NOTE: This impact assessment is based on the Service Strategies as presented in the Draft RWSP. See Part I of this FEIS for revised strategy descriptions and analysis.

CHAPTER 10
BIOSOLIDS RECYCLING PROGRAM IMPACTS AND MITIGATION MEASURES

This chapter describes King County's existing programs for biosolids recycling and the likely markets for future recycling of larger quantities of biosolids under the RWSP system strategies. Biosolids are the semisolid material that remains after wastewater treatment has been completed and the treated liquid effluent is discharged into receiving waters. With further processing, they constitute a rich source of nutrients for plants that can augment or replace chemical fertilizers. King County has been a leader in developing biosolids recycling programs and is committed to supporting its existing markets and developing new markets for beneficial uses of biosolids products.

This chapter provides an environmental analysis of impacts that may occur as a result of applying biosolids to the land through recycling programs. This chapter focuses on King County's current program utilizing biosolids as a soil amendment in both eastern and western Washington. Environmental impacts associated with the existing methods of processing solids at the wastewater treatment facilities are discussed in the chapters describing the Service Strategies (Chapters 5-8). Chapter 12 of this DEIS presents options for alternative means of producing biosolids accompanied by a discussion of environmental impacts.

EXISTING BIOSOLIDS PRODUCTION

Biosolids Facilities and Operations

The County currently processes wastewater solids at two treatment facilities: the West Treatment Plant and the East Treatment Plant. Wastewater solids represent the beneficial residuals from the wastewater liquid stream which were separated during primary and secondary treatment. After liquid is removed from the solids through thickening, the solids are further reduced in volume through a process called anaerobic digestion. This process reduces volatile solids and pathogens. Following digestion, water content is additionally reduced through dewatering. The resulting substance is called biosolids "cake". A number of processes are available to create different products from the biosolids cake. These processes are described in Chapter 12.

Biosolids are transported by long-haul trucks to recycling sites or to a private local firm utilizing the biosolids to produce a commercial compost.

The biosolids consist primarily of a rich organic material mixed with a small amount of sand, grit, microorganisms, trace amounts of metals, and synthetic and naturally occurring chemicals. The rich organic content of biosolids make it highly desirable as a soil amendment. Biosolids products can be used in forestry, agriculture, landscaping and gardening applications.

Volumes Generated

In 1996, King County produced 26,000 dry tons of biosolids in conjunction with the operation of its treatment facilities. The West Treatment Plant has recently been upgraded to provide secondary treatment and the expansion of the East Treatment Plant is nearing completion. Biosolids production is expected to increase over time in relation to population growth and is expected to reach *just under 40,000* dry tons per year by 2030.

Biosolids Products

Summary of Products and Regulations

Biosolids recycling is regulated according to 40 CFR (Code of Federal Regulations) Part 503, Standards for the Use or Disposal of Sewage Sludge. These standards, commonly known as the "503" regulations, are promulgated by the US Environmental Protection Agency (US EPA). The regulations recognize that biosolids, by nature of their origin, have the potential to contain appreciable concentrations of contaminants that may adversely affect human health and/or the environment. The three categories of potential concern identified by the regulations are (1) pathogens, or disease organisms, (2*) vector attraction reduction,* and (3) trace metal content.

Federal, state, and local agencies regulate the production, application and marketing of biosolids. There are two classifications of biosolids based on pathogen content: 1) Class A biosolids have been treated to reduce pathogens to a level where *there are no site access or crop restrictions. Class A designation is required for use on lawns and gardens.* 2) Class B biosolids have been treated to reduce pathogens to a level that is safe for application on land with an initial period of limited public access *and crop restrictions*. Treatments to produce a Class A biosolids do not affect the metals or organic chemicals in the biosolids; odor may or may not be affected. Federal regulations also set maximum limits on trace metal content in biosolids. *All biosolids to be land applied must be under the maximum limits; biosolids meeting a second (lower) set of metal standards (i.e. are of consistently higher quality) have fewer restrictions for use.* The County's biosolids consistently exceed the metals standards and are classified as "highest quality". The state and local health departments may impose stricter standards. (See Table 10-1 for typical biosolids metals content).

The federal regulations on biosolids processing and use and the analogous state regulations mandate that biosolids be applied at agronomic rates to balance uptake of nitrogen by crops with the potential for nitrate leaching to ground water. The maximum rate and the cumulative amount of biosolids that can be applied to a particular parcel of land are intended to limit the concentrations of contaminants in soil, crops, and receiving waters. These regulations limit the accumulation of contaminants in biosolids-amended soil to levels that are not harmful to the health of humans and other biota.

When biosolids are applied in compliance with federal, state and local regulations and permitting requirements, there are no probable significant adverse environmental impacts associated with this practice.

Some Class B cake is composted with sawdust to form a Class A biosolids compost marketed as GroCo. GroCo is sold to commercial landscapers and home gardeners and its use is unrestricted. In 1996 GroCo received 2,587 dry tons or 10% of King County's biosolids production. In 1996, a small portion of GroCo's annual production, 1600 cubic yards, was used by volunteers as part of the Mountains to Sound Greenway regreening project along Interstate 90.

Currently, King County is conducting a pilot program with a private firm, PCL/SMI to dry undigested solids at the West Treatment Plant. In 1996 PCL/SMI received 4,864 dry tons or 19% of King County's production. PCL/SMI is a fully privatized operation and that contractor is solely responsible for the marketing of its product.

Table 10-1
Typical Biosolids Metals Content in 1996

Metal (mg/kg)	40 CFR 503 Limits	West Plant	East Plant
Arsenic (As)	41	8.30	8.99
Cadmium (Cd)	39	6.53	8
Chromium (Cr)	1,200	74.5	91.8
Copper (Cu)	1,500	510	831
Lead (Pb)	300	217	81.3
Mercury (Hg)	17	3.91	3.09
Molybdenum (Mb)	18	11.5	17.4
Nickel (Ni)	420	44.3	25.9
Selenium (Se)	36	5.66	6.67
Zinc (Zn)	2,800	1,080	952

Current Markets

Western Washington

In western Washington, biosolids are used primarily for silviculture (i.e., forestland application) and compost. Weyerhaeuser's Snoqualmie Tree Farm in Snoqualmie has been the major recipient, with an average annual usage of approximately *3,000* dry tons of Class B cake between 1087 and 1994. In 1995, Weyerhaeuser committed to use *5,000* dry tons a year for the next 6 years. In addition, the Washington State Department of

Natural Resources (DNR) agreed in 1995 to a 50-year contract for biosolids use on forestlands, with a maximum annual usage of 6,000 dry tons. This agreement is a part of the Mountains-to-Sound Greenway program, which involves the transfer of land between King County and DNR.

The compost marketed by GroCo is also marketed in the Puget Sound region. The current GroCo contract is for delivery of *a minimum of* 2,000 dry tons of Class B digested cake per year, with an option to increase to up to 3000 dry tons per year.

Eastern Washington

Biosolids markets in eastern Washington use Class B cake as a soil amendment for a variety of crops. In Douglas County, approximately 5,900 dry tons of biosolids were applied to 1,536 acres of wheat fields in 1996. Farmers in Yakima County used 4,760 dry tons for hop production on 1,332 acres during the same period. Biosolids in Yakima County can be applied to irrigated hops, grapes, orchard fruit, corn, hay, alfalfa, hybrid poplars, dryland grain and rangeland. Small quantities of a dried Class A biosolids product were used by eastern Washington farmers over the past several years. Farmers in both counties have indicated a desire for larger quantities of biosolids, with potential usage of 20,000 dry tons per year or more. King County's current production cannot satisfy this demand in addition to that of western Washington markets; furthermore, the higher expense of transport over Snoqualmie Pass makes the handling of biosolids less cost effective. Some Eastern Washington farmers have received approval to store biosolids over the winter which provides greater flexibility by making biosolids available virtually year-round.

Other Potential Biosolids Recycling Sites

Because biosolids are an important soil amendment product, there are other suitable applications other than silviculture or agriculture. Biosolids have been used to improve soil conditions in disturbed areas, such as at Discovery Park in Seattle. In this case, Class B cake was used as a soil amendment to establish grasses and native vegetation and eliminate Scots Broom on fourteen acres within the park where the public access restriction conditions could easily be met. There may be similar projects in the future where applications of Class B may occur subject to compliance with permit conditions. Other projects may be undertaken where a soil amendment would be beneficial but a Class A material would be more suitable.

This market is currently very small but has the potential to expand in the future using either a Class A or B product.

BIOSOLIDS APPLICATIONS

The method of applying biosolids varies according to the crop and local conditions. For eastern Washington agricultural uses, the application equipment may vary, but it must be able to uniformly apply biosolids at the desired rate and be suitable for the terrain and crops. Incorporation follows application and is done with a disc, rake/harrow, or other

means as appropriate for the soil conditions of the field. The practice of leaving biosolids unincorporated in rangeland areas is preferred to help control soil erosion.

Part of the permitting process involves the approval of an "Operations Plan" for each project that specifies site operations, management and environmental monitoring.

For silvicultural operations in western Washington, the application process begins with site selection. Candidate sites have the following characteristics:

- Terrain suitable for ground application of biosolids.
- Stands of trees or other vegetation capable of utilizing the added nutrients.
- Well drained soil, and
- Streams and other waterways which can be protected by required setbacks or buffers.

In forestry sites, biosolids dewatered to approximately 20 percent solids, are applied using the "AeroSpread" throw applicator. Mounted on the chassis of a log forwarder (equipment designed to carry logs in a harvesting operation), paddles of the AeroSpread can throw the biosolids up to 200+ feet. The distance the biosolids are thrown is controlled by changing the angle of ejection and velocity of the rotator blade.

After biosolids are delivered to the site by truck, they are usually applied the same day although longer term storage may be permitted.

The rate of application depends on an approved site-specific prescription for nitrogen calculated by a soil and forest fertilization specialist. This prescription is an agronomic rate, designed to meet the nitrogen needs of the crop yet minimize possible production of excess nitrate. Re-applications of biosolids may occur as needed, usually every four years.

All applications of biosolids require monitoring of surface and well water (if present) to ensure compliance with environmental and public health standards and meet permit requirements.

EXISTING CONDITIONS, IMPACTS, AND MITIGATION MEASURES

This section contains the environmental analysis for the application of Class B cake and Class A products including composted biosolids. Each element of the environment is divided into three headings: eastern Washington markets (primarily agricultural), western Washington markets (primarily silviculture), and other potential biosolids recycling markets . Environmental impacts for eastern and western Washington environments are discussed separately because the environmental conditions and the methods of biosolids application and markets or end users differ between the two areas. Within each element of the environment, impacts are described in terms of product type (Class A or Class B, dewatered cake or other).

Earth Resources

Eastern Washington Markets

Existing Conditions. Eastern Washington soils are primarily silty and sandy loams formed from alluvium and loess (fine-grained material deposited by wind). These soils are usually moderately permeable (percolation occurs at 0.6 to 6.0 inches per hour) and are mildly acidic to mildly alkaline (about pH 6.5 to 8.0). Soils in major river valleys are typically deep. Outside of major river valleys, soils are underlain by basalt or, in northern Douglas County, glacial till at depths less than about 60 inches.

Impacts and Mitigation Measures. Biosolids are used primarily as a soil amendment and fertilizer in eastern Washington agricultural areas, and earth impacts from agricultural application of either Class A or Class B biosolids would be similar. The 503 Regulations limit the amount of biosolids that can be applied over a given period of time to a specific piece of land. This regulatory requirement minimizes the potential impact by reducing the metals buildup in the soil over time. Because King County biosolids meet the lowest limit for metals, cumulative loading is not of concern. The application of either Class A or Class B biosolids in eastern Washington is unlikely to result in significant contaminant loading to soils, and any adverse earth impacts would be minimal. Monitoring for constituents of concern is performed as required by federal and state regulations.

Amending agricultural soil with a biosolids cake product (either Class A or B) has a number of beneficial impacts to earth resources. Soil tilth is improved as organic matter in the biosolids is incorporated into the soils. This provides increased moisture retention and reduced wind erosion. Biosolids are tilled into the soil to create improved soil conditions to support the growth of plant materials.

Biosolids are stored for up to six months near the sites of application. To reduce the potential for erosion of the stored material, storage areas can be located in areas sheltered from the wind. If a dried product is being stored, the storage sites can be surrounded with plowed furrows and/or berms and possibly covered with plastic materials. No additional mitigation measures are necessary.

Western Washington Markets

Existing Conditions. Soils on potential silviculture sites are primarily gravelly loams and gravelly sandy loams typically underlain by glacial till or bedrock at depths of about 40 inches or less. These soils are moderately to strongly acidic with pH values of 6.0 or lower. Permeability is typically fairly rapid (0.6 to 6.0 inches per hour) near the surface but quite slow (less than 0.06 inch per hour) below a depth of about 24 to 40 inches.

Sites selected for biosolids applications are usually flat, although slopes of up to 30 to 40% may be suitable if other permit requirements can be met.

Impacts and Mitigation Measures. The application of biosolids to forest soils reduces the potential for soil erosion while improving site nutrient status by restoring plant nutrients to the soil. Impacts and mitigation measures are described above except that

silvicultural applications are not tilled into the ground. Biosolids applications avoid periods of heavy precipitation, saturated soils, frozen ground or snow to reduce the potential for the biosolids to move beyond the application area.

The regulatory environment described above for eastern Washington agriculture applies to silviculture in western Washington.

Other Potential Biosolids Recycling Sites

Existing Conditions. Soil conditioning projects are most likely to occur in urban or semi rural parts of western Washington such as parks, highway medians, or other previously disturbed or high intensity use areas where a soil amendment would improve the quality of the soils. Soils in the more urban areas are likely to have been heavily modified by past development.

Impacts and Mitigation Measures. In this market, biosolids used would be Class A products, typically compost or Class B products where access can be restricted temporarily. Class A compost is used primarily as a soil amendment in gardens and larger landscaped areas. Potential impacts to earth resources would be beneficial by improving the nutrient value of soils. Any constituents of concern, (e.g. metals), are regulated and levels controlled through monitoring biosolids quality so potential adverse impacts to earth resources through the build up of contaminants is very unlikely.

Air Quality

Eastern and Western Washington Markets (All Markets)

Existing Conditions. Air quality at existing and potential agriculture and silviculture application sites is generally good because these sites are usually located away from urban areas and have minimal concentrations of ambient air pollutants. Activities in agricultural areas are sometimes the source of localized odors associated with livestock management and crop fertilization using organic materials.

Urban or urbanizing areas where biosolids may be applied may have more concentrations of ambient air pollutants and localized odors associated with specific uses.

Impacts and Mitigation Measures. Odors may result from biosolids applications to agricultural and forest lands because numerous organic and inorganic volatile compounds are present in biosolids products, particularly in Class B biosolids.

Class B cake biosolids used in forestry and agricultural applications may emit a musty organic or ammonia-like odor when freshly applied. It diminishes rapidly as the biosolids application dries out or is tilled into the soil. Odor associated with biosolids is very localized and also dissipates quickly with distance.

There is less odor associated with some Class A biosolids products, such as a dried product, than with Class B cake. The application of dried biosolids may be more dusty than the dewatered product when stored or applied. Some Class A products may produce more odor than others and is specific to the technology used in production. However,

there are usually no populated areas in the vicinity of the application areas. Therefore, no significant odor impacts are generated by the application of biosolids.

Volatile compounds in biosolids are the source of odors. The more stabilized the biosolids the fewer odor-causing compounds are contained in the product. The use of Class A biosolids, particularly biosolids that have been composted, would reduce odors further.

Applying biosolids to topsoil under predominantly aerobic conditions facilitates the decomposition of odorous compounds while preventing their formation. Most agricultural crops are grown in topsoil that is kept aerobic through tilling, aerating, and other practices. This mitigation measure is already implemented at all eastern Washington agricultural projects.

Water Resources

Eastern Washington Markets

Existing Conditions. The climate in eastern Washington is dry, with annual precipitation at lower elevations less than 20 inches and many areas receiving less than 10 inches per year. Because of these dry conditions many agricultural areas depend on irrigation, although non-irrigated dryland farming does occur. Because of the dry climate, perennial streams and rivers are confined to major valleys, with most smaller drainages carrying only intermittent streams.

The Columbia River downstream from Grand Coulee Dam and the lower portions of major tributaries such as the Yakima, Wenatchee, and Entiat rivers are classified by Ecology as Class A (excellent) waters. The Columbia River water quality has been characterized as high with generally low suspended loads, low nutrient levels, and low levels of microbial contaminants. Several tributaries of the Columbia have lower water quality. The nature of these problems, which include elevated nutrient and microbial levels in part, reflect inputs from adjacent agricultural land uses.

Groundwater under the Columbia Plateau and the Yakima River valley is found within the three principal basalt formations underlying these areas as well as within the sediments (referred to as “overburden” when more than 50 feet thick) that overlie the basalt formations. Depth to groundwater in these areas varies from less than 20 feet to more than 200 feet. About 200,000 acre-feet of water are pumped from the overburden aquifer annually with about 600,000 additional acre-feet pumped from aquifers in the underlying basalt formations. Between 85 and 90 percent of the total water pumped is used for irrigation. Groundwater quality has been characterized as good although levels of some constituents are above state groundwater quality criteria in some areas. For example, nitrogen concentrations in excess of state standards were found in some irrigated areas, and these high concentrations have been attributed to agricultural practices.

Impacts and Mitigation Measures. The federal biosolids regulations (40 CFR 503) and the associated proposed state regulations limit the rate and total amount of biosolids applied to a given site. These best management practices include maintaining buffers between surface waters and biosolids application sites, applying biosolids at agronomic

rates to maximize crop uptake of available nutrients in biosolids, maintaining moderate soil pH to limit mobilization of metals, and periodic monitoring to determine actual concentrations of contaminants in soils. These best management practices are intended, in part, to ensure that the quality of receiving waters are not impaired. By implementing these best management practices, no significant adverse impact to surface or ground water quality should occur as a result of application of either Class A or Class B biosolids to agricultural lands.

Western Washington Markets

Existing Conditions. The climate at potential silvicultural sites in western Washington is generally humid, with annual precipitation in excess of 50 inches. Most precipitation occurs during the fall, winter, and spring.

Potential silvicultural sites in western Washington are usually located outside developed areas. Most major drainages (e.g., Tolt River, and three forks of the upper Snoqualmie River) and their tributaries in the vicinity of potential silvicultural sites are designated by the state as Class AA (extraordinary) and have correspondingly good water quality. Observed water quality problems in some areas, including elevated levels of nutrients, suspended solids, or microbes, are usually localized and related to specific adjacent land use activities.

The glacial deposits that underlie many of the potential silvicultural sites in western Washington consist of a layering of permeable strata separated by slowly permeable materials. The permeable strata are typically sources of groundwater, with perched, near-surface groundwater layers found in many areas above the uppermost slowly permeable strata (King County, 1987). There are few recent comprehensive studies of groundwater quality in western Washington; however, groundwater quality appears to be generally good. Groundwater quality problems are, in many cases, the result of misuse or over application of nutrients, pesticides, and feed in agricultural operations, noncompliant landfills, and inadequate or failing domestic septic systems. These problems are unlikely to occur in the forested areas supporting silvicultural activities, and groundwater quality in these areas is probably very good.

Impacts and Mitigation Measures. The discussion of best management practices applicable to the protection of surface and ground waters in eastern Washington also applies to silviculture in western Washington. The high rainfall and typically acidic soils on potential western Washington silvicultural sites makes the potential for transport of contaminants from biosolids application sites to surface waters greater in western Washington than in eastern Washington where the soil is more alkaline and rainfall is significantly less. Prior to application of Class B biosolids, local and state regulations require preparation of a site operations plan and water quality monitoring plan that must be approved by the local health district and the State Department of Ecology. The site operations plan must specify management practices to be used that are based on a site evaluation, tailored to the specific site conditions, and designed in part to minimize impacts to water resources. With implementation of these requirements, impacts to surface and ground waters should not be significant.

There is even less potential for surface or groundwater to be affected by constituents present in Class A biosolids due to the reduction in pathogens achieved by additional processing.

Other Potential Biosolids Recycling Sites

Existing Conditions. Use of biosolids products is likely to occur in areas more urban than those surrounding silvicultural sites. These more urban areas, which are clustered around Puget Sound, have lower precipitation amounts and intensities than do typical silvicultural sites. Annual precipitation amounts in most urbanized areas surrounding Puget Sound are less than 50 inches. These urbanized areas often have existing stormwater systems to control runoff, and topography is typically less severe.

The quality of receiving waters in urbanized areas is usually lower than the quality of receiving waters in areas supporting silviculture. Many drainages in the Seattle metropolitan area are classified by Ecology as A (excellent) or, for some drainages, B (good) or lower. Observed surface water quality problems in many urbanized drainages include high temperatures and low dissolved oxygen, particularly during low-flow periods, and high levels of some contaminants such as fecal coliform bacteria.

Impacts and Mitigation Measures. Use of biosolids for other types of soil amendment projects would probably occur on a smaller, less intensive scale than silviculture or agricultural applications due to the urbanized character of the land. If Class B biosolids were used as a soil amendment, all of the best management practices noted above would be implemented and environmental impacts would not be adverse.

Class A biosolids with low levels of pathogens would have minimal effect on water resources if agronomic rates and other best management practices are followed.

Aesthetics and Land Use

Eastern Washington Markets

Existing Conditions. Potential application sites in eastern Washington are used exclusively for agricultural crops or rangeland. This land is located mostly in areas with little topographic relief--relatively flat areas on the Waterville Plateau and adjoining lands east of the Columbia River or in the Yakima River valley downstream of Union Gap. Apart from agricultural crops, vegetation is sparse, and most potential application sites are very visible from surrounding areas. Land uses on and surrounding potential application sites are primarily agricultural. Few residences or other sensitive land uses occur near potential application sites.

Impacts and Mitigation Measures. Activities associated with biosolids applications are similar to activities associated with other soil amendment procedures. Most eastern Washington agricultural areas also contain few land uses that would be as sensitive to aspects of biosolids application, such as odor. For these reasons, adverse aesthetic impacts would be minimal. Biosolids application can create a richer more fertile appearance to the land, resulting in a beneficial impact.

Land uses in the vicinity of biosolids application sites are primarily agricultural, and biosolids application would be compatible with these uses. All application of biosolids is required to meet federal, state, and local regulations.

There is no distinction between the use of Class A and Class B biosolids with regard to aesthetics and land use.

Western Washington Markets

Existing Conditions. Topographic relief on and in the vicinity of application sites is mostly moderate to substantial. Sites and their surroundings are usually heavily forested, and views of and from sites are limited except where clearings provide territorial vistas or where major highways are present (Mountains to Sound I-90 corridor).

Land use activities on and in the immediate vicinity of potential application sites are primarily associated with forest resource management and some recreation. In most cases, few residences or other potentially sensitive land uses occur near potential application sites.

Impacts and Mitigation Measures. Because of the *relative* low visibility of potential silvicultural sites and the typical lack of nearby sensitive land uses, aesthetic and land use impacts from application of either Class A or Class B biosolids would be minimal. Where biosolids are used to restore previously logged areas or logging roads, the aesthetic appearance of the forested area would be improved through the use of biosolids as it would support revegetation

Other Potential Biosolids Recycling Sites

Existing Conditions. There are projects or programs where biosolids are considered for use in primarily urban and suburban areas. Surrounding land uses could be residential, recreational, commercial, and industrial. In most cases, potential application sites would be visible from surrounding properties.

Impacts and Mitigation Measures. A Class A product, typically compost, or Class B product would be applied, generally as a substitute for fertilizers or other soil amendment products. The typical Class A product is stabilized with little distinguishing odor. Given that the types of activities involved with these applications would occur with other soil amendment products and the biosolids used would probably be indistinguishable from other soil amendment products by adjacent land uses, no significant aesthetic or land use impacts would result. Class B product can be considered for use in areas where site access restrictions can be easily implemented (such as fences installed and areas posted). Impacts associated with the use of biosolids as a soil amendment can be considered beneficial as it encourages the growth of vegetation in often previously disturbed areas.

Energy

Western and Eastern Washington Markets

No significant energy impacts are expected to result from the recycling of biosolids in western or eastern Washington. Some energy would be saved by a reduction in demand for commercially produced chemical fertilizers, which require energy to manufacture. Energy, primarily diesel fuel would be expended during transportation of biosolids products to the site where they would be used.

No adverse impacts to energy resources are likely to occur as a result of biosolids transport or application. No mitigation measures are necessary.

Environmental Health

Biosolids contain micro-organisms which may include pathogenic bacteria and viruses, trace metals such as zinc, lead and cadmium, and trace amounts of organic compounds. Environmental health issues include human exposure to pathogens, nitrate leaching into groundwater used for human consumption and potentially uptake of trace metals and organic compounds by plants consumed by humans or by animals.

The 503 regulations rank biosolids into two categories based on pathogen content.Biosolids contain micro-organisms which may include pathogenic bacteria, viruses, protozoa, helminths and fungi. Class A biosolids products have significantly lower numbers of pathogens than Class B biosolids products.

All biosolids must meet either Class A or Class B standards before they can be applied to land. Class A biosolids can generally be used on any site and without restrictions as long as metal concentrations are below those mandated by the 503 Regulations. Class B biosolids can be used with temporary public access restrictions.

Like other fertilizers, biosolids contains nitrogen, some of which can become mobile in the soil column (nitrate) if applied at rates that exceed plant requirements for growth. By calculating the appropriate agronomic application rate for the crop, the risk of excess nitrate reaching groundwater is reduced or eliminated. Nitrate is of concern because high levels violate the state drinking water standards.

Eastern Washington Markets

Existing Conditions. At the present time, King County provides biosolids to farmers in Douglas and Yakima counties. There is the potential for this market to increase if sufficient interest exists in the farming community. Farmers in these counties apply Class B biosolids to hops, orchards, grapes, wheat fields and rangeland. These farms lie in agricultural areas of rural counties.

Impacts and Mitigation Measures. Pathogen survival in biosolids-amended soil is influenced by soil temperature, moisture, pH, and the presence of predatory microbes. While the potential exists for many pathogens to be present in biosolids, most are not detected in King County's products through routine monitoring. Several studies designed

to detect potential health problems associated with land application of biosolids have shown no evidence of adverse health effects, even in highly exposed individuals or in populations near biosolids recycling areas.

Trace metals are naturally occurring in nearly all soils. Some of these elements may be important micronutrients for plants and some animal species. However, if present in large concentrations, these metals have shown toxic effects on plants, animals, and humans. Specifically, copper and nickel have been shown to commonly have phytotoxic effects; arsenic, mercury, and especially lead and cadmium are of greatest concern on human health. Many trace metals, particularly lead, are not readily mobilized in the soil environment. Others, such as cadmium, can be taken up by plants and therefore have the potential to be ingested either directly by humans and animals or indirectly by humans who eat livestock fed on metal-contaminated vegetation.

The 503 regulations specify strict "ceiling concentrations" on the amounts of these metals that are allowable in biosolids, and biosolids cannot be applied to land if they do not fall within these concentrations. The regulations also specify standards required for unrestricted use.

The final public health consideration is organic compounds. Many organic compounds, most of them synthetic, are discharged into municipal wastewater systems. These compounds usually decompose slowly in the treatment process and often adsorb onto the organic components of biosolids products. The U.S. EPA has identified 11 types of compounds of concern in waste products. All of these chemicals may be toxic; they also tend to accumulate and translocate within the food chain. Examples of these compounds include polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), pesticides, and solvents.

Of the 11 types of organic compounds identified by the U.S. EPA, only PCBs are found in detectable concentrations in King County biosolids. However, the levels of PCB contamination in these products are well below the criteria established by the Department of Ecology and no adverse health effects are likely to result from exposure to biosolids or plants grown in biosolids amended soil.

The following mitigating measures are taken to reduce further or control potential environmental health risks. All of these measures help to minimize human exposures and potential risks associated with biosolids application projects. These measures are discussed below:

- King County's wastewater is treated to significantly reduce pathogenic bacteria and viruses. King County maintains active industrial pretreatment and source control programs which help produce a high quality biosolids by minimizing discharges of metals and organic compounds to the wastewater system. In addition, small business and household hazardous waste programs have also been instituted.

- When applied to land, biosolids are exposed to sunlight (ultraviolet light) and the elements (desiccation, temperature, natural soil microorganisms) which further

reduce the number of viable pathogens remaining. Dewatered biosolids dry and stabilize quickly, within days.

- Class B biosolids are isolated from humans because application sites in eastern and western Washington are relatively remote, signs are posted indicating the application of biosolids (and with the duration of public access restrictions) and setbacks (buffers) from residences, roadways, wells and surface waters are established.

- In eastern Washington, inherent site characteristics tend to further isolate biosolids by preventing or retarding the movement of biosolids constituents. These include adequate depth to groundwater, large distance to surface water, adequate soil cation exchange capacity and neutral or nearly neutral soil pH.

- Biosolids are applied at agronomic rates (rates designed to match crop uptake with nitrogen loading and minimize the potential for leaching into groundwater).

- Site soil and groundwater are monitored, as required, to make sure prescribed levels of the constituents in biosolids (e.g. metals) are not exceeded.

Western Washington Markets

Existing Conditions. *Currently, King County's silviculture markets are the forest landowners in the Mountains to Sound Greenway Biosolids Forestry Program-the Weyerhaeuser Company and Washington State Department of Natural Resources. King County applies Class B biosolids at the Weyerhaeuser Snoqualmie Tree Farm and on state forests such as Tiger Mountain and Marckworth State Forest. Other western Washington forest producers have expressed interest in King County biosolids but have not yet used them. Forestry research conducted by the University of Washington at Pack Forest in Pierce County has been ongoing since 1973 and continues to explore issues of interest to present and potential users.*

Impacts and Mitigation Measures. There are few differences between eastern and western Washington regarding potential adverse public health impacts for pathogens, trace metals, and synthetic organics. Generally, silvicultural land application has fewer potential impacts on environmental health because silvicultural products are not directly consumed by humans and are rarely directly consumed by livestock. Further, silvicultural lands are generally managed less intensively than are agricultural properties, thus further reducing potential human exposure to pathogens, metals, and organics.

Mitigation measures for potential environmental health impacts from biosolids application on forestlands are similar to those for agricultural lands. Because forested lands are often used for recreation, additional mitigation measures are utilized. Any forest users will be isolated from biosolids by setbacks/buffers from recreational trails and posting of signs identifying the time public access restrictions are in place.

Other Potential Biosolids Recycling Sites

Biosolids used as a soil amendment for more urban or suburban environments would have similar environmental health impacts and mitigation measures as those described above.

Class B biosolids have a greater potential for adverse impacts to environmental health than Class A biosolids and require more restrictive measures to protect the public (fencing and posting information more frequently).

Vegetation

Eastern Washington Markets

Existing Conditions. In eastern Washington, biosolids are applied to soils to grow irrigated and dryland crops such as hops, orchards, and wheat. Biosolids may also be applied to rangeland to improve soil conditions and increase the vegetative cover, primarily native dry grasses.

Impacts and Mitigation Measures. The nutrients and soil conditioning properties associated with the application of biosolids that meet regulatory requirements have been shown to enhance plant growth and vigor. Research has demonstrated both regionally and nationally that plants grown in biosolids amended soil pose no greater health risk than those without.

In addition, livestock cannot be grazed on land where Class B biosolids have been applied until thirty days after the application.

Western Washington Markets

Existing Conditions. Silvicultural applications of biosolids in western Washington are made in the forests of the Puget lowlands and the foothills of the Cascades, primarily in King County. These areas of the state, in their native condition, were dominated by coniferous forest, with Douglas-fir and western hemlock the major species. Almost none of the original forests remain and the landscape is now covered with younger coniferous forests of the same species. These young forests are highly productive and capable of great accumulations of biomass by trees and vegetation under the tree canopy.

The current markets for biosolids in forestry are the Weyerhaeuser Company and the state Department of Natural Resources under the Mountains to Sound Greenway Biosolids Forestry Program. The Weyerhaeuser Company uses biosolids on its Snoqualmie Tree Farm, located north and east of Snoqualmie in eastern King County. The forests on the tree farm are second- and third-growth stands which are actively managed for timber production. They are regularly harvested and replanted. The primary species planted is Douglas-fir (Pseudotsuga menziesii), but plantations also include natural western hemlock (Tsuga heterophylla) and western red cedar (Thuja plicata), with Pacific silver fir (Abies amabilis) and noble fir (Abies procera) in the higher elevations.

The state Department of Natural Resources uses biosolids in King County at Marckworth State Forest, east of Duvall, and Tiger Mountain State Forest near Issaquah. Both state forests are dominated by older second-growth stands of Douglas-fir and hemlock, with some third-growth plantations. Although the state forests have been less intensively managed than the Weyerhaeuser lands, plant communities are generally the same in both ownerships.

Vegetation at all King County biosolids forestry sites is typical of plant communities in the Douglas-fir, hemlock and western red cedar zones. Drier sites typically have a shrub understory of salal, Oregon grape, bracken fern and vine maple with sword fern and salmonberry on more mesic sites. Biosolids are not applied in stands at the wetter end of the moisture gradient, for example, those typified by skunk cabbage or Devil's club. The dry to mesic community types in this zone also contain a variety of herbaceous plants and mosses: twinflower, foamflower, oxalis, trailing blackberry, lady fern and many others. Riparian areas, which are buffered and do not receive biosolids, often contain a mixture of red alder, big leaf maple, western redcedar, salmonberry, and moisture-loving herbs and mosses.

Impacts and Mitigation Measures. The use of biosolids as a soil amendment or fertilizer has the potential to affect plants and plant communities. Biosolids generally condition soils and improve properties that promote crop growth. But a variety of trace elements can be undesirable when they are present in soil at higher concentrations. Biosolids contain low but measurable concentrations of copper and cadmium, which are known to be toxic to plants. However, because biosolids are applied specifically at rates determined to be beneficial, plant toxicity due to trace metals or organics has not been documented. Application of biosolids generally increases plant productivity because of increased nutrient availability and, in some cases, improves soil physical properties. In general, the total nutrient content, as well as the water-holding and nutrient-holding capacities, of soils is increased.

Nitrogen has traditionally been considered the most important nutrient for fertilization because it is needed by plants in greater amounts than phosphorus or potassium. Nitrogen is also the limiting constituent for land application of biosolids, because when excess nitrogen is applied it can result in nitrate leaching through the soil profile and into ground water. Trace elements in biosolids, such as metals and organic chemicals, are not used to determine application rates. EPA’s risk assessment models were used to set limits for metals and chemicals in biosolids so that even 100 years of annual applications would still not expose humans or animals to harmful levels of these elements.

Each forest site has a unique prescribed application rate of biosolids. First, uptake requirements of the forest stand are determined by the amount, kind, and vigor of trees and understory vegetation growing on the site. A site that is well-stocked with trees and has a dense understory requires more nitrogen than less vegetated sites. After the nitrogen needs of the stand are determined, the amount of nitrogen available from the biosolids is calculated. The available nitrogen comes from two sources in the biosolids: ammonia, which can be taken up by plants immediately, and organic-N, which must be mineralized to ammonium for plant use. By subtracting the amount of nitrogen that will be lost to the plants (through ammonium volatilization and immobilization in the soil) from the amount of nitrogen that will be available from the soil and biosolids, an appropriate application rate can be designed.

Animals

Eastern and Western Washington Markets

Existing Conditions. Animals that could be subject to adverse impacts associated with the application of biosolids are those that inhabit agricultural and forested areas. These include such large mammals as deer, rabbits, squirrels, mountain beaver, elk and bear and smaller animals may inhabit eastern Washington fields and rangeland or, Western Washington forests, such as mice and voles. Birds may include resident and migratory birds such as hawks, songbirds, Canada geese, and pheasants.

Impacts and Mitigation Measures. The application of biosolids to land can affect wildlife by direct contact or can affect wildlife by alterations in vegetation. Wildlife populations may be affected as a result of the bioaccumulation of metals and trace organics or from vegetative changes caused by the nutrient enrichment from biosolids application. However, the application of biosolids does not appear to affect wildlife populations significantly.

Accumulation of trace metals by wildlife varies, depending on the species, habitat and food source. In general, metal accumulation is low and not harmful to individuals or populations. Concentrations are highest in animals that consume invertebrates directly.

Based on the available studies of biosolids recycling impacts on wildlife, no significant adverse impacts are anticipated as a result of any biosolids applications.

Under the 503 regulations, biosolids cannot be applied on any site where they are likely to *adversely* affect endangered or threatened species. Although it is unlikely that general land application practices would have an adverse affect on these species, King County must document the presence of any of these species when applying for permits for biosolids land applications. No additional mitigation is required.

Transportation

Eastern and Western Washington

Existing Conditions. Biosolids are transported from treatment plants to recycling sites by long-haul trucks capable of 5.8 dry tons per truck. The West Treatment Plant produced a total of 14,069 dry tons of biosolids in 1996. The West Plant is projected to produce approximately 14,331 dry tons for 1997. One-way biosolids truck loads in 1996 totaled 1,613, or approximately 6 loads per working day.[1] Based on biosolids projections

[1] Biosolids truck trips are calculated as the number of "biosolids loaded" truck trips leaving the treatment plants per day or year. This is how the truck trips were calculated in the DCLU project level permit for the upgrade of the West Treatment Plant (limiting biosolids truck trips to a maximum of 13 per day). Elsewhere in the EIS, truck trips are calculated as "one-way" trips, that is, one empty truck in to a site and one loaded truck leaving the site would constitute 2 truck trips. If this approach were used for to describe transportation impacts in this chapter, truck trip numbers would be doubled to represent one

for 1997, with King County secondary treatment facilities on line, the total will increase to 2,472 one-way truck loads or approximately 7 trips per working day.

The existing truck route from the West Plant is through Fort Lawton and Discovery Park and along West Government Way, Gilman Avenue West, and 20th Avenue West. At West Dravus Street, the route turns east to 15th Avenue West. The route continues south on 15th Avenue West to Elliott Avenue West, and then Highway 99.

The East Plant produced a total of 10,873 dry tons of biosolids in 1996. East Plant biosolids production was projected at 10,758 dry tons for 1997. One-way biosolids truck loads totaled 1,950 in 1996 (approximately 5.5 trips per day). Based on biosolids projections for 1997, there will be 1,855 annual one-way truck trips (5 trips per day). The existing truck route from the East Plant runs along Oaksdale Avenue S.W. to S.W. Grady Way, and then west along S.W. Grady Way to I-405 and I-5.

In 1994, 43 percent of the biosolids were distributed to Douglas and Yakima Counties for agricultural application. Twenty percent of the biosolids were delivered to PCL/SMI, a privately owned drying facility at the West Treatment Plant. Twenty percent of the biosolids were delivered to Weyerhaeuser Company forestland, and 10 percent of the biosolids were delivered to GroCo Compost. The remaining 7 percent was distributed to State DNR forestland and to other research projects that are administered by Washington State University and the University of Washington.

Impacts and Mitigation Measures. Biosolids production will increase commensurate with wastewater treated as the population in the service area grows. Depending on the service strategy and options selected in the RWSP planning process, the truck trips will be distributed between the two existing treatment plants or three plants if one is sited in the north end. Transportation routes associated with service strategies requiring a third treatment plant are currently unknown.

As a result of the City of Seattle's Department of Construction and Land Use (DCLU) project level permit conditions for the upgrade of the West Treatment Plant, no more than 13 truck loads can be generated by the treatment plant even if it is built out to a maximum capacity of 159 mgd.

empty truck and one loaded truck. All of the projected loaded biosolids truck trips described in this chapter (10) meet the permit conditions (maximum of 13 loaded trucks per day).