SECTION 1.0
INTRODUCTION

The King County Department of Natural Resources invests heavily in water quality and water quality improvements through wastewater collection and treatment. Along with other agencies charged with serving the public interest, King County monitors water quality in the central Puget Sound basin.

King County's main responsibility in terms of maintaining Puget Sound's water quality, is oversight of the regional sewerage collection, treatment process, and disposal systems which discharge wastewater to Puget Sound and waters flowing into the Sound.

King County's monitoring programs, guided by the County's Modeling, Analysis and Assessment Unit, provide extensive marine and freshwater monitoring to assess the water quality of the central basin of Puget Sound (provided in this report) and of the lakes and streams within King County (provided in a separate report). The marine monitoring program primarily focuses on areas near the County's treatment plant outfalls to ensure that effluent discharges do not degrade water quality. Monitoring also focuses on areas outside the immediate vicinity of known discharges in order to assess the background conditions of central Puget Sound.

This report summarizes the results of King County's NPDES and ambient marine monitoring programs for 1997. The report is primarily intended to provide an overview of the sites monitored, the matrices (e.g., water and sediment) sampled, and provide a summary of the analytical results. A brief overview of the sampling area and wastewater collection and treatment process is provided as this is relevant to the design of the County's sampling programs.

1.1 SAMPLING AREA CHARACTERISTICS

Puget Sound is a fjord-like estuary that is bordered by the Olympic mountains to the west and the Cascade mountain range to the east. Pacific Ocean water enters the Sound through Admiralty Inlet and Deception Pass. The Sound is divided into four subdivisions: the Main Basin (Admiralty Inlet and the Central Basin), Whidbey Basin, Southern Basin, and the Hood Canal Basin. Puget Sound contains approximately 40.3 cubic miles of water, with an average tidal change of 12-14 feet and an average water volume exchange of 1.93 cubic miles with each tidal cycle (King County, 1994). The tides within Puget Sound are mainly mixed semi-diurnal, which is characterized by two unequal high tides and two unequal low tides occurring every day. The Sound's average depth is 346 feet with a maximum of 930 feet in the Central Basin. These characteristics help the Sound maintain its water quality. The Sound has near oceanic salinity throughout and nutrient-rich, low oxygen, cold, ocean upwelled deep waters off the coast of Washington enter the Sound during the summer months.

King County's marine waters are located within the Central Basin and extend south to Dash Point, west to Vashon Island, and up north to Richmond Beach. Elliott Bay, a large urban embayment, is also located within King County.

Many complex factors influence water quality in Puget Sound, including human activities, ocean currents, and physical, biological and chemical aspects. The physical characteristics of the Sound help to maintain good water quality in King County, despite the Sound's industrial use and proximity to urban areas. Subtidal water samples consistently indicate good water quality, however, nearshore sediments tend to accumulate contaminants from industrial and urban processes. Sediment carried in runoff from land plays a much greater role in the water quality of Puget Sound than in most oceanic areas. Being surrounded by hills, lakes, and rivers in an urbanized area with substantial rainfall gives the Sound a multitude of complex sediment sources. Sediment sampling generally shows the highest levels of organic compounds in the nearshore areas of Elliott Bay, where urban runoff from storm drains, industrial sources, and nonpoint sources is the greatest.

1.2 WASTEWATER COLLECTION AND TREATMENT

Wastewater from homes, businesses, and industries within King County is transported through pipelines that belong to local sewer agencies and then through King County's system of much larger pipelines to the treatment plants operated by King County. At the plants, solids are separated from liquids. The liquids are then treated and discharged into Puget Sound. The solids are treated and the resulting rich organic material, known as biosolids, can be recycled and used to enrich agricultural soils.

The County provides wastewater treatment and disposal services to cities and local sewer and/or water districts and more than 180 million gallons of wastewater are transported and treated each day. To accomplish this, King County operates and maintains three wastewater treatment plants, one combined sewer overflow (CSO) treatment plant, 37 pump stations, and 243 miles of pipelines (Figure 1-1). The West Point and East Division (Renton) Reclamation Treatment Plants provide primary and secondary wastewater treatment and the Alki Wastewater and Carkeek CSO Treatment Plants provide primary treatment.

The Treatment Process

The goal of the wastewater treatment process is to restore wastewater coming into the treatment plant to a level that does not adversely affect receiving waters. This is done by removing solids (organic matter and debris such as rocks, sand, leaves, and sticks), biodegradable organics, and pathogenic organisms.

Organic matter is a major component of the solids produced by treatment facilities. When wastewater is discharged into Puget Sound, bacteria in the Sound degrade organic matter in the wastewater. In the process, the bacteria consume oxygen in the water and reduce the amount of oxygen available to fish and other aquatic life. The amount of oxygen that bacteria consume degrading organic matter is known as the biochemical oxygen demand (BOD). Since King County discharges treated wastewater

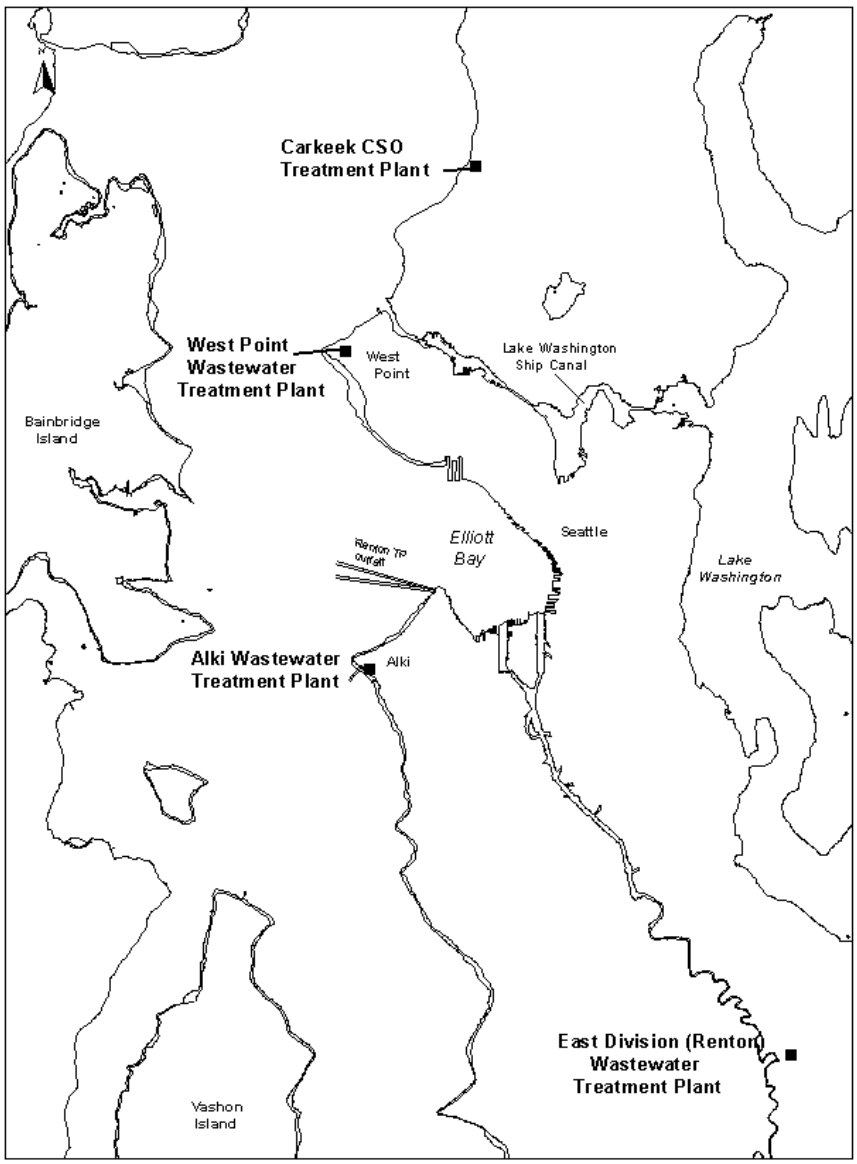

Figure 1-1. King County Treatment Plant Locations

into Puget Sound, it is important to keep the BOD to a minimum by removing the maximum amount of organic material possible before discharge. In primary wastewater treatment, physical processes remove most of the floating and settleable solids. The secondary treatment process removes most of the remaining settleable and dissolved organic matter by biological processes. Figure 1-2 shows an overview of the treatment process.

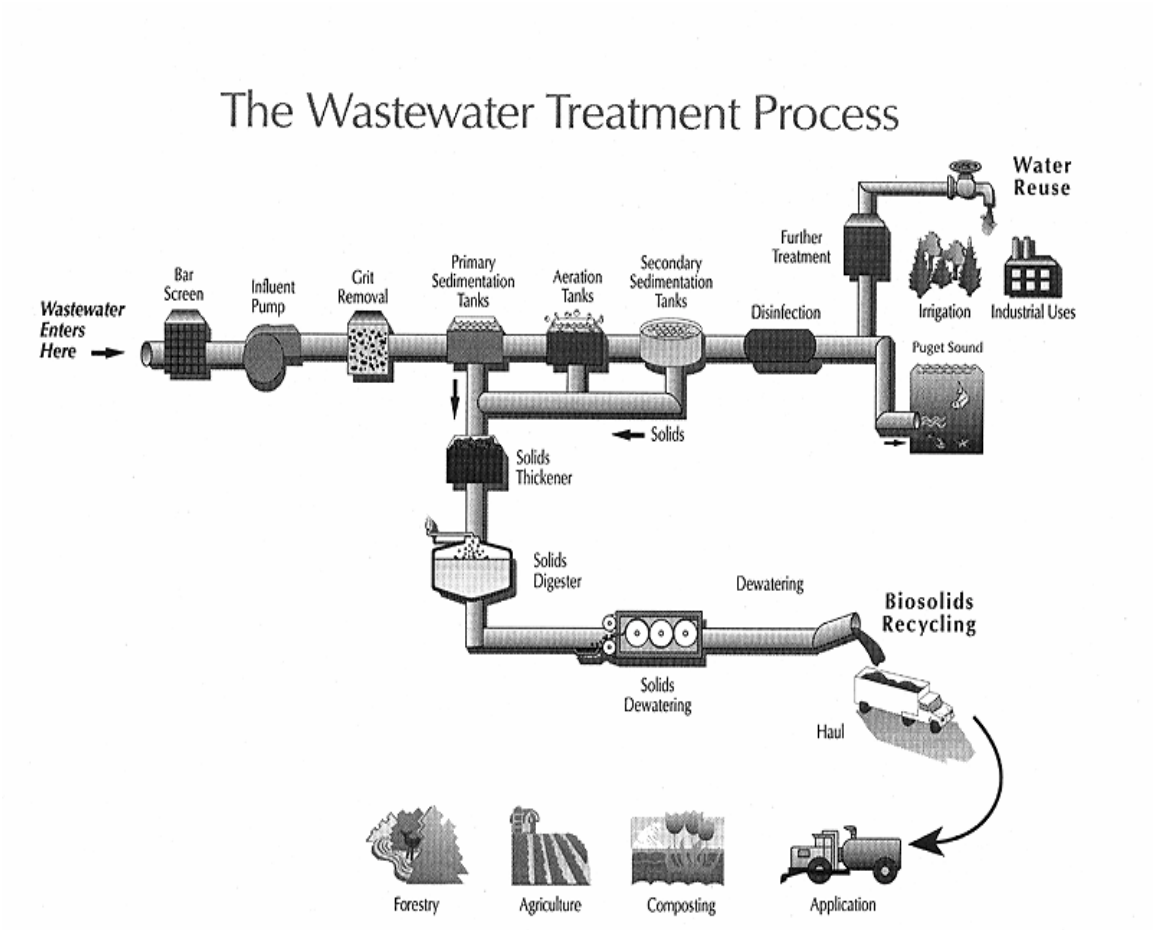

Figure 1-2. The Wastewater Treatment Process

Primary Treatment

Primary treatment is the first stage of the wastewater treatment process and consists of a series of sedimentation tanks, much like quiet ponds, that allow solids to settle out. As wastewater enters the plant it passes through bar screens that catch large objects and debris, such as sticks and plastics. The wastewater then enters a grit chamber allowing sand and gravel to settle to the bottom. The material that is collected from this process is washed, dewatered, and sent to a landfill for disposal. Finally, the wastewater flows into large sedimentation tanks where solids settle out of suspension to form primary sludge. Approximately 50 to 70 percent of the solids are removed by the sedimentation tanks. Machines skim off any material, such as oil and fats that are left floating on the surface. The primary sludge is pumped out for further treatment and recycling. The wastewater is either disinfected and discharged into Puget Sound or sent on for secondary treatment.

Secondary Treatment

The secondary treatment process removes most of the remaining settleable and dissolved biodegradable organic matter. Wastewater is directed into large aeration tanks which bubble air through the water—in the same way rapids and waterfalls aerate a natural stream. Microbes, microscopic organisms such as bacteria and protozoa, are stimulated to consume biodegradable organic matter in these aeration tanks. Secondary sedimentation tanks (secondary clarifiers) are then used to allow much of the microbes, solids, heavy metals, and organic chemicals to settle out. Settling usually takes between four and eight hours. Most of these settled solids are recirculated back through the secondary treatment process (called activated sludge) and the remaining solids are combined with primary sludge and converted into biosolids. Finally, the wastewater is disinfected with chlorine before being discharged. Most of the solids and pollutants have been removed from the final effluent.

Combined Sewer Overflows

Combined sewer systems carry both sanitary sewage and storm water runoff in a single pipe. Combining sewer systems was the standard practice from the late 1800s to about the mid 1900s, therefore, all sewers built in Seattle from 1892 until the early 1940s were combined sewers. When new sewer systems are installed today, stormwater is separated from residential, commercial, and industrial wastewater.

The City of Seattle originally built a combined sewerage system to collect wastewater and stormwater for direct discharge into local water bodies following treatment. The city also built overflow pipes designed to discharge high volumes of untreated wastewater and stormwater into the nearest water body during heavy rains when the storm related flows exceeded the system's capacity. Today, remnants of the combined sewerage system are part of King County's wastewater collection system.

In combined sewer systems, the trunk sewers and interceptors have fixed capacities while the wastewater flow varies with the amount of rainfall. During periods of heavy rain, wastewater volumes may exceed the capacity of sewer pipes that transport the water to treatment plants. To prevent damage to the treatment plants and to prevent sewers from backing up into homes and businesses, combined sewers are designed to overflow at certain points. Typically, these overflows are designed so that the overflows are discharged to marine waters and rivers where the flushing action of tides and currents can disperse pollutants.

Several of these combined sewerage systems have been separated (such as the University Regulator) so that wastewater is transported to the nearest treatment plant and stormwater is transported to a stormwater facility before being discharged into local waters.