long list and are classified in many ways. Typical categories include sediment, nutrients, and metals; oxygen demanding and inert material; particulate and dissolved; chemical, biological, and physical; toxic and nontoxic; and organic and inorganic. Many specific pollutants are incorporated into one classification if their effects on receiving water are similar. Receiving water can assimilate a limited quantity of each, but there are thresholds beyond which the measured amount becomes a pollutant and results in an undesirable impact.

Human health considerations in fresh water can be monitored through the analysis of conventional water column parameters, nutrients, and oil and grease. Water quality problems in marine environments are quite different than those found in freshwater systems. Because of the ocean's tremendous volume, high content of dissolved salts and high productivity, problems in marine environments cannot typically be described through the measurement of dissolved oxygen, pH, temperature, nutrient loading, and turbidity. The majority of problems are associated with the uptake of metals, toxic compounds, and fecal coliform in shellfish and bottom fish. This bioaccumulation of such substances results in a human health hazard, if consumed.

The following discussion summarizes the most significant water quality impacts, which can be attributed to non-point pollution from stormwater runoff.

Oxygen Demand or DO is necessary in water to maintain life. In the oxidation of organic matter by biological activities, oxygen from water is used. A problem from low DO results when the rate of oxygen-demanding material exceeds the rate of replenishment. DO levels are especially important during summer when low stream flows and high temperatures make oxygen less available to aquatic life. Dissolved oxygen concentrations may also become critical when wastes that require oxygen for decomposition enter the water. In addition to diurnal variation, DO also varies with season and stream site. These natural variations are caused by differences in such things as light intensity and hydrogeological conditions. Natural variation can also be caused by water sources; groundwater or water draining bogs and marshes will typically have lower DO concentrations. Fish kills and reduction in aesthetic values have resulted from low-DO conditions.

pH impacts and is impacted by chemical and biological systems of natural waters. Similar to DO, pH responds to natural environmental factors. Changes in pH affect the degree of dissociation of weak acids and bases which affect the toxicity, reactivity, and solubility of many compounds. Diurnal variations in pH occur as a result of changes in production and respiration rates. pH also varies with different water sources such as groundwater or water draining wetlands.

Temperature extremes affect stream productivity and eventually may result in loss of aquatic life. Temperature also affects stream chemistry and varies diurnally and seasonally.

Turbidity is not a measurement of mass or concentration, it is a water quality attribute. Therefore, it can not be used as a quantitative measure to calculate pollutant loadings, but is used qualitatively to compare against a standard. Turbidity responds to physical factors such as runoff, proximity to exposed erodible soils, and stream flow.

Nutrients stimulate the growth of algae and water plants. Typical sources include detergents, fertilizers, septic system effluent, manure, etc. The primary nutrients of concern are nitrogen and phosphorous. Forms of nitrogen include ammonia, nitrite, and nitrate, which are components of fertilizers, septic system effluent, and manure. The typical nutrient concentrations in runoff are usually more than sufficient to stimulate the growth of algae and plant species. The increased algal activity will cause a decrease in DO and an increase in surface algal scums, water discoloration, odors, and overgrowth of plants.

Nitrogen and phosphorus are the principal nutrients for algae and other plants in fresh water ecosystems including wetlands, streams, and lakes. Phosphorus is often the controlling nutrient for algae growth in fresh waters. A large input from nonpoint sources can result in algal blooms that can affect recreational use and reduce the overall quality of receiving waters. Nitrogen can affect the tropic status of receiving waters, but it is also an important parameter for waters used as drinking water supplies.

Pathogens/bacteria commonly refer to fecal coliform bacteria, which are found in the intestinal tracts of warm-blooded animals, including humans. Fecal coliform bacteria in surface waters has historically been used as an indicator of water-borne pathogenic bacteria or viruses. Therefore, fecal coliform are used as indicators of public health concerns. High levels can indicate failing septic systems, poor livestock management practices, poorly operated wastewater treatment systems, municipal storm and sanitary sewers, and other point or nonpoint sources.

High oil and grease concentrations are associated with urban and industrial stormwater runoff. In addition to representing a water quality problem, they can also serve as indicators of a wide array of hydrocarbon compounds that can be toxic to aquatic life at low concentrations. Typically, oil and grease concentrations are low in receiving waters and are usually associated with runoff events.

Total suspended solids originate from erosion of urban and agricultural soils. Sediments washed off paved surfaces are transported by runoff and discharged to receiving waters. Land-clearing activities associated with urban development as well as poor livestock and crop management can accelerate soil erosion and increase sediment transport to receiving waters. The conversion of land from forest to urban increases impervious surfaces and accelerates stormwater runoff. The total volume and peak rate of stormwater is increased and can cause scouring in stream channels, thereby increasing the suspended solids loading in the stream.

Metals commonly found in stormwater runoff from road surfaces and parking areas that are of concern include lead, zinc, copper, chromium, arsenic, cadmium, and nickel. Other potential sources of metals originate from commercial car washes, auto repair facilities, and industrial operations. Most metals are absorbed onto suspended solids present in the runoff and are probably not toxic to aquatic life.

Toxic organic compounds include a variety of contaminants such as pesticides, petroleum hydrocarbons, and volatile organic compounds. Potential nonpoint sources of these contaminants include urban and agricultural runoff, hazardous substance spills, improper disposal of waste products, and industrial discharges. Compounds that are most frequently found in runoff include phosphates, polynuclear aromatic hydrocarbons, volatile organic compounds, and some pesticides. The availability of toxic organic compounds is difficult to determine because of their absorption to particulate matter. Particulate-bound contaminants are usually flushed out of the receiving system during high stormwater flows.

Organic material is an integral component of top soil. The organic content is mostly produced by microorganisms during the degradation of dead plant and animal material. The microbial degradation of organic matter in aerobic systems results in the consumption of oxygen. Waters high in organic matter may experience depressed oxygen concentrations relative to concentrations at saturation.

5.3.2 WATER QUALITY CRITERIA

Water quality standards for surface water in Washington State are established in Chapter 173-201A WAC. Standard criteria allows for comparison of the data of interest to a safe or desired concentration or level. Management practices that violate established standards are subject to further investigation and ultimately appropriate corrective measures.

The Department of Ecology has responsibility for managing the state's water resources which are classified into five classes for surface water: Class AA (extraordinary), Class A (excellent), Class B (good), Class C (fair), and Lake. Specific surface water bodies are classified under WAC 173-201A-130 or 173-201A-140. All unclassified surface waters that are tributaries to Class AA waters are classified Class AA. All other unclassified surface waters within the state are classified Class A.

The marine waters of Friday Harbor are classified as Class AA water. Per WAC 173-201A-140(15) "Mukilteo and all north Puget Sound west of longitude 122° 39' W" is Class AA. Among the beneficial uses that a Class AA water must support are: water supply for domestic, industrial, or agricultural (freshwater); stock watering (freshwater); fish and shellfish rearing, spawning, and harvesting; wildlife habitat; and primary contact recreation, sport fishing, commerce and navigation and aesthetic enjoyment. Water quality standards that apply to Class AA marine waters are presented in Table 5-1.

In addition to the water quality parameters listed in Table 5-1, concentrations of toxic substances, such as organic compounds and metals, must not exceed standards specified in WAC 173-201A-040. These standards are based in the U.S. Environmental Protection Agency (EPA) Quality Criteria for Water (1986) which are derived from federal water quality criteria based on aquatic toxicology.

The WAC defines both acute and chronic criteria for toxic substances. Acute toxicity criteria are based on death percentages of test organisms within 24 hours. Chronic toxicity criteria are defined as the concentration that causes long-term adverse effects on an organism's functions.

TABLE 5-1

Water Quality Criteria for Class AA Marine Waters (WAC 173-201-030(2))

(1)	Fecal coliform organisms	Marine - fecal coliform organisms shall not exceed a geometric mean value of 14 colonies/100 mL, and not have more than 10 percent of samples exceeding 43 colonies/100 mL.
(2)	Dissolved oxygen	Marine - dissolved oxygen shall exceed 6.0 mg/L. When natural conditions occur, causing the dissolved oxygen to be depressed near or below 6.0 mg/L, dissolved oxygen levels may be degraded by up to 0.2 mg/L by human-caused activities.
(3)	Total dissolved gas	Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.
(4)	Temperature	Shall not exceed 13.0 degrees C due to human activities.
(5)	pH	pH shall be within the range of 7.0 to 8.5 with a man-caused variation within a range of less than 0.2 units.
(6)	Turbidity	Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.
(7)	Toxic, radioactive, or deleterious material concentrations	Toxic, radioactive, or deleterious materials concentration shall be below those which may adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health.
(8)	Aesthetic values	Aesthetic values shall be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sign, smell, touch, or taste.

Water quality standards for groundwaters in the state of Washington are established in Chapter 173-200 WAC. The standards establish criteria for maximum containment concentrations in terms of primary and secondary contaminants and radionuclides based on human health based criteria. Special protections area can be designated because of wellheads and recharge areas that are vulnerable to pollution because of hydrogeologic characteristics and sole source aquifer status by federal designation. Currently, no special protection areas are recognized within the study area.

The general impacts of nonpoint sources of pollution that are of concern in Friday Harbor are indicated in Table 5-2.

TABLE 5-2

General Impact of Nonpoint Sources on Friday Harbor

Key Pollutants	Affect on Water	Affected Uses (a)
Bacterial/Viruses	Contamination	Contract recreation, shellfish rearing, spawning, and harvesting
Sediment/Suspended solids	Visual turbidity, deposition	Aesthetic pollution habitat loss for bottom fish and shellfish
Metals	Bioaccumulation	Consumption of fish and shellfish
Toxic Organics	Long-term chronic diseases and cancer	Consumption of fish and shellfish

5.4 EXISTING BACKGROUND WATER QUALITY SURVEYS

To date, there have not been any water quality studies for Friday Harbor. A study completed in 1988 by Verburg & Associates, *San Juan County Watershed Ranking*, provided a great deal of information on the current status and problems of Friday Harbor, but did not include any specific water quality studies.

5.5 SOURCES OF NONPOINT POLLUTANTS

The major types of nonpoint pollution sources in the Town of Friday Harbor are related to urban development and transportation-related activities. Other important sources of nonpoint pollution may include illicit connections to the storm drain system, on-site sewage systems and improper waste storage and disposal practices. Conversion of existing open space to commercial and residential development will increase the probable negative impact on water quality in Friday Harbor which results from non-point pollution. The general impacts of non-point services on beneficial uses that are to be of concern in Friday Harbor are shown in Table 5-2.

5.5.1 URBAN DEVELOPMENT

The level of urban development in the Town of Friday Harbor has increased. The projected increases in population suggest that urban development will continue. Although the Town now consists mostly of single-family homes and small commercial areas, future plans have designated large tracts for multi-family residences and commercial/industrial developments. These uses have a greater impact on the quality and quantity of stormwater runoff.

Throughout the Town undeveloped land is being converted to residential use. The construction-related activities of land clearing and site preparation are potential sources of stormwater pollution. Areas that have been cleared of vegetation are more prone to erosion and can significantly increase sediment loading to nearby water bodies. Sediments can become deposited in natural and constructed channels thereby reducing the 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 amount of stormwater runoff also usually increases during construction 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, the total volume and peak runoff rate increase which erode streambanks and accelerate channel scouring and may cause localized flooding.

In addition to soil erosion, other pollutants can also be generated by building activities. 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.

The impact of increased development on stormwater pollution does not stop after construction. The volume of stormwater runoff and peak discharge rate increases as a direct result of the increase in the amount of impervious area. Higher flow rates can cause localized flooding as the carrying capacity of natural streams and piped conveyance systems is exceeded. The pollutant load of stormwater in residential areas increases as development increases. The potential pollutant sources in residential areas include fertilizers, pesticides, and herbicides from landscaping activities, biological loads from pet wastes, waste oil disposal from vehicle maintenance activities, improper disposal of household and yard wastes and illegal connections of sanitary sewers to the storm sewer system.

Businesses such as professional services, restaurants, grocery stores, dry cleaners and gas stations are significant sources of stormwater pollution. Potential sources of pollution from these developments include oil and grease, suspended solids and metals from the parking lots, bacterial loads, and garbage from improper waste storage and disposal practices at the grocery stores and restaurants, oil and grease and petroleum hydrocarbons from the gas station, illicit sanitary sewer connections and fertilizers, pesticides and herbicides from landscaping activities.

Commercial establishments which include construction equipment storage facilities, tanker storage/warehouse facilities and heavy equipment wash stations can be major sources of pollutants. Potential sources of pollution from these businesses include oil and grease, fuel, hydraulic fluids, petroleum hydrocarbons and suspended solids.

The runoff from the commercial establishments listed above may also be contributing to increased levels of metals such as cadmium, lead, copper, and zinc. These contaminants are produced by dryfall from vehicle emissions, vehicle wear and tear, and chemical products. Other contaminants which may be associated with the commercial establishments include toxic organic compounds such as pesticides and polynuclear aromatic hydrocarbons (PAH). Volatile organic compounds such as solvents may also be present in urban runoff and are typically associated with spills and improper waste disposal activities. Improper chemical storage and waste disposal practices are common sources of contaminates migrating off-site from commercial and industrial establishments. The improper use of garbage dumpsters, such as exposing the contents to rain or depositing garbage on the ground rather than in the dumpster, are sources of stormwater pollution.

Drainage Basin No. 3 outfalls to wetlands. Urban development can severely impact wetlands in several ways. When increased stormwater flows due to development are directed to a wetland area the hydrologic regime of the wetland may be altered which may lead to the destruction 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.

5.5.2 COUNTY AND STATE HIGHWAYS

Stormwater runoff from state and county roads, Town arterials and residential streets and the Washington State ferry loading dock can contain elevated concentrations of metals, suspended solids, oil and grease, 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). Heavy metals in highway runoff originate from highway materials and various aspects of vehicle operations (Wang wt al., 1982). Sources and the metals they contribute include gasoline and exhaust emissions (lead, nickel), lubricating oils (lead, nickel, zinc), grease (zinc, lead), tire wear (cadmium, zinc), concrete paving wear (nickel), bearing wear (copper, lead), brake lining wear (copper, chromium, nickel) and wear of moving engine parts (iron, manganese, chromium, copper) after Kerri et al., 1976; Hopke et al., 1980; and Novotny and Chesters, 1981). Sanding in the winter further contributes sediment to the drainage system. Major thoroughfares in the Town include Spring Street, Guard Street, and Tucker Avenue.

A major source of pollution may exist at the Department of Transportation ferry terminal. The large parking and waiting area at the ferry dock could contribute large amounts of oil and grease, as well as metals.

Results from studies demonstrate that draining highway runoff directly to receiving waters via pipes or bare channels should be avoided. Grassy drainage channels were shown to effectively capture and retain metals. Mud or paved channels, however, demonstrated little or no ability to remove metals from runoff.

5.6 GENERAL CONSIDERATIONS IN URBAN STORMWATER QUANTITY AND QUALITY CONTROL

Each of the issues discussed above for potential stormwater pollution sources represents classic stormwater quantity or quality management problems. Stormwater management solutions to alleviate the stormwater problem areas must be sound from an engineering viewpoint and must also comply with the current and proposed state and federal regulations as discussed in Chapter 3.

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 be identified which provide a framework for consideration of issues which affect the method in which the Town of Friday Harbor handles their stormwater management program. The considerations are briefly discussed in the following paragraphs and include:

- Stormwater quality versus quantity control
- Construction phase versus long-term site operation phase
- Structural versus nonstructural controls
- Source control versus downstream treatment
- Control in new versus existing development
- Special sensitive area considerations

5.6.1 STORMWATER QUALITY VERSUS QUANTITY CONTROL

Stormwater management has traditionally been concerned with control of runoff quantities for the purpose of preventing flooding. Accordingly, most regulations and engineering design procedures represent 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 to achieve control objectives. In the case of quantity control, the objective is to release storm runoff at a rate that does not exceed stream channel capacity (which may not be the same as matching pre-development hydrologic conditions for a given site). For quality control the objective is to provide sufficient holding time for the effective operation of gravity settling or biochemical removal of pollutants. Because storage may benefit both quantity and quality, some of the same storage strategies, if correctly applied, can advance both goals. This discussion will emphasize the achievement of dual water quantity and quality control goals wherever possible.

5.6.2 CONSTRUCTION PHASE VERSUS 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. At the same time, there should be awareness that some measures installed for the construction phase can be converted to permanent service.

5.6.3 STRUCTURAL VERSUS NONSTRUCTURAL CONTROLS

Control of water pollution from industrial and municipal discharges relies to a large extent on structural treatment devices. Although the same principles are generally applied in stormwater quality control, the mechanisms are simpler. For example, grass swales, oil/water separators, and wet ponds could all be considered structural stormwater treatment devices. However, much greater opportunities may exist for nonstructural stormwater quality controls. Nonstructural approaches may include enhanced maintenance programs, regulations, public involvement, land use controls, and other measures. The most effective stormwater quality programs use a mix of structural and nonstructural alternatives.

5.6.4 SOURCE CONTROL VERSUS DOWNSTREAM TREATMENT

While the distinction is not perfect, a source control generally provides pollutant removal at or close to the location of pollutant generation; downstream treatment is at least somewhat removed from the source. Source control measures, such as grass swales, are usually meant to be applied at multiple locations, while a downstream treatment measure, such as an artificial wetland, often receives drainage from more than one individual source. In the extreme case a single downstream treatment structure such as a regional detention pond can serve a relatively large area.

5.6.5 CONTROL IN NEW VERSUS EXISTING DEVELOPMENTS

New developments offer greater opportunities to apply stormwater management techniques than do existing developments. In particular, retroactively fitting structural techniques is generally difficult and expensive, if possible at all, in existing developments. These measures often take substantial land, which may not be available in finished areas. However, existing development areas are frequently amenable to a variety of nonstructural approaches such as modified maintenance practices or public education.

5.6.6 CONTROL OF ACUTE VERSUS CHRONIC IMPACTS

If toxic chemicals drained into Friday Harbor, a fish kill might result; this would be an example of an acute impact to the Harbor's water quality associated with the storm drainage system. Conversely, over time more devastating impacts to Friday Harbor could result from loss of fish habitat associated with erosion and siltation. This would be termed a chronic impact. Reducing acute and chronic impacts requires distinct strategies in the overall stormwater quality management program.

5.6.7 SPECIAL SENSITIVE AREA CONSIDERATIONS

Areas relatively sensitive to the potential impacts of urban stormwater include stream corridors, especially those with valuable fish habitat; flood plains; wetlands; steep slopes; and groundwater aquifers. Some special considerations in stormwater management apply to these areas. These considerations will be brought into the discussion as appropriate.

5.7 STORMWATER MANAGEMENT ALTERNATIVES

Stormwater management alternatives for the control of the quantity of stormwater runoff and the quality of the runoff are not mutually exclusive. The outdated method of designing stormwater conveyance systems that relied on curb and gutters to transport stormwater directly into pipes which discharged the stormwater directly into a stream, river, or lake provided little in the way of stormwater quantity control and nothing in the way of stormwater quality control. As citizens, municipalities and designers are becoming more aware of the damaging effects of stormwater quantity and quality the line between stormwater management alternatives which are strictly concerned with quantity issues and those concerned strictly with quality issues is becoming blurred. In the remainder of this chapter stormwater management alternatives which will serve to limit the quantity of stormwater runoff and improve the quality of the runoff will be discussed.

5.7.1 STRUCTURAL ALTERNATIVES

The quantity of stormwater runoff can be controlled by storage and regulated release of stormwater or by site controls. Storage and regulated release of stormwater includes systems such as detention with stormwater release orifices.

Site controls can minimize the quantity of stormwater released as well as provide water quality benefits. Site controls are generally those controls that attempt to reduce runoff rate and volume at or near the point where the rainfall hits the ground surface. The following types of site controls are common:

- Minimization of directly connected impervious area
- Swales and filter strips
- Porous pavement and parking blocks
- Infiltration devices, such as trenches and basins.

5.7.1.1 Storage And Regulated Release

Storage and regulated release of stormwater is not currently practiced in the Town of Friday Harbor. The proposed Stormwater Management ordinance requires all development except individual, detached, single family residences and duplexes, development which creates or adds less than 5,000 square feet of impervious surface on land disturbing activities of less than one (1) acre, to install detention systems to insure that the rate of stormwater runoff leaving the site in the post-development condition is no greater than the pre-development rate unless it can be demonstrated that existing downstream capacity is adequate. This method of stormwater control minimizes downstream impact on the existing conveyance system.

Detention systems can be either wet or dry systems. Detention systems are widely used for drainage control, however, if wet detention systems are properly sized they can act as effective runoff quality control devices as well.

Dry detention basins are the most common type of detention basin used around the country for peak-flow attenuation. Dry detention systems preform very poorly as treatment devices for runoff. This is primarily due to the short residence time and the fact that these basins do not remove any dissolved pollutants.

A wet detention basin consists of 1) a permanent water pool, 2) an overlying zone in which the design runoff volume temporarily increases the depth of the pool while it is stored and released at the allowed peak discharge rate, and 3) a shallow littoral zone (the biological filter). During storms, runoff replaces "treated" waters which were detained within the permanent pool after the previous storm, thus making the permanent water pool volume and the vegetated littoral zone of utmost importance for water quality enhancement. Wet detention ponds are often used in series with swale interconnectors. 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.

Design, sizing, and maintenance criteria for detention facilities can be found in Chapter III-4 of the DOE *Stormwater Management Manual*.

5.7.1.2 Minimize Directly Connected Impervious Area

Directly connected impervious area (DCIA) is defined as the impermeable area that drains directly to the improved drainage system, *i.e.*, paved gutter, improved ditch, or pipe. The minimization of DCIA is an effective method of runoff quantity and quality control because it delays the concentration of flows into the improved drainage system and maximizes the opportunity for rainfall to infiltrate at or near the point at which it falls. Figure 5-1 illustrates the difference between an area where the DCIA is extensive and one where DCIA has been minimized. The residential lot on the north side of the street has all impervious areas on the lot draining directly to the gutter. This drainage plan allows no opportunity for water falling on the impervious surfaces to infiltrate into the ground; in fact, the system is laid out so that the rain falling on the impervious areas is quickly concentrated and drained to the gutter. The result is a greatly increased peak runoff rate and runoff volume compared to the pre-development condition. The pollutants contained in the runoff from the rooftop, driveway, sidewalk and street are simply collected in the gutter and must be dealt with at some location further down in the drainage system.

In contrast, the drainage layout for the lot on the south side of the street has been designed to minimize DCIA. All impervious areas drain to a pervious area before they reach the grassed swale that serves as the primary conveyance facility for runoff from the lot. The roof runoff drains to the lawn and sheet-flows across it, the driveway is sloped to drain to the lawn instead of the street, and the sidewalk and the street sheet-flow across a grass filter strip before reaching the water in the grassed swale. All of these techniques combine to provide maximum opportunity for infiltration and for retardation of the runoff rate. This approach to drainage system layout, which emphasizes peak-flow reduction and pollutant capture, is called stormwater management, in contrast with the north lot design, which is simply a drainage plan.

5.7.1.3 Swales And Filter Strips

Swales, or grassed waterways, and filter strips are among the oldest stormwater control measures, having been used alongside streets and highways, as well as by the farmer, for many years. A swale is a shallow trench which has the following characteristics:

- the side slopes are flatter than three feet horizontal to one foot vertical.
- it contains contiguous areas of standing or flowing water only following rainfall
- it is planted with or contains vegetation suitable for soil stabilization, stormwater treatment, and nutrient uptake.

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

For small storm, both swales and filter strips remove pollutants from stormwater by 1) slowing the water and settling or filtering our solids as the water travels over the grassed area and 2) allowing infiltration into the underlying soil. In general, the higher the flow rate, the lower the efficiency. Thus, low velocity and shallow depth are key design criteria. A swale designed with a low bottom slope and check dams will perform much more efficiently than one without check dams. Raised driveway culverts are very effective as swale check dams. For maximum efficiency of pollutant removal during small storms, a trapezoidal swale with as large a bottom width as can be fitted into the site plan is desirable, since this will maximize the amount of runoff in contact with the vegetation and soil.

Design equations for swales and filter strips can be found in Chapter III-6 of the DOE Stormwater Manual. Maintenance of both of these devices is an important consideration, for reasons of both aesthetics and hydraulic efficiency. In the case of the swale, care must be taken to insure that flows through a swale used for drainage purposes during large storms are not impeded by an overgrowth of vegetation. To prevent this, the vegetation planted in the channel should be suitable for mowing, and the channel designed so that mowing machines can be easily and efficiently operated along the swale. And of course, the swale should be mowed on a regular basis. For filter strips which are not part of the drainageway during large storms, maintenance is purely an aesthetic matter. These strips can be planted in grass and mowed, or natural vegetation can be used. Ground cover must be sufficiently dense to keep the overland flow from channelizing and eroding rivulets through the filter strip.

Swales and filter strips can be an effective means of providing water quality control in commercial areas.

5.7.1.4 Parking Blocks

Parking blocks are a very effective site-control device. Parking blocks are hollow concrete blocks similar to but smaller than those used in construction. In parking lots or private driveways and parking areas where more than half of the area is used less than 20 percent of the time, the use of parking blocks in the less used portion of such lots give them an attractive appearance and will considerably reduce runoff quantity, flow rates, and pollution from these area.

Parking blocks are put in place in rows, with soil surrounding each one. The area is planted with grass. Runoff quantity reduction occurs as infiltration takes place in the planted areas. Moreover, the greater flow resistance of the grassed areas retards the runoff rate, especially during small storms. And finally, the quality of the runoff is much enhanced over that from a normal parking lot because the pollutants, being restrained by the vegetation matrix, will be more difficult to wash off than it they were simply lying on asphalt or concrete.

In designing a parking block area, the block manufacturer should be consulted to determine the most suitable sub-base to use. Also, only the actual parking spaces should be paved with the blocks, since they do not hold up well under traffic. The traffic lanes through the lot should be paved in the normal fashion.

5.7.1.5 Infiltration Devices

Infiltration devices are those stormwater quality control measures that completely capture runoff from the design storm and allow it to infiltrate into the ground. The DOE *Stormwater Management Manual* lists infiltration systems as the method of choice for handling stormwater runoff. Infiltration system provide groundwater recharge, and pollutant removal, can be integrated into a site's landscaped and open areas, and if designed properly, can serve larger developments. Infiltration devices should be used only in situations where the captured volume of water can infiltrate into the ground within 24 hours.

Infiltration devices can be classified into one of two categories: above-ground infiltration basins and buried infiltration trenches.

An infiltration basin is made by constructing an embankment or by excavating in or down to relatively permeable soils. The basin will temporarily store stormwater until it infiltrates through the bottom and sides of the system. The infiltration "basin" can actually be a landscaped depression within open areas or even a recreational area such as a soccer field. Infiltration basins generally serve areas ranging from a front yard to a 50-acre area.

Infiltration basins can be constructed on-line or off-line with respect to the normal drainage path. When a basin is located on-line, it will capture the water quality design storm entirely, but, when a larger storm occurs, it overflows the basin, which then serves as a detention pond for those larger events.

Off-line infiltration basins are designed to divert the more polluted first flush of stormwater out of the normal path and hold it for later water quality treatment. When the basin reaches capacity, the flow path for any additional stormwater returns to normal and is managed for drainage and flood control. The diverted first flush is not discharged to surface water but is stored until it is gradually removed by infiltration, evaporation, and evapotranspiration. This is the most effective practice for use in enhancing the quality of stormwater. It also helps to reduce stormwater volume and to recharge the groundwater.

Design criteria for infiltration basins can be found in the DOE *Stormwater Management Manual* in Chapter III-3.

Infiltration trenches, which can be located on the surface of the ground or buried beneath the surface, are usually designed to serve areas ranging up to 10 acres in size and are especially appropriate in urban areas, where land costs are very high. An infiltration trench generally consists of a long, narrow excavation, ranging from 3 to 12 feet in depth, which is backfilled with stone aggregate, allowing for the temporary storage of the first-flush stormwater in the voids between the aggregate material. Stored runoff then infiltrates into the surrounding soil, this infiltration occurs through either the trench bottom or the sides, depending on the elevation of the water table and soil properties.

There are two major types of trenches, surface trenches and underground trenches. The major differences between the two involve the amount of stormwater that can be handled and the ease of maintenance.

Surface trenches receive sheet-flow runoff directly from adjacent areas after it has been filtered by a grass buffer. They are typically used in residential areas where relatively small loads of sediment and oil can be trapped in grass filter strips at least 20 feet wide. Sediments can clog infiltration devices and once clogged, rehabilitation of the infiltrative surfaces is a major effort.

Underground trenches can potentially be used in many development situations, although discretion must be exercised in their use. For one thing, while underground trenches can accept runoff from storm sewers, they require installation of special inlets to prevent coarse sediment and oils and greases from clogging the stone reservoir. These inlets should include trash racks, catch basins, and baffles to reduce sediment, leaves, debris, and oils and greases. In addition, pretreatment by routing the flow over grassed filter strips or vegetated swales is essential to protect the infiltration trench.

If properly constructed, with pretreatment practices in place to prevent heavy sediment loading, infiltration trenches can provide stormwater benefits without tremendous maintenance needs. Since trenches are usually "out of sight, out of mind," getting property owners to maintain them can be difficult. Accordingly, a public commitment for regular inspection of privately owned trenches is essential, as is a legally binding maintenance agreement and education of owners about the function and maintenance needs of trenches.

Inspection of trenches should occur frequently within the first few months of operation and regularly thereafter. Such inspections should be done after large storms, in order to check for water-ponding, with water levels in the observation well recorded over several days to check drawdown. in addition, grass buffer strips should maintain a dense, vigorous growth of vegetation; they should receive regular mowing (with bagging of grass clippings) as needed. Finally, pretreatment devices should be checked periodically and cleaned when the sediment reduces available capacity by more than 10 percent.

Design, construction, and maintenance procedures for infiltration trenches and basins can be found in Chapter III-3 of the DOE *Stormwater Management Manual*.

5.7.1.6 Summary

The incorporation of runoff quality controls into urban landscape design is more an art than a science. However, if the design is developed with the following concepts in mind, a good water quality management system will result.

- Design runoff quality controls to capture small storms.
- Design to maximize sediment removal, and removal of other pollutants will generally be good.
- The most effective method for reducing urban runoff pollution is to minimize directly connected impervious area (DCIA).
- Off-line devices are more effective than on-line devices.
- Infiltration devices are most efficient but most difficult to maintain.
- Dry detention is easiest to design and operate, but efficiency can be low, especially when it is on-line.
- Wet detention is more difficult to design but more efficient than dry detention, and often more aesthetic.

With thoughtful planning and careful design, cost-effective runoff quality controls can be integrated into urban development plans to achieve the required level of pollutant reduction with no negative impact on aesthetics. Moreover, experience shows that the aesthetic character of a development site can actually be enhanced by properly integrating runoff quality controls into the site plan.

5.7.2 NON-STRUCTURAL ALTERNATIVES

Management of a stormwater system can be improved through the use of non-structural alternatives.

Non-structural stormwater management alternatives include;

- Maintenance programs
- Changes to the municipal codes or regulations
- Enforcement actions for non-compliance with stormwater regulations
- Public education
- Stormwater Best Management Practices

Non-structural stormwater management alternatives also include source control measures. Source control measures are designed to minimize or eliminate release of stormwater and pollutants at the site of origin. Regulation for new development, such are requiring stormwater detention, infiltration or flow through a grass lined swale are forms of source control. A requirement for erosion and sedimentation control during construction is a source control method for reducing pollutant load to receiving waters. Source control methods also include education of the public to prevent disposal of yard wastes, household chemicals, and motor oil into drainage facilities.

The proposed Stormwater Technical Manual includes the use of non-structural alternatives to control stormwater quantity and quality.

5.7.2.1 Facilities Maintenance

The objective of a stormwater maintenance program is to assure the reliability and dependability of the stormwater system. A complete maintenance program includes not only the physical task of cleaning catch basins, pipes and open ditches, but also involves management items such as completing and maintaining a facilities inventory, maintenance scheduling, assessing costs for contract maintenance versus staff maintenance, and record keeping.

In order to perform maintenance at the appropriate time, a budget, staff and priority schedule needs to be established. Certain types of work are more important than others. It is important that catch basins and conveyance facilities be inspected before the wet season to assure that debris has not blocked a channel or taken up capacity in a manhole. Street sweeping in the fall is important because leaves block catch basin grates which could result in overland flow across private property or flooding of roadways.

Reports and record keeping are important feedback mechanisms which enable management to compare actual versus planned costs, production, and efficiency. Reports provide a database for improved budgeting and resource allocation. Records and reports should include man-hours, equipment hours, materials used and unit of work completed.

Maintenance control establishes accountability for specific results within a specific time frame and budget. The maintenance program needs a control hierarchy to establish a chain of command to complete the work.

The various stormwater facilities which require maintenance are described below.

1. Streets

   Streets with concrete curb and gutter or thickened edges are part of the stormwater conveyance system. All streets accumulate vehicular emission particles, silt, and, leaves and other debris and pollutants which could enter the stormwater conveyance system. Street sweeping (not washing) is an important maintenance item to reduce pollution in the receiving waters and to reduce the potential for blocking of the conveyance system. Street sweeping frequency is recommended at least once per year in the fall, after the leaves have fallen.

2. Catch Basin Cleaning

   Catch basins in the Town include types with and without sumps. Sumps are an important feature which allows deposition of particulate matter carried in the stormwater. When sumps become filled to 60 percent of their volume, the efficiency of silt removal diminishes significantly. All catch basins should be inspected at least once per year. Once a maintenance program is in place, the Town will be able to develop a history on particular areas to determine which basins require more frequent attention. Catch basins are normally cleaned with a mechanical, truck-mounted piece of equipment that sucks the sediment from the basin. For the purposes of this plan catch basin cleaning is estimated to be needed once every two years as a system average.

3. Pipe Cleaning

   Pipes in the Town vary in size from 6-inch to 36-inch diameter. Pipe types include concrete, ductile iron, corrugated metal, and PVC. All pipe should be inspected annually and cleaned every third year. A vacuum system is recommended for cleaning. If pipe flushing is used, adequate downstream siltation control must be in place.

4. Open Ditch Cleaning

Many roads in the Town of Friday Harbor are drained by means of roadside ditches. Ditches and swales can provide biofiltration, if vegetation is allowed to remain within the channel and on the sides. Vegetation should be cut down to 2- to 6-inches and swales can be cleaned by the use of a horizontal auger. Ditches and swales should be cleaned once a year, preferably during the summer months to allow vegetation to grow back before the rainy season.

5. Detention System Cleaning

   Detention systems should be monitored annually for sediment accumulation. Removal of accumulated sediment is anticipated to be needed once every 5 years.

6. Oil/Water Separators

   Oil/water separators must be maintained in order to be effective. If deposited material is not removed on a periodic basis the material may be flushed down stream by winter storms. Inspection of oil/water separators should be scheduled bimonthly and maintenance cleaning scheduled at least on a yearly basis or more frequently if required.

5.7.2.2 Changes To Municipal Codes And Regulations

The federal, state, and local rules, regulations, and guidelines which govern stormwater have been discussed in Chapter 3 of this document.

In order to consolidate the various regulations and policy directives, the proposed Stormwater Technical Manual is included in Appendix A. The proposed Manual provides the ability for the Town to adopt the *DOE Stormwater Management Manual for the Puget Sound Basin*. Adoption of this manual will provide the Town with a comprehensive technical support document for implementing erosion and sedimentation control facilities on development sites, establishment of technical requirements for best managements practices (BMPs), and design criteria for structural stormwater management facilities.

5.7.2.3 Enforcement

Town staffing levels must be sufficient to monitor construction activity, respond to surface water complaints, and provide periodic inspection of private stormwater treatment facilities such as oil/water separators and detention facilities. Existing staff should document the hours spent providing inspection, together with the frequency of inspection of construction sites and private stormwater facilities. From these records and the records time spent responding to complaints an understanding of the adequacy of the current staffing level can be gained.

5.7.2.4 Public Involvement And Education

An important element of a stormwater management plan is public involvement and education (PIE). The involvement of the public is necessary to insure the overall success of the stormwater management plan. For the public to be motivated to participate in stormwater management they must first be made aware of the surface water problems, what role the public has in causing surface water problems and what can be done about them.

The general public must be made aware of how their normal activities affect stormwater quality and quantity. Most citizens believe that stormwater management is someone else's problem. In order to educate the public it is necessary to identify those subjects which have local relevance and then design a program which addresses those issues. Public education programs in the Friday Harbor area should focus on the following issues:

- Voluntary ditch maintenance
- Catch basin stenciling
- Citizen hotline
- Oil recycling center
- Newsletter articles

1. Voluntary Ditch Maintenance

   A voluntary drainage ditch maintenance program should be established which encourages property owners to mow and otherwise maintain the drainage ditches adjacent to their properties. Local groups, clubs, and service organizations can be recruited to provide maintenance for drainage features which have a more community wide significance. The efforts will need to be coordinated by the Town which must also provide a clearing house where information can be stored and distributed. The goal of the program is to insure that drainage ditches are maintained in a condition which insures that ditches will be able to carry the full design capacity of stormwater when needed. The Town may wish to consider an ordinance which requires property owners to maintain the ditches adjacent to their property. Such an ordinance would be similar to sidewalk maintenance ordinances used by other municipalities.

2. Catch Basin Stenciling

   A program which encourages citizens and local service groups to stencil catch basins is needed to discourage the dumping of oil or other harmful substances. Many, if not most, people are unaware that storm drains usually discharge into nearby surface waters. By stenciling all catch basins within the Town with an appropriate warning, citizens will be made aware that anything dumped into a catch basin will soon enter Friday Harbor.

3. Oil Recycling Center

   This program will encourage a local business to become a drop-off point for waste oil to be recycled. The general public must be made aware of the location and hours for the local recycling station and the procedures for disposing of waste oil at the station.

   The goal of this program will be to provide a suitable destination for waste oil. This will serve to provide alternatives to other practices which have been used in the past, such as dumping of waste oil down storm drains. An effort should be made to coordinate the establishment of the waste oil recycling center with other nearby jurisdictions.

4. Newsletter

   A community newsletter which addresses watershed issues should be published. The newsletter can include articles containing relevant information of local interest to help citizens eliminate or minimize stormwater quantity or quality problems.

   The goal of this program will be to place issues concerning activities which affect the watershed before citizens in a timely manner. Issues which will be addressed include:

   - Composting
   - Fertilization practices

- Hazard household waste disposal
- Waste oil recycling
- Pesticide use
- Ditch maintenance
- Sensitive area protection
- Waterfowl feeding (adverse effects)
- Wetlands protection/maintenance
- Citizen hotline

An expected impact of this portion of the plan is to provide residents timely reminders of the role they play and the effect they have on watershed water quality.

5. Citizen Hotline

This portion of the program could establish and publish a phone number for use by citizens to report activities which could cause water quality problems. It could also be used for reporting surface water quality which have been observed.

The goal of this program is to reduce the amount and types of external loading on local streams and water bodies. The impact of this program will be to reduce stormwater impacts which are occurring and to assure that appropriate education of enforcement actions are undertaken.

5.7.2.5 Best Management Practices

In most communities a major source of stormwater contamination comes from sources which are lumped together and are called non-point pollution. Non-point pollution sources can generally be defined as pollution which does not have a single point of discharge. Non-point pollution discharges can be divided into two categories, as follows:

- Commercial
- Residential

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). Best Management Practices are defined as physical, structural, and/or managerial practices, that when used singly or in combination, prevent or reduce pollution of water and have been approved by the Department of Ecology. In its long range plan, the Puget Sound Water Quality Authority has stormwater control as one of 12 key action programs. Their control strategy is to emphasize the use of BMPs.

Chapter IV of the DOE *Stormwater Management Manual for the Puget Sound Basin* contains BMPs for urban land uses. BMPs can be placed into two general groups: source control BMPs, and runoff treatment BMPs. The former group includes those BMPs which keep a pollutant from ever coming in contact with stormwater; the latter group consists of various methods of treating stormwater. 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.

The *Stormwater Management Manual* lists many types of BMPs, and gives some general strategies for their use. The strategies are listed below in order of preference:

<u>Alter the activity:</u> The preferred option is to alter any practice that may contaminate surface water or groundwater by either not producing the pollutant to begin with or by controlling it in such a way as to keep it out of the environment. An example would be recycling used oil rather than dumping it down a storm drain as discussed in Section 5.7.2.4, Public Involvement, and Education.

Illicit or unintentional connection of indoor drains to the storm drain, rather than to the sanitary or process sewer is a significant source of stormwater contamination. It is important that these connections are identified and corrected.

<u>Enclose the activity:</u> If the practice cannot be altered, it should be enclosed in a building. Enclosure accomplishes two things. It keeps rain from coming into contact with the activity, and since drains inside a building must discharge to sanitary or process wastewater sewers or a dead-end sump, any contamination of runoff is avoided.

<u>Cover the activity:</u> Placing the activity inside a building may be infeasible or prohibitively expensive. A less expensive structure with only a roof may be effective although it may not keep out all precipitation. Internal drains must be connected to the sanitary sewer to collect water used to wash down the area as well as any rain that may enter along the perimeter.

<u>Segregate the activity:</u> Segregating an activity that is the most significant source of pollutants from other activities that cause little or no pollution may lower the cost of enclosure or covering to a reasonable level.

If the segregated activity cannot be covered, it may be possible in certain situations to connect the area to the public sanitary sewer subject to the approval of the local Sewer Authority. Or, drains may be connected to a businesses own process wastewater system if the business operates independently of the local authority.

<u>Discharge stormwater to the process wastewater treatment system:</u> Many industries have their own process wastewater treatment system with final disposal directly to the receiving water. Here, stormwater from areas of significant pollution sources can be plumbed to the process treatment system as long as its capacity is not exceeded.

<u>Discharge small, high frequency storms to public sanitary sewer:</u> This BMP would be limited to those few outside activities that contribute unusually high concentrations of pollutants and/or pollutants of unusual concern. Limited entry of these few special cases may not overtax the public sanitary sewer. It is important, however, to first have the approval of the local Sewer Authority.

The entry of stormwater to the sanitary or combined sewer can be limited to the small high-frequency storms that carry off the majority of pollutants over time. Storm flows in excess of the hydraulic capacity of the sanitary or combined sewer would be discharged to the storm drain.

<u>Discharge small, high frequency storms to a dead-end sump:</u> This BMP would be limited to those few activities which contribute unusually high concentrations of pollutants and/or pollutants of unusual concern. This option would be used when discharge into a sanitary sewer or process wastewater treatment is not available or feasible. This option requires the capability to have the sump pumped out regularly and the pumpage disposed of in an appropriate manner.

<u>Treat the stormwater with a stormwater treatment bmp:</u> The treatment of stormwater is the least-preferred option for several reasons. Source control BMPs keep the pollutants completely away from stormwater. In contrast, stormwater treatment devices are not 100 percent effective. Even after treatment freshwater criteria may still not be met for commercial areas.

According to the DOE *Stormwater Management Manual*, BMPs are not required for parking lots with less than 20 stalls, except for a simple oil spill control separator, unless it is a retail business that experiences a high turnover of vehicles.

Given the above strategies for use of BMPs DOE has developed required BMPs for many different business groups. Chapter IV-2 of the *Stormwater Management Manual* list each group of business in the following way:

- Title of business group
- Standard Industrial Code (SIC)
- Description of business activities
- Characteristics of materials used and wastes generated
- Required source control BMPs
- Required stormwater treatment BMPs

The source control BMPs referred to are found in Chapter IV-4, in numerical order, in the *Stormwater Management Manual*, descriptions of regulations that are specifically referred to can be found in Chapter IV-5 and any stormwater treatment BMPs required can be found in Volume III, Runoff Control.

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