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Development Document for Proposed Effluent Limitations Guidelines and Standards for the Landfills Point Source Category

DEVELOPMENT DOCUMENT
FOR
PROPOSED EFFLUENT LIMITATIONS
GUIDELINES AND STANDARDS
FOR THE
LANDFILLS
POINT SOURCE CATEGORY

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1.0 LEGAL AUTHORITY

1.1 Legal Authority

Effluent limitations guidelines and standards for the Landfills industry are being proposed under the authority of Sections 301, 304, 306, 307, 308, and 501 of the Clean Water Act, 33 U.S.C. 1311, 1314, 1316, 1317, 1318, and 1361.

1.2 Background

1.2.1 Clean Water Act (CWA)

The Federal Water Pollution Control Act Amendments of 1972 established a comprehensive program to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Section 101(a)). To implement the Act, EPA is to issue effluent limitations guidelines, pretreatment standards, and new source performance standards for industrial dischargers. These guidelines and standards are summarized briefly in the following sections.

1.2.1.1 Best Practicable Control Technology Currently Available (BPT) (Section 304(b)(1) of the CWA)

In the guidelines for an industry category, EPA defines BPT effluent limits for conventional, priority,[1] and non-conventional pollutants. In specifying BPT, EPA looks at a number of factors. EPA first considers the cost of achieving effluent reductions in relation to the effluent reduction benefits. The Agency also considers: the age of the equipment and facilities; the processes employed and any required process changes; engineering aspects of the control technologies; non-water quality

[1]In the initial stages of EPA CWA regulation, EPA efforts emphasized the achievement of BPT limitations for control of the "classical" pollutants (e.g., TSS, pH, BOD_5). However, nothing on the face of the statute explicitly restricted BPT limitation to such pollutants. Following passage of the Clean Water Act of 1977 with its requirement for points sources to achieve best available technology limitations to control discharges of toxic pollutants, EPA shifted its focus to address the listed priority pollutants under the guidelines program. BPT guidelines continue to include limitations to address all pollutants.

environmental impacts (including energy requirements); and such other factors as the Agency deems appropriate (CWA 304(b)(1)(B)). Traditionally, EPA establishes BPT effluent limitations based on the average of the best performances of facilities within the industry of various ages, sizes, processes or other common characteristic. Where, however, existing performance is uniformly inadequate, EPA may require higher levels of control than currently in place in an industrial category if the Agency determines that the technology can be practically applied.

1.2.1.2 Best Conventional Pollutant Control Technology (BCT) (Section 304(b)(4) of the CWA)

The 1977 amendments to the CWA required EPA to identify effluent reduction levels for conventional pollutants associated with BCT technology for discharges from existing industrial point sources. In addition to other factors specified in Section 304(b)(4)(B), the CWA requires that EPA establish BCT limitations after consideration of a two part "cost-reasonableness" test. EPA explained its methodology for the development of BCT limitations in July 1986 (51 FR 24974).

Section 304(a)(4) designates the following as conventional pollutants: biochemical oxygen demand (BOD_5), total suspended solids (TSS), fecal coliform, pH, and any additional pollutants defined by the Administrator as conventional. The Administrator designated oil and grease as an additional conventional pollutant on July 30, 1979 (44 FR 44501).

1.2.1.3 Best Available Technology Economically Achievable (BAT) (Section 304(b)(2) of the CWA)

In general, BAT effluent limitations guidelines represent the best economically achievable performance of plants in the industrial subcategory or category. The factors considered in assessing BAT include the cost of achieving BAT effluent reductions, the age of equipment and facilities involved, the process employed, potential process changes, and non-water quality environmental impacts, including energy requirements. The Agency retains considerable discretion in assigning the weight to be accorded these factors. Unlike BPT limitations, BAT limitations may be based on effluent reductions attainable through changes in a facility's processes and operations. As with BPT, where existing performance is uniformly inadequate, BAT may require a higher level of performance than is currently being achieved based on technology transferred from a different subcategory or category. BAT may be based upon process changes or internal controls, even when these technologies are not common industry practice.

1.2.1.4 New Source Performance Standards (NSPS) (Section 306 of the CWA)

NSPS reflect effluent reductions that are achievable based on the best available demonstrated control technology. New facilities have the opportunity to install the best and most efficient production processes and wastewater treatment technologies. As a result, NSPS should represent the most stringent controls attainable through the application of the best available control technology for all pollutants (i.e., conventional, nonconventional, and priority pollutants). In establishing NSPS, EPA is directed to take into consideration the cost of achieving the effluent reduction and any non-water quality environmental impacts and energy requirements.

1.2.1.5 Pretreatment Standards for Existing Sources (PSES) (Section 307(b) of the CWA)

PSES are designed to prevent the discharge of pollutants that pass through, interfere-with, or are otherwise incompatible with the operation of publicly-owned treatment works (POTWs). The CWA authorizes EPA to establish pretreatment standards for pollutants that pass through POTWs or interfere with treatment processes or sludge disposal methods at POTWs. Pretreatment standards are technology-based and analogous to BAT effluent limitations guidelines.

The General Pretreatment Regulations, which set forth the framework for the implementation of categorical pretreatment standards, are found at 40 CFR Part 403. Those regulations contain a definition of pass-through that addresses localized rather than national instances of pass-through and establish pretreatment standards that apply to all non-domestic dischargers (see 52 FR 1586, January 14, 1987).

1.2.1.6 Pretreatment Standards for New Sources (PSNS) (Section 307(b) of the CWA)

Like PSES, PSNS are designed to prevent the discharges of pollutants that pass through, interfere-with, or are otherwise incompatible with the operation of POTWs. PSNS are to be issued at the same time as NSPS. New indirect dischargers have the opportunity to incorporate into their plants the best available demonstrated technologies. The Agency considers the same factors in promulgating PSNS as it considers in promulgating NSPS.

1.2.2 Section 304(m) Requirements

Section 304(m) of the CWA, added by the Water Quality Act of 1987, requires EPA to establish schedules for (1) reviewing and revising existing effluent limitations guidelines and standards ("effluent guidelines") and (2) promulgating new effluent guidelines. On January 2, 1990, EPA published an Effluent Guidelines Plan (55 FR 80) that established schedules for developing new and revised effluent guidelines for several industry categories. One of the industries for which the Agency established a schedule was the Centralized Waste Treatment industry.

The Natural Resources Defense Council (NRDC) and Public Citizen, Inc. filed suit against the Agency, alleging violation of Section 304(m) and other statutory authorities requiring promulgation of effluent guidelines (NRDC et al. v. Reilly, Civ. No. 89-2980 (D.D.C.)). Under the terms of a consent decree dated January 31, 1992, which settled the litigation, EPA agreed, among other things, to propose effluent guidelines for the "Landfills and Industrial Waste Combusters" category[2] by December 1995 and take final action on these effluent guidelines by December 1997. On February 4, 1997, the court approved modifications to the Decree which revise the deadlines to November 1997 for proposal and November 1999 for final action. EPA provided notice of these modifications on February 26, 1997, at 62 FR 8726. Although the Consent Decree lists "Landfills and Industrial

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[2] In the 1990 304(m) plan and the 1992 Decree, the category name was "Hazardous Waste Treatment, Phase II", subsequently renamed as "Landfills and Industrial Waste Combusters."

Waste Combusters" as a single entry, EPA is publishing separate rulemaking proposals for Industrial Waste Combusters and for Landfills.

2.0 SUMMARY AND SCOPE

2.1 Introduction

The proposed regulations for the Landfills industry include effluent limitations guidelines and standards for the control of wastewater pollutants. This document presents the information and rationale supporting these proposed effluent limitations guidelines and standards. Section 2.2 presents the proposed subcategorization approach, Section 2.3 describes the scope of the proposed regulations, and Section 2.4 through 2.9 summarizes the proposed effluent limitations and standards.

2.2 Subcategorization

EPA is proposing to subcategorize the landfills category according to the landfill classifications established under the Resource Conservation and Recovery Act (RCRA). These subcategories are summarized below:

Subcategory I: Subtitle D Non-Hazardous Landfills

Subcategory I would apply to wastewater discharges from all landfills classified as RCRA Subtitle D non-hazardous landfills subject to either of the criteria established in 40 CFR Parts 257 (Criteria for Classification of Solid Waste Disposal Facilities and Practices) or 258 (Criteria for Municipal Solid Waste Landfills).

Subcategory II: Subtitle C Hazardous Landfills

Subcategory II would apply to wastewater discharges from a solid waste disposal facility subject to the criteria in 40 CFR 264 Subpart N - Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities and 40 CFR 265 Subpart N - Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.

2.3 Scope of Proposed Regulation

EPA is proposing effluent limitations guidelines and pretreatment standards for wastewater discharges associated only with the operation and maintenance of landfills regulated under Subtitles C and D of the Resource Conservation and Recovery Act. EPA's proposal would not apply to wastewater discharges associated with the operation and maintenance of land application or treatment units, surface impoundments, underground injection wells, waste piles, salt dome or bed formations, underground mines, caves or corrective action units. Additionally, this guideline would not apply to waste transfer stations, or any wastewater not directly attributed to the operation and maintenance of Subtitle C or Subtitle D landfill units. Consequently, wastewaters such as those generated in off-site washing of vehicles used in landfill operations are not within the scope of this guideline.

The wastewater flows which are covered by the rule include leachate, gas collection condensate, drained free liquids, laboratory-derived wastewater, contaminated storm water and contact washwater from truck exteriors and surface areas which have come in direct contact with solid waste at the landfill facility. Groundwater, however, which has been contaminated by a landfill and is collected, treated, and discharged is excluded from this guideline.

EPA is proposing to exclude landfills operated in conjunction with other industrial or commercial operations which only receive waste generated on site (captive facility) and/or receive waste from off-site facilities under the same corporate structure (intra-company facility), so long as the wastewater is commingled for treatment with other non-landfill process wastewaters. A landfill which accepts off-site waste from a company not under the same ownership as the landfill would not be considered a captive or intracompany facility and would be subject to the landfills category effluent guideline when promulgated.

2.4 Best Practicable Control Technology Currently Available (BPT)

EPA is proposing to establish BPT effluent limitations guidelines for conventional, priority, and non-conventional pollutants for both subcategories. For RCRA Subtitle D non-hazardous waste landfills, EPA proposes to establish effluent limitations standards based on equalization, biological treatment, and multimedia filtration. For RCRA Subtitle C hazardous waste landfills, EPA proposes to establish effluent limitations standards based on equalization, chemical precipitation, and biological treatment.

2.5 Best Conventional Pollutant Control Technology (BCT)

EPA is proposing to establish BCT effluent limitations guidelines equivalent to the BPT guidelines for the control of conventional pollutants for both subcategories.

2.6 Best Available Technology Economically Achievable (BAT)

EPA is proposing to establish BAT effluent limitations guidelines equivalent to the BPT guidelines for control of priority and non-conventional pollutants for both subcategories.

2.7 New Source Performance Standards (NSPS)

EPA is proposing to establish NSPS effluent limitations guidelines equivalent to the BPT, BCT, and BAT guidelines for the control of conventional, priority and non-conventional pollutants for both subcategories.

2.8 Pretreatment Standards for Existing Sources (PSES)

EPA is proposing to establish PSES standards for priority and non-conventional pollutants for Subtitle C hazardous landfills only. EPA is proposing to establish PSES standards based on equalization, chemical precipitation, and biological treatment. EPA is not proposing to establish PSES standards for Subtitle D non-hazardous landfills.

2.9 Pretreatment Standards for New Sources (PSNS)

EPA is proposing to establish PSNS effluent limitations guidelines equivalent to PSES guidelines for the control of priority and non-conventional pollutants for Subtitle C hazardous landfills. EPA is not proposing to establish PSNS for Subtitle D non-hazardous landfills.

Table 2-1: Proposed Concentration Limitations for Hazardous Landfill Subcategory, Direct Discharges

Pollutant or Pollutant Property	Maximum for 1 day (mg/l)	Monthly average shall not exceed (mg/l)
BOD_5	160	40
TSS	89	27
Ammonia	5.9	2.5
Arsenic	1.0	0.52
Chromium (Total)	0.86	0.40
Zinc	0.37	0.21
Alpha Terpineol	0.042	0.019
Aniline	0.024	0.015
Benzene	0.14	0.036
Benzoic Acid	0.12	0.073
Naphthalene	0.059	0.022
P-Cresol	0.024	0.015
Phenol	0.048	0.029
Pyridine	0.072	0.025
Toluene	0.080	0.026
pH	Shall be in the range 6.0 - 9.0 pH units.	

Table 2-2: Proposed Concentration Limitations for Hazardous Landfill Subcategory, Indirect Discharges

Pollutant or Pollutant Property	Maximum for 1 day (mg/l)	Monthly average shall not exceed (mg/l)
Ammonia	5.9	2.5
Alpha Terpineol	0.042	0.019
Aniline	0.024	0.015
Benzoic Acid	0.12	0.073
P-Cresol	0.024	0.015
Toluene	0.080	0.026

Table 2-3: Proposed Concentration Limitations for Non-Hazardous Landfill Subcategory, Direct Discharges

Pollutant or Pollutant Property	Maximum for 1 day (mg/l)	Monthly average shall not exceed (mg/l)
BOD_5	160	40
TSS	89	27
Ammonia	5.9	2.5
Zinc	0.20	0.11
Alpha Terpineol	0.059	0.029
Benzoic Acid	0.23	0.13
P-Cresol	0.046	0.026
Phenol	0.045	0.026
Toluene	0.080	0.026
pH	Shall be in the range 6.0 - 9.0 pH units.	

3.0 INDUSTRY DESCRIPTION

The Landfills industry consists of facilities that receive wastes either as commercial or municipal operations, or as on-site (captive) operations owned by waste generators, and discharge wastewater to surface waters and/or Publicly Owned Treatment Works (POTWs) as a result of these operations. The Resource Conservation and Recovery Act (RCRA) defines a landfill as "an area of land or an excavation in which wastes are placed for permanent disposal, and that is not a land application unit, surface impoundment, injection well, or waste pile" (40 CFR 257.2). RCRA classifies landfills as either Subtitle C hazardous or Subtitle D non-hazardous. Wastewaters generated and discharged by landfills can include leachate, gas collection condensate, contaminated groundwater, contaminated storm water, drained free liquids, truck/equipment washwater, laboratory-derived wastewater, and wastewaters recovered from pump wells.

Landfills are commonly classified by the types of wastes they accept and/or by their ownership status. Some of the terms used to describe a landfill include municipal, sanitary, chemical, industrial, RCRA, hazardous waste, Subtitle C, and Subtitle D. Although non-hazardous landfills do not knowingly accept hazardous wastes, these facilities may contain hazardous wastes due to disposal practices that occurred prior to 1980 and the enactment of RCRA and its associated regulations. The following section includes definitions of the various types of landfills, landfill operations, and the wastes processed in each:

Ownership Status

- ***Municipal:*** Municipally owned landfills are those that are owned by local governments. Municipally owned landfills may be designed to accept either Subtitle D or Subtitle C wastes (see "Regulatory Type").

- ***Commercial:*** Commercial landfills are privately owned facilities and can be designed to receive either municipal, hazardous, or non-hazardous industrial wastes. Typical non-hazardous industrial wastes include packaging and shipping materials, construction and demolition debris, ash, and sludge.

- ***Captive:*** Captive sites are landfill facilities operated in conjunction with other industrial or commercial operations which only receive waste generated on-site. Captive landfills are located on, or adjacent to, the facility they service and are common at major hazardous waste generators, such as chemical and petrochemical manufacturing plants.

- ***Intra-company:*** Landfill facilities operated in conjunction with other industrial or commercial operations which only receive waste from off-site facilities under the same corporate structure, ownership, or control. These landfills are similar to captive sites but are used to receive wastes from multiple locations of one company.

<u>Regulatory Type</u>

- ***Subtitle C:*** Subtitle C landfills are those disposal operations authorized by RCRA to accept hazardous wastes as defined in 40 CFR Part 261. Subtitle C hazardous landfills are subject to the criteria in 40 CFR Subpart N (Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities). More details on the regulatory requirements of Subtitle C are presented in Section 3.1

- ***Subtitle D:*** Subtitle D landfills are those disposal operations that are authorized by RCRA to receive municipal, commercial, or industrial wastes not defined as hazardous or which are excluded from regulation under Subtitle C, as defined in 40 CFR Parts 257 and 258. The wastes received at Subtitle D landfills include municipal refuse, ash, sludge, construction and demolition debris, and non-hazardous industrial waste. These facilities were not designed to receive hazardous wastes; however, prior to 1980 and the enactment of RCRA, older landfills may have received waste later classified as hazardous under RCRA. Any Subtitle D landfill accepting municipal refuse after October 9, 1993 is classified as a Municipal Waste Disposal Unit, and is regulated under 40 CFR 258. Any Subtitle D landfill not accepting municipal waste after October 9, 1993 continues to be regulated under 40 CFR 257. For the purposes of this document, Subtitle D landfills not accepting municipal refuse are referred to as "Subtitle D non-municipal" landfills.

The following discussions present a regulatory history of this industry and past EPA studies.

3.1 Regulatory History of the Landfills Industry

Depending on the type of wastes disposed of at a landfill, the landfill may be subject to regulation and permitting under either Subtitle C or Subtitle D of the Resource Conservation and Recovery Act (RCRA). Subtitle C facilities receive wastes that are identified or listed as hazardous wastes under EPA regulations. Subtitle D landfills can accept wastes that are not required to be sent to Subtitle C facilities. The following sections outline some of the key regulations that have been developed to control the environmental impacts of Subtitle C and Subtitle D landfills.

3.1.1 RCRA Subtitle C

Subtitle C of the RCRA of 1976 directed EPA to promulgate regulations to protect human health and the environment from the improper management of hazardous wastes. Based on this statutory mandate, the goal of the RCRA program was to provide comprehensive, "cradle-to-grave" management of hazardous waste. These regulations establish a system for tracking the disposal of hazardous wastes and special design requirements for landfills depending on whether a landfill accepted hazardous or non-hazardous waste. Key statutory provisions in RCRA Subtitle C include:

- Section 3001: Requires the promulgation of regulations identifying the characteristics of hazardous waste and listing particular hazardous wastes.
- Section 3002: Requires the promulgation of standards, such as manifesting, record keeping, etc., applicable to generators of hazardous waste.
- Section 3003: Requires the promulgation of standards, such as manifesting, record keeping, etc., applicable to transporters of hazardous waste.
- Section 3004: Requires the promulgation of performance standards applicable to the owners and operators of facilities for the treatment, storage, or disposal of hazardous waste.
- Section 3005: Requires the promulgation of regulations requiring each person owning or operating a treatment, storage, or disposal facility to obtain a permit.

These regulations establish a system for tracking the disposal of hazardous wastes and performance and design requirements for landfills accepting hazardous waste. Under RCRA, requirements are initially triggered by a determination that a waste is hazardous as defined in 40 CFR Part 261. Any party, including the original generator, that treats, stores, or disposes of a hazardous waste must notify EPA and obtain an EPA identification number. There are existing performance regulations governing the operation of hazardous waste landfills included in 40 CFR Parts 264 and 265. RCRA Subtitle C hazardous waste regulations apply to landfills that presently accept hazardous wastes or have accepted hazardous waste at any time after November 19, 1980.

3.1.1.1 Land Disposal Restrictions

The Hazardous and Solid Waste Amendments (HSWA) to the RCRA, enacted on November 8, 1984, largely prohibit the land disposal of untreated hazardous wastes. Once a hazardous waste is prohibited from land disposal, the statute provides only two options for legal land disposal: 1) meet the EPA-established treatment standard for the waste prior to land disposal, or 2) dispose of the waste in a land disposal unit that has been found to satisfy the statutory no migration test. A no migration unit is one from which there will be no migration of hazardous constituents for as long as the waste remains hazardous. (RCRA Sections 3004 (d),(e),(g)(5)).

Under Section 3004, the treatment standards that EPA develops may be expressed as either constituent concentration levels or as specific methods of treatment. Under RCRA Section 3004(m)(1), the criteria for these standards is that they must substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized. For purposes of the restrictions, the RCRA program defines land disposal to include, among other things, any placement of hazardous waste in a landfill. Land disposal restrictions are published in 40 CFR Part 268.

EPA has used hazardous waste treatability data as the basis for land disposal restrictions standards. First, EPA has identified Best Demonstrated Available Treatment Technology (BDAT) for each listed hazardous waste. BDAT is the treatment technology that EPA finds to be the most effective in treating a waste and that also is readily available to generators and treaters. In some cases, EPA has designated as BDAT for a particular waste stream a treatment technology shown to have successfully treated a similar but more difficult to treat waste stream. This ensured that the land disposal restrictions standards for a listed waste stream were achievable since they always reflected the actual treatability of the waste itself or of a more refractory waste.

As part of the Land Disposal Restrictions (LDRs), Universal Treatment Standards (UTS) were promulgated as part of the RCRA phase two final rule (July 27,1994). The UTS are a series of concentrations for wastewaters and non-wastewaters that provide a single treatment standard for each constituent. Previously, the LDR regulated constituents according to the identity of the original waste; thus several numerical treatment standards existed for each constituent. The UTS simplified the standards by having only one treatment standard for each constituent in any waste residue. The LDR and the UTS restricted the concentrations of wastes that could be disposed of in landfills, thus improving the environmental quality of the leachate from landfills.

The LDR treatment standards established under RCRA may differ from the Clean Water Act effluent guidelines both in their format and in the numerical values set for each constituent. The differences result from the use of different legal criteria for developing the limits and resulting differences in the technical and economic criteria and data sets used for establishing the respective limits.

The differences in format of the LDR and effluent guidelines are that the LDR establish a single daily limit for each pollutant parameter whereas the effluent guidelines establish monthly and daily limits. Additionally, the effluent guidelines provide for several types of discharge, including new and existing sources, and indirect and direct discharge.

The differences in numerical limits established under the Clean Water Act may differ not only from LDR and UTS but also from point-source category to point-source category (e.g., Electroplating, 40 CFR 413; and Metal Finishing, 40 CFR 433). The effluent guidelines limitations and standards are industry-specific, subcategory-specific, and technology-based. The numerical limits are typically based on different data sets that reflect the performance of specific wastewater management and treatment practices. Differences in the limits reflect differences in the statutory factors that the Administrator is required to consider in developing technically and economically achievable limitations and standards: manufacturing products and processes (which for landfills involves types of waste disposed), raw materials, wastewater characteristics, treatability, facility size, geographic location, age of facility and equipment, non-water quality environmental impacts, and energy requirements. A consequence of these differing approaches is that similar or identical waste streams are regulated at different levels dependent on the receiving body of the wastewater (e.g. a POTW, a surface water, or a land disposal facility).

3.1.1.2 Minimum Technology Requirements

To further protect human health and the environment from the adverse affects of hazardous waste disposed of in landfills, the 1984 HSWA to RCRA established minimum technology requirements for landfills receiving hazardous waste. These provisions required the installation of double liners and leachate collection systems at new landfills, at replacements of existing units, and at lateral expansions of existing units. The Amendments also required all hazardous waste landfills to install groundwater monitoring wells by November 8, 1987. Performance regulations governing the operation of hazardous waste landfills are included 40 CFR Parts 264 and 265.

3.1.2 RCRA Subtitle D

Landfills managing non-hazardous wastes are currently regulated under the RCRA Subtitle D program. These landfills include municipal, private intra-company, private captive, and commercial facilities used for the management of municipal refuse, incinerator ash, sewage sludge, and a range of industrial wastes.

3.1.2.1 40 CFR Part 257, Subpart A Criteria

EPA promulgated these criteria on September 13, 1979 (44 FR 53460) under the authority of RCRA Sections 1008(a) and 4004(a) and Sections 405(d) and (e) of the Clean Water Act. These criteria apply to all solid waste disposal facilities and practices. However, certain facilities and practices are not covered by the criteria, such as agricultural wastes returned to the soil as fertilizers or soil conditioners; overburden resulting from mining operations; land application of domestic sewage or treated domestic sewage; hazardous waste disposal facilities which are subject to regulations under RCRA Subtitle C (discussed above); municipal solid waste landfills that are subject to the revised criteria in 40 CFR Part 258 (discussed below); and use or disposal of sewage sludge on the land when the sewage sludge is used or disposed of in accordance with 40 CFR Part 503 (See 40 CFR Part 257.1(c)(1) - (11)).

The criteria include general environmental performance standards addressing eight major areas: flood plains, protection of endangered species, protection of surface water, protection of groundwater, limitations on the land application of solid waste, periodic application of cover to prevent disease vectors, air quality standards (prohibition against open burning), and safety practices ensuring protection from explosive gases, fires, and bird hazards to airports. Facilities that fail to comply with any of these criteria are considered open dumps, which are prohibited by RCRA Section 4005. Those facilities that meet the criteria are considered sanitary landfills under RCRA Section 4004(a).

3.1.2.2 40 CFR Part 258 Revised Criteria for Municipal Solid Waste Landfills

On October 9, 1991, EPA promulgated revised criteria for municipal solid waste landfills in accordance with the authority provided in RCRA Sections 1008(a)(3), 4004(a), 4010 (c) and CWA Sections 405(d) and (e) (see 56 FR 50978). Under the terms of these revised criteria, municipal solid waste landfills are defined to mean a discrete area of land or an excavation that receives household waste, and is not a land application unit, surface impoundment, injection well, or waste pile, as those terms are defined in 40 CFR 257.2 and 258.2. In addition to household waste, a municipal solid waste landfill unit also may receive other types of RCRA Subtitle D wastes, such as commercial solid waste, non-hazardous sludge, and industrial solid waste. Such a landfill may be publicly or privately owned. A municipal solid waste landfill unit may be a new unit, existing municipal solid waste landfill unit or a lateral expansion.

The municipal solid waste landfill revised criteria include location standards (Subpart B), operating criteria (Subpart C), design criteria (Subpart D), groundwater monitoring and corrective action (Subpart E), closure and post-closure care criteria (Subpart F), and financial assurance requirements (Subpart G). The design criteria provide that new municipal solid waste landfill units and lateral expansions of existing units (as defined in Section 258.2) must be constructed in accordance with either: (1) a design approved by a Director of a State whose municipal solid waste landfill permit program has been approved by EPA and which satisfies a performance standard to ensure that unacceptable levels of certain chemicals do not migrate beyond a specified distance from the landfill (Sections 258.40(a)(1), (c), (d), Table 1); or (2) a composite liner and a leachate collection system (Sections 258.40(a)(2), (b)). The groundwater monitoring criteria generally require owners or operators of municipal solid waste landfills to monitor groundwater for contaminants and generally implement a corrective action remedy when monitoring indicates that a groundwater protection standard has been exceeded. However, certain small municipal solid waste landfills located in arid or remote locations are exempt from both design and groundwater monitoring requirements. The closure standards require that a final cover be installed to minimize infiltration and erosion. The post-closure provisions generally require, among other things, that groundwater monitoring continue and that the leachate collection system be maintained and operated for 30 years after the municipal solid waste landfill is closed. The Director of an approved State may increase or decrease the length of the post-closure period.

Again, as is the case with solid waste disposal facilities that fail to meet the open dumping criteria in 40 CFR Part 257, Subpart A, municipal solid waste landfills that fail to satisfy the revised criteria in Part 258 constitute open dumps and are therefore prohibited by RCRA Section 4005 (40 CFR 258.1(h)). All solid waste disposal facilities (i.e., municipal solid waste landfills) that are subject to the requirements in the Part 258 revised criteria and that collect and discharge landfill-generated waste waters are included in this category.

3.1.2.3 40 CFR Part 257, Subpart B Conditionally Exempt Small Quantity Generator Revised Criteria

A conditionally exempt small quantity generator is generally defined as one who generates no more than 100 kilograms of hazardous waste per month in a calendar year (40 CFR 261.5(a)). Such conditionally exempt small quantity generators (with certain exceptions) are not subject to RCRA Subtitle C requirements. However, on July 1, 1996, EPA: (1) amended Part 257 to establish criteria that must be met by non-municipal, non-hazardous solid waste disposal units that receive conditionally exempt small quantity generator waste; and (2) established separate management and disposal standards (in 40 CFR 261.5(f)(3) and (g)(3)) for those who generate conditionally exempt small quantity generator waste (see 61 FR 342169). The conditionally exempt small quantity generator revised criteria for such disposal units include location standards, groundwater monitoring, and corrective action requirements.

3.1.3 Current Wastewater Regulations

Prior to this regulatory initiative, EPA has not promulgated national effluent guidelines for the discharge of wastewaters from the landfills industry. In the absence of these guidelines, permit writers have had to rely on a combination of their own best professional judgement (BPJ), water quality standards, and technology transfer from other industrial guidelines in setting permit limitations for direct discharges from landfills to surface waters. In addition, municipalities also have had to rely on their own best professional judgement, pass-through analyses, and other local factors in establishing pretreatment standards for the discharge of wastewaters to their municipal sewage systems and POTWs.

In 1989, EPA completed a preliminary study of the Landfills industry. In a report entitled: "Preliminary Data Summary for the Hazardous Waste Treatment Industry," EPA concluded that wastewater discharges from landfills can be a significant source of toxic pollutants being discharged to surface waters and POTWs. In a consent decree between NRDC and EPA, dated January 31, 1992, it was agreed that EPA would propose effluent limitations guidelines for the landfills point source category.

3.2 Industry Profile

The growth of the Landfills industry is a direct result of RCRA and subsequent EPA and State regulations that establish the conditions under which solid waste may be disposed. The adoption of increased control measures required by RCRA has had a number of ancillary effects.

The RCRA requirements have affected the Landfills industry in different ways. On the one hand, it has forced many landfills to close because they lacked adequate on-site controls to protect against migration of hazardous constituents in the landfill, and it was not economical to upgrade the landfill facility. As a result, a large number of landfills, especially facilities serving small populations, have closed rather than incur the significant expense of upgrading.

Conversely, large landfill operations have taken advantage of economies of scale to serve wide geographic areas and accept an increasing portion of the nation's solid waste. For example, responses to the EPA's Waste Treatment Industry Survey indicated that 75 percent of the nation's municipal solid waste was deposited in large landfills representing only 25 percent of the landfill population.

EPA has identified several trends in the waste disposal industry that may increase the quantity of leachate produced by landfills. More stringent RCRA regulation and the restrictions on the management of wastes have increased the amount of waste disposed at landfills with leachate collection systems as well as the number of facilities choosing to send their solid wastes off-site to commercial facilities in lieu of pursuing on-site management options. As a result of the increased disposal of solid wastes in landfills, the amount of leachate generated, collected, and discharged will increase, thus potentially putting at risk the integrity of the nation's waters.

3.2.1 Industry Population

The initial landfill population studied as part of EPA's survey of the industry was defined by a mailing list database developed by EPA from various sources such as State environmental and solid waste departments, the National Survey of Hazardous Waste Treatment, Storage, Disposal, and Recycling Facilities respondent list, Environmental Ltd.'s 1991 Directory of Industrial and Hazardous Waste Management Firms, and other sources discussed in Chapter 4. A total of 10,477 landfills (plus one pre-test facility) were identified as the initial landfill population in the United States in 1992, representing 9,882 Subtitle D non-hazardous landfills and 595 Subtitle C hazardous landfills, presented in Table 3-1 by state. A sampling of this initial population was solicited for technical information via screener surveys, and a sampling of the screener survey respondents were sent Detailed Questionnaires. A total of 252 landfill facilities received Detailed Questionnaires and 220 facilities responded with sufficient technical data to be included in the questionnaire database. A detailed discussion of screener survey and Detailed Questionnaire strata is presented in Chapter 4, Section 4.3.

Because Detailed Questionnaires were only sent to a sampling of the initial industry population, the information provided by questionnaire respondents needed to be scaled up to represent the entire Landfills industry. National estimates were calculated by matching up the screener survey stratum with the Detailed Questionnaire stratum. A weighting factor was calculated for each questionnaire respondent and any data provided by the respondent was scaled up by this factor. Therefore, all data presented throughout this chapter as national estimates are based on a combination of the Detailed Questionnaire respondents' data scaled up by their individual weighting factors. Figure 3-1 presents the logic used for the development of the national estimates. The methodology for calculating national estimates is presented in the Statistical Development Document for the Landfills industry.

3.2.2 Number and Location of Facilities

Many of the landfill facilities presented in Table 3-1 do not generate and/or collect wastewaters within the scope of this regulation. Landfill generated wastewaters evaluated for regulation in this guideline include leachate, gas collection condensate, truck/equipment washwater, drained free liquids, laboratory-derived wastewater, floor washings, recovering pumping wells, and contaminated storm water. Contaminated groundwater and non-contaminated storm water are not proposed to be subject to the proposed regulation.

National estimates of the Landfills industry indicate that only 1,662 of the total population of landfill facilities collect in-scope wastewaters. EPA's survey of the industry was limited to those facilities that collect in-scope landfill generated wastewaters, or about 16 percent of the total number of landfills located in the U.S. Table 3-2 presents these Subtitle D and Subtitle C landfills that collect in-scope wastewater by ownership type. The national estimates for the industry indicate that approximately 43 percent of these landfills are municipally-owned facilities, 41 percent are commercially-owned, and 13 percent are non-commercial captives. Table 3-2 also shows that the majority of non-hazardous landfills are municipally- or commercially-owned facilities whereas hazardous landfills are primarily commercially-owned and captive facilities.

3.2.2.1 Captive Landfill Facilities

Based on EPA's survey of the Landfills industry for this guideline, over 200 captive and intra-company facilities with on-site landfills were identified. EPA has decided not to include within the scope of the guideline landfill facilities operated in conjunction with other industrial or commercial operations which only receive waste from off-site facilities under the same corporate structure (intra-company facility) and/or receive waste generated on-site (captive facility) so long as the wastewater is commingled for treatment with other process wastewaters.

A majority of these landfills were found at industrial facilities that are or will be subject to three effluent guidelines: Pulp and Paper (40 CFR Part 430), Centralized Waste Treatment (proposed 40 CFR Part 437, 60 FR 5464 January 27, 1995), or Organic Chemicals, Plastics and Synthetic Fibers (40 CFR Part 414). In addition, EPA identified approximately 30 landfills subject to one or more of the following categories: Nonferrous Metals Manufacturing (40 CFR Part 421), Petroleum Refining (40 CFR 419), Timber Products Processing (40 CFR Part 429), Iron and Steel Manufacturing (40

CFR Part 420), Transportation Equipment Cleaning (new category to be proposed in 1998), and Pesticide Manufacturing (40 CFR Part 455).

Industry supplied data estimates that there are over 118 Pulp and Paper facilities with on-site landfills and that over 90 percent commingle landfill leachate with process wastewater for treatment on-site. The wastewater flow originating from landfills typically represents less than one percent of the total flow through the facilities' wastewater treatment plant and in no case exceeds three percent of the treated flow. Approximately six percent of pulp and paper mills send landfill generated wastewater to a POTW along with process wastewater.

Based on responses to the 1992 Waste Treatment Industry: Landfills Questionnaire, EPA estimates that there are more than 30 facilities subject to the Organic Chemicals, Plastics and Synthetic Fibers (OCPSF) guideline with on-site landfills. At OCPSF facilities with on-site landfills, landfill leachate typically represents less than one percent of the industrial flow at the facility, in no case exceeds six percent of the flow, and is typically commingled with process wastewater for treatment.

3.2.3 General Information on Landfill Facilities

Landfill facilities located throughout the U.S. are estimated to cover approximately 726,000 acres of land area, 20 percent of which is used as actual disposal area (landfill), 3 percent is used for wastewater treatment operations, and 63 percent is undeveloped land. Table 3-3 presents national estimates of the total landfill area covered by non-hazardous and hazardous landfill facilities. National estimates indicate that hazardous facilities use less of their total facility area for waste disposal, only about 5 percent, compared to non-hazardous facilities which use approximately 30 percent of their total facility area for waste disposal. Table 3-4 presents facility land area ranges for non-hazardous and hazardous facilities as well as totals for the industry. These frequency distributions show that a typical facility is 100 to 1,000 acres in size, and the landfill covers between 10 and 100 acres of that area. The majority of non-hazardous and hazardous landfill facilities have from 10 acres to 1,000 acres of undeveloped land available; larger facilities may have as much as 1,000 to 10,000 acres of undeveloped land.

Landfills are made up of individual cells which may be dedicated to one type of waste or may accept many different types of waste. When a landfill cell reaches capacity volume, it is closed and is referred to as an "inactive" cell. Landfill cells that are not at capacity and continue to accept waste are considered to be "active" cells. Table 3-5 presents national estimates of the number of landfill cells, both active and inactive, at non-hazardous and hazardous landfills. National estimates of landfill facilities in the U.S. indicate that the average number of cells in a landfill is approximately six, with facilities averaging anywhere from 2.75 active cells to six inactive cells. For hazardous facilities, most landfills average 7.6 cells, with 4.2 active cells and 8.2 inactive cells. For non-hazardous facilities, landfills average 5.7 cells with 2.5 active cells and 5.4 inactive cells. The number of survey respondents was lower for "active" cells compared to "inactive" cells because these facilities reflect the number of landfills in the U.S. that are presently open or active. There are fewer active landfills in the U.S. than inactive, or closed landfills.

The number and type of customers served helps to define the size of a landfill. Table 3-6 presents the national estimates of the household and non-household population served by landfills that collect in-scope landfill wastewaters. The total population served by the Landfills industry is 46.3 million household and 5.2 million non-household customers. Non-hazardous landfills serve 99 percent of these customers. Hazardous landfills account for only 307,000 household customers and 170,000 non-household customers. Table 3-7 presents the frequency distributions of the number of household and non-household customers for the non-hazardous and hazardous subcategories as well as for both subcategories combined. Most non-hazardous facilities serve between 100 and 1,000 non-household customers and 10,000 to 100,000 household customers. Hazardous facilities serve all ranges of non-household customers, from zero to 10,000, but serve very few household customers.

3.2.4 Waste Receipts and Types

Wastes received by landfills in the United States vary from municipal solid waste to highly toxic materials. Table 3-8 presents the national estimates of the types of waste received at landfills and the percentage each waste represents of the total waste received during the following three periods: pre-1980; 1980-1985; and 1986-1992. The primary waste types landfilled during the pre-1980 time period were municipal solid waste and industrial wastes, making up 61 percent of the waste, and commercial solid waste and construction and demolition debris making up 17 percent of the waste. Similar types of waste were landfilled after 1980; however, the percentage of municipal solid waste and industrial waste decreased, and the amount of commercial solid waste, incinerator residues, PCB/TSCA wastes, and asbestos-containing wastes increased. The landfilling of "other" waste types which include contaminated soils, auto shredder scrap, and tires, also increased after 1980.

Table 3-9 presents the national estimates of wastes received by the Landfills industry in 1992 by regulatory classification. These data indicate that landfills contained approximately 6.1 billion tons of waste in 1992, and project a future capacity of 8.3 billion tons. However, the estimated future capacity of Subtitle D landfills is much larger than the future capacity of Subtitle C landfills. On average, Subtitle D landfills represent almost 75 percent of the future capacity of U.S. landfills.

Table 3-10 presents the national estimates of the annual tonnage of waste accepted by landfills from 1988 through 1992. In 1988, the annual tonnage of waste accepted by Subtitle C and Subtitle D landfills was 221 million tons and by 1992, the amount of waste accepted annually increased by 94 million tons. The annual tonnage of waste accepted by the industry increased 17 percent from 1989 to 1990, and 12 percent from 1990 to 1991. However, Subtitle C landfills experienced the greatest increase and in annual waste accepted from 1989 to 1991; in 1990 the amount of waste increased 23 percent from 1989, and in 1991 the amount of waste increased 43 percent from 1990. Over the three year period,from 1989 to 1991, the annual tonnage of waste landfilled in Subtitle C landfills increased 56 percent. Conversely, the annual tonnage of waste accepted by Subtitle D landfills increased by only 4 percent from 1990 to 1991 and 1991 to 1992, down from a 15 percent increase in 1990. This increase in annual waste deposited in Subtitle C landfills may reflect the more strict enforcement of RCRA regulations regarding what types of waste can be deposited in a Subtitle D landfill (Subtitle C hazardous waste is now restricted from Subtitle D landfills and is disposed in Subtitle C landfills).

3.2.5 Sources of Wastewater

As noted earlier, wastewater is generated from a number of landfill operations. In general, the types of wastewater generated by activities associated with landfills and collected for treatment, discharge, or recycled back to the landfill are leachate, landfill gas condensate, truck/equipment washwater, drained free liquids, laboratory-derived wastewater, floor washings, recovering pumping wells, contaminated groundwater, and storm water. Table 3-11 presents the national estimates of the number of landfills that generate each type of wastewater and the minimum, maximum, and mean flows. Each of these wastewater sources are discussed below.

3.2.5.1 Landfill Leachate

Landfill leachate is a liquid that has passed through or emerged from solid waste and contains soluble, suspended, or miscible materials removed from such waste (40 CFR 258.2). Leachate typically is collected from a liner system above which waste is placed for disposal. Leachate also may be collected through the use of slurry walls, trenches or other containment systems. The leachate generated varies from site-to-site, based on a number of characteristics which include the types of waste accepted, operating practices including shedding, daily cover and capping, the depth of fill, compaction of wastes, and landfill age. Based on EPA's survey of the industry, a total of 1,989 landfill facilities generate wastewater at flows ranging from one gallon per day to 533,000 gallons per day, with a daily mean of approximately 13,600 gallons. Landfill leachate accounts for over 95 percent of in-scope wastewaters in the Landfills industry.

3.2.5.2 Landfill Gas Condensate

Landfill gas condensate is a liquid that has condensed in the landfill gas collection system during the extraction of gas from within the landfill. Gases such as methane and carbon dioxide are generated due to microbial activity within the landfill and must be removed to avoid hazardous conditions. In the gas collection systems, gases containing high concentrations of water vapor condense in traps staged throughout the gas collection network. The gas collection condensate contains volatile compounds and typically accounts for a small portion of flow from a landfill. The national estimates presented on Table 3-11 report a total of 158 landfill facilities that generate landfill gas condensate at daily flows ranging from 3 gallons to 11,700 gallons. The mean flow of landfill gas condensate for the Landfills industry is approximately 510 gallons per day.

3.2.5.3 Truck and Equipment Washwater

Truck and equipment washwater is generated during either truck or equipment washes at landfills. During routine maintenance or repair operations, trucks and/or equipment used within the landfill (e.g., loaders, compactors, or dump trucks) are washed, and the resultant washwaters are collected for treatment. In addition, it is common practice in hazardous landfills to wash the wheels, body, and undercarriage of trucks used to deliver the waste to the open landfill face upon leaving the landfill. On-site wastewater treatment equipment and storage tanks also are periodically cleaned with their washwaters collected. It is estimated that 416 landfill facilities generate truck and equipment washwater at a mean flow of 786 gallons per day and at daily flows ranging from 5 gallons per day to 15,000 gallons per day.

Floor washings are also generated during routine cleaning and maintenance of landfill facilities. National estimates presented on Table 3-11 indicate there are 70 landfill facilities that generate and collect floor washings at flows ranging from 10 gallons per day to 5,450 gallons per day. The mean flow of floor washings for the Landfills industry is approximately 1,760 gallons per day.

3.2.5.4 Drained Free Liquids

Drained free liquids are aqueous wastes drained from waste containers (e.g., drums, trucks, etc.) or wastewater resulting from waste stabilization prior to landfilling. Landfills that accept containerized waste may generate this type of wastewater. Wastewaters generated from these waste processing activities are collected and usually combined with other landfill generated wastewaters for treatment. National estimates presented on Table 3-11 identify 33 landfill facilities that generate drained free liquids at a mean daily flow of 12,400 gallons. Daily flows range from a minimum of one gallon per day to a maximum of 82,000 gallons per day.

3.2.5.5 Laboratory-Derived Wastewater

Laboratory-derived wastewater is generated from on-site laboratories that characterize incoming waste streams and monitor on-site treatment performance. This source of wastewater is minimal and is usually combined with leachate and other wastewaters prior to treatment at the wastewater treatment plant.

3.2.5.6 Recovering Pumping Wells

In addition to the contaminated groundwater generated during groundwater pumping operations, there are various ancillary operations that also generate a wastewater stream. These operations include construction and development, well maintenance, and well sampling (i.e. purge water). These wastewaters will have very similar characteristics to the contaminated groundwater. EPA's survey of the Landfills industry identified 50 landfill facilities that generate wastewater from recovering pumping wells. Daily flows range from a minimum of 0.3 gallons to a maximum 80,167 gallons and a mean daily flow of 16,900 gallons.

3.2.5.7 Contaminated Groundwater

Contaminated groundwater is water below the land surface in the zone of saturation that has been contaminated by landfill leachate. Contamination of groundwater may occur at landfills without liners or at facilities that have released contaminants from a liner system into the surrounding groundwater and is collected and treated by landfills. Groundwater also can infiltrate the landfill or the leachate collection system if the water table is high enough to penetrate the landfill area. EPA identified approximately 163 landfill facilities that generate contaminated groundwater. Daily flows ranged from 6 gallons per day to 987,000 gallons per day, with a mean daily flow of approximately 48,000 gallons. Contaminated groundwater has been excluded from regulation under this guideline as discussed in Chapter 2 of this document.

3.2.5.8 Storm Water

There are two types of storm water, contaminated and non-contaminated. Contaminated storm water is runoff that comes in direct contact with the solid waste, waste handling and treatment areas, or wastewater flows that are covered under this rule. Non-contaminated (non-contact) storm water does not come in direct contact with solid waste, waste handling and treatment areas, or wastewater flows which are covered under this rule. National estimates indicate that there are 1,135 landfill facilities that generate storm water at flows ranging from 10 gallons per day to 2 million gallons per day, with a mean daily flow of approximately 66,200 gallons. Storm water that does not come into contact with the wastes would not be subject to the proposed limitations and standards.

3.2.6 Leachate Collection Systems

All facilities included in EPA's survey of the Landfills industry generate and collect landfill leachate. To prevent waste material, products of waste decomposition, and free moisture from traveling beyond the limits of the disposal site, landfill facilities utilize some type of leachate collection system. The purpose of the leachate collection system is to collect leachate for treatment or alternate disposal and to reduce the depths of leachate buildup or level of saturation over the liner.

The leachate collection system usually contains several individual components. Two main leachate collection systems may be necessary: an underdrain system and a peripheral system. The underdrain system is constructed prior to landfilling and consists of a drainage system that removes the leachate from the base of the fill. The peripheral system can be installed after landfilling has occurred and, as such, is commonly used as a remedial method. The underdrain system includes a drainage layer of high permeability granular material, drainage tiles to collect the diverted flow laterally toward them, and a low permeability liner underlying the system to retard the leachate that percolates vertically through the unsaturated zone of refuse. Where the leachate meets the low permeability layer, saturated depths of leachate develop and leachate flow is governed by hydraulic gradients within the drainage layer (see reference 8).

There are several different types of leachate collection systems employed by the Landfills industry to collect the wastewaters generated by landfill operations. Table 3-12 presents the different types of leachate collections systems and the national estimates of the number of facilities which employ each system. A simple gravity flow drain field is the most basic and commonly used type of collection system employed by 50 percent of the industry. Compound leachate collection systems, which are comprised of a liner system and collection pipes, were used by 20 percent of the industry and french drains, which are gravel channels used to facilitate leachate drainage, were used by 15 percent of landfill facilities in the U.S. Other types of leachate collection systems utilized by 10 percent of the Landfills industry include collection sumps and risers, combined gas/leachate extraction wells, perforated toe drains to pump stations, and gravity flow in pipes to a holding pond, basin, or pump station to storage tanks.

3.2.7 Pretreatment Methods

Several types of waste accepted by landfills for disposal may require some type of pretreatment Wastes that may require pretreatment include free liquids, containerized waste, and bulk wastes. Free liquids may be drained or removed, or stabilized. Containerized waste and bulk wastes may be shredded, stabilized, or solidified. Table 3-13 presents the types of pretreatment methods currently in use by the Landfills industry and national estimates of the number of facilities that pretreat these wastes.

Approximately 75 percent of non-hazardous landfill facilities do not accept free liquids, and of those that do, 20 percent do not pretreat the liquids before treatment at an on-site wastewater treatment facility or treatment off-site. In comparison, approximately 65 percent of hazardous landfill facilities accept free liquids and pretreat by stabilizing, draining or removing the liquid. Containerized waste is accepted by only 40 percent of non-hazardous landfill facilities, but is accepted by almost 75 percent of hazardous landfill facilities. The most common type of pretreatment for containerized waste is solidification followed by stabilization. Bulk wastes are accepted by most landfills, although many facilities do not pretreat this type of waste. Bulk wastes are usually treated by stabilization or solidification and stabilization; however, other types of pretreatment include compaction, chemical treatment, flocculation, macro/microencapsulation, and recycling.

3.2.8 Baseline Treatment

Many landfills in the United States currently have wastewater treatment systems in place. The most common treatment system used by landfills is biological treatment. However, chemical precipitation and combinations of biological treatment, chemical precipitation, equalization, and filtration also are used widely. Table 3-14, as well as Table 8-1, presents the types of treatment and the national estimates of the number of facilities that employ each type of wastewater treatment. As expected, indirect and zero dischargers often do not employ on-site treatment because they either ship their wastewaters off-site or use alternate disposal methods such as deep well injection, incineration, evaporation, land application, or recirculation. A detailed discussion of treatment technology and performance is presented in Chapter 8.

EPA's survey of the Landfills industry solicited wastewater treatment facility operating information from non-hazardous and hazardous landfills. Table 3-15 presents the national estimates of the number of landfill facilities that operate wastewater treatment systems between 1 and 24 hours per day. Direct and zero or alternative discharge facilities tend to operate treatment systems continuously, whereas many indirect discharge facilities operate less than 24 hours per day. Table 3-16 presents the average daily hours of operation of a typical on-site wastewater treatment facility. Table 3-17 presents the national estimates of the number of landfill facilities that operate wastewater treatment systems between 1 and 7 days per week. Again, direct and zero or alternative discharge facilities commonly operate their treatment systems continuously, whereas indirect dischargers do not. Table 3-18 presents the average number of days per week a typical wastewater treatment facility is in operation.

3.2.9 Discharge Types

Landfill facilities surveyed by the EPA are often grouped by discharge types. Direct discharge facilities are those that discharge their wastewaters directly to a receiving stream or body of water. Indirect discharging facilities discharge their wastewater indirectly to a POTW. Zero or alternative discharge facilities use treatment and disposal practices that result in no discharge of wastewater to surface waters. Zero or alternative disposal options for landfill generated wastewater include off-site treatment at another landfill wastewater treatment system or a Centralized Waste Treatment facility, deep well injection, incineration, evaporation, land application, solidification, and recirculation.

Table 3-19 presents the national estimates of the number of landfill facilities grouped by discharge type. These estimates show that the majority of non-hazardous facilities included in the survey were indirect dischargers, whereas the majority of hazardous facilities were mainly direct and zero dischargers.

Table 3-1: Number of Landfills per U.S. State

State	Subtitle D Landfills	Subtitle C Landfills	Total Landfills
Alabama	238	38	276
Alaska	201	1	202
Arizona	90	2	92
Arkansas	134	3	137
California	630	16	646
Colorado	216	12	228
Connecticut	125	22	147
Delaware	8	14	22
Florida	91	9	100
Georgia	277	17	294
Hawaii	15	1	16
Idaho	112	6	118
Illinois	182	14	196
Indiana	101	29	130
Iowa	118	13	131
Kansas	118	8	126
Kentucky	121	33	154
Louisiana	73	17	90
Maine	291	2	293
Maryland	50	5	55
Massachusetts	722	1	723
Michigan	762	9	771
Minnesota	257	4	261
Mississippi	97	3	100
Missouri	128	7	135
Montana	257	1	258
Nebraska	41	8	49
Nevada	127	3	130
New Hampshire	58	0	58
New Jersey	467	8	475
New Mexico	121	7	128
New York	565	10	575
North Carolina	244	39	283
North Dakota	85	1	86
Ohio	119	24	143
Oklahoma	189	7	196
Oregon	231	10	241
Pennsylvania	41	22	63
Rhode Island	12	0	12
South Carolina	127	9	136
South Dakota	193	0	193
Tennessee	112	9	121
Texas	601	70	671
Utah	92	7	99
Vermont	73	0	73
Virginia	440	8	448
Washington	72	9	81
West Virginia	57	5	62
Wisconsin	183	3	186
Wyoming	218	45	263
Puerto Rico	0	3	3
Guam	0	1	1
Total	9,882	595	10,477

Table 3-2: Ownership Status of Landfill Facilities

Ownership Status	Number of Facilities		
	Subtitle D Non-Hazardous Subcategory	Subtitle C Hazardous Subcategory	Industry Total
Commercial	506	171	677
Non-Commercial (intra-company)	5	48	53
Non-Commercial (captive)	121	94	215
Municipal	708	2	710
Federal Government	4	2	6
Government (other than Federal or Municipal)	0	0	0
Indian Tribal Interest	0	0	0
Other	1	0	1
Total	1,345	317	1,662

Table 3-3: Total Landfill Facility Area

Facility Land Type	Landfill Facility Area (acres)		
	Subtitle D Non-Hazardous Subcategory	Subtitle C Hazardous Subcategory	Industry Total
Total Facility Area	416,733	309,194	725,927
Wastewater Treatment Area	9,424	10,147	19,571
Waste Disposal Area (landfill)	119,700	16,552	136,323
Undeveloped Land	254,610	207,085	459,811

Table 3-4: Landfill Facility Land Area Ranges

Subcategory	Land Area Range (acres)	Number of Landfill Facilities			
		Total Facility Area	Wastewater Treatment Area	Waste Disposal Area (landfill)	Undeveloped Land
All Facilities	0	0	747	28	110
	>0-1	0	320	16	2
	>1-10	9	437	126	69
	>10-100	490	136	1,128	561
	>100-1,000	1,044	22	362	745
	>1,000-10,000	119	0	0	85
	Total	1,662	1,662	1,660	1,662
Subtitle C Hazardous	0	0	38	5	49
	>0-1	0	128	14	0
	>1-10	2	70	47	2
	>10-100	95	65	199	99
	>100-1,000	136	15	52	106
	>1,000-10,000	84	0	0	60
	Total	317	316	317	316
Subtitle D Non-Hazardous	0	0	708	23	61
	>0-1	0	191	2	2
	>1-10	7	366	79	67
	>10-100	395	72	930	551
	>100-1,000	909	7	310	638
	>1,000-10,000	34	0	0	25
	Total	1,345	1,344	1,344	1,344

Table 3-5: Number of Landfill Cells

Subcategory	Type of Landfill Cell	Number of Cells	
		Estimated Mean	Estimated Total
All Facilities	Total cells	6.12	13,299
	Active cells	2.75	4,608
	Inactive cells	6.05	8,690
Subtitle C Hazardous	Total cells	7.64	3,776
	Active cells	4.23	1,112
	Inactive cells	8.24	2,663
Subtitle D Non-Hazardous	Total cells	5.68	9,523
	Active cells	2.48	3,496
	Inactive cells	5.41	6,027

Table 3-6: Household and Non-Household Population Served

Population Served	Number of Customers		
	Subtitle D Non-Hazardous Subcategory	Subtitle C Hazardous Subcategory	Industry Total
Non-Household	5,043,542	170,420	5,213,962
Household	46,007,775	307,243	46,315,018

Table 3-7: Household vs. Non-Household Customers

	Number of Facilities		
Number of Non-Household Customers	Subtitle D Non-Hazardous Subcategory	Subtitle C Hazardous Subcategory	Industry Total
0	76	123	205
1	83	40	124
>1-10	33	12	45
>10-100	202	4	203
>100-1,000	544	87	628
>1,000-10,000	351	51	400
>10,000-100,000	55	0	54
>100,000-1,00,000	2	0	2
Total	1,346	317	1,661
Number of Household Customers			
0	180	313	506
1	0	0	0
>1-10	55	0	55
>10-100	29	0	28
>100-1,000	42	0	42
>1,000-10,000	195	2	195
>10,000-100,000	742	0	733
>100,000-1,00,000	102	2	103
Total	1,345	317	1,662

Table 3-8: Wastes Received by Landfills in the United States

Waste Type	Mean % for Time Period Pre-1980	Mean % for Time Period 1980-85	Mean % for Time Period 1986-92
Municipal Solid Waste	38.3	33.4	33.9
Household Hazardous Waste	0.217	0.218	0.215
Yard Waste	4.76	4.39	3.76
Commercial Solid Waste	8.56	9.92	9.94
Institutional Wastes	1.36	1.43	2.14
Industrial Wastes	22.8	19.6	17.4
Agricultural Waste	0.340	0.297	0.284
Pesticides	0.033	0.009	0.321
PCB, TSCA Wastes	0.192	1.12	0.980
Asbestos-Containing Waste	0.905	3.73	3.42
Radioactive Waste	0.019	0.002	0.001
Medical or Pathogenic Waste	0.255	0.182	0.123
Superfund Clean-Up Wastes	0.000	0.021	0.014
Mining Wastes	0.519	0.47	0.180
Incinerator Residues	1.01	1.43	3.14
Fly Ash, Not Incinerator Waste	4.49	5.82	6.30
Construction/Demolition Debris	8.40	5.91	7.95
Sewage Sludge	1.81	3.15	2.88
Dioxin Waste	0.000	0.039	0.024
Other Sludge	4.89	4.90	2.91
Other Waste Types	1.23	4.49	5.25
Industry Total	100.09	100.528	101.132

Table 3-9: Total Volume of Waste Received by Landfills in 1992 by Regulatory Classification

Time Frame	Regulatory Class	All Facilities		Subtitle C Hazardous Subcategory		Subtitle D Non-Hazardous Subcategory	
		Estimated Total Number Landfills	Total Volume Landfilled (tons)	Estimated Total Number Landfills	Total Volume Landfilled (tons)	Estimated Total Number Landfills	Total Volume Landfilled (tons)
Current	Pre 1980	561	954,273,421	190	155,418,921	370	798,854,500
	RCRA Subtitle C	333	159,252,888	323	158,994,443	10	258,445
	RCRA Subtitle D	906	1,501,319,521	115	249,656,514	791	1,251,663,007
	TSCA	108	53,167,884	102	52,654,468	6	513,416
	NRC	.	.	.	.	.	.
	Local Regulation	461	2,365,983,720	57	6,374,393	404	2,359,609,326
	CERCLA	4	10,507,627	2	72,587	2	10,435,040
	Other Regulation	560	1,018,656,724	114	36,250,349	446	982,406,374
	Total Volume Landfilled	2,146	6,063,161,789	491	659,421,679	1,655	5,403,740,110
			Future Capacity (tons)		Future Capacity (tons)		Future Capacity (tons)
Future	Pre 1980	86	101,032,485	.	.	86	101,032,485
	RCRA Subtitle C	201	66,313,422	193	65,192,737	8	1,120,685
	RCRA Subtitle D	884	6,056,763,187	33	96,321,683	851	5,960,441,504
	TSCA	34	11,202,929	28	10,897,045	6	305,884
	NRC	2	300,860	.	.	2	300,860
	Local Regulation	293	962,479,373	57	4,710,196	236	957,769,177
	CERCLA	50	4,297,618	50	4,297,618	.	.
	Other Regulation	501	1,126,823,595	127	30,749,439	374	1,096,074,156
	Total Volume Landfilled	1,706	8,329,213,474	266	212,168,721	1,441	8,117,044,753

Table 3-10: Annual Tonnage of Waste Accepted by Landfills

Year	Annual Tonnage of Waste (tons)		
	Subtitle D Non-Hazardous Subcategory	Subtitle C Hazardous Subcategory	Industry Total
1988	185,184,608	36,305,235	221,489,843
1989	196,377,576	28,867,681	225,245,257
1990	232,535,432	37,413,692	269,949,125
1991	241,454,300	65,402,768	306,857,068
1992	252,101,069	63,022,850	315,123,919

Table 3-11: Wastewater Flows Generated by Individual Landfills

Type of Wastewater Generated	Number of Landfills	Minimum Average Flow (gal/day)	Maximum Average Flow (gal/day)	Industry Mean (gal/day)
Floor washing	70	10	5,450	1,760
Landfill leachate	1,989	1	533,000	13,600
Contaminated groundwater	163	6	987,320	47,900
Storm water run-off	1,135	10	2,066,600	66,200
Landfill gas condensate	158	3	11,732	510
Recovering pumping wells	50	0.3	80,167	16,900
Truck/equipment washwater	416	5	15,000	786
Drained free liquids	33	1	82,000	12,400
Other	2	0	0	0
Total	4,016			

Table 3-12: Type of Leachate Collection Systems Used at Individual Landfills

Type of Leachate Collection	Number of Landfills		
	Subtitle D Non-Hazardous Subcategory	Subtitle C Hazardous Subcategory	Industry Total
None	46	87	132
Simple Gravity Flow Drain Field	977	266	1,242
French Drain System	341	38	379
Compound Leachate Collection	416	93	509
Suction Lysimeters		2	2
Other	196	49	246
Total	1,976	535	2,510

Table 3-13: Pretreatment Methods in Use at Individual Landfills

Type of Waste	Pretreatment Method	Number of Landfills		
		Subtitle D Non-Hazardous Subcategory	Subtitle C Hazardous Subcategory	Industry Total
Free Liquids	No Pretreatment	324	113	437
	None Accepted	1,277	283	1,560
	Drained or Removed	51	115	166
	Stabilization	38	172	211
	Other	17	84	101
	Total	1,707	767	2,475
Containerized Waste	No Pretreatment	515	100	616
	None Accepted	1,008	180	1,188
	Shredded	23	70	94
	Stabilized	6	135	141
	Solidified	41	138	179
	Other	110	80	190
	Total	1,703	703	2,408
Bulk Wastes	No Pretreatment	993	216	1,209
	None Accepted	414	61	475
	Baled	33	2	35
	Shredded	82	49	131
	Stabilized	15	201	216
	Solidified	74	126	200
	Other	100	38	138
	Total	1,711	693	2,404

Table 3-14: Types of Wastewater Treatment Employed by the Landfills Industry

Type of Treatment	Number of Landfills		
	Direct Discharge	Indirect Discharge	Zero Discharge
No treatment	84	689	468
Biological treatment	119	37	19
Chemical precipitation	63	45	8
Chemcial precipitation and biological treatment	32	10	0
Filtration and biological treatment	45	4	5
Equalization and biological treatment	65	28	7
Equalization, biological treatment, and filtration	37	4	5
Equalization, chemcial precipitation, and biological treatment	26	8	0
Equalization, chemcial precipitation, biological treatment, and filtration	26	2	0

Table 3-15: Wastewater Treatment Facility Hours of Operation per Day

Hours of Operation (hours/day)	Subtitle D Non-Hazardous Subcategory			Subtitle C Hazardous Subcategory			Industry Total		
	Direct	Indirect	Zero	Direct	Indirect	Zero	Direct	Indirect	Zero
0	0	0	0	0	0	0	0	0	0
1-23	11	299	40	11	4	6	23	277	42
24	165	500	330	122	20	153	286	545	488
Total	176	799	370	133	24	159	309	822	530

Table 3-16: Wastewater Treatment Facility Average Hours of Operation per Day

Subcategory	Average Hours of Operation/Day		
	Direct Discharge	Indirect Discharge	Zero Discharge
All Facilities	22.81	19.10	22.55
Subtitle C Hazardous	22.78	22.18	23.46
Subtitle D Non-Hazardous	22.86	18.42	21.89

Table 3-17: Wastewater Treatment Facility Days of Operation per Week

Days of Operation (days/week)	Subtitle D Non-Hazardous Subcategory			Subtitle C Hazardous Subcategory			Industry Total		
	Direct	Indirect	Zero	Direct	Indirect	Zero	Direct	Indirect	Zero
0	0	0	0	0	0	0	0	0	0
1-6	7	228	40	19	2	6	31	205	42
7	168	571	330	115	22	153	279	618	488
Total	175	799	370	134	24	159	310	823	530

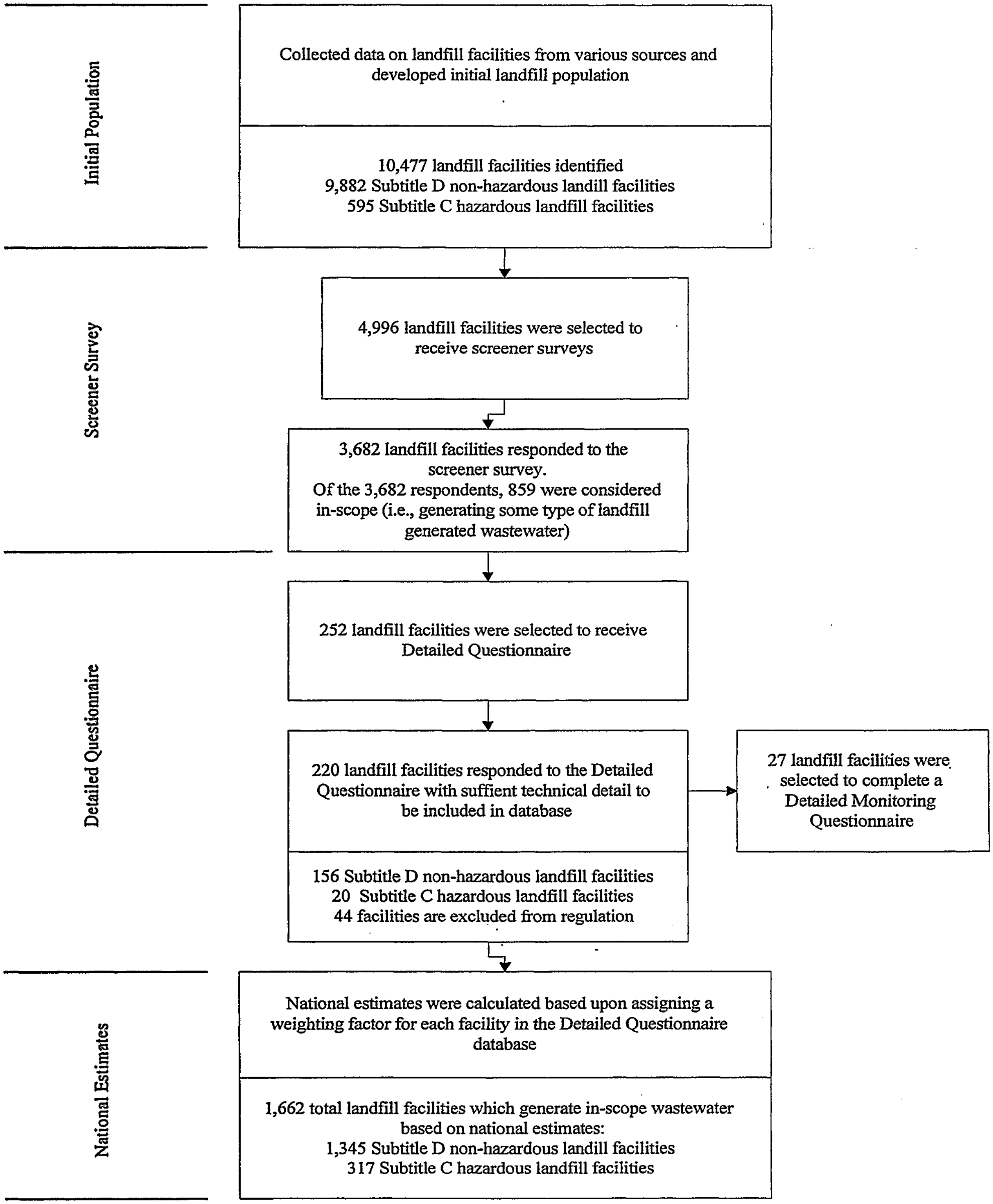
Table 3-18: Wastewater Treatment Facility Average Days of Operation per Week

Subcategory	Average Days of Operation/Week		
	Direct Discharge	Indirect Discharge	Zero Discharge
All Facilities	6.73	6.46	6.81
Subtitle C Hazardous	6.56	6.83	6.77
Subtitle D Non-Hazardous	6.94	6.38	6.84

Table 3-19: Total Number of Facilities by Discharge Type

Subcategory	Discharge Type			Total
	Direct	Indirect	Zero	
All Facilities	310	823	529	1,662
Subtitle C Hazardous	134	24	159	317
Subtitle D Non-Hazardous	176	799	370	1,345

Figure 3-1: Development of National Estimates for the Landfills Industry



4.0 DATA COLLECTION ACTIVITIES

4.1 Introduction

As part of the Landfills industry study, EPA collected data from a variety of different sources. These sources included existing data from previous EPA and other governmental data collection efforts, industry provided information, new data collected from questionnaire surveys, and field sampling data. Each of these data sources is discussed below, as well as the quality assurance/quality control (QA/QC) and other data editing procedures. Summaries and analyses of the data collected by EPA are presented in Chapters 5 through 10.

4.2 Preliminary Data Summary

EPA's initial effort to develop effluent limitations guidelines and pretreatment standards for the waste treatment industry began in 1986. EPA conducted a study of the hazardous waste treatment industry in which it determined the scope of the industry, its operations, and types of discharges. In this study, the hazardous waste treatment industry included landfills with leachate collection and treatment facilities, incinerators with wet scrubbers, and aqueous hazardous waste treatment facilities. This study characterized the wastewaters generated by facilities in the industry and the wastewater treatment technologies used to treat these wastewaters. In addition, the study included industry profiles, the cost of wastewater control and treatment, and environmental assessments. The results of this study were published by EPA in a report entitled "Preliminary Data Summary for the Hazardous Waste Treatment Industry" (EPA 440/1-89-100), in September, 1989.

The data presented in this report were collected from the following sources:

- EPA Office of Research and Development databases: includes field sampling efforts at 13 hazardous waste landfills in 1985.
- State Agencies: includes a Wisconsin sampling program of 20 municipal landfills in 1983.

- EPA Office of Emergency and Remedial Response Contract Laboratory Program (CLP) Statistical Database, "Most Commonly Occurring Analytes in 56 Leachate Samples." 1980-83 data.

- National Enforcement Investigations Center (NEIC) sampling program conducted for the Hazardous Waste Groundwater Task Force during 1985.

- EPA sampling at 6 landfill facilities (1986-1987).

- Subtitle D leachate data for miscellaneous Subtitle D landfills, compiled by the EPA Office of Solid Waste.

The EPA Preliminary Data Summary identified 911 landfills that generate leachate. Of these, 173 discharged their leachate directly to surface waters, and 355 discharged indirectly through publicly owned treatment works (POTWs). The remaining 383 used other methods of leachate disposal. The most common "other" disposal method was contract hauling to a commercial aqueous waste treatment facility. However, some facilities land applied their leachate (spraying of the leachate over the landfill) or injected it into a deep well for disposal.

The key findings of the EPA Preliminary Data Summary included:

- Some leachates were found to contain high concentrations (e.g., over 100,000 micrograms per liter (μg/l)) of toxic organic compounds.

- Raw leachates were found to contain high concentrations of BOD_5, COD, and TOC.

- Leachate flow rates varied widely due to climatic and geological conditions and landfill size. An average landfill was estimated to have a leachate generation rate of approximately 30,000 gallons per day (gpd).

- Due to current RCRA regulations, the number of leachate collection systems used at landfills was expected to increase.

- RCRA regulations also would cause solid waste generators to increase their use of commercial landfill facilities.

A wide range of biological and physical/chemical treatment technologies were found to be in use by landfills, capable of removing high percentages of conventional, nonconventional, and toxic pollutants. Advanced treatment technologies identified in this study include air stripping, ammonia stripping, activated carbon, and lime precipitation.

After a thorough analysis of the landfill data presented in the Preliminary Data Summary, EPA identified the need to develop an effluent guidelines regulation for the Landfills industry in order to set national guidelines and standards. EPA's decision to develop effluent limitations guidelines was based on the Preliminary Data Summary's assessment of the current and future trends in the Landfills industry, its analysis of the concentrations of pollutants in the raw leachate, and the study's discussion on the treatment and control technologies available for effective pollution reduction in landfill leachate.

4.3 Clean Water Act Section 308 Questionnaires

A major source of information and data used in developing effluent limitations guidelines and standards was industry responses to detailed technical and economic questionnaires, and the subsequent detailed monitoring questionnaires, distributed by EPA under the authority of Section 308 of the Clean Water Act. These questionnaires requested information on each facility's industrial operations, ownership status, solid wastes disposed, treatment processes employed, and wastewater discharge characteristics. EPA first developed a database of various types of landfills in the United States using information collected from: 1) State environmental and solid waste departments, 2) other State agencies and contacts, 3) the National Survey of Hazardous Waste Treatment Storage, Disposal and Recycling Facilities respondent list, 4) Environmental Ltd.'s 1991 Directory of Industrial and Hazardous Waste Management Firms, 5) the Resource Conservation and Recovery Act (RCRA) 1992 list of Municipal Landfills, and 6) the Resource Conservation and Recovery Information System (RCRIS) National Oversight Database. Based upon these sources, the initial population of 10,477 facilities in the landfill database was divided into two categories: 595 Subtitle C hazardous and 9,882 Subtitle D non-hazardous facilities.

This database served as the initial population for EPA to collect industry provided data. EPA's data collection process involved three stages:

- Screener Surveys
- Detailed Technical Questionnaires
- Detailed Monitoring Questionnaires

Each of these data collection activities are discussed in the following sections. A more detailed discussion of the landfills survey population can be found in Appendix A.

4.3.1 Screener Surveys

Once the database identifying the number of landfills in the U.S. was complete, EPA developed a screener survey to collect initial data on all possible landfill sites in the U.S. and to update information on ownership and facility contacts.

4.3.1.1 Recipient Selection and Mailing

The 10,478 facilities were divided into four strata for the purpose of determining the screener survey recipients. These strata were defined as:

1. Subtitle C facilities.
2. Subtitle D facilities that are known wastewater generators.
3. Subtitle D facilities in states with no more than 100 landfills and are not known to be wastewater generators.
4. Subtitle D facilities in states with more than 100 landfills and are not known to be wastewater generators.

All of the facilities in strata 1, 2, and 3 were selected to receive the screener survey. A random sample of the facilities in stratum 4 were selected. Table 4-1 presents the sample frame, number of facilities sampled, and the number of respondents to receive the screener survey.

Table 4-1: Screener Questionnaire Strata

Screener Stratum (g)	Number in Frame (N_g)	Number Sampled (n_g)	Number of Responses (n'_g)
1	595	595	524
2	134	134	120
3	892	892	722
4	8,856	3,375	2,621
Total	10,477	4,996	3,987

4.3.1.2 Information Collected

Information collected by the screener surveys included:

- mailing address.
- landfill type, including types and amount of solid waste disposed and landfill capacity.
- wastewater generation rates as a result of landfill operations, including leachate, gas condensate, and contaminated groundwater.
- regulatory classification and ownership status.
- wastewater discharge status.
- wastewater monitoring practices.
- wastewater treatment technology in use.

4.3.1.3 Data Entry, Coding, and Analysis

The EPA operated a toll-free help line to assist the screener recipients with filling out the 3-page survey. The Agency responded to several thousand phone calls from facilities over a six week period. The help line answered questions regarding applicability, EPA policy, and economic and technical details.

All screener surveys returned to EPA were reviewed manually to verify that each respondent completed the critical questions in the survey (e.g., wastewater generation and collection, number and types of landfills, discharge status, and wastewater treatment technology). The screeners were in a bubble-sheet format and were scanned directly into a computer database. Once entered, the database was checked for logical inconsistencies and follow up contacts were made to facilities to resolve any inconsistencies.

After the QA process, facilities in the database were divided into two groups: 1) facilities that indicated they collected landfill generated wastewaters; and 2) those that did not. Facilities that did not collect landfill generated wastewaters were considered out of the scope of the Landfills industry study and were not investigated further.

4.3.1.4 Mailout Results

Of the 4,996 screener questionnaires mailed by EPA, 3,628 responded, and of those, 3,581 were eligible and complete and were entered into the screemer database. Of these, EPA identified 859 facilities that generate and collect one or more types of landfill generated wastewaters.

4.3.2 Detailed Technical Questionnaires

Once the information from the screener surveys was entered into the database and analyzed, EPA then developed a detailed technical and economic questionnaire to obtain more information from facilities that collect landfill generated wastewater as indicated in their screener survey.

4.3.2.1 Recipient Selection and Mailing

The 859 facilities that were found to generate and collect landfill wastewater from the screener database, plus one pre-test questionnaire facility that was not in the screener database, were used as the frame for selection of facilities to be sent a Detailed Questionnaire. These facilities were divided into the following eight strata:

1. Commercial private, municipal, or government facilities that have wastewater treatment and are direct or indirect dischargers.
2. Commercial private, municipal, or government facilities that have wastewater treatment and are not direct or indirect dischargers.
3. Non-commercial private facilities with wastewater treatment
4. Facilities with no wastewater treatment
5. Commercial facilities that accept PCB wastes
6. Municipal hazardous waste facilities
7. Small businesses with no wastewater treatment
8. Pre-test facilities that were not in the screener population

All facilities in strata 1, 5, 6, 7, and 8 were selected to receive the Detailed Questionnaire. A random sample of the facilities in strata 2, 3, and 4 were selected to receive the Detailed Questionnaire.

This selection criteria resulted in a mailing of the Detailed Questionnaire to 252 facilities. The population analysis (referred to as national estimates) conducted on these questionnaire recipients is discussed briefly in Chapter 3 (Section 3.2.1) and in greater detail in the rulemaking record for this proposed regulation under the topic "Statistical Analysis of Questionnaire Data".

4.3.2.2 Information Collected

The Detailed Questionnaire solicited technical and costing information regarding landfill operations at the selected facilities and was divided into the following four sections:

- Section A - Facility Identification and Operational Information:

    1. General facility information, including: ownership status, landfill type, the number of landfills on site, regulatory status, discharge status, when the landfill began accepting waste, and projected closure date.

    2. Landfill operation, including: types of waste accepted at the landfill, the amount of waste accepted, landfill capacity, how the waste was organized in the landfill, landfill caps, and landfill liners.

    3. Wastewater generation from landfill operations, including: the types of wastewater generated and the generation rates, and the ultimate disposal of the wastewaters generated and collected.

- Section B - Wastewater Treatment:

    1. Description of treatment methods employed by the facility to treat the wastewaters identified in Section A. This description includes a discussion of commingled wastewaters, wastewater treatment technologies, residual waste disposal, and treatment plant capacities.

- Section C - Wastewater Monitoring Data:

    1. A summary of the monitoring data pertaining to the landfill generated wastewaters identified in Section A that were collected in 1992 by the facility, including: minimum, maximum, averages, number of observations, and sampling and analytical methods.

- Section D - Detailed Wastewater Treatment Design Information:

    1. Detailed technical design, operation and costing information pertaining to the wastewater treatment technologies identified in Section B.

4.3.2.3 Data Entry, Coding, and Analysis

The EPA operated a toll-free help line to assist the questionnaire recipients with filling out the Detailed Questionnaire. The EPA responded to over one thousand phone calls from facilities over a three month period. While some calls pertained to questions of applicability, most were of a technical nature regarding specific questions in the questionnaire.

Once the completed questionnaires were received by the EPA, each one was thoroughly reviewed for technical accuracy and content. After the questionnaire was reviewed, it was coded for double-key entry into the questionnaire database. All discrepancies between the two inputted values were corrected by referring to the original questionnaire.

Several QA/QC procedures were implemented for the questionnaire database, including a manual completeness and accuracy check of a random selection of 20 percent of the questionnaires and a database logic check of each completed questionnaire. These QA/QC procedures helped verify the questionnaires for completeness, resolve any internal consistencies, and identify outliers in the data which were checked for accuracy.

4.3.2.4 Mailout Results

Of the 252 recipients, 220 responded with sufficient technical and economic data to be included in the final EPA Detailed Questionnaire database.

4.4 Detailed Monitoring Questionnaire

In addition to the Detailed Questionnaire, EPA also requested detailed wastewater monitoring information from 27 facilities included in the Detailed Questionnaire database via a Detailed Monitoring Questionnaire.

4.4.1 Recipient Selection and Mailing

These facilities were selected based upon their responses to the Detailed Questionnaire. EPA reviewed each facility's monitoring summary, discharge permit requirements, and their on-site treatment technologies. From these responses, EPA selected 27 facilities to receive a Detailed Monitoring Questionnaire which could provide useful information on technology performance, pollutant removals, and wastewater characterization.

4.4.2 Information Collected

Facilities selected to receive the Detailed Monitoring Questionnaire were requested to send analytical data (1992, 1993, and 1994 annual data) on daily equalized influent to their wastewater treatment system, as well as effluent data from the treatment system. The three years of analytical data assisted EPA in calculating the variability factors (Chapter 11) used in determining the industry effluent limits. Analytical data for intermediate waste treatment points also were requested for some facilities. In this manner, EPA was able to obtain performance information across individual treatment units in addition to the entire treatment train.

4.4.3 Data Entry, Coding, and Analysis

EPA conducted a thorough review of each Detailed Monitoring Questionnaire response to ensure that the data provided was representative of the facility's treatment system. EPA collected data from 24 semi-continuous and continuous treatment systems and 2 batch treatment systems. A Detailed Monitoring Questionnaire database then was developed which included all monitoring data submitted by the selected facilities.

4.5 Engineering Site Visits

EPA conducted engineering site visits at 19 facilities including one facility outside the U.S. The purpose of these visits was to evaluate each facility as a potential week-long sampling candidate to collect treatment performance data. The selection of these facilities was based on the responses to the Detailed Questionnaire and included facilities from as broad a cross section of the industry as possible. EPA visited landfills of various ownership status (municipal, commercial, captive), landfills that accept various waste types (construction and demolition, ash, sludge, industrial, municipal, hazardous), and landfills in different geographic regions of the country. Facilities selected for engineering site visits employed various types of treatment processes, including: equalization, chemical and biological treatment, filtration, air stripping, steam stripping, and membrane separation.

Each landfill was visited for one day. During the engineering site visit, EPA obtained information on:

- the facility and its operations.
- the wastes accepted for treatment and the facility's acceptance criteria.
- the raw wastewater generated and its sources.
- the wastewater treatment on site.
- the location of potential sampling points.
- the site-specific sampling needs, issues of access, and required sampling safety equipment.

Table 4-2 presents a summary of the landfill facilities that were included in the engineering site visits.

4.6 Wastewater Characterization Site Visits

While conducting engineering site visits to landfill facilities, EPA also collected samples for raw wastewater characterization at 15 landfills. EPA collected grab samples of untreated wastewater at various types of landfills and analyzed for constituents in the wastewater including conventionals, metals, organics, pesticides and herbicides, PCBs, and dioxins and furans. Chapter 6 presents the characterization data obtained by EPA.

Table 4-2 also presents a summary of the landfill facilities by type that were included in the characterization site visits and the number of wastewater characterization samples collected.

4.7 EPA Week-Long Sampling Program

To collect wastewater treatment performance data, EPA conducted week-long sampling efforts at six landfills. Selection of these facilities was based on the analysis of the information collected during the engineering site visits. Table 4-3 presents a summary of the types of landfills sampled and treatment technologies evaluated.

EPA prepared a detailed sampling plan for each sampling episode. Wastewater samples were collected at influent, intermediate, and effluent sample points throughout the entire on-site wastewater treatment system. Sampling at five of the facilities consisted of 24-hour composite samples for five consecutive days. For the sixth facility, composites were taken of four completed batches over five days. Individual grab samples were collected for oil and grease. Volatile organic grab samples were composited in the laboratory prior to analysis.

Samples then were analyzed using EPA Office of Water approved analytical methods. The following table presents the pollutant group and the analytical method used:

Pollutant Group	Analytical Method
Conventional and Nonconventionals	Standard Methods
Metals	EPA 1620
Organics	EPA 1624, 1625
Herbicides, Pesticides, PCBs	EPA 1656, 1657,1658
Dioxins/Furans	EPA 1613

Data resulting from the influent samples were used to characterize raw wastewater for the industry and develop the list of pollutants of interest. The data collected from the influent, intermediate, and effluent points were used to evaluate performance of the wastewater treatment systems, develop current discharge concentrations, pollutant loadings, and the best available treatment (BAT) options for the Landfills industry. Data collected from the effluent points were used to calculate long term averages for each of the proposed regulatory options.

4.8 Other Data Sources

In addition to the original data collected by EPA, other data sources were used to supplement the industry database. Each of these data sources is discussed below.

4.8.1 Industry Supplied Data

The Landfills industry was requested to provide relevant information and data. Leachate and groundwater characterization and treatability studies were received from several facilities, including 25 discharge monitoring report (DMR) data packages. Industry supplied data was used to characterize the industry, develop pollutant loadings, and develop effluent limitations.

4.8.2 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)/Superfund Amendments and Reauthorization Act (SARA) Groundwater Data

Groundwater data was obtained from the "CERCLA Site Discharges To POTWs Treatability Manual" (EPA 540/2-90-007), prepared by the Industrial Technology Division of the EPA Office of Water Standards and Regulations for the EPA Office of Emergency and Remedial Response. Data from this study were used to supplement the groundwater data collected during characterization and week-long sampling events. The purpose of the study was to:

- Identify the variety of compounds and concentration ranges present in groundwater at CERCLA sites.
- Collect data on the treatability of compounds achieved by various on-site pretreatment systems.
- Evaluate the impact of CERCLA discharges to a receiving POTW.

A total of eighteen CERCLA facilities were sampled in this study; however, only facilities that received contaminated groundwater as a result of landfilling activities were selected to be used in conjunction with the EPA groundwater sampling data. The data from seven CERCLA facilities were combined with EPA sampling data to help characterize the hazardous subcategory and to develop both the current discharge concentrations and pollutant loadings for facilities in the hazardous subcategory.

4.8.3 POTW Study

EPA used the data included in the report entitled "Fate of Priority Pollutants in Publicly Owned Treatment Works" (EPA 440/1-82-303), commonly referred to as the "50-POTW Study", in determining those pollutants that would pass through a POTW. This study presents data on the performance of 50 representative POTWs that generally achieve secondary treatment (30 mg/l of BOD_5 and TSS). Additional work performed with this database included the revision of some data editing criteria. Because the data collected for evaluating POTW removals included influent levels of pollutants that were close to the detection limit, the POTW data were edited to eliminate low influent concentration levels. The data editing rules for the 50-POTW study were as follows: 1) detected pollutants must have at least 3 pairs (influent/effluent) of data points to be included, 2) for analytes that included a combination of high and low influent concentrations, the data were edited to eliminate all influent values, and corresponding effluent values, less than 10 times the minimum level, 3) for analytes where no influent concentrations were greater than 10 times the minimum level, all influent values less than five times the minimum level and the corresponding effluent values were eliminated, and 4) for analytes where no influent concentration was greater than five times the minimum level, the data were edited to eliminate all influent concentrations, and corresponding effluent values, less than 20 µg/l. The remaining averaged pollutant influent values and the corresponding averaged effluent values then were used to calculate the average percent removal for each pollutant when conducting the POTW pass-through analysis for this industry, which is discussed in detail in Chapter 7.

4.8.4 National Risk Management Research Laboratory Data

EPA's National Risk Management Research Laboratory (NRMRL) developed a treatability database (formerly called the Risk Reduction Engineering laboratory (RREL) database). This computerized database provides information, by pollutant, on removals obtained by various treatment technologies. The database provides the user with the specific data source and the industry from which the wastewater was generated. The NRMRL database was used when conducting the POTW pass-through analysis by supplementing the treatment information provided in the 50-POTW study when there was insufficient information on specific pollutants. For each of the pollutants of interest not found in the 50-POTW database, data from portions of the NRMRL database were obtained. These files were edited so that only treatment technologies representative of typical POTW secondary treatment operations (e.g., activated sludge, activated sludge with filtration, aerobic lagoons) were used. The files were further edited to include information pertaining to domestic or industrial wastewater, unless only other wastewater data were available. Pilot-scale and full-scale data were used; bench-scale data were eliminated. Data only from a paper in a peer-reviewed journal or government report were used; lesser quality references were edited out. Additionally, acceptable references were reviewed and non-applicable study data were eliminated. From the remaining pollutant removal data, the average percent removal for each pollutant was calculated. The pass-through analysis conducted for this industry is discussed in detail in Chapter 7.

4.9 QA/QC and Other Data Editing Procedures

This section presents the quality assurance/quality control (QA/QC) procedures and editing rules used to analyze the different analytical data sets that were described in the previous sections; including industry supplied data, Detailed Questionnaire data, Detailed Monitoring Questionnaire data, EPA field sampling, and analytical data collected by other EPA organizations. Slightly different conventions were used in setting limits (see the "Statistical Support Document for Proposed Effluent Limitations Guidelines and Standards for the Landfills Category", EPA 821-B-97-006).

4.9.1 QA/QC Procedures

Each analytical data source received a QA/QC review before being included in the EPA analytical, Detailed Questionnaire, and Detailed Monitoring Questionnaire databases. The specific QA/QC activities completed for each analytical data source are discussed below.

4.9.2 Analytical Database Review

The EPA sampling program analytical data were managed by EAD's Sample Control Center. The Sample Control Center developed and maintained the analytical database, as well as provided a number of QA/QC functions, the findings of which were documented in data review narratives. Completeness checks then were performed to ensure the completeness of the analytical database. Both of these QA/QC activities are discussed below. In addition, the following paragraphs outline the editing procedures and data conventions used to finalize the landfill analytical database, to characterize each industry subcategory, and to develop current discharge information and pollutant loadings.

4.9.2.1 Data Review Narratives

The Sample Control Center performed a QA/QC data review and documented their findings in the data review narrative that accompanied each laboratory data package. The data review narrative identified missing data and any other data discrepancies encountered during the QA/QC review. The narratives then were checked against the data and sampling episode traffic reports to make sure no data discrepancies were overlooked.

4.9.2.2 Completeness Checks

A data completeness check of the analytical database was performed by cross referencing the list of pollutants requested for analysis with the list of pollutants the laboratory actually analyzed at each sample point. This was accomplished by preparing:

- a list of all requested analytical methods and method numbers.
- a list of all pollutants and CAS numbers specified under each requested analytical method.
- a schedule of analyses requested by episode for each sample point.

The purpose of the completeness check was to verify that all analyses requested were performed by the laboratory and posted to the database in a consistent manner. The completeness check resulted in identifying:

- any pollutant that was scheduled to be analyzed but was not analyzed.
- pollutants that were analyzed but were not scheduled to be analyzed.
- any pollutant for which the expected number of samples analyzed did not agree with the actual number of samples analyzed.

Discrepancies then were then evaluated and resolved by subsequent QA/QC reviews. All changes to data in the landfill analytical database were documented in a status report prepared by the Sample Control Center entitled "Status of the Waste Treatment Industry: Landfills Database".

4.9.2.3 Trip Blanks and Equipment Blanks

Qualifiers assigned to data as a result of trip blank and equipment blank contamination were addressed in the same way the Sample Control Center addressed contamination of lab method blanks:

- Sample Results Less than Five Times Blank Results: When the sample result was less than five times the blank result, there were no means by which to ascertain whether the presence of the analyte could have attributed to blank contamination. Therefore, the result was included in the database as non-detect, with a nominal detection limit equal to the dilution-adjusted instrument detection limit.
- Sample Results Greater than Five Times but Less than Ten Times Blank Results: These data were of acceptable quality and were used to represent maximum values.

- Sample Results Greater than Ten Times Blank Results or Analyte not Detected in Sample: The presence of the analyte in the blank did not adversely affect the data in those cases where the sample results were greater than ten times the associated blank results or when the analyte was not detected in associated samples. Such data were acceptable without qualification.

4.9.2.4 Field Duplicates

Field duplicates were collected during the EPA sampling episodes to help determine the accuracy and consistency of the sampling techniques employed in the field. In the analytical database, field duplicate results were represented by the letter "D" preceding the sample point number. Duplicate samples considered acceptable were combined on a daily basis using the following rules:

- If all duplicates were non-detect values, then the aggregate sample was labeled non-detect (ND), and the value of the aggregate sample was the maximum of the ND values.
- If the maximum detected value was greater than the maximum ND value, then the aggregate sample was labeled NC, and the value of the aggregate sample was the sum of the non-censored (NC) and ND values divided by the total number of duplicates for that independent sample.
- If the maximum NC value was less than or equal to the maximum ND value, then the aggregate sample was labeled ND and the value of the aggregate sample was the maximum of the ND values.
- If all duplicates were NC values, then the aggregate sample was labeled NC and the value of the aggregate sample was the average of the NC values.

In the laboratory, analytical precision was calculated by determining the relative percent difference of paired spiked samples. Data was considered acceptable if the relative percent difference was within the laboratory criteria for analytical precision.

Duplicate relative percent difference values were considered acceptable if they were within the laboratory criteria for analytical precision plus or minus 10 percent.

4.9.2.5 Grab Samples

Most data presented in the analytical database represent composite sample results, but other types of results exist due to sampling requirements. Most grab sample results were represented by the letters "A", "B", or "C" following the sample point number in the analytical database for grabs collected on the same day. Grab samples of this nature were only collected for oil and grease/hexane extractable material and were included when calculating average concentrations of pollutants. Grab samples of any kind were averaged on a daily basis before being used in data analyses.

4.9.2.6 Non-Detect Data

Non-detect data were given numeric values so that they could be considered in the data analyses. Non-detect data can be set either at the method detection limit, at the instrument detection limit, at half of the method detection limit, or equal to zero. Detection limits can be standardized (as in the method detection limit) or variable (as in the instrument detection limit or the sample detection limit, which may vary depending on dilution). The instrument detection limit is the lowest possible detection limit; the instrument cannot detect the contaminant below this level. In many cases, the method detection limit is significantly higher than the instrument detection limit.

For the Landfills industry, all non-detect data collected from the EPA sampling episodes used in calculations were defined as follows: 1) the value used for non-detect data was represented by the detection limit reported in the analytical database, and 2) if the detection limit of the non-detect data was greater than the detected results, the average was calculated using all of the data, but the results were flagged for review on an individual basis. When flagged results were reviewed as a whole, the high detection limits were found to be on the same order of magnitude as the detect values; therefore, all flagged data were included in calculating averages.

4.9.2.7 Bi-Phasic Samples

In one sampling episode for a captive hazardous landfill at an industrial facility, some samples collected became bi-phasic. For these samples, analytical results for each phase were reported separately. Consolidated results for the bi-phasic samples were calculated by factoring the percent of each phase relative to the total sample volume with the results of each phase and adding the weighted results together. Pollutants were not always detected in both the aqueous and organic phases of a bi-phasic sample. In instances where a pollutant was detected in one phase and not in the other phase, the detection limit was set at zero, which removed the non-detect phase from the equation. When both phases were non-detect, the lowest of the two detection limits was used as the result.

4.9.2.8 Conversion of Weight/Weight Data

In some cases, wastewater samples collected in the field were analyzed as solids due to criteria specified in the analytical method. These results were reported in the database in solids units of µg/kg or ng/kg, and needed to be converted to µg/l and ng/l, respectively, to be used in data analysis. Conversion factors were supplied in the database to convert these solid units (weight/weight) to volumetric units (weight/volume).

The landfill analytical database contained a file called "solids" that contained percent solids values for those samples associated with a result that were reported on a weight/weight basis. This percent solids value was necessary to convert results from a weight/weight basis to a weight/volume basis.

The following formula was utilized to convert the "amount" from a weight/weight basis to a weight/volume basis. This formula assumed a density of 1:

$$\text{Amount (weight/weight)} \times (\text{percent Solids}/100) = \text{Amount (weight/volume)}$$

where,

Amount =	The result contained in the "amount" field in the "result" file.
percent Solids =	The percent solids result contained in the "percent" field in the "solids" file.

After conversion, the amount was expressed in weight/volume units as shown below:

Weight/Weight Units	Weight/Volume Units
pg/kg	pg/l
ng/kg	ng/l
μg/kg	μg/l
μg/g	μg/ml
mg/kg	mg/l

4.9.2.9 Average Concentration Data

All data conventions discussed above were employed when the average concentration of a group of data was calculated. Average concentrations were calculated to develop raw waste loads, current discharge concentrations, and percent removal values. To calculate the average concentration of a pollutant at a particular sample point, the following hierarchy was used: 1) all non-detect data was set at the detection limit listed in the database, 2) all weight/weight units were converted to weight/volume units using the percent solids file, 3) all units were then converted to μg/l, 4) the biphasic sample results were combined into one consolidated result, 5) both duplicate pairs and grab samples were combined using the rules discussed above, and 6) the weekly average was calculated by adding all results and dividing by the number of results.

4.9.3 Detailed Questionnaire Database Review

Each Detailed Questionnaire was reviewed for: 1) completeness, 2) internal consistency, and 3) outliers. Outliers refer to data values that are well outside those expected for this industry. For example, flow rates above 10 million gallons per day would be considered suspect. In cases such as this, the QA/QC reviewer would verify the accuracy and correctness of the data.

All information that was computerized was given a 100 percent QA/QC check to ensure that all data were inputted properly. This was accomplished by double key entry, and any discrepancies between the two inputted values compared with the original submission were corrected.

Additional handling procedures for Detailed Questionnaires were presented earlier in Section 4.3.2.

4.9.4 Detailed Monitoring Questionnaire Data Review

Detailed Monitoring Questionnaire data were evaluated using the same procedures outlined for the Detailed Questionnaire process. The QA/QC steps included reviews for: 1) completeness, 2) internal consistency, and 3) outliers.

Additional handling procedures for Detailed Monitoring Questionnaires were presented earlier in Section 4.4.

Table 4-2: Types of Facilities Included in EPA's Characterization and Engineering Site Visits

Ownership Type	Characterization Site Visits	Engineering Site Visits*
Municipal	4	9
Commerical	9	8
Non-Commercial (captive, intra-company)	2	1
Waste Type	Characterization Samples Collected	
Subtitle D	13	15
Subtitle C	5	3
Landfill Type	Characterization Samples Collected	
Subtitle D Non-Hazardous	10	15
(Municipal)	(2)	(14)
(Non-Municipal)	(8)	(1)
Subtitle C Hazardous	5	3
Groundwater	3	0

*One engineering site visit was conducted outside the U.S.

Table 4-3: Types of Facilities Included in EPA's Week-Long Sampling Program

Episode	Ownership Type			Waste Type		Landfill Subcategory		Treatment Technology
	Municipal	Commercial	Non-Commercial	Subtitle D	Subtitle C	Non-Hazardous	Hazardous	
4626	X			X		X		Equalization, chemical precipitation, biological treatment, filtration
4667	X			X		X		Equalization/stripper, chemical precipitation, biological treatment, GAC, filtration
4687	X			X		X		Equalization, filtration, reverse osmosis
4690			X		X		X	Air stripping* Steam stripping*
4721		X			X		X	Equalization, biological treatment
4759		X			X		X	Equalization, chemical precipitation, biological treatment

*Two separate treatment systems

5.0 INDUSTRY SUBCATEGORIZATION

In developing technology-based regulations for the Landfills industry, EPA considered whether a single set of effluent limitations and standards should be established for the industry, or whether different limitations and standards were appropriate for subcategories within the industry. The Clean Water Act (CWA) requires EPA, in developing effluent limitations, to assess several factors, including manufacturing processes, products, the size and age of a site, wastewater use, and wastewater characteristics. The Landfills industry, however, is not typical of many of the other industries regulated under the CWA that are manufacturing operations. Therefore, EPA developed additional factors that specifically address the characteristics of landfill operations. Similarly, several factors typically considered for subcategorization of manufacturing facilities were not considered applicable to the Landfills industry. The factors considered for the subcategorization of the Landfills industry are listed below:

- Resource Conservation and Recovery Act (RCRA) Regulatory classification
- Types of wastes received
- Wastewater characteristics
- Facility size
- Ownership
- Geographic location
- Facility age
- Economic impacts
- Treatment technologies and costs
- Energy requirements
- Non-water quality impacts

5.1 Subcategorization Approach

Based on assessment of the above factors, EPA has concluded that the most appropriate basis for subcategorization is by landfill classification under RCRA for the reasons explained in greater detail below. Subcategorization on this basis incorporates many of the most relevant differences within the Landfills industry. EPA found that the types of waste received at the landfill and the resulting characteristics of the wastewater are most clearly correlated with the RCRA classification of a landfill. Additionally, this subcategorization approach has the advantage of being the easiest to implement because it follows the same classification previously established by EPA under RCRA and currently in use (and widely understood) by permit writers and regulated landfills facilities.

5.2 Proposed Subcategories

EPA is proposing to subcategorize the Landfills industry into two subcategories as follows:

- Subcategory I: Subtitle D Non-Hazardous Landfills
- Subcategory II: Subtitle C Hazardous Landfills

Subcategory I applies to wastewater discharges from all facilities classified as RCRA Subtitle D Non-Hazardous landfills subject either to the criteria established in 40 CFR Part 257 or 40 CFR Part 258.

Subcategory II applies to wastewater discharges from solid waste disposal facilities classified as RCRA Subtitle C Hazardous landfills subject to the criteria in 40 CFR 264 Subpart N (Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities).

A discussion of the types of landfills regulated under these provisions of RCRA is presented in Chapter 3 (Section 3.1 - Regulatory History of the Landfills Industry).

5.3 Other Factors Considered for Basis of Subcategorization

Before deciding to propose subcategorization on the basis of the existing RCRA regulatory classification for the Landfills industry, EPA also evaluated the appropriateness of developing subcategories based on the other factors presented earlier in this chapter. The following subsections present EPA's evaluation of each of these factors.

5.3.1 Types of Wastes Received

The type of solid waste that is deposited in a landfill often has a direct correlation with the characteristics of the leachate produced by that landfill. Wastes deposited in landfills range from municipal, non-hazardous materials, to hazardous wastes containing contaminants such as pesticides. An analysis of the data collected as part of this study showed that there are differences in the wastewater generated by facilities that dispose of hazardous wastes as compared to non-hazardous wastes. These differences are reflected in both the number of pollutants of interest (as defined in Chapter 7) identified in each subcategory and in the concentrations of these pollutants found in the wastewaters generated. Tables presented in Chapters 6 and 7 of this document support this comparison. Specifically, the pollutant of interest list for the Non-Hazardous subcategory contains a total of 33 pollutants, whereas the pollutant of interest list for the Hazardous subcategory contains 63 pollutants. Pollutants targeted for analysis during EPA sampling episodes were detected approximately 47 percent of the time at hazardous facilities versus approximately 31 percent of the time at non-hazardous facilities. Organic pollutants and metals were routinely detected more frequently and at higher concentrations at hazardous landfills than at non-hazardous landfills.

EPA has determined that the most practical method of distinguishing the type of waste deposited in a landfill is achieved by utilizing the RCRA classification of landfills. As discussed in Section 5.1, the RCRA classification selected as the basis for subcategorization is based on the types of wastes received by the landfill: hazardous waste or non-hazardous waste. Therefore, types of waste disposed at a landfill is a factor which is taken into consideration by the fact that it is directly encompassed by the RCRA classification scheme and selected subcategorization method.

There also are a number of landfill cells and monofills within the Subtitle D class of non-hazardous landfills dedicated to accept only one type of waste which includes, but is not limited to, construction and demolition (C&D) debris, ash, or sludge. EPA is not proposing to further subcategorize Subtitle D landfill facilities. This decision is based on two considerations: (1) similarities in waste acceptance and leachate characteristics between monofills and other Subtitle D Non-hazardous landfills; and (2) ease of implementation. First, EPA evaluated leachate characteristics from Subtitle D landfills including monofills, ashfills, co-disposal sites, and construction and demolition (C&D) landfills. Table 5-1 includes data from three reports[1] which analyzed monofills and co-disposal sites and compares these data to the average influent data collected from non-hazardous landfills as part of the Landfills industry study. The data contained in these reports indicate that the leachate characteristics at construction and demolition, co-disposal and ash monofill facilities are comparable to the leachate characteristics from municipal solid waste landfills. Both the number and type of parameters in the leachate do not differ among these types of facilities, and concentration levels for all pollutants are comparable, with many parameters found at lower concentrations in the data from the construction and demolition, co-disposal and ash monofill facilities. Therefore, EPA has concluded that untreated leachate characteristics at these facilities were not significantly different than other non-hazardous landfill facilities to merit subcategorization.

This is not unexpected, as the waste deposited in municipal landfills and dedicated monofills is not mutually exclusive. Although cells at a dedicated landfill may prohibit disposal of municipal refuse, a municipal waste landfill may also accept ash, sludge, and construction and demolition wastes. EPA has determined that there were no pollutants of interest identified in untreated leachate from dedicated monofills that were not already present in municipal landfills. EPA concluded that the pollutants proposed to be regulated for the Non-hazardous Subtitle D subcategory will control the discharges from all types of Subtitle D landfills including monofills.

The second consideration was based on ease of implementation. As discussed in Section 5.2, the RCRA classification scheme selected as the basis for subcategorization clearly defines non-hazardous, hazardous, and municipal solid waste landfill facilities. However, RCRA does not make any further distinction nor further divide the Subtitle D landfill facilities based on whether they are monofills or if they receive multiple types of waste. Therefore, by further subcategorizing the Subtitle D facilities into monofills and multiple waste landfills a new classification scheme would

[1] "A Study of Leachate Generated from Construction and Demolition Landfills", Department of Environmental Engineering Sciences, University of Florida, August 1996; "Characterization of Municipal Waste Combustion Ashes and Leachates from Municipal Solid Waste Landfills, Monofills, and Co-Disposal Sites", U.S. EPA, EPA 530-SW-87-028D, October 1987; "Characterization of Municipal Waste Combustion Ash, Ash Extracts, and Leachates", U.S. EPA, EPA 530-SW-90-029A, March 1990.

be introduced to permit writers and regulated facilities. EPA concluded that the current RCRA classification scheme is widely understood by permit writers and regulated landfill facilities, therefore, making it the easiest of the subcategorization approaches to implement. Additionally, there are many facilities that operate both dedicated cells (similar to monofills) and municipal solid waste (MSW) cells at the same landfill and commingle the wastewaters prior to treatment. Establishing one subcategory for all non-hazardous landfills will ease implementation issues and adequately control discharges from the landfills industry.

5.3.2 Wastewater Characteristics

EPA concluded that leachate characteristics from non-hazardous and hazardous landfills differed significantly from each other in the types of pollutants detected and the concentrations of those pollutants. The tables supporting this conclusion are presented in Chapters 6 (Tables 6-7 through 6-11) and 7 (Tables 7-1 and 7-2) of this document. As expected, EPA found that the leachate from hazardous landfills contained a greater number of contaminants at higher concentrations compared to leachate from non-hazardous landfills. This conclusion supports subcategorization based on RCRA classification of hazardous and non-hazardous landfills.

In EPA's evaluation of contaminated groundwater, the wastewater characteristics of contaminated groundwater from hazardous landfills differed significantly from the contaminated groundwater characteristics at non-hazardous waste landfills, as shown in Table 5-2. Contaminated groundwater from non-hazardous landfills contained only 16 pollutants of interest (as defined in Chapter 7) compared to the contaminated groundwater from hazardous waste landfills which contained a total of 54 pollutants of interest. In addition, effluent data collected in support of this proposal demonstrate that contaminated groundwater flows at hazardous and non-hazardous facilities are, in general, adequately treated.

Due to the site-to-site variability of contaminated groundwater, EPA has decided that the treatment of these flows is best addressed through the corrective actions programs. Corrective actions programs at the federal, state, and local level have the ability to consider the site-to-site variability of the contaminated groundwater and provide the most applicable treatment necessary to control the contaminants. Therefore, EPA has decided to exclude contaminated groundwater from this regulation because the Agency believes that it is better controlled through corrective actions program.

Some landfill facilities collect and treat both landfill leachate and contaminated groundwater. Contaminated groundwater may be very dilute or may have characteristics similar in nature to leachate. In cases where the groundwater is very dilute, it is possible that contaminated groundwater may be used as a dilution flow. In these cases, the permit limits will be based on separate treatment of the flows in order to prevent dilution of the regulated leachate flows. However, in cases where the groundwater may exhibit characteristics similar to leachate, commingled treatment is appropriate and may be more cost effective than separate treatment. The characteristics of the contaminated groundwater must be considered before making a determination if commingling groundwater and leachate for treatment is appropriate.

5.3.3 Facility Size

EPA considered subcategorization of the Landfills industry on the basis of facility size and found that landfills of varying sizes generate similar wastewaters and use similar treatment technologies. Based upon a review of the industry provided data in the landfills database, there was no observed correlation between waste acceptance amount or wastewater flow rate and the selection of treatment technologies. For example, a landfill facility can add cells or increase its waste receipt rate depending on the local market need without altering or changing the characteristics of the wastewaters generated. In addition, the size of a landfill was not determined to be a factor in cost-effectiveness of the regulatory options considered by EPA. Finally, EPA has determined wastewaters from landfills can be treated to the same level regardless of facility size. EPA has not proposed a de-minimis flow exemption for this guideline; however, EPA has accounted for landfill facilities that generate small volumes of wastewater by estimating compliance costs for the proposed BPT/BAT/PSES options based on treating their wastewaters off-site at a CWT facility (see Section 9.2.2).

5.3.4 Ownership

EPA considered subcategorizing the industry by ownership. A significant number of landfills are owned by state, local, or federal governments, while others are commercially or privately owned. Landfills generally fall into two major categories of ownership: municipal or private. Landfills owned by municipalities are primarily designed to receive non-hazardous solid waste such as municipal waste, non-hazardous industrial waste, construction and demolition debris, ash, and sludge. However, municipally-owned landfills may also be designed to accept hazardous wastes.

Privately-owned landfills can also provide for the disposal of non-hazardous solid waste such as those mentioned above, and, like municipally-owned facilities, may also be designed to accept hazardous wastes. EPA found that currently commercially- and municipally-owned landfills generally accept and manage wastes strictly by the RCRA classification and, although there are distinct economic differences, there is no distinction in the wastewater characteristics and wastewater treatment employed at commercially- or municipally-owned landfills. Since all landfill types could be of either ownership status, EPA determined that subcategorization based upon municipal and private ownership was not appropriate.

5.3.5 Geographic Location

EPA considered subcategorizing the industry by geographic location. Landfill sites are not limited to any one region of the United States. A table presenting the number of landfills by state is presented in Chapter 3 (Table 3-1). While landfills from all sections of the country were included in the Agency's survey efforts, collection of wastewater characterization data as part of EPA's sampling episodes was limited to landfill facilities in the Northeast, South, and Midwest, where annual precipitation is either average or above average. Although wastewater generation rates appear to vary with annual precipitation, which is indirectly related to geographic location, a direct correlation between leachate characteristics and geographic location could not be established due to lack of sampling data from arid parts of the United States. However, the Agency believes that seasonal variations in rainfall cause only minor fluctuations in leachate characteristics due to dilution effects and volume of leachate generated. In addition, many landfill facilities have developed site-specific best management practices to control the amount of rainwater that enters a landfill and eventually becomes part of the leachate. These practices include proper contouring of landfill cells, extensive use of daily cover, and capping of inactive landfill cells in order to minimize the amount of uncontaminated rainwater that enters the landfill. EPA's data collection efforts indicate that landfill facilities in less arid climates are more likely to use these management practices to control their wastewater generation and flows to the on-site wastewater treatment plant. The data collected by EPA did not indicate any significant variations in wastewater treatment technologies employed by facilities in colder climates versus warmer climates.

EPA notes that geographic location may have a differential impact on the costs of operating a landfill. For example, the cost of additional equipment required for the operation of the landfill or treatment system or tipping fees charged for the hauling of waste may tend to differ from region to region. These issues were addressed in the economic impact assessment of the proposal.

Therefore, since the effect of geographic location appears to have a minimal impact on wastewater characteristics or can be easily addressed at minimal effort and cost, EPA determined that subcategorization based upon geographic location was not appropriate.

5.3.6 Facility Age

EPA considered subcategorization based on the age-related changes in leachate concentrations of pollutants for different age classes of landfills based on the evaluation of several factors. First, a facility's wastewater treatment system typically receives and commingles leachate from several landfills or cells of different ages. The Agency did not observe any facility that found it advantageous or necessary to treat age-related leachates separately. Additionally, the EPA did not find any correlation between the relative ages of the landfills and the method of leachate treatment. Second, based on responses to the questionnaire, discussions with landfill operators, and historical data, it appears that leachate pollutant concentrations change substantially over the first two to five years of a landfill's operation, but then change only slowly thereafter.

These two observations imply that landfill treatment systems must be designed to accommodate the full range of concentrations and pollutants expected in influent wastewaters. EPA has concluded that the proposed BPT/BAT/PSES treatment technologies can successfully treat the variations in landfill wastewaters likely to occur due to age-related changes in the leachate. EPA also has taken into account the ability of treatment systems to accommodate age-related changes in raw leachate concentrations and pollutants, as well as short-term fluctuations, by proposing effluent limitations (for those regulated pollutants having long term sampling data) that reflect the variability observed in monitoring data spanning 12 to 36 months. Additionally, age-related effects on treatment technologies, costs, and pollutant loads were addressed by utilizing data collected from a variety of landfills of various ages and types of operation (e.g., closed/capped, inactive, or active).

EPA also evaluated sampling data collected from hazardous and non-hazardous landfill facilities of different ages to compare general leachate characteristics based on conventional and selected nonconventional pollutant parameters, as shown in Table 5-3. While certain pollutant parameters follow the generally accepted pattern of younger landfills having leachates with higher pollutant concentrations, as shown for TOC and TSS for both municipal and hazardous facilities, data for other parameters such as COD for the hazardous facilities and BOD for the municipal facilities show the opposite trend. However, in general, these pollutant concentrations are within the same order of magnitude and the Agency believes that this variability in wastewater characteristics can be adequately handled in the proposed BPT/BAT/PSES treatment options.

Based on this analysis of the effects of age on wastewater characteristics, EPA determined that subcategorization based on facility age is not appropriate.

5.3.7 Economic Characteristics

EPA also considered subcategorizing the industry based on the economic characteristics of the landfill facilities. If a group of facilities with common economic characteristics, such as revenue size, was in a much better or worse financial condition than others, EPA could consider subcategorization on economics. However, based on the results of the detailed questionnaires, financial conditions of compliance costs associated with the proposed BPT/BAT/PSES regulations did not inordinately effect any particular segment of the landfills industry. Therefore, EPA determined that subcategorization based on the economic characteristics of landfills facilities was not justified.

5.3.8 Treatment Technologies and Costs

Wastewater treatment for this industry ranges from primary systems such as equalization, screening, and settling, to advanced tertiary treatment systems such as filtration, carbon adsorption, and membrane separation. EPA found that the selected treatment technology employed at a facility was dependent on wastewater characteristics and permit requirements. Landfills with more complex mixtures of toxic pollutants in their wastewaters generally had more extensive treatment systems and may utilize several treatment processes (e.g., facilities with high levels of both organic and inorganic pollutants may employ both a chemical and biological treatment system). However, subcategorizing by the waste type received by a landfill as outlined in the RCRA classification of landfills is less difficult to implement and results in addressing the same factors as using treatment processes employed. As a result, EPA did not consider treatment technologies or costs to be a basis for subcategorization.

5.3.9 Energy Requirements

The Agency did not subcategorize based on energy requirements because energy usage was not considered a significant factor in this industry and is not related to wastewater characteristics. Energy costs resulting from this regulation were accounted for in the costing section of this development document (Chapter 9) and in the economic impact assessment.

5.3.10 Non-Water Quality Impacts

The Agency evaluated the impacts of this regulation on the potential for increased generation of solid waste and air pollution. The non-water quality impacts did not constitute a basis for subcategorization. Non-water quality impacts and costs of solid waste and air pollution control are included in the economic analysis and regulatory impact analysis for this regulation. See Chapter 10 for more information regarding non-water quality impacts.

Table 5-1: Subtitle D Non-Hazardous Landfill Data Comparison (ug/l)

Pollutant	C & D Study		EPA Characterization Studies - Data Range			Subtitle D Non-Hazardous Master File		
			1990	1987				
Metals	Mean [1]	Facilities Det/Total [2]	Monofills	Co-Disposal	Monofills	Median	Mean	Max
Arsenic	12.3	12/16	ND(50) - 400	8 - 46	10 - 218	32.4	50.4	179
Barium	661	13/13	ND(2) - 9,220	270 - 890	NA	650	849	3,570
Boron	NA	NP	NA	NA	NA	2,523	3,874	16,250
Chromium	NA	NP	ND(7) - 32	ND(10) - 13	5 - 914	28	47	240
Hexavalent Chromium	NA	NP	NA	NA	NA	30	63	234
Molybdenum	NA	NP	NA	NA	NA	10	27	69
Silicon	NA	NP	470 - 15,300	NA	NA	7,283	28,817	159,000
Strontium	NA	NP	NA	NA	NA	2,525	5,160	30,100
Titanium	NA	NP	NA	NA	NA	28	162	1,740
Zinc	658	15/15	5.2 - 370	9 - 1,210	48 - 3,300	100	1,183	31,813
Organics								
1,4-Dioxane	49	1/5	NA	NA	NA	11	118	323
2-Butanone	NA	NP	NA	NA	ND(50)	1,768	5,874	36,544
2-Propanone	NA	NP	NA	NA	ND(50)	184	1,396	8,614
4-Methyl-2-Pentanone	130	2/8	NA	NA	ND(50)	100	3,789	46,161
Alpha-Terpineol	NA	NP	NA	NA	ND(50)	123	334	1,061
Benzoic Acid	15,457	4/9	ND(50) - 73	NA	ND(50)	3,897	8,423	33,335
Dichloroprop	NA	NP	NA	NA	ND(50)	6	10	29
Disulfoton	3.3	2/4	NA	NA	NA	6	9	20
Hexanoic acid	NA	NP	NA	NA	ND(50)	65	621	4,291
MCPA	NA	NP	NA	NA	NA	403	816	4,370
MCPP	NA	NP	NA	NA	NA	233	432	1,900
Methylene Chloride	26.4	4/9	NA	NA	ND(50)	37	309	5,091
N,N-Dimethylformamide	NA	NP	NA	NA	ND(50)	10	214	1,008
O-Cresol	50	2/8	NA	NA	ND(50)	15	298	2,215
Phenol	384	3/6	ND(10) - 32	ND(50) - 2,100	ND(1.5)	102	287	1,425
P-Cresol	NA	NP	NA	NA	ND(50)	75	246	998
Toluene	61	7/9	NA	ND(50) - 120	ND(50)	108	156	598
Tripropyleneglycol Methyl Ether	NA	NP	NA	NA	ND(50)	197	568	1,235

Table 5-1: Subtitle D Non-Hazardous Landfill Data Comparison (ug/l)

Conventional/Nonconventionals								
BOD	87,320	14/14	NA	NA	NA	173,069	993,869	7,609,318
COD	754,500	16/17	NA	1,300,000 - 3,900,000	5 - 1,200,000	1,100,000	2,259,142	16,700,000
Ammonia Nitrogen	20,420	16/78	4,380 - 77,400	160,000 - 410,000	1,200 - 36,000	75,000	372,485	5,860,000
TDS	2,263,100	17/18	924,000 - 41,000,000	NA	NA	3,246,076	5,979,674	33,900,000
TSS	1,859,100	17/18	NA	1,930,000 - 7,970,000	NA	106,000	1,092,879	1,650,000
Total Phenols	620	7/7	NA	NA	NA	473	94,934	2,051,249
Nitrate/Nitrite	NA	NP	NA	NA	NA	700	5,457	50,800
TOC	306,540	7/7	17 - 420,000	438,000 - 1,310,000	59,100 - 636,000	295,000	684,055	4,820,000
Dioxins/Furans								
1234678-HpCDD	NA	NP	ND(NV) - 0.222(2)	0.12 - 0.77(2)	0.009 - 172(2)	0.14	2.42	7.08
OCDD	NA	NP	ND(NV) - 0.107	0.21 - 15	0.06 - 120	0.10	9.84	82.4

All units in ug/l unless otherwise noted
*: The number of sites that detected the parameter/the total number of sites that sampled the parameter
(1): Mean includes non-detects for metals and conventionals/nonconventionals and does not include non-detects for organics and dioxins/furans
(2): Total homolog concentration
NA: Not Analyzed
ND: Not Detected
NV: Not Available
NP: Not Applicable

Table 5-2

Hazardous Groundwater Results (ug/l)

HAZARDOUS SUBCATEGORY

			QID 16018	QID 16031	QID 16032	QID 16034	QID 16036	QID 16094	QID 16095		QID 16136	QID 16141	QID 16144 E4690	
Groundwater														
Pollutant of Interest	Cas #	MDL	Inf	Eff	Eff	Inf	Inf	Eff	Inf	Eff	Inf	Eff	Inf	Eff
1,1-Dichloroethane	75243	10		2		230	113		89	5 ND			121522	10
1,1,1-Trichloroethane	71556	10		5		180	185	1 ND	370	5 ND			37598	10
1,1,2,2-Tetrachloroethane	79345	10					0.5 ND	1 ND					218139	445
1,2,4-Trichlorobenzene	120821	10											265	19 ND
1,2-Dichlorobenzene	95501	10						1 ND					10491	19 ND
1,2-Dichloroethane	107062	10		2			4	1 ND					1E+06	357
1,2,3-Trichloropropane	96184	10											1E+06	138
1,3-Dichlorobenzene	541731	10											16628	19 ND
1,4-Dichlorobenzene	106467	10						1 ND					25655	19 ND
1,4-Dioxane	123911	10				46							6429	3738
2,4-Dichlorophenol	120832	10											101	109 ND
2378-TCDD	1746016	1E-05											0.0002	
2378-TCDF	5E+07	1E-05											0.0066	
2,4,5-T	93765	0.2											5	
2,4,5-TP	93721	0.2											2	
2-Propanone	67641	50											25424	446
Ammonia as Nitrogen	7664417	10											27444	17760
Arsenic	7440382	10										50 ND	80	13
Benzene	71432	10	520	1							4606		37922	10
Benzoic Acid	65850	50											1330	1920
Benzyl Alcohol	100516	10											298	282
Bis(2-chloroethyl)ether	111444	10											16518	34716
Bis(2-ethylhexyl)phthalate	117817	10											1039	19 ND
BOD	C-002	2000			2700								86500	55230
Boron	7440428	100											846	770
Cadmium	7440439	5										3 ND	9	8
Chlorobenzene	108907	10	920	2				1 ND					12936	10
Chloroform	67663	10		2									132025	32
COD	C-004	5000			23600								6E+06	2E+06
Copper	7440508	25											53	521
Dalapon	75990	0.2											109	
Dicamba	1918009	0.2											34	
Dichlorvos	62737	5											236	
Dinoseb	88857	0.5											14	
Dioxathion	78342	5											270	
Ethyl Benzene	100414	10	372	2									14694	10
Hexane Extractable Materia	C-036	5000											2E+06	8750
Hexanoic Acid	142621	10											16368	28013
Lithium	7439932	100											305	219
Methylene Chloride	75092	10		2									123572	40

Table 5-2

Hazardous Groundwater Results (µg/l)

HAZARDOUS SUBCATEGORY

Groundwater			QID 16018	QID 16031	QID 16032	QID 16034	QID 16036	QID 16094	QID 16095		QID 16136	QID 16141	QID 16144 E4690	
Pollutant of Interest	Cas #	MDL	Inf	Eff	Eff	Inf	Inf	Eff	Inf	Eff	Inf	Eff	Inf	Eff
Molybdenum	7439987	10											13	13
Naphthalene	91203	10				54					4100		3766	19 ND
Nickel	7440020	40										10	136	1462
Nitrate/Nitrite	C-005	50										1000 ND	2136	1571
Pentachlorobenzene	608935	20											4333	38 ND
Phenol	108952	10											6029	1537
Silicon	7440213	100											6738	6602
Strontium	7440246	100											17156	12360
TOC	C-012	1000											2E+06	730700
Toluene	108883	10	573	2					19	5 ND	2573		22080	10
Trans-1,2-Dichloroethene	156605	10		5				1 ND					84660	14
Trichloroethene	79016	10		5			5						272606	33
TSS	C-009	4000										37000	121639	26450
Zinc	7440666	20				120							576	3451

MDL: Method detection limit

QID: Questionnaire ID

E: Sampling episode

ND: Non-detect with respect to instrument detection limit (IDL)

*: IDL is greater than detected value

Table 5-2 (continued)

Non-Hazardous Groundwater Results (ug/l)

NON-HAZARDOUS SUBCATEGORY

Groundwater			QID 16016 E4683				QID16085 E4685			QID16088 E4684				QID 16129				QID 16132		QID 16163	
Pollutant of Interest	Cas #	MDL	Inf		Eff		Inf		Eff	Inf		Eff		Inf		Eff		Eff		Eff	
1,1-Dichloroethane	75243	10	10	ND	0.3	ND	5.5			8.6		1		22				0.35	ND	4	ND
1,1,1-Trichloroethane	71556	10	10	ND	0.5	ND	1.4	ND		2.1		1	ND	17				0.45	ND	5	ND
1,2-Dichloroethane	107062	10	10	ND	0.3	ND	1.4	ND		2.1	ND	1	ND	15				0.35	ND	8	
2,4,5-T	93765	0.2	0.2	ND			0.2	ND		2				1	ND						
2,4,5-TP	93721	0.2	0.2	ND	2000	ND	0.2	ND		5				1.9	ND						
2-Propanone	67641	50	50	ND	10.5		50	ND		50	ND			742				1.3			
Ammonia as Nitrogen	7664417	10	1340				1284		256	1300		409		80551		563					
Arsenic	7440382	10	2	ND	16		4.3			3		2		13				11		25	
Benzene	71432	10	10	ND	0.3	ND	1.4	ND	5.7	2.2		1	ND	13				0.35	ND		
Benzyl Alcohol	100516	10	10	ND			10	ND		10	ND			19							
BOD	C-002	2000	14000		1000		1000	ND	751	1000	ND			2E+05		1835					
Boron	7440428	100	173				362			97				1091							
Cadmium	7440439	5	4	ND	18		0.4		19	4	ND	15		5	ND			3.8		2	
Chlorobenzene	108907	10	10	ND	0.5	ND	1.4	ND		2.1	ND	1.5	ND	12				0.35	ND	5	ND
Chloroform	67663	10	10	ND	0.5	ND	1.7			2.1	ND	1	ND	15							
COD	C-004	5000	28000		21637		51000			14000										33300	
Copper	7440508	25	12		38		10	ND		10	ND			53		121		10		2.5	
Dalapon	75990	0.2	0.2	ND			0.2	ND		6											
Dicamba	1918009	0.2	0.2	ND			0.2	ND		10											
Dinoseb	88857	0.5	0.5	ND			0.5	ND		3				50	ND						
Ethyl Benzene	100414	10	10	ND	0.3	ND	1.4	ND		2.1	ND	1	ND	15				0.35	ND	5	ND
Methylene Chloride	75092	10	10	ND	1		3.3	ND		2.1	ND	3.5	ND	49		0.6		0.45			
Naphthalene	91203	10	10	ND	36	ND	10	ND		10	ND			12							
Nickel	7440020	40	14	ND	30		59			14	ND	27		45		21		16		40	
Nitrate/Nitrite	C-005	50	2660				1300			1340										10000	ND
Phenol	108952	10	10	ND	54.5	ND	5718	ND		10	ND			145							
Silicon	7440213	100	3530				3880			3270											
Strontium	7440246	100	201				657			200											
TOC	C-012	1000	10000	ND			40000			10000	ND							3996			
Toluene	108883	10	10	ND	0.3	ND	1.4	ND		2.1	ND	1	ND	47				0.35	ND	5	ND
Trans-1,2-Dichloroethene	156605	10	10	ND	0.3	ND	2.8		5.7	3.6		1	ND	38		0.5	ND	0.35	ND	5	ND
Trichloroethene	79016	10	10	ND	0.35		10	ND		2.1	ND	1	ND	19		0.5		0.45		1	
TSS	C-009	4000	4000	ND			24000		5593	4000	ND			43848		2651					
Zinc	7440666	20	15.2		35		70			16				82		24					

MDL: Method detection limit
QID: Questionnaire ID
E: Sampling episode
ND: Non-detect with respect to instrument detection limit (IDL)
*: IDL is greater than detected value

Table 5-3: Comparision of Untreated Wastewater Charcteristics at Landfills of Varying Age

	Subtitle D Non-Hazardous Municipal		Subtitle C Hazardous	
	Year Landfill Began Accepting Waste		Year Landfill Began Accepting Waste	
Analyte (mg/l)	1971	1986	1968	1980
Ammonia	245	192	460	557
BOD5	1290	1073	955	4250
COD	201	472	2400	1920
TOC	657	1526	799	5850
TSS	200	657	31	111

Note: Samples collected during EPA sampling episodes 1994-95

6.0 WASTEWATER GENERATION AND CHARACTERIZATION

In 1994, under the authority of Section 308 of the Clean Water Act (CWA), the Environmental Protection Agency (EPA) distributed the "Waste Treatment Industry Questionnaire Phase II: Landfills" to 252 facilities that EPA had tentatively identified as possible generators of landfill wastewater. Some of the facilities employed on-site wastewater treatment, others did not. These facilities were selected for survey purposes to represent a total of 1,024 potential generators of landfill wastewater. A total of 220 questionnaire respondents generated landfill leachate in 1992. This section presents information on wastewater generation at these facilities based on the questionnaire responses. In addition, this section also summarizes the information on wastewater characteristics for landfill facilities that were sampled by EPA and for those facilities that provided self-monitoring data.

6.1 Wastewater Generation and Sources of Wastewater

Landfill facilities do not generate "process wastewater" as defined in 40 CFR 122.2 as "any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, by-product, intermediate product, finished product or waste product" in the traditional sense. This definition of process wastewater is used for manufacturing or processing operations; since landfill operations do not include or result in "manufacturing processes" or "products", EPA refers to the wastewater treated at landfill facilities as landfill generated wastewaters.

In general, the types of wastewater generated by activities associated with landfills and collected for treatment, discharge, or reuse are: leachate, landfill gas condensate, truck/equipment washwater, drained free liquids, laboratory derived wastewaters, floor washings, recovering pumping wells, contaminated groundwater, and storm water runoff. For the purposes of the Landfill industry study, all of these wastewater sources are considered "in-scope" except for contaminated groundwater and non-contaminated storm water.

In 1992, approximately 23 billion gallons of wastewater was generated at landfill facilities. Approximately 7.1 billion gallons of this wastewater is considered “in-scope”. The remaining 15.9 billion gallons of wastewater generated at landfills consists of contaminated groundwater and non-contaminated storm water. The primary sources of wastewater at landfills are defined below.

Landfill leachate as defined in 40 CFR 258.2, is liquid that has passed through or emerged from solid waste and contains soluble, suspended, or miscible materials removed from such waste. Over time, the seepage of water through the landfill as a result of precipitation may increase the mobility of pollutants and thereby increase the potential for their movement into the wider environment. As water passes through the layers of waste, it may “leach” pollutants from the disposed waste. This mobility may present a potential hazard to public health and the environment (e.g., groundwater contamination). One measure used to prevent the movement of toxic and hazardous waste constituents from a landfill is a landfill liner operated in conjunction with a leachate collection system. Leachate is typically collected from a liner system placed at the bottom of the landfill. Leachate also may be collected through the use of slurry walls, trenches, or other containment systems. The leachate generated varies from site to site based on a number of factors including the types of waste accepted, operating practices (including shedding, daily cover and capping), the depth of fill, compaction of wastes, annual precipitation, and landfill age. Landfill leachate accounts for over 95 percent of the total volume of in-scope wastewaters.

Landfill gas condensate is a liquid which has condensed in the landfill gas collection system during the extraction of gas from within the landfill. Gases such as methane and carbon dioxide are generated due to microbial activity within the landfill and must be removed to avoid hazardous conditions. The gases tend to contain high concentrations of water vapor which is condensed in traps staged throughout the gas collection network. The gas collection condensate contains volatile compounds and typically accounts for a small portion of flow from a landfill.

Truck/equipment washwater is generated during either truck or equipment washes at landfills. During routine maintenance or repair operations, trucks and/or equipment used within the landfill (e.g., loaders, compactors, or dump trucks) are washed and the resultant washwaters are collected for treatment. In addition, it is common practice in hazardous landfills to wash the wheels, body, and undercarriage of trucks used to deliver the waste to the open landfill face upon leaving the landfill. On-site wastewater treatment equipment and storage tanks also are cleaned periodically and their associated washwaters are collected. Floor washings generated during routine cleaning and maintenance of the facility also are collected for treatment.

Drained free liquids are aqueous wastes drained from waste containers (e.g., drums, trucks, etc.) or wastewater resulting from waste stabilization prior to landfilling. Landfills that accept containerized waste may generate this type of wastewater. Drained free liquids are collected and usually combined with other landfill generated wastewaters for treatment at the wastewater treatment plant.

Laboratory-derived wastewater is generated from on-site laboratories which characterize incoming waste streams and monitor on-site treatment performance. This source of wastewater is minimal and is usually combined with leachate and other wastewaters and treated at the wastewater treatment plant.

Contaminated storm water is runoff that comes in direct contact with the solid waste, waste handling and treatment areas, or wastewater flows that are covered under this rule. Storm water that does not come into contact with these areas was not considered to be within the scope of this study.

Landfill operations also generate and discharge wastewaters that are considered out of the scope of the proposed regulation. These sources include contaminated groundwater and non-contaminated storm water. The exclusion of these flows is discussed in Chapter 2: Scope of the Regulation. A brief description of these wastewaters is presented below.

Contaminated groundwater is water below the land surface in the zone of saturation that has been contaminated by landfill leachate. Contaminated groundwater occurs at landfills without liners or at facilities that have released contaminants from a liner system and is then collected and treated by landfills. Groundwater also can infiltrate the landfill or the leachate collection system if the water table is high enough to penetrate the landfill area.

Non-contaminated (non-contact) storm water includes storm water that flows off the cap or cover of the landfill and does not come in direct contact with solid waste, waste handling and treatment areas, or wastewater flows which are covered under this rule.

These landfill generated waste streams are considered out of the scope of the landfills regulations for the following reasons. EPA found that pollutants in contaminated groundwater flows are treated to very low levels prior to discharge. Therefore, it was concluded that, whether as a result of corrective action measures taken pursuant to Resource Conservation and Recovery Act (RCRA) authority or State action to clean up contaminated landfill sites, landfill discharges of treated contaminated groundwater are being adequately controlled, and that further regulation under this proposed rule would be redundant and unnecessary. As for non-contaminated storm water, this runoff includes storm water that flows off the cap or cover of the landfill and does not come in direct contact with the waste. Therefore, this wastewater is considered out of the scope of landfill regulation because it is already covered by other EPA regulations.

Many landfill facilities, particularly hazardous landfills, commingle waste streams such as contaminated groundwater, non-contaminated storm water, or process wastewater from on-site industrial operations with in-scope landfill generated wastewaters prior to or after treatment. These out-of-scope waste streams are not included as wastewater sources reviewed for effluent limitations guidelines and standards for this rulemaking. The flow monitoring data received from facilities with commingled waste streams were reviewed to determine if the discharge streams included out-of-scope wastewater. In cases where the waste streams included greater than 15 percent out-of-scope wastewater, the monitoring data were not used to characterize landfill generated wastewater.

6.2 Wastewater Flow and Discharge

Tables 6-1 and 6-2 present national estimates of the flows for primary wastwater sources found at landfills reported in Section A of the Waste Treatment Industry 308 Questionnaire Phase II: Landfills. A brief discussion of national estimates and how these estimates are calculated is presented in Chapter 3, Section 3.2.1. The flows in both tables are reported by subcategory: Non-Hazardous (broken down into Subtitle D municipal solid waste and non-municipal solid waste facilities) and Hazardous; and by discharge type: direct, indirect, and zero.

Direct discharge facilities are those that discharge their wastewaters directly into a receiving stream or body of water. Based on national estimates, there were no direct discharging hazardous landfills identified in the Landfills industry study; therefore, this discharge type has been omitted from the Hazardous subcategory on Table 6-1 and is reported as a zero on Table 6-2. Indirect discharging facilities discharge their wastewater indirectly to a publicly-owned treatment works (POTW). Zero or alternative discharge facilities use treatment and disposal practices that result in no discharge of wastewater to surface waters. Disposal options for landfill generated wastewater include off-site treatment at another landfill wastewater treatment system or a Centralized Waste Treatment facility, deep well injection, incineration, evaporation, land application, and recirculation back to the landfill.

Table 6-1 presents wastewater flows by subcategory and discharge type for the different types of wastewater generated by landfills in 1992. Total flows are reported for wastewaters treated on-site and off-site, discharged untreated to a POTW or surface water, and recycled flows that are put back into the landfill. Wastewater flows identified as "Other" treatment include evaporation, incineration, or deep well injection. The national estimates presented in Tables 6-1 and 6-2 are based on 176 of the 220 facilities that generate and treat landfill leachate; the remaining 44 facilities are excluded from the proposed landfill regulation as discussed in Chapter 2.

In-scope wastewater flows from Table 6-1 were combined and presented in Table 6-2. Table 6-2 does not include out-of-scope flows from contaminated groundwater or storm water. National estimates are presented for the in-scope wastewater flows and the associated number of non-hazardous and hazardous facilities by subcategory and discharge type.

6.2.1 Wastewater Flow and Discharge at Subtitle D Non-Hazardous Landfills

Approximately 6.7 billion gallons of in-scope wastewater were generated at non-hazardous landfills in 1992. Flows collected from leachate collection systems are the primary source of wastewater, accounting for over 98 percent of the in-scope wastewaters generated at non-hazardous landfills.

Landfill facilities have several options for the discharge of their wastewaters. EPA estimates that there are 158 Subtitle D non-hazardous facilities discharging wastewater directly into a receiving stream or body of water, accounting for 1.2 billion gallons per year. In addition, there are 762 facilities discharging wastewater indirectly to a POTW, accounting for 4.5 billion gallons per year.

Also, there are a number of facilities which use treatment and disposal practices that result in no discharge of wastewater to surface waters. The Agency estimates that there are 343 of these zero or alternative discharge facilities. Several zero discharge or alternative facilities in the Non-Hazardous subcategory recycle wastewater flows back into the landfill. The recirculation of leachate is generally believed to encourage the biological activity occurring in the landfill and accelerate the stabilization of the waste. The recirculation of landfill leachate is not prohibited by federal regulations, although many states have prohibited the practice. EPA estimates that 349 million gallons per year are recirculated back to Subtitle D non-hazardous landfill units.

6.2.2 Wastewater Flow and Discharge at Subtitle C Hazardous Landfills

Approximately 367 million gallons of in-scope wastewater were generated at hazardous landfills in 1992. Flows collected from leachate collection systems are the primary source of wastewater, accounting for approximately 74 percent of the in-scope wastewaters generated at hazardous landfills, and 24 percent of the flows are generated by routine maintenance activities such as truck/equipment washing and floor washing.

Landfill facilities have several options for the discharge of their wastewaters. EPA's survey of the Landfills industry did not identify any hazardous landfills covered by the proposed guideline which discharge in-scope wastewaters directly to surface waters. EPA estimates that there are 6 facilities discharging wastewater indirectly to a POTW, accounting for 40 million gallons per year.

The Agency estimates that 141 hazardous landfill facilities use zero or alternative discharge disposal options. EPA estimates that 103 facilities ship wastewater off-site for treatment, often to a treatment plant located at another landfill or to a Centralized Waste Treatment facility. Shipping off-site accounts for 9 million gallons per year of wastewater. Another 37 facilities use underground injection for disposal of their wastewaters, accounting for 312 million gallons per year; and 1 facility solidifies less than 0.1 million gallons per year of landfill wastewater.

6.3 Wastewater Characterization

The information reported in this section was collected through the EPA sampling program and data supplied by the Landfills industry via technical questionnaires. EPA sampling programs consisted of five-day events at landfills with selected BAT treatment systems (where the raw leachate and treatment system points were sampled) as well as one-day events to characterize raw leachate quality at selected types of landfill facilities. Industry provided data, as supplied in the Detailed Questionnaire and in the Detailed Monitoring Questionnaire responses, were also used to characterize landfill generated wastewaters. In addition, data collected as part of the Centralized Waste Treatment Industry study (see reference 31) and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) groundwater study (see reference 25) were used in the characterization of the wastewaters from hazardous landfill facilities. These data sources are discussed in detail in Chapter 4 as well as the QA/QC procedures and editing rules used to evaluate these data. The raw wastewater Master File then was developed for each subcategory by combining the influent data from all of the available data sources to characterize the raw wastewater by subcategory.

This section presents background information on the types of wastewaters generated at landfill facilities and the factors that affect the wastewater characteristics, pollutant parameters analyzed and detected at EPA sampling episodes, the methodology for developing the Master File, and the pollutant parameters identified in typical landfill generated wastewaters along with the minimum and maximum concentrations of these pollutants. This section also presents available literature data on the wastewater characteristics of Non-Hazardous subcategory landfill generated wastewaters.

6.3.1 Background Information

Landfill generated wastewaters are composed of several wastewater sources that have been discussed in Section 6.1, including landfill leachate, landfill gas condensate, truck/equipment washwater, drained free liquids, laboratory-derived wastewater, floor washings, recovering pumping wells, contaminated groundwater, and storm water runoff. Wastewaters within the scope of the proposed landfill regulation include the above mentioned sources with the exception of contaminated groundwater and non-contaminated storm water. The primary sources of in-scope landfill generated wastewater are discussed below.

6.3.1.1 Landfill Leachate

Leachate is the liquid which passes through or emerges from solid waste, and contains soluble, suspended, or miscible materials removed from such waste. Leachate quality is affected by several factors that vary depending on each individual landfill, including:

- types of waste accepted/deposited
- operating practices (shredding, cover, and capping)
- amount of infiltration
- depth of fill
- compaction
- age

Waste types received for disposal are the most representative characteristic of a landfill and, therefore, of the wastewater generated, since the main contaminants in the wastewater are derived from the materials deposited into the fill (see Chapter 5: Industry Subcategorization). Infiltration and age primarily affect the concentration level of contaminants in the leachate. The remaining factors mainly influence the rate of infiltration.

Characterization of landfill leachate is a function of both the concentration of contaminants in the leachate and the volume of leachate generated. On a relative basis, the highest concentrations of contaminants are typically present in the leachates of new or very young landfills. However, the amount (i.e., the mass) of pollutants are not necessarily the highest in the life of a landfill because new landfills generally generate low volumes of leachate. As the volume of waste approaches the field capacity of the landfill and the production of leachate increases, both the pollutant loadings (mass x concentrations) and the concentrations of certain contaminants (mostly organic pollutants) increase. The concentration increase is attributed to the onset of decomposition activities within the landfill and to the leachate traversing the entire depth of refuse. Therefore, the largest expected loadings of contaminants from a typical landfill result during a period of high leachate production and high contaminant levels (see reference 13). The exact periods of varying leachate production cannot be quantified readily but are site-specific and dependent on each of the above variables.

Over a period of time (as the landfill ages and leaching continues) the concentration of contaminants in the leachate decreases (see reference 13). Substantial quantities of leachate may continue to be produced by the landfill; however, loadings are lower due to the lower concentrations of contaminants remaining in the landfill. As decomposition of the landfill continues, a stabilized state of equilibrium is attained where further leaching produces leachate with lower loadings than during the period of peak leachate production. This stabilized state is presumably the result of decomposition of landfill waste by indigenous microorganisms, which will remove many of the contaminants usually susceptible to further leaching.

Biological decomposition of landfill municipal refuse has been examined by many researchers and has been modeled after the anaerobic breakdown of other organic wastes. The following discussion of the decomposition process has been adapted from a report on the characteristics of landfill leachate prepared by the Wisconsin Department of Natural Resources (see reference 13).

Biological activity occurs in a landfill shortly after deposition of organic material. At first, wastes high in moisture content decompose rapidly under aerobic conditions, creating large amounts of heat. As oxygen is depleted, the intermediate anaerobic stage of decomposition begins. This change from aerobic to anaerobic conditions occurs unevenly through the landfill and depends upon the rate of oxygen diffusion in the fill layers. The first stage of anaerobic decomposition converts complex organic wastes to soluble organic molecules. This solubilization is performed by extracellular enzymes. Once the organics are solubilized, the second stage of anaerobic decomposition converts them to simple organic molecules, the most common of which are organic acids (such as acetic, propionic, and butyric acids). Leachate percolating through a landfill can amass these organic acids, resulting in decreased pH of the leachate and increasing oxygen demand. Anaerobic activity also can lower the reduction oxidation (redox) status of the wastes which, under low pH conditions, can cause an increase in inorganic contaminants. Eventually, bacteria within the landfill begin converting the organic acids to methane. The removal of organic acids from the landfill increases the pH of the leachate which can lead to a decrease in the solubility of inorganic contaminants, lowering inorganic concentrations in the leachate.

A landfill's age or degree of decomposition may, in certain circumstances, be ascertained by observing the concentration of various leachate indicator parameters, such as BOD_5, TDS, or the organic nitrogen concentration. The concentrations of these leachate indicator parameters can vary over the decomposition life of a landfill. Using these indicator parameters alone does not take into account any refuse-filling variables, such as processing and fill depth. To compensate for these additional variables, ratios of leachate parameters over time were examined by researchers (see reference 13). One such ratio is the ratio of BOD_5 to COD in the leachate. Leachates from younger landfills typically exhibit BOD_5 to COD ratios of approximately 0.8, while older landfills exhibit a ratio as low as 0.1. The decline in the BOD_5 to COD ratio with age is due primarily to the readily decomposable material (phenols, alcohols) degrading faster than the more recalcitrant compounds (heavy molecular weight organic compounds). As a result, the BOD_5 of the leachate will decrease faster than the COD as the landfill ages. Other ratios examined that reportedly decrease over time include: volatile solids to fixed solids, volatile acids to TOC, and sulfate to chloride (see reference 13).

It is common to find that the sum of individual organic contaminants does not always match the measured TOC and/or COD value. As demonstrated by data collected by EPA for this guideline, the sum of the individual organic pollutants represent only a certain percentage of the TOC and/or COD value, as shown in Tables 6-7, 6-8, 6-9, and 6-11 presented later in this chapter. Compounds that comprise this difference are not always readily identified due to the complex nature of leachate and due to the presence of other organic compounds found in leachate. A myriad of organic compounds exist in decomposing refuse and most of the organics in leachate are soluble. Reportedly, free volatile acids constitute the main organic fraction in leachate (see reference 13). However, other organic compounds have been identified in landfill leachates including carbohydrates, proteins, and humic and fulvic-like substances. Gaps in mass balance results are typically attributed to these compounds.

Responses to EPA's Detailed Questionnaire indicate that 1,659 in-scope landfills collect leachate at a mean daily flow of 14,000 gallons per day. In 1992, approximately 6.9 billion gallons of landfill leachate were generated by landfills in the United States. Of this 6.9 billion gallons, approximately 1.7 billion gallons were treated on-site, 475 million gallons were treated off-site, 3.6 billion gallons were sent untreated to POTWs, 417 million gallons were sent untreated to a surface water, 350 million gallons were recycled back to the landfill, and 358 million gallons were treated or disposed by other methods.

6.3.1.1.1 <u>Additional Sources of Non-Hazardous Leachate Characterization Data</u>

Various sources of non-hazardous landfill leachate characteristics exist in published literature. Most of these are from studies taken at an isolated range of municipal landfills in the 1970s and 1980s. Data presented in these reports on leachate characteristics are typically expressed in ranges due the variability of the results. The range of values, as well as the lack of specific information on factors affecting leachate results (e.g., sampling methods, analytical methods, landfill waste types, etc.) limit the usefulness of these data. However, these data are mentioned as additional background information in support of EPA's characterization activities. Table 6-3 presents a summary of available municipal leachate characteristic data from the following sources:

- Five published papers: George, 1972; Chian and DeWalle, 1977; Metry and Cross, 1977; Cameron, 1978; and Shams-Korzani and Henson, 1993.
- McGinley, Paul M. and Kmet, P. "Formation, Characteristics, treatment and Disposal of Leachate from Municipal Solid Waste Landfills." Wisconsin Department of Natural Resources Special Report, August 1984, and
- Sobotka & Co., Inc. Case history data compiled and reported to U.S. EPA's Economic Analysis Branch, Office of Solid Waste, July 1986.

The variability and high pollutant concentrations in older landfill leachate characterization data can be attributed to landfills that accepted waste prior to the enactment of RCRA in 1980. Landfills in operation prior to this date may have disposed of a multitude of different industrial and/or toxic wastes in addition to municipal solid waste. The disposal of these high-strength wastes could account for the large variability observed in leachate characteristics data collected from municipal landfills in this period. After the promulgation of RCRA, controls were established that specified the type and characteristics of wastes that may be received by either a hazardous (Subtitle C) or non-hazardous (Subtitle D) facility (see Chapter 3: Section 3.1 for the discussion on regulatory history). Control measures, such as leachate collection systems, also have been mandated under RCRA for both types of landfills. By instituting the acceptance criteria and leachate control standards under RCRA, the characteristics of the leachate from both hazardous and non-hazardous landfills will not vary as greatly as observed in landfills prior to 1980. The smaller concentration range for pollutants from landfills in operation since RCRA became effective is supported by the data collected by EPA. Whereas pollutant variability was observed in EPA data, it was not as great as found in the literature data collected from older facilities. Data collected as part of the Landfill Rulemaking effort were within the specified ranges as found in previous literature sources, however, this data did not exhibit the large variability that is indicative of older pre-RCRA landfill operations.

6.3.1.2 Landfill Gas Condensate

Landfill gas condensate forms in the collection lines used to extract and vent/treat landfill gas. Condensate collects at low points in the system and is usually removed by pumping to the on-site wastewater holding tank or treatment system. Responses to EPA's Detailed Questionnaire indicate that 158 landfills collect landfill gas condensate at a mean daily flow of 510 gallons per day. In 1992, approximately 23 million gallons of landfill gas condensate were generated by landfills in the United States. Of this 23 million gallons, approximately 20 million gallons were treated on-site, 1.7 million gallons treated off-site, and 0.8 million gallons were sent untreated to POTWs. Of the 155 facilities collecting gas condensate, 66 commingle condensate with leachate for treatment on-site, 79 facilities do not treat the condensate on-site, and 10 facilities treat landfill gas condensate separately from other landfill generated wastewaters.

Landfill gas condensate represents a small amount of the total wastewater flow volume for the industry. Hazardous waste landfills produce 9 million gallons/year of gas condensate, or about 3 percent of the leachate flow volume. Municipal waste landfills produce 14 million gallons/year of gas condensate, or about 0.2 percent of the leachate flow volume.

Of the 37 respondents to the Detailed Questionnaire that collect landfill gas condensate, five facilities treat the condensate separately from leachate. Types of condensate treatment include equalization, neutralization, oil-water separation, GAC, and air stripping. All five facilities discharged the treated waste stream indirectly to a POTW. Table 6-4 presents landfill gas condensate monitoring data provided in the Detailed Questionnaire from two facilities that collect and treat landfill gas condensate separately from other landfill generated wastewaters. Facility 16012 presented landfill gas condensate monitoring data after treatment by hydrocarbon/aqueous phase separation and caustic neutralization, and facility 16015 presented monitoring data after treatment by equalization, caustic neutralization, and carbon adsorption.

6.3.1.3 Truck and Equipment Washwater

Truck and equipment washwater is generated during either truck or equipment washes at the landfill. Depending on the type and usage of the vehicle/equipment cleaned and the type of landfill, the washwater volume and characteristics can vary greatly. For hazardous and non-hazardous landfill facilities, washwaters will typically be more dilute in strength in comparison to typical leachate characteristics and contain mostly solids. Contaminants in the washwater are attributed to the insoluble solids, consisting of mostly inorganics, metals, and low concentrations of organic compounds. Since truck and equipment washwaters tend to contain the same constituents as the waste being landfilled, and are similar in characteristic to the landfill leachate, they are typically combined for treatment with leachate and other landfill generated wastewaters.

Responses to EPA's Detailed Questionnaire indicate that 356 in-scope landfills collect truck and equipment washwater at a mean daily flow of 864 gallons per day. In 1992, approximately 102 million gallons of truck and equipment washwater were generated by landfills in the United States. Of this 102 million gallons, approximately 38 million gallons were treated on-site, 9 million gallons were sent untreated to POTWs, 1.5 million gallons were either treated off-site, recycled back to the landfill, or sent untreated to a surface water, and 53 million gallons were treated or disposed by other methods.

6.3.1.4 Drained Free Liquids

Drained free liquids are liquids drained from containerized waste prior to landfilling. Wastewater characteristics and volume of drained free liquids vary greatly depending upon the contents and origin of the waste. However, they will have the characteristics of the containerized waste and, therefore, similar characteristics to landfill leachate. This also is true of other wastewaters generated by waste processing activities, such as waste stabilization. Waste stabilization includes the chemical fixation or solidification of the solid waste. Wastewaters generated from these activities include decant from the waste treated and any associated rinse waters. These waste processing wastewaters are collected separately and are then combined with leachate and other landfill operation wastewaters for treatment at the wastewater treatment facility.

Responses to EPA's Detailed Questionnaire indicate that 25 in-scope landfills collect drained free liquids at a mean daily flow of 5 gallons per day. In 1992, approximately 0.6 million gallons of drained free liquids were generated by landfills in the United States. Of this 0.6 million gallons, approximately 521,000 gallons were recycled back to the landfill and 47,000 gallons were treated or disposed by other methods.

6.3.2 Pollutant Parameters Analyzed at EPA Sampling Episodes

The EPA conducted 19 sampling episodes at 18 landfill facilities. Five episodes were conducted at hazardous landfill facilities and 13 at non-hazardous facilities. One-day sampling episodes were conducted for the purpose of collecting raw wastewater samples to characterize landfill generated wastewaters. Samples collected during the week-long sampling episodes included raw wastewater samples as well as intermediate and effluent samples to evaluate the entire wastewater treatment system. Chapter 4 discusses these data collection activities in further detail.

Table 6-5 presents the pollutants analyzed at the one-day and week-long sampling episodes. A total of 470 pollutants were analyzed for in the raw wastewater, intermediate, and treated effluent waste stream samples, including 232 toxic and nonconventional organic compounds, 69 toxic and nonconventional metals, 4 conventional pollutants, and 165 toxic and nonconventional pollutants including pesticides, herbicides, dioxins, and furans. The list of pollutants analyzed are included under the following analytical methods: method 1613 for dioxins/furans; method 1620 for metals; method 1624 for volatile organics; method 1625 for semivolatile organics; and methods 1656, 1657, and 1658 for pesticides/herbicides, as well as classical wet chemistry methods.

Table 6-6 presents the list of pollutants analyzed at EPA sampling episodes by subcategory and episode number and whether they were detected in the facility's raw wastewater. If a pollutant was not detected it is reported on the table as ND, if a pollutant was detected it is reported as a blank, and pollutants that were not sampled are represented by a dash.

Composite samples were collected at the week-long sampling events at episodes 4626, 4667, 4687, 4690, 4721, and 4759; grab samples were collected at the remaining 11 one-day sampling events. A preliminary list of pollutants of interest was developed by reducing the list of 470 pollutants by the number of pollutants that were never detected at any facility in a subcategory. For the Non-Hazardous subcategory, a total of 316 pollutants were analyzed for but never detected in the raw wastewater at Subtitle D municipal facilities, and 324 pollutants were never detected in the raw wastewater at Subtitle D non-municipal facilities. For the Hazardous subcategory, a total of 250 pollutants were never detected in the raw wastewater. Therefore, out of the 470 pollutants initially analyzed for, a total of 154 pollutants were detected at least once at Subtitle D municipal facilities; 146 pollutants were detected at least once at Subtitle D non-municipal facilities; and 220 pollutants were detected at least once at hazardous facilities. Using the editing criteria which is presented in detail in Chapter 7, this preliminary list of pollutants of interest was reduced to the final list of 33 pollutants of interest for the Non-Hazardous subcategory (32 pollutants of interest for Subtitle D municipal facilities and 10 pollutants of interest for Subtitle D non-municipal facilities); and 63 pollutants of interest for the Hazardous subcategory. These pollutants are presented on Tables 6-7 and 6-8 and are discussed further below.

6.3.3 Raw Wastewater Characterization Data

EPA compiled raw wastewater sampling data obtained from the following sources: EPA sampling; the Detailed Questionnaire; the Detailed Monitoring Questionnaire; the CERCLA groundwater database; and the Centralized Waste Treatment Industry (CWT) database in order to characterize wastewater from the Landfills industry.

EPA then reviewed each data source to determine if the data was representative of landfill generated wastewater. First, EPA selected only those sample points corresponding to raw wastewater by reviewing treatment flow diagrams and sampling programs at each landfill facility. Second, EPA used several criteria to eliminate sampling data not considered representative of raw landfill wastewaters. Only those data collection points which sampled wastewaters containing at least 85 percent leachate and/or gas condensate were included in the characterization study. In this way, facilities that sampled wastestreams containing mostly storm water or sanitary wastewaters were eliminated. Also, any sample point containing industrial process wastewater was eliminated. This eliminated the possibility of finding pollutants that may not have originated in a landfill.

Next, EPA grouped all data points according to the classification of the landfill, e.g. municipal solid waste, hazardous waste, or Subtitle D non-municipal solid waste. Tables 6-9 through 6-11 present the range of all values compiled for raw wastewaters, listed by landfill type.

In several instances, EPA conducted sampling at a facility that also provided data in the technical questionnaires. In these cases, EPA compiled all data at that landfill from the different sources to obtain one average concentration for each pollutant at each landfill. The median concentration of each landfill average concentration was then calculated to determine the median industry raw wastewater concentrations. These median values are presented in Tables 6-7 and 6-8 as the raw wastewater Master File.

6.3.4 Conventional, Toxic, and Selected Nonconventional Pollutant Parameters

The Clean Water Act defines different types of pollutant parameters used to characterize raw wastewater. These parameters include conventional, nonconventional, and toxic pollutants. Conventional pollutants found in landfill generated wastewaters include:

- Total Suspended Solids (TSS)
- 5-day Biochemical Oxygen Demand (BOD_5)
- pH
- Oil and Grease (measured as Hexane Extractable Material)

Total solids in wastewater is defined as the residue remaining upon evaporation of the liquid at just above its boiling point. TSS is the portion of the total solids that can be filtered out of solution using a 1 micron filter. Raw wastewater TSS in leachate is a function of the type and form of wastes accepted for disposal at landfill facilities. The concentration of TSS also is influenced by the landfill design and operational parameters such as depth of fill, compaction, and capping. BOD_5 is one of the most important gauges of pollution potential of a wastewater and varies with the amount of biodegradable matter that can be assimilated by biological organisms under aerobic conditions. The nature of the chemicals contained in landfill generated wastewaters affects the BOD_5 due to the differences in susceptibility of different molecular structures to microbiological degradation. Landfill generated wastewater containing compounds with lower susceptibility to decomposition by microorganisms tend to exhibit lower BOD_5 values, even though the total organic loading may be much higher as compared to wastewaters exhibiting substantially higher BOD_5 values. For example, a landfill generated wastewater may have a low BOD_5 value while at the same time exhibiting a high TOC or COD concentration. Raw wastewater BOD_5 values can vary depending on the waste deposited in the landfill and the landfill age, as noted previously in Section 6.3.1.1.

The pH of a solution is a unitless measurement which represents the acidity or alkalinity of a wastewater stream (or aqueous solution) based on the disassociation of the acid or base in the solution into hydrogen (H^+) or hydroxide (OH^-) ions, respectively. Raw wastewater pH can be a function of the waste deposited in a landfill but can vary depending on the conditions within the landfill, as noted previously in Section 6.3.1.1. Fluctuations in pH are controlled readily by equalization followed by neutralization. Control of pH is necessary to achieve proper removal of pollutants in treatment systems such as metals precipitation and biological treatment systems.

Oil and grease also may be present in selected landfill generated wastewaters. Proper control of oil and grease is important because it can interfere with the operation of certain wastewater treatment system processes such as chemical precipitation and the settling operations in biological systems. If it is not removed prior to discharge, excessive levels of oil and grease can interfere with the operation of POTWs and can create films along surface waters, disrupting the biological activities in those waterways.

Table 6-9 presents observed minimum and maximum concentration data for TSS, BOD_5, and oil and grease for each landfill subcategory and the observed minimum and maximum values for pH. The minimum and maximum values presented for each pollutant were obtained from the Source File for both subcategories. The Source File reports the facility average for each pollutant in a subcategory, and contains many pollutants which were detected at least once in a subcategory but were not necessarily selected as pollutants of interest.

Certain classical nonconventional pollutants often are grouped with conventional pollutants (as defined by the Clean Water Act) for the purposes of raw wastewater characterization. These pollutant parameters include: ammonia as nitrogen, nitrate/nitrite, total dissolved solids, total organic carbon, total phenols, chemical oxygen demand, amenable cyanide, and total phosphorus. All of these pollutants are pollutants of interest with the exception of total phosphorus. For the purposes of presenting raw wastewater characterization data, these nonconventional pollutants have been included with the conventional pollutants for each landfill subcategory in Table 6-9.

6.3.5 Toxic Pollutants and Remaining Nonconventional Pollutants

Table 6-10 presents the metals data for raw wastewaters from the two subcategories: Non-Hazardous and Hazardous. A wide range of metals were detected in raw wastewaters from landfill facilities in both subcategories including both toxic pollutant and nonconventional pollutant metals.

Table 6-11 presents the organic toxic and nonconventional pollutant data for the two subcategories. A wide range of organic pollutants were detected in raw wastewaters at landfill facilities in the Non-Hazardous and Hazardous subcategories. Many of these are common organic pollutants found in municipal or commercial waste.

6.3.6 Raw Wastewater at Subtitle D Non-Hazardous Landfills

6.3.6.1 Raw Wastewater at Subtitle D Non-Hazardous Landfills: Municipal

Raw wastewater generated at Subtitle D municipal landfills contained a range of conventional, toxic, and nonconventional pollutants. These wastewaters also contained significant concentrations of common nonconventional metals such as iron, magnesium, and manganese. These metals are naturally occurring elements found in raw water, and the presence of these metals in landfill raw wastewater can be attributed to background levels in the water source used at the facility. Any change between the influent and effluent concentrations of these metals are impacted by the addition of treatment chemicals that contain these metals and, therefore, were not considered as pollutants of interest. Generally, concentrations of toxic heavy metals were found at relatively low concentrations. EPA did not find toxic metals such as arsenic, cadmium, mercury, and lead at treatable levels in any of EPA's sampling episodes. Typical organic pollutants found in leachate included 2-butanone (methyl ethyl ketone) and 2-propanone (acetone) which are common solvents used in household products (such as paints and nail polish) and common industrial solvents such 4-methyl-2-pentanone and 1,4-dioxane. Trace concentrations of only a few pesticides were detected in wastewaters from municipal landfills. Additionally, the wastewater was characterized by high loads of organic acids such as benzoic acid and hexanoic acid resulting from anaerobic decomposition of solid waste.

EPA identified 32 pollutants of interest for Subtitle D municipal landfills including: eight conventional/nonconventional pollutants, six metals, 16 organics and pesticides/herbicides, and two dioxins/furans. Three hundred and sixteen pollutants were never detected in EPA sampling episodes, and approximately 122 pollutants were detected but were not considered to be above the minimum level.

6.3.6.2 Raw Wastewater at Subtitle D Non-Hazardous Landfills: Non-Municipal

A subset of the Subtitle D Non-Hazardous landfill subcategory is Subtitle D non-municipal. These types of landfills do not accept typical municipal solid waste or household refuse; rather, these facilities accept a number of different types of non-hazardous, non-municipal solid wastes. Waste incinerator ash, industrial non-hazardous wastes and sludges, wastewater treatment plant sludge, yard waste, or construction and demolition (C&D) wastes.

EPA identified 10 pollutants of interest for Subtitle D non-municipal landfills including: eight conventional/nonconventional pollutants, one metal, and one pesticide/herbicide. Three hundred twenty-four pollutants were never detected in EPA sampling episodes, and 136 pollutants were detected but were not considered to be above the minimum level.

Many non-hazardous non-municipal facilities accept two or more of the non-municipal waste types discussed above. Certain unique facilities accept only one type of waste and are referred to as "monofills". Because of the unique nature of these monofills, EPA performed an analysis to determine if significant differences existed in raw wastewater characteristics from Subtitle D municipal landfills and these monofill facilities. However, characterization and treatment data collected as part of EPA's sampling episodes focused primarily on the more prevalent Subtitle D municipal landfills. To complete this analysis, additional data on raw wastewaters from monofill facilities were collected from several sources including prior EPA studies (see Chapter 5, Section 5.3.1 for discussion of these studies) and industry supplied data. These data were evaluated to identify any pollutants found at significant concentrations in monofills which were not found in Subtitle D municipal landfills.

Based on a review of these data sources, EPA observed that the pollutants present in raw wastewaters from monofills were not significantly different from those found in Subtitle D municipal landfills, and, in fact, only a subset of Subtitle D municipal landfill pollutants of interest were found in raw wastewaters from these monofill facilities. In addition, concentrations of virtually all pollutants found in ash, sludge, and C&D waste monofills were significantly lower than those found in raw wastewaters from Subtitle D municipal landfills (see Table 5-1, Chapter 5). As discussed in Chapter 11, EPA proposes to establish equivalent effluent limitations for all Subtitle D non-hazardous landfills.

6.3.6.3 Dioxins and Furans in Raw Wastewater at Subtitle D Non-Hazardous Landfills

There are 210 isomers of chlorinated dibenzo-p-dioxins (CDD) and chlorinated dibenzofurans (CDF). EPA is primarily concerned with the 2,3,7,8-substituted congeners, of which 2,3,7,8-TCDD is considered to be the most toxic and is the only one that is a toxic pollutant. Non 2,3,7,8-substituted congeners are considered less toxic in part, because they are not readily absorbed by living organisms. Dioxins and furans may be formed as by-products in certain industrial unit operations related to petroleum refining, pesticide and herbicide production, paper bleaching, and production of materials involving chlorinated compounds. Dioxins and furans are not water-soluble and are not expected to leach out of non-hazardous landfills in significant quantities.

As part of EPA sampling episodes at 13 non-hazardous landfills, raw wastewater samples were collected, and a total of 17 congeners of dioxins and furans were analyzed. The results of the data analyses are presented in Table 6-12. Additional raw leachate data from previous EPA studies (see Chapter 5, Section 5.3.1) were analyzed from ash monofills. EPA found low levels of OCDD, HpCDD, and HxCDD in raw wastewaters at several landfills. The most toxic dioxin congener, 2,3,7,8-TCDD, was never detected in raw wastewater at a Subtitle D landfills. All concentrations of dioxins and furans in raw, untreated wastewater were well below the Universal Treatment Standards proposed for FO39 wastes (multi-source leachate) in 40 CFR 268.1, which establish minimum concentration standards based on an acceptable level of risk. At the concentrations found in raw landfill wastewaters, dioxins and furans are expected to partition to the biological sludge as part of the proposed BPT/BAT treatment technologies. Partitioning of dioxins and furans to the sludge was included in the evaluation of treatment benefits and water quality impacts. EPA sampling data and calculations conclude that the concentrations of dioxins and furans present in the wastewater would not prevent the sludge from being redeposited in a non-hazardous landfill.

6.3.7 Raw Wastewater at Subtitle C Hazardous Landfills

Raw wastewaters from Subtitle C hazardous landfills also were characterized through EPA sampling episodes and industry supplied data obtained through the Detailed Questionnaires. Wastewater generated at Subtitle C landfills contained a wide range of conventional, toxic, and nonconventional pollutants at treatable levels. There was a significant increase in the number of pollutants found in raw wastewaters at hazardous landfills compared to non-hazardous landfills. Pollutants which were common to both untreated non-hazardous and hazardous wastewaters were generally an order of magnitude higher in hazardous landfill wastewater. The list of pollutants of interest for the Hazardous subcategory (presented in Table 6-8), which includes 63 parameters, reflects the more toxic nature of hazardous landfill wastewater and the wide range of industrial waste sources.

Pollutants typical of raw leachate from hazardous facilities included higher levels of arsenic, chromium, copper, nickel, and zinc than those concentrations found at Subtitle D facilities. Cadmium, lead, and mercury were not detected at treatable concentrations in the raw wastewater for any of the hazardous landfills sampled during EPA sampling episodes.

EPA identified a total of 63 pollutants of interest for Subtitle C hazardous landfills including: 11 conventional/nonconventional pollutants, 11 metals, 37 organics and pesticides/herbicides, and four dioxins/furans. Two hundred fifty pollutants were never detected in EPA sampling episodes, and approximately 157 pollutants were detected but were not considered to be present at above the minimum level.

6.3.7.1 Dioxins and Furans in Raw Wastewater at Subtitle C Hazardous Landfills

As part of EPA sampling episodes at two in-scope Subtitle C landfills and two in-scope pre-1980 industrial landfills, raw leachate samples were collected, and a total of 17 congeners of dioxins and furans were analyzed. The results of these analyses are presented in Table 6-13. Again, EPA did not detect the most toxic dioxin congener, 2,3,7,8-TCDD, at an in-scope hazardous/industrial landfill. EPA found low levels of several congeners in raw wastewaters at many of the sampled landfills. Low levels of OCDD, OCDF, HpCDD, and HpCDF were detected in over half of the landfills sampled. However, all concentrations of dioxins and furans in raw, untreated wastewater were well below the Universal Treatment Standards proposed for F039 wastes (multi-source leachate) in 40 CFR 268.1, which establish minimum concentration standards based on an acceptable level of risk. At the concentrations found in raw landfill wastewaters, dioxins and furans are expected to partition to the biological sludge as part of the proposed BPT/BAT/PSES treatment technologies. Partitioning of dioxins and furans to the sludge was included in the evaluation of treatment benefits and water quality impacts.

Table 6-1: Wastewater Generation in 1992: Hazardous Subcategory (gallons)

Discharge Type	Wastewater Type	Treated On-Site	Treated Off-Site	Untreated to POTW	Untreated to Surface Water	Recycled Flow	Other
Indirect	Leachate	37,600,000	0	0	0	0	0
	Gas Condensate	772,000	0	0	0	0	0
	Truck/Equipment Washwater	1,220,000	0	101,000	0	0	0
	Floor Washings	706,000	0	0	0	0	0
	Storm water	0	0	4,740,000	294,000,000	0	0
	Total Indirect	40,298,000	0	4,841,000	294,000,000	0	0
Zero	Leachate	42,300,000	20,800,000	0	0	0	169,000,000
	Gas Condensate	8,390,000	0	0	0	0	0
	Drained Free Liquids	0	0	0	0	0	47,000
	Truck/Equipment Washwater	36,300	513,000	0	0	0	50,300,000
	Floor Washings	0	0	0	0	0	35,000,000
	Contaminated Groundwater	28,700,000	0	0	0	0	0
	Storm water	211,000,000	2,300,000	30,700,000	662,000,000	0	0
	Total Zero	290,426,300	23,613,000	30,700,000	662,000,000	0	254,347,000
Subcategory Total		330,724,300	23,613,000	35,541,000	956,000,000	0	254,347,000

Table 6-1: Wastewater Generation in 1992: Non-Hazardous Subcategory Subtitle D Municipal Facilities (gallons)

Discharge Type	Wastewater Type	Treated On-Site	Treated Off-Site	Untreated to POTW	Untreated to Surface Water	Recycled Flow	Other
Direct	Leachate	565,000,000	782,000	55,400,000	167,000,000	49,000	94,400,000
	Gas Condensate	1,570,000	0	501,000	0	0	0
	Drained Free Liquids	715	0	0	0	0	0
	Truck/Equipment Washwater	15,300,000	0	54,900	0	0	0
	Floor Washings	4,890,000	0	0	0	0	0
	Contaminated Groundwater	163,000,000	0	0	0	0	0
	Storm water	1,830,000,000	0	0	3,430,000,000	0	0
	Total Direct	2,579,760,715	782,000	55,955,900	3,597,000,000	49,000	94,400,000
Indirect	Leachate	756,000,000	2,330,000	3,460,000,000	0	29,800,000	5,870,000
	Gas Condensate	9,700,000	65,900	292,000	0	0	19,700
	Truck/Equipment Washwater	20,700,000	0	9,000,000	594,000	0	0
	Floor Washings	794,000	0	3,320,000	0	0	0
	Contaminated Groundwater	226,000,000	0	259,000,000	0	0	0
	Storm water	2,230,000,000	0	677,000,000	3,890,000,000	85,400,000	1,060,000,000

Table 6-1: Wastewater Generation in 1992: Non-Hazardous Subcategory Subtitle D Municipal Facilities (gallons)

Discharge Type	Wastewater Type	Treated On-Site	Treated Off-Site	Untreated to POTW	Untreated to Surface Water	Recycled Flow	Other
Indirect (cont.)	Other	0	0	3,910,000	0	0	0
	Total Indirect	3,243,194,000	2,395,900	4,412,522,000	3,890,594,000	115,200,000	1,065,889,700
Zero	Leachate	170,000,000	449,000,000	0	0	233,000,000	88,600,000
	Gas Condensate	0	1,610,000	0	0	0	0
	Truck/Equipment Washwater	425,000	0	0	0	177,000	2,990,000
	Contaminated Groundwater	296,000,000	0	0	0	0	0
	Storm water	3,930,000	0	0	137,000,000	212,000,000	24,700,000
	Total Zero	470,355,000	450,610,000	0	137,000,000	445,177,000	116,290,000
Subcategory Total		6,293,309,715	453,005,900	4,468,477,900	7,624,594,000	560,426,000	1,276,579,700

Table 6-1: Wastewater Generation in 1992: Non-Hazardous Subcategory Subtitle D Non-Municipal Facilities (gallons)

Discharge Type	Wastewater Type	Treated On-Site	Treated Off-Site	Untreated to POTW	Untreated to Surface Water	Recycled Flow	Other
Direct	Leachate	37,600,000	0	9,800	250,000,000	0	0
	Storm water	117,000,000	0	0	28,400,000	0	0
	Total Direct	154,600,000	0	9,800	278,400,000	0	0
Indirect	Leachate	43,000,000	0	120,000,000	0	85,100,000	0
	Contaminated Groundwater	0	0	4,120,000	0	0	0
	Storm water	19,800,000	0	0	0	0	43,100,000
	Total Indirect	62,800,000	0	124,120,000	0	85,100,000	43,100,000
Zero	Leachate	0	2,570,000	0	0	1,290,000	0
	Drained Free Liquids	0	0	0	0	521,000	0
	Truck/Equipment Washwater	0	0	0	0	209,000	0
	Storm water	0	0	0	0	17,100,000	0
	Total Zero	0	2,570,000	0	0	19,120,000	0
Subcategory Total		217,400,000	2,570,000	124,129,800	278,400,000	104,220,000	43,100,000

Table 6-2: Quantity of In-Scope Wastewater Generated in 1992 (gal)

Discharge Status	Subcategory					Total Wastewater Generated	Total Number of Facilities
	Non-Hazardous			Hazardous			
	Subtitle D Municipal	Subtitle D Non-Municipal	Subtitle D Facilities	Subtitle C	Subtitle C Facilities		
Direct	904,947,615	287,609,800	158	0	0	1,192,557,415	158
Indirect	4,298,485,600	248,100,000	762	40,399,000	6	4,586,984,600	768
Zero	945,802,000	4,590,000	343	326,386,300	141	1,276,778,300	484
Total	6,149,235,215	540,299,800	1,263	366,785,300	147	7,056,320,315	1,410

Table 6-3: Contaminant Concentration Ranges in Municipal Leachate as Reported in Literature Sources

Pollutant Parameter	George (1972)	Chain/DeWalle (1977)	Metry/Cross (1977)	Cameron (1978)	Wisconsin Report (20 Sites)	Sobotka Report (44 Sites)
Conventional						
BOD	9 - 54,610	81 - 33,360	2,200 - 720,000	9 - 55,000	ND - 195,000	7 - 21,600
pH	3.7 - 8.5	3.7 - 8.5	3.7 - 8.5	3.7 - 8.5	5 - 8.9	5.4 - 8.0
TSS	6 - 2,685	10 - 700	13 - 26,500		2 - 140,900	28 - 2,835
Non-Conventional						
Alkalinity	0 - 20,850	0 - 20,850	310 - 9,500	0 - 20,900	ND - 15,050	0 - 7,375
Bicarbonate			3,260 - 5,730			
Chlorides	34 - 2,800	4.7 - 2,467	47 - 2,350	34 - 2,800	2 - 11,375	120 - 5,475
COD	0 - 89,520	40 - 89,520	800 - 750,000	0 - 9,000	6.6 - 97,900	440 - 50,450
Fluorides				0 - 2.13	0 - 0.74	0.12 - 0.790
Hardness	0 - 22,800	0 - 22,800	35 - 8,700	0 - 22,800	52 - 225,000	0.8 - 9,380
NH3-Nitrogen	0 - 1,106	0 - 1,106	0.2 - 845	0 - 1,106		11.3 - 1,200
NO3-Nitrogen	0 - 1,300	0.2 - 1,0.29	4.5 - 18			0 - 5,0.95
Organic Nitrogen			2.4 - 550			4.5 - 78.2
Ortho-Phosphorus		6.5 - 85	0.3 - 136	0 - 154		
Sulfates	1 - 1,826	1 - 1,558	20 - 1,370	0 - 1,826	ND - 1,850	8 - 500
Sulfide				0 - 0.13		
TOC		256 - 28,000			ND - 30,500	5 - 6,884
TDS	0 - 42,276	584 - 44,900	100 - 51,000	0 - 42,300	584 - 50,430	1,400 - 16,120
Total-K-Nitrogen	0 - 1,416				2 - 3,320	47.3 - 938
Total Phosphorus	1 - 154	0 - 130			ND - 234	
Total Solids		0 - 59,200				1,900 - 25,873
Metals						
Aluminum				0 - 122	ND - 85	0.010 - 5.07
Arsenic				0 - 11.6	ND - 70.2	0 - 0.08
Barium				0 - 5.4	ND - 12.5	0.01 - 10
Beryllium				0 - 0.3	ND - 0.36	0.001 - 0.01
Boron				0.3 - 73	0.867 - 13	
Cadmium		0.03 - 17		0 - 0.19	ND - 0.04	0 - 0.1
Calcium	5 - 4,080	60 - 7,200	240 - 2,570	5 - 4,000	200 - 2,500	95.5 - 2,100
Total Chromium				0 - 33.4	ND - 5.6	0.001 - 1.0
Copper	0 - 9.9	0 - 9.9		0 - 10	ND - 4.06	0.003 - 0.32
Cyanide				0 - 0.11	ND - 6	0 - 4.0
Iron	0.2 - 5,500	0 - 2,820	0.12 - 1,700	0.2 - 5,500	ND - 1,500	0.22 - 1,400
Lead	0 - 0.5	<0.10 - 2.0		0 - 5.0	0 - 14.2	0.001 - 1.11
Magnesium	16.5 - 15,600	17 - 15,600	64 - 547	16.5 - 15,600	ND - 780	76 - 927
Manganese	0.06 - 1,400	0.09 - 125	13	0.06 - 1,400	ND - 31.1	0.03 - 43
Mercury				0 - 0.064	ND - 0.01	0 - 0.02
Molybendum				0 - 0.52	0.01 - 1.43	
Nickel				0.01 - 0.8	ND - 7.5	0.01 - 1.25
Potassium	2.8 - 3,770	28 - 3,770	28 - 3,800	2.8 - 3,770	ND - 2,800	30 - 1,375
Sodium	0 - 7,700	0 - 7,700	85 - 3,800	0 - 7,700	12 - 6,010	
Titanium				0 - 5.0	<0.01	
Vanadium				0 - 1.4	0.01	
Zinc	0 - 1,000	0 - 370	0.03 - 135	0 - 1,000	ND - 731	0.01 - 67

All concentrations in mg/l, except pH (std units).
ND = Non-detect

Table 6-4: Landfill Gas Condensate (from Detailed Questionnaire)

QID	Pollutant	# Obs	# ND	Avg. Conc.	Unit
16012	**Conventional**				
	Oil & Grease	1	0	422	mg/l
	Metals				
	Arsenic	1	0	570	ug/l
16015	**Organics**				
	1,2-Benzenedicarboxylic Acid, Diethyl Ester	3	1	2.0	mg/l
	1,3-Butadiene, 1,1,2,3,4,4-Hexachloro-	3	1	2.2	mg/l
	1,3-Dichlorobenzene	3	1	1.2	mg/l
	1,4-Dichlorobenzene	3	1	2.0	mg/l
	2,4,6-Trichlorophenol	3	2	15.0	mg/l
	2,4-Dichlorophenol	3	2	15.0	mg/l
	2,4-Dimethylphenol	3	2	17.3	mg/l
	2,6-Dinitrotoluene	3	2	5.83	mg/l
	2-Methyl-4,6-Dinitrophenol	3	0	100	mg/l
	2-Nitrophenol	3	2	17.5	mg/l
	3,4-Benzopyrene	3	2	2.0	mg/l
	3-Methyl-4-Chlorophenol	3	1	20.0	mg/l
	Benz(E)Acephenenthrylene	3	2	2.33	mg/l
	Benzenamine, 4-Nitro-	3	1	2.2	mg/l
	Benzene, Nitro-	3	2	4.3	mg/l
	Benzene Hexachloride	3	1	2.3	mg/l
	Benzene, Ethyl-	3	2	3.4	mg/l
	Benzene, Methyl-	3	2	2.6	mg/l
	Benzo(Def)Phenanthrene	3	1	2.2	mg/l
	Bis(2-Chloroethoxy)Methane	3	2	2.8	mg/l
	Chloroform	3	2	3.9	mg/l
	Di-n-propyl Nitrosamine	3	0	3.3	mg/l
	Ethene, Trichloro	3	2	2.5	mg/l
	Ethene, Tetrachloro-	3	1	10.6	mg/l
	O-Chlorophenol	3	2	8.7	mg/l
	Residue, Non-flammable	3	0	27.2	mg/l
	Metals				
	Gold	3	1	0.04	mg/l
	Lead	3	2	0.13	mg/l
	Zinc	3	0	0.14	mg/l

16012: Treated effluent after hydrocarbon/aqueous phase separation and caustic neutralization.
16015: Treated effluent after equalization, caustic neutralization, and carbon adsorption.
QID: Questionnaire ID number
Obs: Number of observations
ND: Number of non-detects

Table 6-5 Epa Sampling Episode Pollutants Analyzed			
POLLUTANT	CAS NUM	POLLUTANT	CAS NUM
CLASSSICAL WET CHEMISTRY		**1657: PESTICIDES/HERBICIDES**	
AMENABLE CYANIDE	C-025	MONOCROTOPHOS	6923-22-4
AMMONIA NITROGEN	7664-41-7	NALED	300-76-5
BOD	C-002	PARATHION (ETHYL)	56-38-2
CHLORIDE	16887-00-6	PHORATE	298-02-2
COD	C-004	PHOSMET	732-11-6
FLUORIDE	16984-48-8	PHOSPHAMIDON E	297-99-4
HEXANE EXTRACTABLE MATERIAL	C-036	PHOSPHAMIDON Z	23783-98-4
HEXAVALENT CHROMIUM	18540-29-9	RONNEL	299-84-3
NITRATE/NITRITE	C-005	SULFOTEPP	3689-24-5
PH	C-006	SULPROFOS	35400-43-2
RECOVERABLE OIL AND GREASE	C-007	TEPP	107-49-3
TDS	C-010	TERBUFOS	13071-79-9
TOC	C-012	TETRACHLORVINPHOS	22248-79-9
TOTAL CYANIDE	57-12-5	TOKUTHION	34643-46-4
TOTAL PHENOLS	C-020	TRICHLORFON	52-68-6
TOTAL PHOSPHORUS	14265-44-2	TRICHLORONATE	327-98-0
TOTAL SOLIDS	C-008	TRICRESYLPHOSPHATE	78-30-8
TOTAL SULFIDE	18496-25-8	TRIMETHYLPHOSPHATE	512-56-1
TSS	C-009	**1656: PESTICIDES/HERBICIDES**	
1613: DIOXINS/FURANS		ACEPHATE	30560-19-1
2378-TCDD	1746-01-6	ACIFLUORFEN	50594-66-6
2378-TCDF	51207-31-9	ALACHLOR	15972-60-8
12378-PECDD	40321-76-4	ALDRIN	309-00-2
12378-PECDF	57117-41-6	ATRAZINE	1912-24-9
23478-PECDF	57117-31-4	BENFLURALIN	1861-40-1
123478-HXCDD	39227-28-6	ALPHA-BHC	319-84-6
123678-HXCDD	57653-85-7	BETA-BHC	319-85-7
123789-HXCDD	19408-74-3	GAMMA-BHC	58-89-9
123478-HXCDF	70648-26-9	DELTA-BHC	319-86-8
123678-HXCDF	57117-44-9	BROMACIL	314-40-9
123789-HXCDF	72918-21-9	BROMOXYNIL OCTANOATE	1689-99-2
234678-HXCDF	60851-34-5	BUTACHLOR	23184-66-9
1234678-HPCDD	35822-46-9	CAPTAFOL	2425-06-1
1234678-HPCDF	67562-39-4	CAPTAN	133-06-2
1234789-HPCDF	55673-89-7	CARBOPHENOTHION	786-19-6
OCDD	3268-87-9	ALPHA-CHLORDANE	5103-71-9
OCDF	39001-02-0	GAMMA-CHLORDANE	5103-74-2
1657: PESTICIDES/HERBICIDES		CHLOROBENZILATE	510-15-6
AZINPHOS ETHYL	2642-71-9	CHLORONEB	2675-77-6
AZINPHOS METHYL	86-50-0	CHLOROPROPYLATE	5836-10-2
CHLORFEVINPHOS	470-90-6	CHLOROTHALONIL	1897-45-6
CHLORPYRIFOS	2921-88-2	DIBROMOCHLOROPROPANE	96-12-8
COUMAPHOS	56-72-4	DACTHAL (DCPA)	1861-32-1
CROTOXYPHOS	7700-17-6	4,4'-DDD	72-54-8
DEF	78-48-8	4,4'-DDE	72-55-9
DEMETON A	8065-48-3A	4,4'-DDT	50-29-3
DEMETON B	8065-48-3B	DIALLATE A	2303-16-4A
DIAZINON	333-41-5	DIALLATE B	2303-16-4B
DICHLORFENTHION	97-17-6	DICHLONE	117-80-6
DICHLORVOS	62-73-7	DICOFOL	115-32-2
DICROTOPHOS	141-66-2	DIELDRIN	60-57-1
DIMETHOATE	60-51-5	ENDOSULFAN I	959-98-8
DIOXATHION	78-34-2	ENDOSULFAN II	33213-65-9
DISULFOTON	298-04-4	ENDOSULFAN SULFATE	1031-07-8
EPN	2104-64-5	ENDRIN	72-20-8
ETHION	563-12-2	ENDRIN ALDEHYDE	7421-93-4
ETHOPROP	13194-48-8	ENDRIN KETONE	53494-70-5
FAMPHUR	52-85-7	ETHALFLURALIN	55283-68-6
FENSULFOTHION	115-90-2	ETRADIAZOLE	2593-15-9
FENTHION	55-38-9	FENARIMOL	60168-88-9
HEXAMETHYLPHOSPHORAMIDE	680-31-9	HEPTACHLOR	76-44-8
LEPTOPHOS	21609-90-5	HEPTACHLOR EPOXIDE	1024-57-3
MALATHION	121-75-5	ISODRIN	465-73-6
MERPHOS	150-50-5	ISOPROPALIN	33820-53-0

Table 6-5 Epa Sampling Episode Pollutants Analyzed (Continued)			
POLLUTANT	**CAS NUM**	**POLLUTANT**	**CAS NUM**
1656: PESTICIDES/HERBICIDES		**1620: METALS**	
KEPONE	143-50-0	IODINE	7553-56-2
METHOXYCHLOR	72-43-5	IRIDIUM	7439-88-5
METRIBUZIN	21087-64-9	IRON	7439-89-6
MIREX	2385-85-5	LANTHANUM	7439-91-0
NITROFEN	1836-75-5	LEAD	7439-92-1
NORFLUORAZON	27314-13-2	LITHIUM	7439-93-2
PCB-1016	12674-11-2	LUTETIUM	7439-94-3
PCB-1221	11104-28-2	MAGNESIUM	7439-95-4
PCB-1232	11141-16-5	MANGANESE	7439-96-5
PCB-1242	53469-21-9	MERCURY	7439-97-6
PCB-1248	12672-29-6	MOLYBDENUM	7439-98-7
PCB-1254	11097-69-1	NEODYMIUM	7440-00-8
PCB-1260	11096-82-5	NICKEL	7440-02-0
PENTACHLORONITROBENZENE	82-68-8	NIOBIUM	7440-03-1
PENDAMETHALIN	40487-42-1	OSMIUM	7440-04-2
CIS-PERMETHRIN	61949-76-6	PALLADIUM	7440-05-3
TRANS-PERMETHRIN	61949-77-7	PHOSPHORUS	7723-14-0
PERTHANE	72-56-0	PLATINUM	7440-06-4
PROPACHLOR	1918-16-7	POTASSIUM	7440-09-7
PROPANIL	709-98-8	PRASEODYMIUM	7440-10-0
PROPAZINE	139-40-2	RHENIUM	7440-15-5
SIMAZINE	122-34-9	RHODIUM	7440-16-6
STROBANE	8001-50-1	RUTHENIUM	7440-18-8
TERBACIL	5902-51-2	SAMARIUM	7440-19-9
TERBUTHYLAZINE	5915-41-3	SCANDIUM	7440-20-2
TOXAPHENE	8001-35-2	SELENIUM	7782-49-2
TRIADIMEFON	43121-43-3	SILICON	7440-21-3
TRIFLURALIN	1582-09-8	SILVER	7440-22-4
1658: PESTICIDES/HERBICIDES		SODIUM	7440-23-5
DALAPON	75-99-0	STRONTIUM	7440-24-6
DICAMBA	1918-00-9	SULFUR	7704-34-9
DICHLOROPROP	120-36-5	TANTALUM	7440-25-7
DINOSEB	88-85-7	TELLURIUM	13494-80-9
MCPA	94-74-6	TERBIUM	7440-27-9
MCPP	7085-19-0	THALLIUM	7440-28-0
PICLORAM	1918-02-1	THORIUM	7440-29-1
2,4-D	94-75-7	THULIUM	7440-30-4
2,4-DB	94-82-6	TIN	7440-31-5
2,4,5-T	93-76-5	TITANIUM	7440-32-6
2,4,5-TP	93-72-1	TUNGSTEN	7440-33-7
1620: METALS		URANIUM	7440-61-1
ALUMINUM	7429-90-5	VANADIUM	7440-62-2
ANTIMONY	7440-36-0	YTTERBIUM	7440-64-4
ARSENIC	7440-38-2	YTTRIUM	7440-65-5
BARIUM	7440-39-3	ZINC	7440-66-6
BERYLLIUM	7440-41-7	ZIRCONIUM	7440-67-7
BISMUTH	7440-69-9		
BORON	7440-42-8		
CADMIUM	7440-43-9		
CALCIUM	7440-70-2		
CERIUM	7440-45-1		
CHROMIUM	7440-47-3		
COBALT	7440-48-4		
COPPER	7440-50-8		
DYSPROSIUM	7429-91-6		
ERBIUM	7440-52-0		
EUROPIUM	7440-53-1		
GADOLINIUM	7440-54-2		
GALLIUM	7440-55-3		
GERMANIUM	7440-56-4		
GOLD	7440-57-5		
HAFNIUM	7440-58-6		
HOLMIUM	7440-60-0		
INDIUM	7440-74-6		

Table 6-5 Epa Sampling Episode Pollutants Analyzed (Continued)

POLLUTANT	CAS NUM	POLLUTANT	CAS NUM
1624: VOLATILE ORGANICS		**1625: SEMIVOLATILE ORGANICS**	
1,1-DICHLOROETHANE	75-34-3	1-METHYLFLUORENE	1730-37-6
1,1-DICHLOROETHENE	75-35-4	1-METHYLPHENANTHRENE	832-69-9
1,1,1-TRICHLOROETHANE	71-55-6	1-PHENYLNAPHTHALENE	605-02-7
1,1,1,2-TETRACHLOROETHANE	630-20-6	1,2-DIBROMO-3-CHLOROPROPANE	96-12-8
1,1,2-TRICHLOROETHANE	79-00-5	1,2-DICHLOROBENZENE	95-50-1
1,1,2,2-TETRACHLOROETHANE	79-34-5	1,2-DIPHENYLHYDRAZINE	122-66-7
1,2-DIBROMOETHANE	106-93-4	1,2,3-TRICHLOROBENZENE	87-61-6
1,2-DICHLOROETHANE	107-06-2	1,2,3-TRIMETHOXYBENZENE	634-36-6
1,2-DICHLOROPROPANE	78-87-5	1,2,4-TRICHLOROBENZENE	120-82-1
1,2,3-TRICHLOROPROPANE	96-18-4	1,2,4,5-TETRACHLOROBENZENE	95-94-3
1,3-DICHLOROPROPANE	142-28-9	1,2:3,4-DIEPOXYBUTANE	1464-53-5
1,4-DIOXANE	123-91-1	1,3-BENZENEDIOL (RESORCINOL)	108-46-3
2-BUTANONE (MEK)	78-93-3	1,3-DICHLORO-2-PROPANOL	96-23-1
2-CHLORO-1,3-BUTADIENE	126-99-8	1,3-DICHLOROBENZENE	541-73-1
2-CHLOROETHYLVINYL ETHER	110-75-8	1,3,5-TRITHIANE	291-21-4
2-HEXANONE	591-78-6	1,4-DICHLOROBENZENE	106-46-7
2-METHYL-2-PROPENENITRILE	126-98-7	1,4-DINITROBENZENE	100-25-4
2-PROPANONE (ACETONE)	67-64-1	1,4-NAPHTHOQUINONE	130-15-4
2-PROPENAL (ACROLEIN)	107-02-8	1,5-NAPHTHALENEDIAMINE	2243-62-1
2-PROPEN-1-OL (ALLYL ALCOHOL)	107-18-6	2-BROMOCHLOROBENZENE	694-80-4
3-CHLOROPROPENE	107-05-1	2-CHLORONAPHTHALENE	91-58-7
4-METHYL-2-PENTANONE	108-10-1	2-CHLOROPHENOL	95-57-8
ACRYLONITRILE	107-13-1	2-ISOPROPYLNAPHTHALENE	2027-17-0
BENZENE	71-43-2	2-METHYL-4,6-DINITROPHENOL	534-52-1
BROMODICHLOROMETHANE	75-27-4	2-METHYLBENZOTHIOAZOLE	120-75-2
BROMOFORM	75-25-2	2-METHYLNAPHTHALENE	91-57-6
BROMOMETHANE	74-83-9	2-NITROANILINE	88-74-4
CARBON DISULFIDE	75-15-0	2-NITROPHENOL	88-75-5
CHLOROACETONITRILE	107-14-2	2-PHENYLNAPHTHALENE	612-94-2
CHLOROBENZENE	108-90-7	2-PICOLINE	109-06-8
CHLOROETHANE	75-00-3	2-(METHYLTHIO)BENZOTHIAZOLE	615-22-5
CHLOROFORM	67-66-3	2,3-BENZOFLUORENE	243-17-4
CHLOROMETHANE	74-87-3	2,3-DICHLOROANILINE	608-27-5
CIS-1,3-DICHLOROPROPENE	10061-01-5	2,3-DICHLORONITROBENZENE	3209-22-1
CROTONALDEHYDE	4170-30-3	2,3,4,6-TETRACHLOROPHENOL	58-90-2
DIBROMOCHLOROMETHANE	124-48-1	2,3,6-TRICHLOROPHENOL	933-75-5
DIBROMOMETHANE	74-95-3	2,4-DIAMINOTOLUENE	95-80-7
DIETHYL ETHER	60-29-7	2,4-DICHLOROPHENOL	120-83-2
ETHYL BENZENE	100-41-4	2,4-DIMETHYLPHENOL	105-67-9
ETHYL CYANIDE	107-12-0	2,4-DINITROPHENOL	51-28-5
ETHYL METHACRYLATE	97-63-2	2,4-DINITROTOLUENE	121-14-2
IODOMETHANE	74-88-4	2,4,5-TRICHLOROPHENOL	95-95-4
ISOBUTYL ALCOHOL	78-83-1	2,4,5-TRIMETHYLANILINE	137-17-7
METHYLENE CHLORIDE	75-09-2	2,4,6-TRICHLOROPHENOL	88-06-2
M-XYLENE	108-38-3	2,6-DICHLORO-4-NITROANILINE	99-30-9
O+P XYLENE	136777-61-2	2,6-DICHLOROPHENOL	87-65-0
TETRACHLOROETHENE	127-18-4	2,6-DINITROTOLUENE	606-20-2
TETRACHLOROMETHANE	56-23-5	2,6-DI-TERT-BUTYL-P-BENZOQUINONE	719-22-2
TOLUENE	108-88-3	3-BROMOCHLOROBENZENE	108-37-2
TRANS-1,2-DICHLOROETHENE	156-60-5	3-CHLORONITROBENZENE	121-73-3
TRANS-1,3-DICHLOROPROPENE	10061-02-6	3-METHYLCHOLANTHRENE	56-49-5
TRANS-1,4-DICHLORO-2-BUTENE	110-57-6	3-NITROANILINE	99-09-2
TRICHLOROETHENE	79-01-6	3,3-DICHLOROBENZIDINE	91-94-1
TRICHLOROFLUOROMETHANE	75-69-4	3,3'-DIMETHOXYBENZIDINE	119-90-4
VINYL ACETATE	108-05-4	3,5-DIBROMO-4-HYDROXYBENZONITRILE	1689-84-5
VINYL CHLORIDE	75-01-4	3,6-DIMETHYLPHENANTHRENE	1576-67-6
		4-AMINOBIPHENYL	92-67-1
		4-BROMOPHENYL PHENYL ETHER	101-55-3
		4-CHLORO-2-NITROANILINE	89-63-4
		4-CHLORO-3-METHYLPHENOL	59-50-7
		4-CHLOROANILINE	106-47-8
		4-CHLOROPHENYL PHENYL ETHER	7005-72-3
		4-NITROANILINE	100-01-6
		4-NITROBIPHENYL	92-93-3

Table 6-5 Epa Sampling Episode Pollutants Analyzed(Continued)

POLLUTANT	CAS NUM	POLLUTANT	CAS NUM
1625: SEMIVOLATILE ORGANICS		**1625: SEMIVOLATILE ORGANICS**	
4-NITROPHENOL	100-02-7	N-C12 (N-DODECANE)	112-40-3
4,4-METHYLENE-BIS(2-CHLOROANILINE)	101-14-4	N-C14 (N-TETRADECANE)	629-59-4
4,5-METHYLENE-PHENANTHRENE	203-64-5	N-C16 (N-HEXADECANE)	544-76-3
5-CHLORO-O-TOLUIDINE	95-79-4	N-C18 (N-OCTADECANE)	593-45-3
5-NITRO-O-TOLUIDINE	99-55-8	N-C20 (N-EICOSANE)	112-95-8
7,12-DIMETHYLBENZ(A)ANTHRACENE	57-97-6	N-C22 (N-DOCOSANE)	629-97-0
ACENAPHTHENE	83-32-9	N-C24 (N-TETRACOSANE)	646-31-1
ACENAPHTHYLENE	208-96-8	N-C26 (N-HEXACOSANE)	630-01-3
ACETOPHENONE	98-86-2	N-C28 (N-OCTACOSANE)	630-02-4
ALPHA-NAPHTHYLAMINE	134-32-7	N-C30 (N-TRIACONTANE)	638-68-6
ALPHA-TERPINEOL	98-55-5	NITROBENZENE	98-95-3
ANILINE	62-53-3	N-NITROSODIETHYLAMINE	55-18-5
ANTHRACENE	120-12-7	N-NITROSODIMETHYLAMINE	62-75-9
ARAMITE	140-57-8	N-NITROSODI-N-BUTYLAMINE	924-16-3
BENZANTHRONE	82-05-3	N-NITROSODI-N-PROPYLAMINE	621-64-7
BENZENETHIOL	108-98-5	N-NITROSODIPHENYLAMINE	86-30-6
BENZIDINE	92-87-5	N-NITROSOMETHYL -ETHYLAMINE	10595-95-6
BENZOIC ACID	65-85-0	N-NITROSOMETHYL-PHENYLAMINE	614-00-6
BENZO(A)ANTHRACENE	56-55-3	N-NITROSOMORPHOLINE	59-89-2
BENZO(A)PYRENE	50-32-8	N-C10 (N-DECANE)	124-18-5
BENZO(B)FLUORANTHENE	205-99-2	N-C12 (N-DODECANE)	112-40-3
BENZO(GHI)PERYLENE	191-24-2	N-C14 (N-TETRADECANE)	629-59-4
BENZO(K)FLUORANTHENE	207-08-9	N-C16 (N-HEXADECANE)	544-76-3
BENZYL ALCOHOL	100-51-6	N-C18 (N-OCTADECANE)	593-45-3
BETA-NAPHTHYLAMINE	91-59-8	N-C20 (N-EICOSANE)	112-95-8
BIPHENYL	92-52-4	N-C22 (N-DOCOSANE)	629-97-0
BIS(2-CHLOROETHOXY) METHANE	111-91-1	N-C24 (N-TETRACOSANE)	646-31-1
BIS(2-CHLOROETHYL) ETHER	111-44-4	N-C26 (N-HEXACOSANE)	630-01-3
BIS(2-CHLOROISOPROPYL) ETHER	108-60-1	N-C28 (N-OCTACOSANE)	630-02-4
BIS(2-ETHYLHEXYL) PHTHALATE	117-81-7	N-C30 (N-TRIACONTANE)	638-68-6
BUTYL BENZYL PHTHALATE	85-68-7	NITROBENZENE	98-95-3
CARBAZOLE	86-74-8	N-NITROSODIETHYLAMINE	55-18-5
CHRYSENE	218-01-9	N-NITROSODIMETHYLAMINE	62-75-9
CROTOXYPHOS	7700-17-6	N-NITROSODI-N-BUTYLAMINE	924-16-3
DIBENZOFURAN	132-64-9	N-NITROSODI-N-PROPYLAMINE	621-64-7
DIBENZOTHIOPHENE	132-65-0	N-NITROSODIPHENYLAMINE	86-30-6
DIBENZO(A,H)ANTHRACENE	53-70-3	N-NITROSOMETHYL -ETHYLAMINE	10595-95-6
DIETHYL PHTHALATE	84-66-2	N-NITROSOMETHYL-PHENYLAMINE	614-00-6
DIMETHYL PHTHALATE	131-11-3	N-NITROSOMORPHOLINE	59-89-2
DIMETHYL SULFONE	67-71-0	N-NITROSOPIPERIDINE	100-75-4
DI-N-BUTYL PHTHALATE	84-74-2	N,N-DIMETHYLFORMAMIDE	68-12-2
DI-N-OCTYL PHTHALATE	117-84-0	O-ANISIDINE	90-04-0
DIPHENYL ETHER	101-84-8	O-CRESOL	95-48-7
DIPHENYLAMINE	122-39-4	O-TOLUIDINE	95-53-4
DIPHENYLDISULFIDE	882-33-7	P-CRESOL	106-44-5
ETHYL METHANESULFONATE	62-50-0	P-CYMENE	99-87-6
ETHYLENETHIOUREA	96-45-7	P-DIMETHYLAMINO-AZOBENZENE	60-11-7
ETHYNYLESTRADIOL-3-METHYL ETHER	72-33-3	PENTACHLOROBENZENE	608-93-5
FLUORANTHENE	206-44-0	PENTACHLOROETHANE	76-01-7
FLUORENE	86-73-7	PENTACHLOROPHENOL	87-86-5
HEXACHLOROBENZENE	118-74-1	PENTAMETHYLBENZENE	700-12-9
HEXACHLOROBUTADIENE	87-68-3	PERYLENE	198-55-0
HEXACHLOROCYCLOPENTADIENE	77-47-4	PHENACETIN	62-44-2
HEXACHLOROETHANE	67-72-1	PHENANTHRENE	85-01-8
HEXACHLOROPROPENE	1888-71-7	PHENOL	108-95-2
HEXANOIC ACID	142-62-1	PHENOTHIAZINE	92-84-2
INDENO(1,2,3-CD)PYRENE	193-39-5	PRONAMIDE	23950-58-5
ISOPHORONE	78-59-1	PYRENE	129-00-0
ISOSAFROLE	120-58-1	PYRIDINE	110-86-1
LONGIFOLENE	475-20-7	SAFROLE	94-59-7
MALACHITE GREEN	569-64-2	SQUALENE	7683-64-9
METHAPYRILENE	91-80-5	STYRENE	100-42-5
METHYL METHANESULFONATE	66-27-3	THIANAPHTHENE (2,3-BENZOTHIOPHENE)	95-15-8
NAPHTHALENE	91-20-3	THIOACETAMIDE	62-55-5
N-C10 (N-DECANE)	124-18-5	THIOXANTHONE	492-22-8
		TRIPHENYLENE	217-59-4
		TRIPROPYLENEGLYCOLMETHYL ETHER	20324-33-8

Table 6-4. EPA Sampling Episode List of Analytes Never Detected

							Non-Hazardous Subcategory											Hazardous Subcategory			
			Subtitle D Municipal							Subtitle D Non-Municipal											
POLLUTANT	CAS NUM	E4191	E4626	E4667	E4687	E4738	E4503	E4630	E4631	E4638	E4639	E4644	E4683	E4690	E4721	E4631	E4659	E4682	E4690	E4721	E4759
1613: DIOXINS/FURANS																					
2378-TCDD	1746-01-6	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2378-TCDF	51207-31-9	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		ND	ND		ND	ND
12378-PECDD	40321-76-4	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
12378-PECDF	57117-41-6	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		ND	ND		ND	ND
23478-PECDF	57117-31-4	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
123478-HXCDD	39227-28-6	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
123678-HXCDD	57653-85-7	ND	-	-	ND		ND	ND	ND	ND	ND	ND	ND		ND		ND	ND	ND	ND	ND
123789-HXCDD	19408-74-3	ND	-	-	ND		ND	ND	ND	ND	ND	ND	ND		ND		ND	ND	ND	ND	ND
123478-HXCDF	70648-26-9	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		ND	ND		ND	ND
123678-HXCDF	57117-44-9	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		ND	ND		ND	ND
123789-HXCDF	72918-21-9	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
234678-HXCDF	60851-34-5	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND
1234678-HPCDD	35822-46-9		-	-	ND		ND		ND	ND	ND	ND	ND		ND		ND	ND			ND
1234678-HPCDF	67562-39-4	ND	-	-	ND		ND	ND	ND	ND	ND	ND	ND		ND		ND	ND			ND
1234789-HPCDF	55673-89-7	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		ND	ND		ND	ND
OCDD	3268-87-9		-	-	ND		ND		ND	ND	ND	ND	ND				ND	ND			ND
OCDF	39001-02-0	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		ND	ND			ND
1620: METALS																					
ALUMINUM	7429-90-5									ND	ND	ND	ND				ND				
ANTIMONY	7440-36-0				ND	ND	ND	ND	ND			ND		ND		ND	ND				
ARSENIC	7440-38-2								ND		ND		ND								
BARIUM	7440-39-3																				
BERYLLIUM	7440-41-7	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BISMUTH	7440-69-9	ND		ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BORON	7440-42-8			ND																	
CADMIUM	7440-43-9						ND	ND	ND	ND			ND		ND	ND	ND		ND	ND	
CALCIUM	7440-70-2																				
CERIUM	7440-45-1	ND		ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND
CHROMIUM	7440-47-3				ND		ND	ND	ND		ND	ND	ND				ND		ND		
COBALT	7440-48-4		ND		ND				ND	ND	ND	ND	ND		ND						
COPPER	7440-50-8				ND		ND					ND			ND	ND	ND				
DYSPROSIUM	7429-91-6	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ERBIUM	7440-52-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	
EUROPIUM	7440-53-1	ND			ND	ND	ND	ND	ND				ND	ND	ND	ND	ND	ND	ND	ND	
GADOLINIUM	7440-54-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND
GALLIUM	7440-55-3	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GERMANIUM	7440-56-4	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GOLD	7440-57-5	ND		ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HAFNIUM	7440-58-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HOLMIUM	7440-60-0	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
INDIUM	7440-74-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND
IODINE	7553-56-2	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
IRIDIUM	7439-88-5	ND	ND		ND	ND	ND	ND	ND				ND	ND	ND	ND	ND		ND	ND	ND
IRON	7439-89-6																				
LANTHANUM	7439-91-0	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
LEAD	7439-92-1	ND	ND				ND	ND	ND			ND	ND		ND	ND	ND		ND	ND	
LITHIUM	7439-93-2	ND			ND	ND		ND		ND	ND		ND								
LUTETIUM	7439-94-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND
MAGNESIUM	7439-95-4																				
MANGANESE	7439-96-5																				
MERCURY	7439-97-6				ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND		
MOLYBDENUM	7439-98-7				ND	ND	ND	ND		ND			ND		ND	ND					
NEODYMIUM	7440-00-8	ND	ND	ND	ND		ND	ND	ND		ND		ND	ND	ND	ND	ND	ND	ND	ND	
NICKEL	7440-02-0									ND	ND	ND	ND								
NIOBIUM	7440-03-1	ND			ND	ND	ND	ND	ND				ND	ND	ND	ND		ND	ND	ND	ND
OSMIUM	7440-04-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PALLADIUM	7440-05-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
PHOSPHORUS	7723-14-0	ND			ND						ND	ND	ND				ND				
PLATINUM	7440-06-4	ND	ND		ND	ND	ND	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND
POTASSIUM	7440-09-7	ND										ND									
PRASEODYMIUM	7440-10-0	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
RHENIUM	7440-15-5	ND	ND		ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	
RHODIUM	7440-16-6	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	
RUTHENIUM	7440-18-8	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
SAMARIUM	7440-19-9	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	
SCANDIUM	7440-20-2	ND			ND	ND	ND	ND	ND				ND	ND	ND	ND	ND	ND	ND	ND	
SELENIUM	7782-49-2	ND			ND	ND	ND	ND			ND	ND	ND	ND	ND		ND				
SILICON	7440-21-3	ND																			

Table 6-6: EPA Sampling Episode List of Analytes Never Detected

		Non-Hazardous Subcategory															Hazardous Subcategory				
			Subtitle D Municipal								Subtitle D Non-Municipal										
POLLUTANT	CAS NUM	E4491	E4626	E4667	E4687	E4738	E4503	E4630	E4631	E4638	E4639	E4644	E4683	E4690	E4721	E4631	E4659	E4682	E4690	E4721	E4759
SILVER	7440-22-4	ND	ND		ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SODIUM	7440-23-5																				
STRONTIUM	7440-24-6	ND																			
SULFUR	7704-34-9	ND										ND									
TANTALUM	7440-25-7	ND			ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	
TELLURIUM	13494-80-9	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TERBIUM	7440-27-9	ND	ND		ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND
THALLIUM	7440-28-0	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND
THORIUM	7440-29-1	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
THULIUM	7440-30-4	ND	ND	ND	ND	ND	ND	ND	ND		ND		ND	ND	ND	ND	ND	ND	ND	ND	ND
TIN	7440-31-5	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		ND			ND	
TITANIUM	7440-32-6				ND						ND	ND	ND				ND		ND		
TUNGSTEN	7440-33-7	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	
URANIUM	7440-61-1	ND	ND		ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND
VANADIUM	7440-62-2				ND		ND		ND	ND	ND	ND	ND				ND				
YTTERBIUM	7440-64-4	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND
YTTRIUM	7440-65-5			ND			ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
ZINC	7440-66-6											ND									
ZIRCONIUM	7440-67-7	ND	ND		ND	ND	ND·	ND	ND	ND	ND		ND	ND	ND		ND	ND	ND	ND	
1624: VOLATILE ORGANICS																					
1,1-DICHLOROETHANE	75-34-3			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				
1,1-DICHLOROETHENE	75-35-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
1,1,1-TRICHLOROETHANE	71-55-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND
1,1,1,2-TETRACHLOROETHANE	630-20-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
1,1,2-TRICHLOROETHANE	79-00-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
1,1,2,2-TETRACHLOROETHANE	79-34-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
1,2-DIBROMOETHANE	106-93-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROETHANE	107-06-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND				
1,2-DICHLOROPROPANE	78-87-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	•	ND	ND		ND	ND
1,2,3-TRICHLOROPROPANE	96-18-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
1,3-DICHLOROPROPANE	142-28-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-DIOXANE	123-91-1	ND				ND	ND	ND	ND		ND	ND	ND		ND		ND			ND	
2-BUTANONE (MEK)	78-93-3						ND	ND	ND	ND	ND	ND	ND				ND				
2-CHLORO-1,3-BUTADIENE	126-99-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
2-CHLOROETHYLVINYL ETHER	110-75-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-HEXANONE	591-78-6	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND				ND
2-METHYL-2-PROPENENITRILE	126-98-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
2-PROPANONE (ACETONE)	67-64-1							ND		ND	ND	ND	ND								
2-PROPENAL (ACROLEIN)	107-02-8	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-PROPEN-1-OL (ALLYL ALCOHOL)	107-18-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND
3-CHLOROPROPENE	107-05-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-METHYL-2-PENTANONE	108-10-1	ND				ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				
ACRYLONITRILE	107-13-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZENE	71-43-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				
BROMODICHLOROMETHANE	75-27-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BROMOFORM	75-25-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BROMOMETHANE	74-83-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBON DISULFIDE	75-15-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		ND	
CHLOROACETONITRILE	107-14-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
CHLOROBENZENE	108-90-7	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND			ND
CHLOROETHANE	75-00-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND		ND	ND
CHLOROFORM	67-66-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
CHLOROMETHANE	74-87-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,3-DICHLOROPROPENE	10061-01-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
CROTONALDEHYDE	4170-30-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIBROMOCHLOROMETHANE	124-48-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIBROMOMETHANE	74-95-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIETHYL ETHER	60-29-7	ND		ND		ND	ND	ND	ND	ND	ND	ND	ND	ND			ND		ND		ND
ETHYL BENZENE	100-41-4						ND	ND	ND	ND	ND	ND	ND	ND			ND				
ETHYL CYANIDE	107-12-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYL METHACRYLATE	97-63-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
IODOMETHANE	74-88-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ISOBUTYL ALCOHOL	78-83-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND	
METHYLENE CHLORIDE	75-09-2				ND		ND	ND	ND	ND	ND	ND	ND		ND		ND				
M-XYLENE	108-38-3				ND		ND	ND	ND	ND	ND	ND	ND	ND			ND		ND		
O+P XYLENE	136777-61-2				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND		ND		ND
TETRACHLOROETHENE	127-18-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND				ND
TETRACHLOROMETHANE	56-23-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND
TOLUENE	108-88-3								ND	ND	ND	ND	ND	ND			ND				

Table 6-6: EPA Sampling Episode List of Analytes Never Detected

		Non-Hazardous Subcategory															Hazardous Subcategory				
			Subtitle D Municipal							Subtitle D Non-Municipal											
POLLUTANT	CAS NUM	E4491	E4626	E4667	E4687	E4738	E4503	E4630	E4631	E4638	E4639	E4614	E4683	E4690	E4721	E4631	E4659	E4682	E4690	E4721	E4759
TRANS-1,2-DICHLOROETHENE	156-60-5	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND
TRANS-1,3-DICHLOROPROPENE	10061-02-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,4-DICHLORO-2-BUTENE	110-57-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRICHLOROETHENE	79-01-6	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND				ND
TRICHLOROFLUOROMETHANE	75-69-4	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
VINYL ACETATE	108-05-4	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
VINYL CHLORIDE	75-01-4	ND				ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND
1625: SEMIVOLATILE ORGANICS																					
1-METHYLFLUORENE	1730-37-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYLPHENANTHRENE	832-69-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-PHENYLNAPHTHALENE	605-02-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROBENZENE	95-50-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		ND
1,2-DIPHENYLHYDRAZINE	122-66-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
1,2,3-TRICHLOROBENZENE	87-61-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,3-TRIMETHOXYBENZENE	634-36-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-TRICHLOROBENZENE	120-82-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4,5-TETRACHLOROBENZENE	95-94-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2:3,4-DIEPOXYBUTANE	1464-53-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-BENZENEDIOL (RESORCINOL)	108-46-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-DICHLORO-2-PROPANOL	96-23-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-DICHLOROBENZENE	541-73-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-TRITHIANE	291-21-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		ND
1,4-DICHLOROBENZENE	106-46-7		ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		ND
1,4-DINITROBENZENE	100-25-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-NAPHTHOQUINONE	130-15-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,5-NAPHTHALENEDIAMINE	2243-62-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-BROMOCHLOROBENZENE	694-80-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-CHLORONAPHTHALENE	91-58-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-CHLOROPHENOL	95-57-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-ISOPROPYLNAPHTHALENE	2027-17-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYL-4,6-DINITROPHENOL	534-52-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
2-METHYLBENZOTHIOAZOLE	120-75-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLNAPHTHALENE	91-57-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
2-NITROANILINE	88-74-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-NITROPHENOL	88-75-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND
2-PHENYLNAPHTHALENE	612-94-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-PICOLINE	109-06-8			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
2-(METHYLTHIO)BENZOTHIAZOLE	615-22-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
2,3-BENZOFLUORENE	243-17-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DICHLOROANILINE	608-27-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DICHLORONITROBENZENE	3209-22-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,4,6-TETRACHLOROPHENOL	58-90-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,6-TRICHLOROPHENOL	933-75-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIAMINOTOLUENE	95-80-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DICHLOROPHENOL	120-83-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIMETHYLPHENOL	105-67-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND		
2,4-DINITROPHENOL	51-28-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND
2,4-DINITROTOLUENE	121-14-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-TRICHLOROPHENOL	95-95-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-TRIMETHYLANILINE	137-17-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-TRICHLOROPHENOL	88-06-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-DICHLORO-4-NITROANILINE	99-30-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-DICHLOROPHENOL	87-65-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-DINITROTOLUENE	606-20-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	ND	ND	ND
2,6-DI-TERT-BUTYL-P-BENZOQUINONE	719-22-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-BROMOCHLOROBENZENE	108-37-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-CHLORONITROBENZENE	121-73-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYLCHOLANTHRENE	56-49-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-NITROANILINE	99-09-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3-DICHLOROBENZIDINE	91-94-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3'-DIMETHOXYBENZIDINE	119-90-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,5-DIBROMO-4-HYDROXYBENZONITRILE	1689-84-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,6-DIMETHYLPHENANTHRENE	1576-67-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-AMINOBIPHENYL	92-67-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-BROMOPHENYL PHENYL ETHER	101-55-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-CHLORO-2-NITROANILINE	89-63-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-CHLORO-3-METHYLPHENOL	59-50-7	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
4-CHLOROANILINE	106-47-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 6-6: EPA Sampling Episode List of Analytes Never Detected

		Non-Hazardous Subcategory																Hazardous Subcategory			
		Subtitle D Municipal						Subtitle D Non-Municipal													
POLLUTANT	CAS NUM	E4491	E4626	E4667	E4687	E4738	E4503	E4630	E4631	E4638	E4639	E4644	E4683	E4690	E4721	E4631	E4659	E4682	E4690	E4721	E4759
4-CHLOROPHENYL PHENYL ETHER	7005-72-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-NITROANILINE	100-01-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-NITROBIPHENYL	92-93-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-NITROPHENOL	100-02-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND
4,4-METHYLENE-BIS(2-CHLOROANILINE)	101-14-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,5-METHYLENE-PHENANTHRENE	203-64-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5-CHLORO-O-TOLUIDINE	95-79-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5-NITRO-O-TOLUIDINE	99-55-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7,12-DIMETHYLBENZ(A)ANTHRACENE	57-97-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACENAPHTHENE	83-32-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND		ND
ACENAPHTHYLENE	208-96-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACETOPHENONE	98-86-2	ND		ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND		ND	ND
ALPHA-NAPHTHYLAMINE	134-32-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND
ALPHA-TERPINEOL	98-55-5					ND	ND	ND	ND	ND	ND	ND	ND	ND				ND	ND		ND
ANILINE	62-53-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND		ND		
ANTHRACENE	120-12-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ARAMITE	140-57-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZANTHRONE	82-05-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZENETHIOL	108-98-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZIDINE	92-87-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZOIC ACID	65-85-0	ND				ND	ND	ND	ND	ND	ND	ND	ND		ND						
BENZO(A)ANTHRACENE	56-55-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(A)PYRENE	50-32-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(B)FLUORANTHENE	205-99-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(GHI)PERYLENE	191-24-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(K)FLUORANTHENE	207-08-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZYL ALCOHOL	100-51-6	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		
BETA-NAPHTHYLAMINE	91-59-8		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND
BIPHENYL	92-52-4	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BIS(2-CHLOROETHOXY) METHANE	111-91-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BIS(2-CHLOROETHYL) ETHER	111-44-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
BIS(2-CHLOROISOPROPYL) ETHER	108-60-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
BIS(2-ETHYLHEXYL) PHTHALATE	117-81-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
BUTYL BENZYL PHTHALATE	85-68-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBAZOLE	86-74-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHRYSENE	218-01-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CROTOXYPHOS	7700-17-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIBENZOFURAN	132-64-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
DIBENZOTHIOPHENE	132-65-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIBENZO(A,H)ANTHRACENE	53-70-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIETHYL PHTHALATE	84-66-2	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIMETHYL PHTHALATE	131-11-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIMETHYL SULFONE	67-71-0	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DI-N-BUTYL PHTHALATE	84-74-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DI-N-OCTYL PHTHALATE	117-84-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIPHENYL ETHER	101-84-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
DIPHENYLAMINE	122-39-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIPHENYLDISULFIDE	882-33-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYL METHANESULFONATE	62-50-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLENETHIOUREA	96-45-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYNYLESTRADIOL-3-METHYL ETHER	72-33-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FLUORANTHENE	206-44-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
FLUORENE	86-73-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND		ND
HEXACHLOROBENZENE	118-74-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROBUTADIENE	87-68-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROCYCLOPENTADIENE	77-47-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROETHANE	67-72-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEXACHLOROPROPENE	1888-71-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEXANOIC ACID	142-62-1	ND					ND		ND	ND	ND	ND	ND		ND				ND		
INDENO(1,2,3-CD)PYRENE	193-39-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ISOPHORONE	78-59-1			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ISOSAFROLE	120-58-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LONGIFOLENE	475-20-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MALACHITE GREEN	569-64-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHAPYRILENE	91-80-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHYL METHANESULFONATE	66-27-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NAPHTHALENE	91-20-3		ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND		ND		
N-C10 (N-DECANE)	124-18-5		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
N-C12 (N-DODECANE)	112-40-3	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
N-C14 (N-TETRADECANE)	629-59-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND		ND

Table 6-6: EPA Sampling Episode List of Analytes Never Detected

POLLUTANT	CAS NUM	Non-Hazardous Subcategory: Subtitle D Municipal: E4491	E4626	E4667	E4687	E4738	E4503	Subtitle D Non-Municipal: E4630	E4631	E4618	E4619	E4644	E4683	E4690	E4721	E4631	Hazardous Subcategory: E4659	E4682	E4690	E4721	E4759
N-C16 (N-HEXADECANE)	544-76-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
N-C18 (N-OCTADECANE)	593-45-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
N-C20 (N-EICOSANE)	112-95-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
N-C22 (N-DOCOSANE)	629-97-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
N-C24 (N-TETRACOSANE)	646-31-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
N-C26 (N-HEXACOSANE)	630-01-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
N-C28 (N-OCTACOSANE)	630-02-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
N-C30 (N-TRIACONTANE)	638-68-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NITROBENZENE	98-95-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-NITROSODIETHYLAMINE	55-18-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-NITROSODIMETHYLAMINE	62-75-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-NITROSODI-N-BUTYLAMINE	924-16-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-NITROSODI-N-PROPYLAMINE	621-64-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-NITROSODIPHENYLAMINE	86-30-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-NITROSOMETHYL -ETHYLAMINE	10595-95-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-NITROSOMETHYL-PHENYLAMINE	614-00-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-NITROSOMORPHOLINE	59-89-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-NITROSOPIPERIDINE	100-75-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N,N-DIMETHYLFORMAMIDE	68-12-2	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
O-ANISIDINE	90-04-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
O-CRESOL	95-48-7	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND			
O-TOLUIDINE	95-53-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
P-CRESOL	106-44-5	ND		ND			ND	ND	ND	ND	ND	ND	ND				ND		ND		
P-CYMENE	99-87-6	ND			ND	ND		ND	ND	ND	ND	ND	ND	ND			ND	ND	ND		ND
P-DIMETHYLAMINO-AZOBENZENE	60-11-7	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENTACHLOROBENZENE	608-93-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENTACHLOROETHANE	76-01-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENTACHLOROPHENOL	87-86-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENTAMETHYLBENZENE	700-12-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PERYLENE	198-55-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PHENACETIN	62-44-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PHENANTHRENE	85-01-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND		ND
PHENOL	108-95-2					ND	ND	ND		ND	ND	ND	ND								
PHENOTHIAZINE	92-84-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PRONAMIDE	23950-58-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PYRENE	129-00-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
PYRIDINE	110-86-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
SAFROLE	94-59-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SQUALENE	7683-64-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
STYRENE	100-42-5	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
THIANAPHTHENE (2,3-BENZOTHIOPHENE)	95-15-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
THIOACETAMIDE	62-55-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
THIOXANTHONE	492-22-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPHENYLENE	217-59-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPROPYLENEGLYCOLMETHYL ETHER	20324-33-8	ND		ND			ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND		
1656: PESTICIDES/HERBICIDES																					
ACEPHATE	30560-19-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACIFLUORFEN	50594-66-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
ALACHLOR	15972-60-8	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND
ALDRIN	309-00-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ATRAZINE	1912-24-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND			
BENFLURALIN	1861-40-1	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
ALPHA-BHC	319-84-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND		ND	
BETA-BHC	319-85-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
GAMMA-BHC	58-89-9		ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
DELTA-BHC	319-86-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		
BROMACIL	314-40-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
BROMOXYNIL OCTANOATE	1689-99-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
BUTACHLOR	23184-66-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	
CAPTAFOL	2425-06-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CAPTAN	133-06-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBOPHENOTHION	786-19-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ALPHA-CHLORDANE	5103-71-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
GAMMA-CHLORDANE	5103-74-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHLOROBENZILATE	510-15-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		
CHLORONEB	2675-77-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHLOROPROPYLATE	5836-10-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
CHLOROTHALONIL	1897-45-6	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	
DIBROMOCHLOROPROPANE (DBCP)	96-12-8	ND		ND		ND	ND		ND	ND	ND	ND	ND	ND	ND		ND		ND	ND	

Table 6-6: EPA Sampling Episode List of Analytes Never Detected

		Non-Hazardous Subcategory														Hazardous Subcategory					
			Subtitle D Municipal						Subtitle D Non-Municipal												
POLLUTANT	CAS NUM	E4491	E4626	E4667	E4687	E4738	E4503	E4630	E4631	E4638	E4639	E4644	E4683	E4690	E4721	E4631	E4659	E4682	E4690	E4721	E4759
DACTHAL (DCPA)	1861-32-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
4,4'-DDD	72-54-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	72-55-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
4,4'-DDT	50-29-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND		
DIALLATE A	2303-16-4A	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND		ND
DIALLATE B	2303-16-4B	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		
DICHLONE	117-80-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DICOFOL	115-32-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIELDRIN	60-57-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
ENDOSULFAN I	959-98-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND
ENDOSULFAN II	33213-65-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ENDOSULFAN SULFATE	1031-07-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		ND
ENDRIN	72-20-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
ENDRIN ALDEHYDE	7421-93-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
ENDRIN KETONE	53494-70-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
ETHALFLURALIN	55283-68-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	
ETRADIAZOLE	2593-15-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
FENARIMOL	60168-88-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEPTACHLOR	76-44-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		
HEPTACHLOR EPOXIDE	1024-57-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
ISODRIN	465-73-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
ISOPROPALIN	33820-53-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
KEPONE	143-50-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHOXYCHLOR	72-43-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
METRIBUZIN	21087-64-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
MIREX	2385-85-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NITROFEN	1836-75-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
NORFLUORAZON	27314-13-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1016	12674-11-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1221	11104-28-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1232	11141-16-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1242	53469-21-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1248	12672-29-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1254	11097-69-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1260	11096-82-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENTACHLORONITROBENZENE (PCNB)	82-68-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
PENDAMETHALIN	40487-42-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
CIS-PERMETHRIN	61949-76-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-PERMETHRIN	61949-77-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PERTHANE	72-56-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
PROPACHLOR	1918-16-7	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	
PROPANIL	709-98-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PROPAZINE	139-40-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		
SIMAZINE	122-34-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND			
STROBANE	8001-50-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TERBACIL	5902-51-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TERBUTHYLAZINE	5915-41-3	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND				
TOXAPHENE	8001-35-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIADIMEFON	43121-43-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIFLURALIN	1582-09-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	
1657: PESTICIDES/HERBICIDES																					
AZINPHOS ETHYL	2642-71-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AZINPHOS METHYL	86-50-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHLORFEVINPHOS	470-90-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHLORPYRIFOS	2921-88-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
COUMAPHOS	56-72-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CROTOXYPHOS	7700-17-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DEF	78-48-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DEMETON A	8065-48-3A	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		
DEMETON B	8065-48-3B	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIAZINON	333-41-5		ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		
DICHLORFENTHION	97-17-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
DICHLORVOS	62-73-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
DICROTOPHOS	141-66-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	
DIMETHOATE	60-51-5	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIOXATHION	78-34-2	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DISULFOTON	298-04-4	ND	ND				ND	ND	ND		ND		ND	ND	ND	ND	ND		ND	ND	ND
EPN	2104-64-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHION	563-12-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 6-6: EPA Sampling Episode List of Analytes Never Detected

								Non-Hazardous Subcategory										Hazardous Subcategory			
			Subtitle D Municipal								Subtitle D Non-Municipal										
POLLUTANT	CAS NUM	E4491	E4626	E4667	E4687	E4738	E4503	E4630	E4631	E4638	E4639	E4644	E4683	E4690	E4721	E4631	E4659	E4682	E4690	E4721	E4759
ETHOPROP	13194-48-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FAMPHUR	52-85-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FENSULFOTHION	115-90-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FENTHION	55-38-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEXAMETHYLPHOSPHORAMIDE	680-31-9	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	
LEPTOPHOS	21609-90-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MALATHION	121-75-5		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
MERPHOS	150-50-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
METHAMIDOPHOS	10265-92-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
METHYL CHLORPYRIFOS	5598-13-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHYL PARATHION	298-00-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
METHYL TRITHION	953-17-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MEVINPHOS	7786-34-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MONOCROTOPHOS	6923-22-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NALED	300-76-5	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
PARATHION (ETHYL)	56-38-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PHORATE	298-02-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PHOSMET	732-11-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PHOSPHAMIDON E	297-99-4	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	
PHOSPHAMIDON Z	23783-98-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RONNEL	299-84-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SULFOTEPP	3689-24-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SULPROFOS	35400-43-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TEPP	107-49-3		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
TERBUFOS	13071-79-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TETRACHLORVINPHOS	22248-79-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOKUTHION	34643-46-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
TRICHLORFON	52-68-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRICHLORONATE	327-98-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRICRESYLPHOSPHATE	78-30-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIMETHYLPHOSPHATE	512-56-1		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	
1658: PESTICIDES/HERBICIDES																					
DALAPON	75-99-0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND		ND		ND	ND
DICAMBA	1918-00-9		ND					ND	ND	ND	ND	ND	ND								
DICHLOROPROP	120-36-5	ND	ND					ND	ND	ND	ND	ND	ND								
DINOSEB	88-85-7	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND		ND		ND	ND			
MCPA	94-74-6							ND	ND		ND		ND								
MCPP	7085-19-0					ND	ND	ND	ND		ND		ND			ND			ND		
PICLORAM	1918-02-1	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND		ND	ND	ND			ND	
2,4-D	94-75-7		ND			ND		ND	ND	ND	ND	ND	ND				ND				
2,4-DB	94-82-6		ND	ND		ND		ND	ND	ND	ND	ND	ND		ND						
2,4,5-T	93-76-5	ND	ND					ND	ND	ND	ND	ND	ND			ND	ND				
2,4,5-TP	93-72-1		ND			ND		ND	ND	ND	ND		ND								
CLASSSICAL WET CHEMISTRY																					
AMENABLE CYANIDE	C-025	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	
AMMONIA NITROGEN	7664-41-7										ND										
BOD	C-002													ND							
CHLORIDE	16887-00-6	ND																			
COD	C-004																				
FLUORIDE	16984-48-8																				
HEXANE EXTRACTABLE MATERIAL	C-036	-					-		ND	ND	ND	ND	ND				ND				
HEXAVALENT CHROMIUM	18540-29-9					ND		ND	ND	ND	ND	ND	ND	ND		ND		ND	ND		
NITRATE/NITRITE	C-005																				
PH	C-006																				
RECOVERABLE OIL AND GREASE	C-007		-	-	-	-		-	-	-	-	ND	-	-	-	-	ND	-	-	-	-
TDS	C-010																				
TOC	C-012										ND	ND	ND				ND				
TOTAL CYANIDE	57-12-5			ND	ND	ND	ND				ND	ND	ND	ND					ND		
TOTAL PHENOLS	C-020							ND					ND								
TOTAL PHOSPHORUS	14265-44-2								ND	ND	ND		ND				ND				
TOTAL SOLIDS	C-008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	-	-	-	-
TOTAL SULFIDE	18496-25-8		-										ND	ND							
TSS	C-009										ND	ND	ND								

Table 6-7: Subtitle D Non-Hazardous Subcategory Master File

Subtitle D Non-Hazardous Pollutant of Interest	Subtitle D Municipal Median Concentration (ug/l)	Subtitle D Non-Municipal Median Concentration (ug/l)
Conventional		
BOD	209,786	67,000
TSS	150,000	20,500
Classical (Non-Conventional)		
Ammonia as Nitrogen	81,717	75,000
COD	1,023,000	1,100,000
Hexavalent Chromium	64.9	
Nitrate/Nitrite	651	950
TDS	2,894,289	4,850,000
TOC	376,521	236,000
Total Phenols	637	251
Organic (Toxic & Non-Conventional)		
1,4-Dioxane	10.8	
2-Butanone	1,768	
2-Propanone	991	
4-Methyl-2-Pentanone	100	
Alpha-Terpineol	123	
Benzoic Acid	3,897	
Hexanoic Acid	5,818	
Methylene Chloride	36.8	
N,N-Dimethylformamide	10	
O-Cresol	15	
P-Cresol	75	
Phenol	101	
Toluene	108	
Tripropyleneglycol Methyl Ether	197	
Metals (Toxic & Non-Conventional)		
Barium	482	
Chromium	28.2	
Strontium	1,671	4,615
Titanium	63.8	
Zinc	140	
Pesticides/Herbicides (Non-Conventional)		
Dichloroprop	6.1	
Disulfoton	6.1	
MCPA		403
Dioxins/Furans (Non-Conventional)		
1234678-HpCDD	0.00014	
OCDD	0.0018	

Table 6-8: Subtitle C Hazardous Subcategory Raw Wastewater Master File

Subtitle C Hazardous Pollutant of Interest	Median Conc. (ug/l)	Subtitle C Hazardous Pollutant of Interest	Median Conc. (ug/l)
Conventional		**Organics (cont.)**	
BOD	101,000	Toluene	347
Hexane Extractable Material	35,500	Trans-1,2-Dichloroethene	78.7
TSS	67,655	Trichloroethene	250
Classical (Non-Conventional)		Tripropyleneglycol Methyl Ether	808
Amenable Cyanide	1,638	Vinyl Chloride	42.7
Ammonia as Nitrogen	8,600	**Metals (Toxic & Non-Coventional)**	
COD	1,199,500	Arsenic	190
Nitrate/Nitrite	5,500		
TDS	12,628,750	Chromium	47.8
TOC	409,547	Copper	36.4
Total Phenols	25,004	Lithium	830
Organics (Toxic & Non-Conventional)		Molybdenum	157
1,1-Dichloroethane	51.5	Nickel	302
1,4-Dioxane	235	Selenium	20
2,4-Dimethylphenol	70.3		
2-Butanone	1,464	Strontium	1500
2-Propanone	2,882	Tin	57.2
4-Methyl-2-Pentanone	580	Titanium	36.5
Alpha-Terpineol	91.2	Total Cyanide	50.1
Aniline	149	Zinc	218
Benzene	98.7	**Pesticides/Herbicides (Non-Coventional)**	
Benzoic Acid	1,001	2,4,5-TP	4.1
Benzyl Alcohol	55	2,4-D	5.1
Diethyl Ether	60.8	2,4-DB	18.5
Ethylbenzene	100	Dicamba	4.9
Hexanoic Acid	593	Dichloroprop	8.6
Isobutyl Alcohol	19.6	MCPA	383
Methylene Chloride	324	MCPP	870
M-Xylene	41.4	Picloram	5.8
Napthalene	58.8	Terbuthylazine	14.5
O+P Xylene	17.1	**Dioxins/Furans (Non-Conventional)**	
O-Cresol	61.4	1234678-HpCDD	0.00018
Phenol	562	1234678-HpCDF	0.00013
Pyridine	61	OCDD	0.00035
P-Cresol	120	OCDF	0.0019

Table 6-9: Range of Conventional and Selected Nonconventional Pollutants Raw Wastewater Concentrations (ug/l)

		Non-Hazardous Subcategory								Hazardous Subcategory			
		Subtitle D Municipal				Subtitle D Non-Municipal							
Pollutant	Cas No.	Min	Max	#Obs	#ND	Min	Max	#Obs	#ND	Min	Max	#Obs	#ND
Amenable Cyanide	C-025									0.01	29,895	4	2
Biological Oxygen Demand (BOD)	C-002	10,500	7,609,318	31	0	1,000	3,799,333	9	1	11,190	6,500,000	16	0
Total Suspended Solids (TSS)	C-009	6,500	14,470,000	26	0	4,000	16,500,000	8	2	14,840	18,500,000	17	0
pH	C-006	6.7	9.8	5	0	6.6	9.2	9	0	5.8	11	6	0
Hexane Extractable Material	C-036	5,000	26,000	4	0	5,000	64,000	9	4	5,000	686,889	5	1
Ammonia as Nitrogen	7664417	1,782	2,900,000	24	0	100	5,860,000	9	1	362	550,781	13	0
Chemical Oxygen Demand (COD)	C-004	35,000	11,881,700	28	0	80,000	16,700,000	9	0	47,300	10,400,000	16	0
Nitrate/Nitrite	C-005	20	50,800	17	3	50	36,000	9	1	380	300,040	11	0
Total Dissolved Solids (TDS)	C-010	752,000	17,533,000	22	0	936,000	33,900,000	9	0	128,500	31,898,889	13	0
Total Organic Carbon (TOC)	C-012	9,400	3,446,084	22	0	10,000	4,820,000	9	2	2,000	3,824,286	16	2
Total Phenols	C-020	146	2,051,249	14	0	50	39,200	9	1	280	121,735	5	0
Total Phosphorus	14265442	17	6,500	6	0	10	22,700	7	2	10	310,000	12	1

#Obs: Number of observations
#ND: Number of non-detects

Table 6-10: Range of Metals and Toxic Pollutants Raw Wastewater Concentrations (ug/l)

		Non-Hazardous Subcategory								Hazardous Subcategory			
		Subtitle D Municipal				Subtitle D Non-Municipal							
Pollutant	Cas No.	Min	Max	#Obs	#ND	Min	Max	#Obs	#ND	Min	Max	#Obs	#ND
Aluminum	7429905	60.5	111,100	7	0	21.5	712,000	8	3				
Arsenic	7440382					1.9	18,300	10	3	2.4	1,370	16	2
Barium	7440393	43	3,500	19	1	140	3,570	10	0				
Boron	7440428	696	5,704	7	0	75.9	16,250	8	0	73.6	14,950	15	0
Chromium	7440473	2	240	27	9					10	112,600	14	3
Chromium (Hexavalent)	18540299	10	4,291	9	3								
Copper	7440508									9	8,502	15	4
Iron	7439896	2,494	1,667,600	27	0	556	100,000	8	0	3,585	763,000	15	0
Lithium	7439932									182	9,400	10	0
Magnesium	7439954	24,100	212,480	14	0	8,139	388,000	9	0	2,885	1,156,000	14	0
Manganese	7439965	149	78,820	20	0	471	7,151	9	0	0.7	328,600	14	0
Molybdenum	7439987					4.2	69.3	8	4	9	18,757	12	2
Nickel	7440020									18.5	19,520	16	0
Phosphorus	7723140									593	118,000	12	1
Selenium	7782492									2	347	13	5
Silicon	7440213	1,034	91,100	4	0	2,498	159,000	8	0	7	30,400	14	0
Strontium	7440246	787	2,146	4	0	277	30,100	8	0	0.7	30,839	13	0
Sulfur	7704349	3,969	107,999	4	0	13,700	386,573	7	0	2.4	5,792,000	14	0
Tin	7440315									30.2	1,118	9	2
Titanium	7440326	4	157	6	1	4.4	1,740	8	2	3.4	764	13	2
Total Cyanide	57125									10	13,317	12	0
Zinc	7440666	11.5	31,813	27	1	2	1,240	10	1	22	49,200	18	0

#Obs: Number of observations
#ND: Number of non-detects

Table 6-11: Range of Organic Pollutants Raw Wastewater Concentrations (ug/l)

		Non-Hazardous Subcategory								Hazardous Subcategory			
		Subtitle D Municipal				Subtitle D Non-Municipal							
Pollutant	Cas No.	Min	Max	#Obs	#ND	Min	Max	#Obs	#ND	Min	Max	#Obs	#ND
1,1-Dichloroethane	75343									0.5	56,887	15	4
1,4-Dioxane	123911	10	323	5	2					10	7,611	13	6
1234678-HpCDD	35822469	0.00005	0.007	3	1					0.00005	0.007	6	2
1234678-HpCDF	67562394									0.00005	0.022	6	2
2,4-D	94757									0.5	310	9	4
2,4-DB	94826									2.87	120	6	1
2,4-Dimethylphenol	105679									10	2,546	12	5
2,4,5-TP	93721									0.1	10	9	4
2-Butanone	78933	19.3	36,544	14	3					50	15,252	14	4
2-Propanone	67641	50	8,614	12	4	50	780	10	6	61.2	52,518	18	2
4-Methyl-2-Pentanone	108101	35	46,161	13	4					18	12,067	16	4
Alpha-Terpineol	98555	10	1,061	5	1					10	654	6	3
Aniline	62533									10	2,500	10	5
Benzene	71432									0.3	19,396	18	6
Benzoic Acid	65850	50	33,335	7	3					50	2,316,700	12	1
Benzyl Alcohol	100516									10	13,308	11	5
Dicamba	1918009									0.49	31	6	0
Dichloroprop	120365	1	29.1	5	2					2.188	44.3	6	1
Diethyl Ether	60297									10	4,200	12	6
Disulfoton	298044	2.3	19.7	5	2								
Ethyl Benzene	100414									0.5	10,212	16	5
Hexanoic Acid	142621	10	37,256	5	1					13.334	31,086	10	0
Isobutyl Alcohol	78831									10	10,000	10	6
MCPA	94746					50	4370	8	2	14.458	7,071	6	1
MCPP	7085190					50	1900	8	4	12.752	12,887	6	2
Methylene Chloride	75092	1.6	5,091	20	6					1	59,823	15	5
M-Xylene	108383									10	650	8	2
Naphthalene	91203									10	7,799	14	4
N,N-Dimethylformamide	68122	10	1,008	5	3								
OCDD	3268879	0.0001	0.082	3	1	0.0001	0.0176	8	5	0.0001	0.062	7	2
OCDF	39001020									0.0001	0.591	6	2
O-Cresol	95487	1	2,215	8	6					10	500	11	2
O+P Xylene	136777612									10	230	6	2
P-Cresol	106445	1	998	9	3					10	17,396	10	2
Phenol	108952	2	1,425	14	5					10	1,548,330	15	1
Picloram	1918021									0.5	8.5	5	2
Pyridine	110861									10	10,000	9	6
Terbuthylazine	5915413									5	123,226	5	2
Toluene	108883	3	598	23	5					5	18,166	21	4
Trans-1,2-Dichloroethene	156605									0.4	40,286	15	4
Trichloroethene	79016									0.5	123,613	17	4
Tripropyleneglycol Methyl Ether	20324338	99	1,235	5	2					99	3,182	6	3
Vinyl Chloride	75014									0.2	5,170	10	5

#Obs: Number of observations

#ND: Number of non-detects

Table 6-12: Dioxins and Furans at Non-Hazardous EPA Sampling Episodes by Episode and Sample Point

Subtitle D Episode/SP	Sample Type	1234678-HpCDD	1234678-HpCDF	OCDD	OCDF	123478-HxCDD	123478-HxCDF	1234789-HpCDF	123678-HxCDD	123678-HxCDF	12378-PeCDD	12378-PeCDF	123789-HxCDD	123789-HxCDF	234678-HxCDF	23478-PeCDF	2378-TCDD	2378-TCDF
Municipal																		
4491 sp01 - inf	grab	140 pg/l	ND	1800 pg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4626 sp01 - inf	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4626 sp02 - inf	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4626 sp03 - inf	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4626 sp08 - eff	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4626 sp09 - FC	grab	32.9 ng/kg	ND	803 ng/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4626 sp09 - FC	grab	41.2 ng/kg	ND	1100 ng/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4667 sp01 - inf	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4667 sp06 - eff	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4667 sp07 - FC	grab	29 ng/kg	ND	279 ng/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4667 sp07 - FC	grab	32 ng/kg	ND	271 ng/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4667 sp07 - FC	grab	44 ng/kg	ND	308 ng/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4667 sp07 - FC	grab	43 ng/kg	ND	338 ng/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4667 sp07 - FC	grab	39 ng/kg	ND	290 ng/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4687 sp01 - inf	comp	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4687 sp03 - eff	comp	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4738 sp01 - inf	grab	240 pg/l	56 pg/l	11,000 pg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4738 sp02 - inf	grab	480 pg/l	ND	5,300 ng/kg	ND	ND	ND	ND	6 ng/kg	ND	ND	ND	16 ng/kg	ND	ND	ND	ND	ND
Non-Municipal																		
4503 sp01 - inf	grab	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4630 sp01 - inf	grab	103 pg/l	ND	5380 pg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4631 sp03 - inf	grab	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4638 sp01 - inf	grab	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4639 sp01 - inf	grab	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4644 sp01 - inf	grab	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4721 sp04 - inf	grab	ND	ND	503 pg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Note: Only filter cake was analyzed for dioxins and furans in Municipal episodes 4626 and 4667

sp: sample point	comp: composite sample	NS: Not sampled	mg/l = 1000 ug/l
inf: influent	grab: grab sample	ND: Non-detect	ug/l = 1000 ng/l
eff: effluent		FC: Filter cake	ng/l = 1000 pg/l

Table 6-13: Dioxins and Furans at Hazardous EPA Sampling Episodes by Episode and Sample Point

Episode Sample Point	Sample Type	1234678-HpCDD	1234678-HpCDF	OCDD	OCDF	123478-HxCDD	123478-HxCDF	1234789-HpCDF	123678-HxCDD	123678-HxCDF	12378-PeCDD	12378-PeCDF	123789-HxCDD	123789-HxCDF	234678-HxCDF	23478-PeCDF	2378-TCDD	2378-TCDF
4631 sp01 - inf	grab	13,600 pg	1,180 pg/l	116,000 pg	5,600 pg/l	ND	95.4 pg/l	162 pg/l	798 pg/l	202 pg/l	ND	79.1 pg/l	196 pg/l	ND	ND	ND	ND	31.1 pg/l
4631 sp02 - inf	grab	479 pg/l	88 pg/l	7,920 pg/l	573 pg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4659 sp01 - inf	grab	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4682 sp01 - inf	grab	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4682 sp02 - inf	grab	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4721 spD01 - inf	comp	446 pg/l	ND	4,160 pg/l	135 pg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4721 sp01 - inf	comp	752 pg/l	86 pg/l	9,070 pg/l	357 pg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4721 sp01 - inf	comp	593 pg/l	55 pg/l	6,290 pg/l	243 pg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4721 sp01 - inf	comp	576 pg/l	ND	5,040 pg/l	136 pg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4721 sp01 - inf	comp	496 pg/l	62 pg/l	4,630 pg/l	212 pg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4721 sp02 - eff	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4721 sp03 - inf	grab	551 pg/l	70 pg/l	5,080 pg/l	162 pg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4721 sp05 - inf	grab	698 pg/l	ND	5,080 pg/l	290 pg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4721 sp06 - inf	grab	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4759 sp01 - inf	comp	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4759 sp03 - eff	comp	ND	ND	100 pg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

sp: sample point | comp: composite sample | D: Duplicate | mg/l = 1000 ug/l
inf: influent | grab: grab sample | ND: Non-detect | ug/l = 1000 ng/l
eff: effluent | NS: Not sampled | ng/l = 1000 pg/l

7.0 POLLUTANT PARAMETER SELECTION

7.1 Introduction

EPA reviewed wastewater characterization data presented in Chapter 6 to determine the conventional, nonconventional, and toxic pollutants that were detected at significant quantities in landfills wastewaters. These pollutants are classified by EPA into three categories: conventional, nonconventional and toxic pollutants. Conventional pollutants include BOD_5, TSS, oil and grease, and pH. Toxic pollutants (also called priority pollutants) include selected metals, pesticides and herbicides, and over 100 organic parameters that cover a comprehensive list of volatile and semi-volatile compounds. Nonconventional pollutants are any pollutants that do not fall within the specific conventional and toxic pollutant lists, for example, TOC, COD, chloride, fluoride, ammonia-nitrogen, nitrate/nitrite, total phenol, and total phosphorous.

EPA is authorized to regulate conventional and toxic pollutants under Sections 304(a)(4) and 301(b)(2)(C) of the Clean Water Act (CWA), respectively. The list of toxic pollutants from Section 307 of the CWA has been expanded from the 65 priority pollutants and classes of pollutants identified in the Settlement Agreement of NRDC vs Train (reference 54) to include 126 priority pollutants. In addition, the Agency also may regulate other nonconventional pollutants, taking into account factors such as treatable amounts, toxicity, analytical methods, frequency of occurrence, use of indicator pollutants and the pass through of pollutants at publicly owned treatment works (POTWs).

This chapter presents the criteria used for the selection of parameters determined to be pollutants of interest in the industry and the selection of pollutants for establishing effluent limitations guidelines and standards.

7.2 Pollutants Considered for Regulation

To characterize landfill wastewaters and to determine the pollutants that could potentially be discharged in significant amounts, EPA collected wastewater characterization samples at 15 landfill facilities that were analyzed for 470 conventional, toxic and nonconventional pollutants including metals, organics, pesticides, herbicides, and dioxins and furans. The wastewater characterization analysis is presented in Chapter 6.

From the original list of 470 analytes, EPA developed a list of pollutants of interest for each subcategory that reflects the types of pollutants typically found in landfill wastewaters. The pollutants of interest list provided a basis for calculating pollutant mass loadings for the industry and potential loading reduction benefits to be achieved from the proposed regulation. The list of pollutants of interest also served as the basis for selecting pollutants for regulation.

7.3 Selection of Pollutants of Interest

Pollutants of interest for landfill facilities were selected by subcategory using the wastewater characterization data presented in Chapter 6. Figure 7-1 presents a diagram that illustrates the procedures used to select pollutants of interest.

The following criteria were used to develop a pollutants of interest list for each subcategory:

1. Any pollutant detected three or more times in the influent at a concentration at or above 5 times the minimum level at more than one facility was determined to be a pollutant of interest.

2. For dioxins/furans, any pollutant detected three or more times in the influent at a concentration above the minimum level at more than one facility was determined to be a pollutant of interest.

3. Pollutants that are naturally occurring compounds found in soil or groundwater at landfill facilities or pollutants that are used as treatment chemicals in this industry were excluded from the pollutants of interest list.

The first criteria established a list of pollutants that were detected at significant concentrations at more than one facility and therefore, considered to be present at significant concentrations in all landfill wastewaters.

The second criteria was used to address dioxins and furans, which are potentially toxic even at low concentrations. At this stage, EPA selected any dioxin and furan as a pollutant of interest if it was detected in raw wastewater so that these pollutants could be further evaluated for regulation on a case-by-case basis.

Pollutants that met the first and second criteria but were naturally occurring compounds found in soil or groundwater or are found commonly in treatment chemicals were then excluded from the individual subcategory pollutants of interest list. These compounds include aluminum, boron, calcium, chloride, fluoride, iron, manganese, magnesium, potassium, silicon, sodium, sulfur, total phosphorus, and total sulfide.

Tables 7-1 and 7-2 present the final pollutants of interest selected for each subcategory. Non-Hazardous subcategory pollutants of interest presented in Table 7-1 are subdivided into those pollutants present at Subtitle D municipal solid waste landfills and those present at Subtitle D non-municipal solid waste landfills. However, these lists were combined into one pollutant of interest list for the entire Non-Hazardous landfill subcategory. Only one Non-Hazardous subcategory pollutant of interest, MCPA, was present at non-municipal solid waste landfills and was not present at municipal solid waste landfills. Therefore, MCPA was added to the list of pollutants of interest for the entire Non-Hazardous subcategory. Pollutants of interest in both subcategories include conventional, nonconventional, and toxic pollutants and include metals, organics, pesticides, herbicides, and dioxins and furans.

7.4 Development of Pollutant Discharge Loadings

EPA developed estimates of the mass loading of pollutant discharges for the pollutants of interest on a facility-by-facility basis. The loadings were determined for current discharges and for projected discharges based on each of the proposed regulatory options. Mass loadings were based on current discharge concentrations and potential regulated flows at each facility. Pollutant discharge loadings were calculated using the procedures described below.

7.4.1 Development of Current Discharge Concentrations

The current discharge concentration database contains the discharge concentration for each pollutant of interest at each facility in each subcategory. Mass loadings were determined by multiplying the pollutant concentration by the facility-specific regulated wastewater flow. EPA used all available data obtained during the project including Detailed Questionnaire data, detailed monitoring reports, and EPA sampling data to determine mass loadings.

In the Detailed Technical and Monitoring Questionnaires, facilities were requested to provide information on wastewater treatment-in-place and to provide concentration data on treated wastewater effluent. All available information for each facility on effluent wastewater was compiled using the data conventions discussed in Chapter 4 for raw wastewater. Data were available from the following sources: EPA sampling activities, the Detailed Technical Questionnaire, and the Detailed Monitoring Questionnaire. For facilities with multiple effluent sample points, the final effluent concentration was calculated by taking a flow weighted average of the samples. From this information, a data file was created that contained one average concentration value for each pollutant of interest at each facility. The amount of data in the file varied significantly from facility to facility. Several of the current discharge concentrations were based on of hundreds of sampling data points obtained through the Detailed Monitoring Questionnaire, while others may have been based on as few as one sampling data point. The Detailed Monitoring Questionnaire data reflects up to three years of data and is unique to each facility in terms of numbers of parameters analyzed and monitoring frequency. Additionally, monitoring may have been performed weekly, monthly, or quarterly. For facilities sampled by EPA, there was information available for all 470 analytes and sampling typically reflected the daily performance of a system over a five day period.

For facilities with wastewater treatment-in-place, but with either no available effluent data or incomplete effluent data, a treated effluent average concentration was generated. To develop the treated effluent average concentration, facilities were grouped by subcategory and then placed in treatment-in-place groups depending on the type of treatment employed on site. Within a treatment-in-place group, the treated effluent average concentration result for a pollutant of interest was calculated by taking the median of all weighted source averages for all facilities within the treatment-in-place group. If there were no data for a particular pollutant within a treatment-in-place group, the treated effluent average concentration result for a pollutant of interest in a subcategory was calculated by taking the median of all weighted source averages for all facilities within the entire subcategory.

For facilities with no treatment-in-place, raw wastewater concentrations were used to represent effluent discharge values. Facility averages were calculated using all available data sources and using the procedures outlined above. For facilities with no treatment-in-place and with either no influent data or incomplete influent data, the subcategory median raw wastewater results (see Section 6.3.3 for details on developing the raw wastewater Master File) were used to represent the current discharge for each pollutant of interest.

In the Hazardous subcategory and for Subtitle D non-municipal solid waste facilities in the Non-Hazardous subcategory, there were insufficient effluent data to calculate a representative treatment-in-place or subcategory treated effluent average concentration result for several pollutants of interest. In the Hazardous subcategory, the treated effluent average concentration was based on data from a limited number of facilities. Subtitle D non-municipal facilities did not provide adequate data to calculate current discharge concentration values for a majority of the pollutants of interest in the Non-Hazardous subcategory. The alternate methodologies developed to calculate representative current discharge concentration values for both the Hazardous subcategory and for Subtitle D non-municipal facilities in the Non-Hazardous subcategory are discussed below.

7.4.1.1 Alternate Methodology for Non-Hazardous Subcategory: Subtitle D Non-Municipal

For Subtitle D non-municipal solid waste facilities in the Non-Hazardous subcategory, the effluent data from municipal solid waste landfills was used to supplement insufficient non-municipal data. Due to the similarities in the median raw wastewater concentrations from Subtitle D municipal and non-municipal facilities, this procedure was determined to be appropriate. Subtitle D municipal and non-municipal raw wastewater concentration data are presented in the Non-Hazardous subcategory Master File in Table 6-7 in Chapter 6.

The procedure employed to calculate current discharge concentrations for Subtitle D non-municipal solid waste facilities is as follows: 1) use all available non-municipal landfill effluent data, 2) place non-municipal facilities in municipal facility treatment-in-place groups according to treatment-in-place employed on-site, and 3) use municipal landfills treatment-in-place treated effluent average concentration results for each non-municipal facility with insufficient data.

One Non-Hazardous subcategory pollutant of interest, MCPA, was determined to be a pollutant of interest for non-municipal landfills, but not for municipal landfills and, therefore, treated effluent average concentration data were not available. In this case, the Master File raw wastewater concentration for MCPA from non-municipal facilities was considered along with the typical percent removals for the treatment-in-place groups. Treatment-in-place group removals for MCPA were estimated using the regulatory treatment option removals. For treatment-in-place groups with either no regulatory treatment option match or with insufficient data, the National Risk Management Research Laboratory (NRMRL) treatment database (discussed in Section 4.8.4) was used as a supplement. If no NRMRL treatment data existed, treatment data for other pollutants within the same analytical method or similar methods were used. Removals from both the regulatory treatment options and the NRMRL treatment database then were averaged together to obtain the estimated removal for each treatment-in-place group. The current discharge concentration then was calculated by multiplying the Master File raw wastewater result by the estimated treatment-in-place group percent removal (calculated as described above) and subtracting that value from the Master File result.

7.4.1.2 Alternate Methodology for the Hazardous Subcategory

Current discharge concentrations for the facilities in the Hazardous subcategory were estimated using the long term averages developed for the subcategory (see Chapter 11: Development of Effluent Limitations and Standards). A current discharge concentration file similar to the one developed for municipal solid waste facilities in the Non-Hazardous subcategory could not be developed for hazardous facilities because of a lack of data. The lack of data was due to the fact that there were no direct discharging hazardous facilities identified in the EPA database. Therefore, the current discharge concentrations were modeled on the indirect dischargers in the EPA database as a function of the expected discharge concentrations after treatment using the long term averages. Industry-provided effluent data were used whenever available. An approach was developed to estimate the expected discharge concentration from the installed treatment systems at each facility where data was not available. These current discharge concentration values were developed as a multiple of the required effluent concentrations.

Based upon the installed treatment system at the facility, a procedure was created to model the characteristics of the current discharge concentrations. The current discharge concentration was estimated as twice the long term average (LTA) for a facility without any biological or chemical treatment in place. The modeling approach used to develop the current discharge concentration for the indirect dischargers in the Hazardous subcategory is presented below.

QID	Treatment-In-Place	Modeling Scheme
16017	Separation and neutralization	2 x LTA^{med}
16041	Sequencing batch reactors	LTA
16087	Equalization, chemical precipitation, primary sedimentation, activated sludge, and secondary sedimentation	LTA

For facility 16017, the current discharge concentration value was based upon a function of the LTA^{med}. The LTA^{med} is defined as the median of the long term averages in the Hazardous subcategory. The long term averages used in this subcategory are from BAT facilities 16041 and 16087; therefore, the corresponding long term averages were used for both of these BAT facilities.

7.4.2 Development of Pollutant Mass Loadings

Using the current discharge concentration file discussed above, EPA generated mass loading estimates for each pollutant of interest by multiplying the current discharge concentration value by the facility's average discharge daily flow rate. This resulted in mass loadings, reported in pounds per day, for each facility in the database. Mass loadings were calculated to determine the amount of pollution discharged directly or indirectly to surface waters by landfill facilities and to determine the amount of pollutants projected to be discharged after implementation of the proposed regulatory technology. Summaries of pollutant mass loadings for the selected regulatory options are presented in Chapter 11.

7.5 Assessment of Pollutants of Interest

As indicated above, EPA developed extensive lists of pollutants of interest for this industry. The full list of pollutants of interest were used to develop pollutant loadings and pollutant reductions as a result of treatment. However, only certain pollutants were selected for regulation. The specific regulation of every pollutant may not be the most cost-effective approach to developing effluent limitations guidelines.

The treatment technologies evaluated as the basis of the proposed regulation have been demonstrated to provide removals for classes of compounds with similar treatability characteristics. Several of the pollutants of interest in the landfill industry are similar in terms of their chemical structure and treatability. As a result, the regulation of a set of pollutants within a chemical class ensures that the treatment technologies will provide adequate control of other pollutants of interest within that class of compounds.

Based upon this analysis, several pollutants of interest were not selected for regulation in the Non-Hazardous and Hazardous subcategories because they are represented adequately by another regulated pollutant or are controlled through regulation of another related parameter, as discussed in the sections below. In addition, several other pollutants of interest also were not selected for regulation because inadequate data were available for these pollutants at the facilities selected as the technology basis of the regulation. The methodology used in the selection of the BPT/BAT/NSPS and PSES/PSNS facilities from which the limits are based is described in Chapter 11. At these selected BPT facilities, several of the pollutants of interest were found at concentrations below treatable levels, while others were found at only trace amounts and therefore were not considered likely to cause toxic effects.

7.6 Selection of Pollutants To Be Regulated for Direct Dischargers

Based upon the data analyses outlined above, EPA developed a list of pollutants to be regulated for the Hazardous and Non-Hazardous subcategories. Figure 7-2 presents a diagram that illustrates the procedures used to select pollutants to be regulated. EPA is not proposing to establish effluent limitations and standards for all conventional, toxic, and nonconventional pollutants. There may be constituents present in a specific landfill or type of landfill that are not addressed in the development of this guideline and which may be of concern to a receiving stream or POTW. Due to the specific nature of landfill waste at various sites, EPA concludes that Best Professional Judgement (BPJ) should be used for considering specific wastewater characteristics that may be unique to a particular landfill and were not identified during the proposed rulemaking process. The following sections discuss EPA's reasons for not proposing effluent limitations for selected pollutants.

7.6.1 Non-Hazardous Subcategory Pollutants to be Regulated for Direct Dischargers

The proposed list of pollutants to be regulated for the Non-Hazardous subcategory was developed from the pollutants of interest list for the Non-Hazardous subcategory. The Non-Hazardous pollutants of interest list combines the pollutants of interest from Subtitle D municipal and non-municipal solid waste facilities for a total of 33 pollutants of interest. The pollutants chosen to be regulated were demonstrated to be removed by equalization, biological treatment, and multimedia filtration. Initially, all 33 pollutants of interest were considered for regulation; however, after a thorough analysis was conducted, 24 pollutants of interest were not selected for regulation under BPT/BAT/NSPS for one of the following reasons:

- The pollutant (or pollutant parameter) is controlled through the regulation of other pollutants (or pollutant parameters).
- The pollutant (or pollutant parameter) is present in only trace amounts and/or is not likely to cause toxic effects.

- The pollutant (or pollutant parameter) is not present in treatable amounts at the selected BPT facilities upon which the effluent limitations are based.

The following nine Non-Hazardous subcategory pollutants of interest are pollutants that are controlled through the regulation of other pollutants:

Nine Pollutants Not Selected for Regulation in the Non-Hazardous Subcategory Because They Are Controlled Through the Regulation of Other Pollutants
COD TOC Total Phenols Hexanoic Acid O-Cresol 2-Butanone 2-Propanone 4-Methyl-2-Pentanone Tripropyleneglycol Methyl Ether

COD is an alternative method of estimating the oxygen demand of the wastewater; however, BOD_5 has been selected for regulation because it is more appropriately controlled by a biological treatment system. TOC measures all oxidizable organic material in a waste stream, including the organic chemicals not oxidized (and therefore not detected) in BOD_5 and COD tests. TOC is a rapid test for estimating the total organic carbon in a waste stream. For similar reasons to those for not selecting COD for regulation, TOC also was not selected for regulation because BOD_5 is a more appropriate control parameter for biological treatment systems. Total phenols is a general, wet chemistry indicator measurement for phenolic compounds and should be controlled by regulating phenol. Similarly, hexanoic acid is relatively biodegradable and should be controlled by regulating benzoic acid. O-cresol is structurally similar to p-cresol and should be controlled by regulating p-cresol. Since 2-butanone, 2-propanone and 4-methyl-2-pentanone have similar treatability characteristics as toluene in a biological treatment system, these three pollutants should be controlled by regulating toluene. Tripropyleneglycol methyl ether has similar treatability characteristics as alpha-terpineol in a biological treatment system and should be controlled by regulating alpha-terpineol.

The following ten Non-Hazardous subcategory pollutants of interest are present in only trace amounts and/or are not likely to cause toxic effects:

Ten Pollutants Not Selected for Regulation in the Non-Hazardous Subcategory Because They Are Present In Only Trace Amounts And/Or Are Not Likely To Cause Toxic Effects
Nitrate/Nitrite
TDS
N,N-Dimethylformamide
1,4-Dioxane
Methylene Chloride
Dichloroprop
Disulfoton
MCPA
1,2,3,4,6,7,8-HpCDD
OCDD

For this industry, nitrate/nitrite is used primarily as a measure of the extent of nitrification that occurs during the biodegradation process. Typically, levels of nitrate/nitrite found in landfill wastewaters do not require removal. Removal of nitrate/nitrite can be obtained by specially designed biological treatment systems (such as nitrification/denitrification systems) that are able to complete the conversion of nitrate/nitrite to nitrogen gas. Often, removal of nitrate/nitrite is required to address specific water quality concerns for an individual receiving water (i.e., nutrient problems in the Great Lakes); however, EPA has determined that the levels of nitrate/nitrite in landfill wastewaters does not justify regulation on a national level and specific water quality considerations can be addressed by individual permit writers.

TDS is used primarily as a water quality measurement and not as a pollutant that can be controlled through biological treatment. It often is used as a measurement of the salinity of an ambient water or a wastewater and often indicates the presence of such naturally occurring salts as sodium, iron, and magnesium. While it can inhibit biological treatment processes at levels above 10,000 mg/l, acclimated biological treatment systems can operate successfully with influent TDS concentrations as high as 76,000 mg/l (reference 55). The median concentration of total dissolved solids in the Non-

Hazardous subcategory was only 4,900 mg/l for non-municipal solid waste landfills and 2,900 mg/l for municipal solid waste landfills. Therefore, EPA has determined that concentrations of total dissolved solids found in landfills in the Non-Hazardous subcategory do not justify regulation. Levels of n,n-dimethylformamide found in landfill wastewaters generally were observed near the analytical detection limit (median concentration for non-hazardous municipal solid waste landfills was 10 ug/l) and did not warrant regulation.

Two other pollutants, 1,4-dioxane and methylene chloride, are volatile pollutants that are not biodegraded during biological treatment, but rather are stripped out of the wastewater into the atmosphere during the aeration process. While EPA does not recognize the transfer of pollutants from one medium to another as effective treatment, based on the concentrations of these pollutants in untreated wastewaters, the Agency believes that the loadings of these pollutants to the atmosphere will be well below the threshold levels to be established by EPA's Air Programs for air discharges from wastewater treatment systems and, therefore, is excluding these two pollutants from regulation because they are not likely to cause toxic effects.

EPA found low levels of dichloroprop; disulfoton; MCPA; 1,2,3,4,6,7,8-HpCDD, and OCDD in raw wastewaters at several Non-Hazardous subcategory landfills. At the concentrations found, these pollutants are expected to partition to the biological sludge as part of the proposed BPT/BAT treatment technologies. EPA sampling data and calculations conclude that the concentrations of these pollutants present in the wastewater would not prevent the sludge from being redeposited in a non-hazardous landfill.

The following five pollutants were not selected for regulation in the Non-Hazardous subcategory because they are not present at treatable concentrations at those facilities chosen as the basis for the development of effluent limitations:

Five Pollutants Not Selected For Regulation in the Non-Hazardous Subcategory Because They Are Not Present at Treatable Concentrations at Those Facilities Chosen as the Basis for Developing Effluent Limitations
Barium Chromium Hexavalent Chromium Strontium Titanium

These five metals were present in wastewaters at the facilities selected as the basis for BPT/BAT/NSPS, but EPA has determined that these pollutants are not removed readily by the selected BPT/BAT/NSPS treatment technology (biological treatment) at the observed concentrations and should not be regulated. Mean raw wastewater concentrations of these five metals at BPT facilities ranged from 0.07 mg/l for chromium and titanium to 2.8 mg/l for strontium. Percent removals at these BPT facilities ranged from negative removals for hexavalent chromium and barium, to low percent removals for strontium (12 percent), to relatively high percent removals for chromium (46 percent and 57 percent) and titanium (92 percent). While the negative and low percent removals were observed at BPT facilities with relatively high influent concentrations, the higher percent removals were observed at BPT facilities with influent concentrations of chromium and titanium approaching the method detection limit, which raises doubt about the accuracy of these percent removals. EPA also considered control of these five pollutants by other technologies, but the observed concentrations were considered well below treatable concentrations for conventional metals treatment technologies (for example, chemical precipitation).

In conclusion, the following nine pollutants of interest are proposed for regulation in the Non-Hazardous subcategory:

Nine Pollutants Selected for Regulation in the Non-Hazardous Subcategory
BOD_5
TSS
Ammonia as Nitrogen
Zinc
Alpha-Terpineol
Benzoic Acid
P-Cresol
Phenol
Toluene

The Agency wishes to note that zinc was selected for regulation in spite of the fact that exclusion criteria used to eliminate other pollutants of interest apply, at least partially. Zinc has been selected for regulation in spite of its relatively low untreated wastewater concentration. The median concentration of zinc found in raw wastewater at municipal solid waste landfills and at non-municipal solid waste landfills is 0.14 mg/l and 0.09 mg/l, respectively. Zinc was selected for regulation because EPA observed incidental removals ranging from 66 percent to 93 percent at the treatment systems selected for BPT. Additionally, raw wastewater concentrations of zinc were not observed at levels that would inhibit biological treatment systems (see Chapter 11, Section 11.2.1).

The development of the effluent limitations for each of these pollutants is described in detail in Chapter 11.

7.6.2 Hazardous Subcategory Pollutants to be Regulated for Direct Dischargers

The preliminary list of pollutants to be regulated for the Hazardous subcategory was developed from the Hazardous subcategory pollutants of interest list. The pollutants chosen to be regulated were demonstrated to be removed by chemical precipitation followed by biological treatment. Initially, all 63 pollutants of interest were considered for regulation; however, after a thorough analysis was conducted, 48 pollutants of interest were not selected for regulation under BPT/BAT/NSPS for one of the following reasons:

- The pollutant (or pollutant parameter) is controlled through the regulation of other pollutants (or pollutant parameters).

- The pollutant (or pollutant parameter) is present in only trace amounts and/or is not likely to cause toxic effects.

- The pollutant (or pollutant parameter) is not present in treatable amounts at the selected BPT facilities upon which the effluent limitations are based.

The following seventeen Hazardous subcategory pollutants of interest were not selected for regulation because they are controlled through the regulation of other pollutants:

Seventeen Pollutants Not Selected For Regulation in the Hazardous Subcategory Because They Are Controlled Through the Regulation of Other Pollutants
COD
TOC
Total Phenols
2-Butanone
2-Propanone
2,4-Dimethylphenol
4-Methyl-2-Pentanone
Benzyl Alcohol
Diethyl Ether
Ethylbenzene
Isobutyl Alcohol
Hexanoic Acid
Nickel
M-Xylene
O-Cresol
O+P Xylene
Tripropyleneglycol Methyl Ether

COD is an alternative method of estimating the oxygen demand of the wastewater; however, BOD_5 has been selected for regulation because it is more appropriately controlled by a biological treatment system. TOC measures all oxidizable organic material in a waste stream, including the organic chemicals not oxidized (and therefore not detected) in BOD_5 and COD tests. TOC is a rapid test for estimating the total organic carbon in a waste stream. For similar reasons to the rationale for not selecting COD for regulation, TOC was also not selected for regulation because BOD_5 is a more appropriate control parameter for biological treatment systems.

While present in treatable concentrations, EPA did not collect adequate performance data for nickel at well-operated landfill facilities with the recommended technology basis for the Hazardous subcategory; however, nickel should be controlled adequately through the regulation of both chromium and zinc. Total phenols is a general, wet chemistry indicator measurement for phenolic compounds and should be controlled by regulating phenol. Similarly, 2,4-dimethylphenol has similar chemical and treatability characteristics to phenol and therefore should also be controlled through the regulation of phenol. Hexanoic acid, benzyl alcohol, and isobutyl alcohol are relatively biodegradable and should be controlled by regulating benzoic acid. O-cresol is structurally similar to p-cresol and should be controlled by regulating p-cresol. M-xylene, o+p-xylene, 2-butanone, 2-propanone, 4-methyl-2-pentanone, and ethylbenzene have similar treatability characteristics as toluene in a biological treatment system and should be controlled by regulating toluene. Similarly, tripropyleneglycol methyl ether and diethyl ether have similar treatability characteristics as alpha-terpineol in a biological treatment system and should be controlled by regulating alpha-terpineol.

The following twenty-two pollutants of interest were not selected for regulation in the Hazardous subcategory because they are present in only trace amounts and/or are not likely to cause toxic effects:

Twenty-Two Pollutants Not Selected for Regulation in the Hazardous Subcategory Because They Are Present In Only Trace Amounts And/Or Are Not Likely To Cause Toxic Effects
Hexane Extractable Material
Nitrate/Nitrite
TDS
1,1-Dichloroethane
1,4-Dioxane
Methylene Chloride
Trans-1,2-Dichloroethene
Trichloroethene
Vinyl Chloride
2,4-D
2,4-DB
2,4,5-TP
Dicamba
Dichloroprop
MCPA
MCPP
Picloram
Terbutylazine
1,2,3,4,6,7,8-HpCDD
1,2,3,4,6,7,8-HpCDF
OCDD
OCDF

For this industry, nitrate/nitrite is used primarily as a measure of the extent of nitrification that occurs during the biodegradation process. Typically, levels of nitrate/nitrite found in landfill wastewaters do not require removal. Removal of nitrate/nitrite can be obtained by specially designed biological treatment systems (such as nitrification/denitrification systems) that are able to complete the conversion of nitrate/nitrite to nitrogen gas. Often, removal of nitrate/nitrite is required to address specific water quality concerns for an individual receiving water (i.e., nutrient problems in the Great Lakes); however, EPA has determined that the levels of nitrate/nitrite in landfill wastewaters does not justify regulation on a national level and specific water quality considerations can be addressed by individual permit writers.

TDS is used primarily as a water quality measurement and not as a pollutant that can be controlled through biological treatment. It often is used as a measurement of the salinity of an ambient water or a wastewater and often indicates the presence of such naturally occurring salts as sodium, iron, and magnesium. While it can inhibit biological treatment processes at levels above 10,000 mg/l, acclimated biological treatment systems can operate successfully with influent TDS concentrations as high as 76,000 mg/l (reference 55). The median concentration of total dissolved solids was 12,600 mg/l for landfills in the Hazardous subcategory. Therefore, EPA has determined that concentrations of total dissolved solids found in landfills in the Hazardous subcategory do not justify regulation. Similarly, hexane extractable material is a general, wet chemistry indicator measurement for oil and grease compounds that generally can be controlled through source reduction and good housekeeping. Therefore EPA did not select hexane extractable material for regulation.

Six other pollutants , 1,1-dichloroethane, 1,4-dioxane, methylene chloride, trans-1,2-dichloroethene, trichloroethene and vinyl chloride, are volatile pollutants that are not biodegraded during biological treatment, but rather are stripped out of the wastewater into the atmosphere during the aeration process. While EPA does not recognize the transfer of pollutants from one medium to another as effective treatment, based on the concentrations of these pollutants in untreated wastewaters, the Agency believes that the loadings of these pollutants to the atmosphere will be well below the threshold levels to be established by EPA's Air Programs for air discharges from wastewater treatment systems and, therefore, is excluding these six pollutants from regulation because they are not likely to cause toxic effects.

Low levels of 2,4-D, 2,4-DB, 2,4,5-TP, dicamba, dichloroprop, MCPA, MCPP, picloram, terbutylazine, 1,2,3,4,6,7,8-HpCDD, 1,2,3,4,6,7,8-HpCDF, OCDD, and OCDF were detected in over half of the Hazardous subcategory landfills sampled during EPA's sampling program. At the concentrations found in raw landfill wastewaters, these pollutants are expected to partition to the biological sludge as part of the proposed BPT/BAT/PSES treatment technologies. EPA sampling data and calculations conclude that the concentrations of these pollutants present in the untreated wastewater would not prevent the sludge from being redeposited in a hazardous landfill.

The following nine pollutants were not selected for regulation in the Hazardous subcategory because they are not present at treatable concentrations at those facilities chosen as the basis for developing effluent limitations:

Nine Pollutants Not Selected for Regulation in the Hazardous Subcategory Because They Are Not Present at Treatable Concentrations at Those Facilities Chosen as the Basis for Developing Effluent Limitations
Amenable Cyanide
Copper
Lithium
Molybdenum
Selenium
Strontium
Tin
Titanium
Total Cyanide

While several of these pollutants were found in treatable concentrations at selected BPT facilities, the Hazardous subcategory median untreated wastewater concentrations for many of these pollutants were well below treatable concentrations. Median untreated wastewater concentrations of six of the metals ranged from about 0.02 to 0.06 mg/l for selenium, copper, titanium, and tin; 0.16 mg/l for molybdenum; and 0.8 mg/l for lithium, which are well below treatable concentrations for conventional metals precipitation technologies. While median untreated wastewater concentrations for strontium are estimated at 1.5 mg/l for the Hazardous subcategory, performance data from a BPT facility shows only a 12 percent removal of strontium at an influent concentration of 2.8 mg/l.

For total cyanide, the median untreated wastewater concentration for the Hazardous subcategory has been estimated at 0.05 mg/l, which is well below treatable concentrations for conventional cyanide destruction technologies. While median untreated wastewater concentrations of amenable cyanide have been estimated at 1.6 mg/l, EPA believes that the median untreated wastewater concentration data for total cyanide is more representative of cyanide concentrations in hazardous landfill wastewaters than amenable cyanide data, since the Agency has collected much more data on total cyanide than on amenable cyanide.

Based on these factors, the Agency has concluded that these seven metals plus amenable and total cyanide were present in untreated landfill wastewaters at concentrations that were too low to be treated effectively by conventional metals and cyanide treatment technologies (chemical precipitation and chemical oxidation, respectively) and has decided to exclude them from regulation.

In conclusion, the following 15 pollutants of interest are proposed for regulation under BPT/BAT/NSPS in the Hazardous subcategory:

Fifteen Pollutants Selected For Regulation In The Hazardous Subcategory
BOD_5
TSS
Ammonia as Nitrogen
Arsenic
Chromium
Zinc
Alpha-Terpineol
Aniline
Benzene
Benzoic Acid
Naphthalene
P-Cresol
Phenol
Pyridine
Toluene

The development of the effluent limitations for each of these pollutants is described in detail in Chapter 11.

7.7 Selection of Pollutants to be Regulated for Indirect Dischargers

Section 307(b) of the CWA requires the Agency to promulgate pretreatment standards for existing sources (PSES) and new sources (PSNS). To establish pretreatment standards, EPA must first determine whether each BAT pollutant under consideration passes through a POTW, or interferes with the POTW's operation or sludge disposal practices.

7.7.1 Pass-Through Analysis for Indirect Dischargers

The Agency evaluated POTW pass-through for the landfill pollutants of interest for both subcategories, listed in Tables 7-1 and 7-2. In determining whether a pollutant is expected to pass through a POTW, the Agency compared the nation-wide average percentage of a pollutant removed by well-operated POTWs with secondary treatment to the percentage of a pollutant removed by BAT treatment systems. A pollutant is determined to "pass through" a POTW when the average percentage removal achieved by a well-operated POTW (i.e. those meeting secondary treatment standards) is less than the percentage removed by the industry's direct dischargers that are using the proposed BAT technology.

This approach to the definition of pass-through satisfies two competing objectives set by Congress: 1) that wastewater treatment performance for indirect dischargers be equivalent to that for direct dischargers, and 2) that the treatment capability and performance of the POTW be recognized and taken into account in regulating the discharge of pollutants from indirect dischargers. Rather than compare the mass or concentration of pollutants discharged by the POTW with the mass or concentration of pollutants discharged by a BAT facility, EPA compares the percentage of the pollutants removed by the BAT treatment system with the POTW removal. EPA takes this approach because a comparison of mass or concentration of pollutants in a POTW effluent to pollutants in a BAT facility's effluent would not take into account the mass of pollutants discharged to the POTW from non-industrial sources, nor the dilution of the pollutants in the POTW effluent to lower concentrations from the addition of large amounts of non-industrial wastewater.

To establish the performance of well-operated POTWs, EPA used the information provided from "Fate of Priority Pollutants in Publicly Owned Treatment Works", referred to as the 50-POTW Study, supplemented by EPA's National Risk Management Research Laboratory's (NRMRL) treatability database. NRMRL's database was used for those pollutants not found in the 50-POTW study. These studies were discussed previously in Chapter 4. Because the data collected for evaluating POTW removals included influent levels of pollutants that were close to the detection limit, the POTW data were edited to eliminate low influent concentration levels. For analytes that included a combination of high and low influent concentrations, the data were edited to eliminate all influent values, and corresponding effluent values, less than 10 times the minimum level. For analytes where no influent concentrations were greater than 10 times the minimum level, all influent values less than five times the minimum level and the corresponding effluent values were eliminated. For analytes where no influent concentration was greater than five times the minimum level, the data were edited to eliminate all influent concentrations, and corresponding effluent values, less than 20 μg/l. These editing rules were used to eliminate low POTW removals that simply reflected low influent levels. The POTW database was further edited so that only treatment technology data for activated sludge, aerobic lagoons, and activated sludge with filtration were used.

After editing the database according to the above criteria, EPA averaged the remaining influent data and the remaining effluent data from the 50-POTW database. The percent removals achieved for each pollutant were determined from these averaged influent and effluent levels. This percent removal was then compared to the percent removal for the proposed BAT option treatment technology.

7.7.2 Non-Hazardous Subcategory Pollutants to be Regulated for Indirect Dischargers

EPA conducted a pass-through analysis on the priority and nonconventional pollutants proposed to be regulated under BAT for hazardous landfills. The pass-through analysis was not performed for the regulated conventional pollutants, namely BOD_5 and TSS, since the conventional pollutants are not regulated under PSES and PSNS. Of the seven nonconventional and toxic pollutants regulated under BAT for the Non-Hazardous subcategory, only one pollutant proposed for regulation under

BAT, ammonia as nitrogen, appeared to pass through. However, for the reasons discussed in Chapter 11, EPA is not proposing pretreatment limits for ammonia, or any other pollutant, in the Non-Hazardous subcategory.

7.7.3 Hazardous Subcategory Pollutants to be Regulated for Indirect Dischargers

EPA conducted a pass-through analysis on the priority and nonconventional pollutants proposed to be regulated under BAT for hazardous landfills. The pass-through analysis was not performed for the regulated conventional pollutants, namely BOD_5 and TSS, since the conventional pollutants are not regulated under PSES and PSNS. Of the thirteen nonconventional and toxic pollutants regulated under BAT for the Hazardous subcategory, seven were determined to pass through. However, EPA proposes pretreatment standards for only the following six pollutants: ammonia as nitrogen, benzoic acid, toluene, alpha-terpineol, p-cresol, and aniline. Even though phenol appeared to pass through, EPA has decided not to set pretreatment standards for phenol. The rationale for not setting pretreatment standards for phenol can be found in Chapter 11. The list of pollutants regulated under BAT, the BAT option percent removals, the average POTW percent removals, and the results of the pass-through analysis for the Hazardous subcategory are shown in Table 7-3. The proposed pretreatment standards for the Hazardous subcategory are listed in Table 11-12.

Six Pollutants Selected For Regulation For Indirect Dischargers In The Hazardous Subcategory
Ammonia as Nitrogen
Alpha-Terpineol
Aniline
Benzoic Acid
P-Cresol
Toluene

The development of the pretreatment limitations for each of these pollutants is described in detail in Chapter 11.

Table 7-1: Non-Hazardous Subcategory Pollutants of Interest

Non-Hazardous Pollutant of Interest	Cas #	Subtitle D Municipal Pollutant of Interest	Subtitle D Non-Municipal Pollutant of Interest
Conventional			
BOD	C-002	X	X
TSS	C-009	X	X
Nonconventional			
Ammonia as Nitrogen	7664417	X	X
COD	C-004	X	X
Nitrate/Nitrite	C-005	X	X
TDS	C-010	X	X
TOC	C-012	X	X
Total Phenols	C-020	X	X
Organic			
1,4-Dioxane	123911	X	
2-Butanone	78933	X	
2-Propanone	67641	X	
4-Methyl-2-Pentanone	108101	X	
Alpha-Terpineol	98555	X	
Benzoic Acid	65850	X	
Hexanoic Acid	142621	X	
Methylene Chloride	75092	X	
N,N-Dimethylformamide	68122	X	
O-Cresol	95487	X	
P-Cresol	106445	X	
Phenol	108952	X	
Toluene	108883	X	
Tripropyleneglycol Methyl Ether	20324338	X	
Metals			
Barium	7440393	X	
Chromium	7440473	X	
Hexavalent Chromium	18540299	X	
Strontium	7440246	X	X
Titanium	7440326	X	
Zinc	7440666	X	
Pesticides/Herbicides			
Dichloroprop	120365	X	
Disulfoton	298044	X	
MCPA	94746		X
Dioxins/Furans			
1234678-HpCDD	35822469	X	
OCDD	3268879	X	

Table 7-2: Hazardous Subcategory Pollutants of Interest

Pollutant of Interest	Cas #	Pollutant of Interest	Cas #
Conventional		**Organics (cont.)**	
BOD	C-002	P-Cresol	106445
Hexane Extractable Material	C-036	Toluene	108883
TSS	C-009	Trans-1,2-Dichloroethene	156605
Nonconventional		Trichloroethene	79016
Amenable Cyanide	C-025	Tripropyleneglycol Methyl Ether	20324338
Ammonia as Nitrogen	7664417	Vinyl Chloride	75014
COD	C-004	**Metals**	
Nitrate/Nitrite	C-005	Arsenic	7440382
TDS	C-010	Chromium	7440473
TOC	C-012	Copper	7440508
Total Phenols	C-020	Lithium	7439932
Organics		Molybdenum	7439987
1,1-Dichloroethane	75343	Nickel	7440020
1,4-Dioxane	123911	Selenium	7782492
2,4-Dimethylphenol	105679	Strontium	7440246
2-Butanone	78933	Tin	7440315
2-Propanone	67641	Titanium	7440326
4-Methyl-2-Pentanone	108101	Total Cyanide	57125
Alpha-Terpineol	98555	Zinc	7440666
Aniline	62533	**Pesticides/Herbicides**	
Benzene	71432	2,4,5-TP	93721
Benzoic Acid	65850	2,4-D	94757
Benzyl Alcohol	100516	2,4-DB	94826
Diethyl Ether	60297	Dicamba	1918009
Ethylbenzene	100414	Dichloroprop	120365
Hexanoic Acid	142621	MCPA	94746
Isobutyl Alcohol	78831	MCPP	7085190
Methylene Chloride	75092	Picloram	1918021
M-Xylene	108383	Terbuthylazine	5915413
Napthalene	91203	**Dioxins/Furans**	
O+P Xylene	136777612	1234678-HpCDD	35822469
O-Cresol	95487	1234678-HpCDF	67562394
Phenol	108952	OCDD	3268879
Pyridine	110861	OCDF	39001020

Table 7-3: Pass-Through Analysis for Pollutants to be Regulated in the Hazardous Subcategory

Pollutant	Average BAT Percent Removal	Average POTW Percent Removal	Pass-Through
Ammonia	74%	60%	Yes
Arsenic	55%	66%	No
Chromium	80%	82%	No
Zinc	64%	81%	No
Alpha Terpineol	99%	95%	Yes
Aniline	98%	62%	Yes
Benzene	88%	95%	No
Benzoic Acid	99%	82%	Yes
Naphthalene	80%	95%	No
P-Cresol	98%	68%	Yes
Phenol	99%	95%	Yes
Pyridine	57%	95%	No
Toluene	99%	96%	Yes

Figure 7-1: Development of Pollutants of Interest

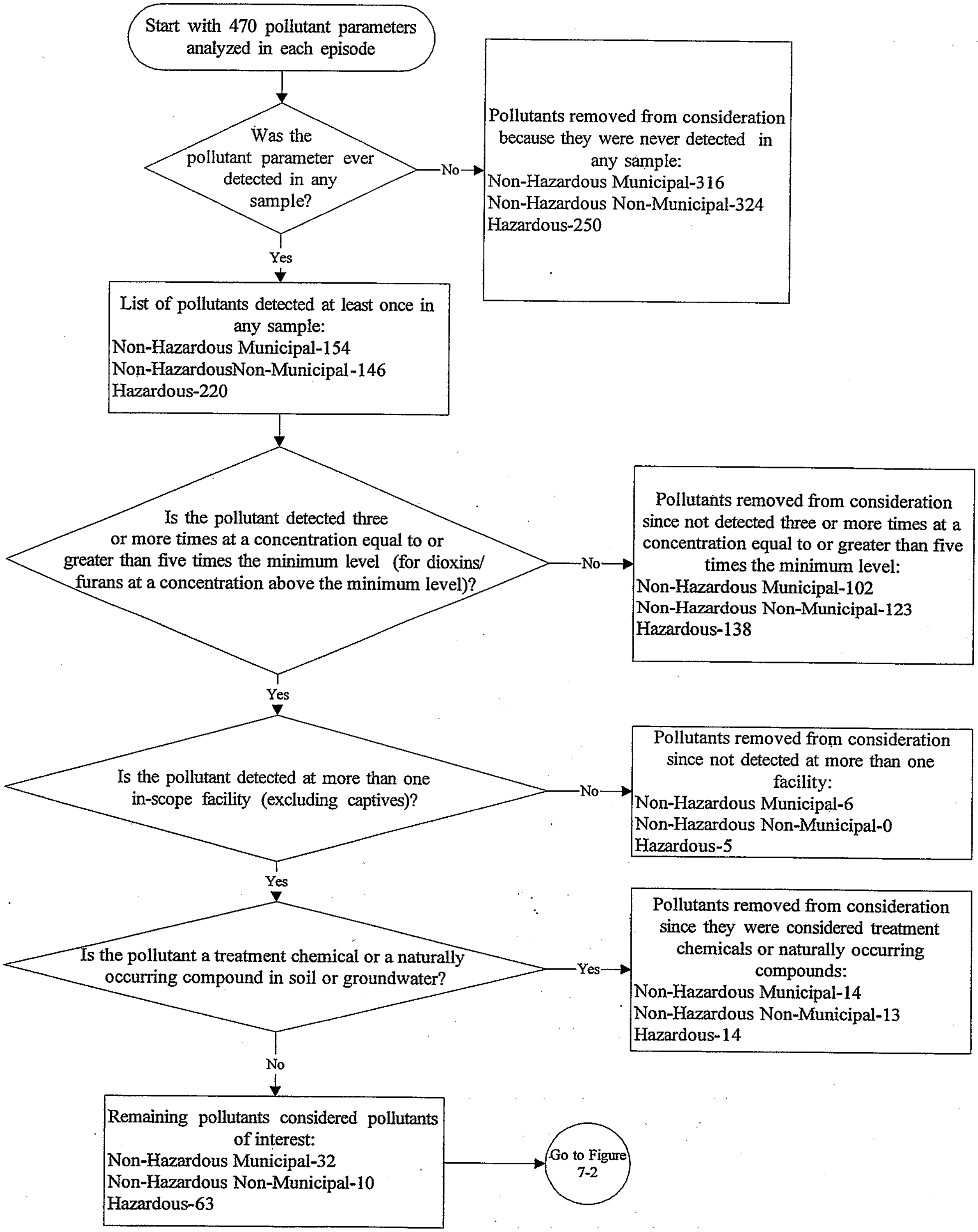
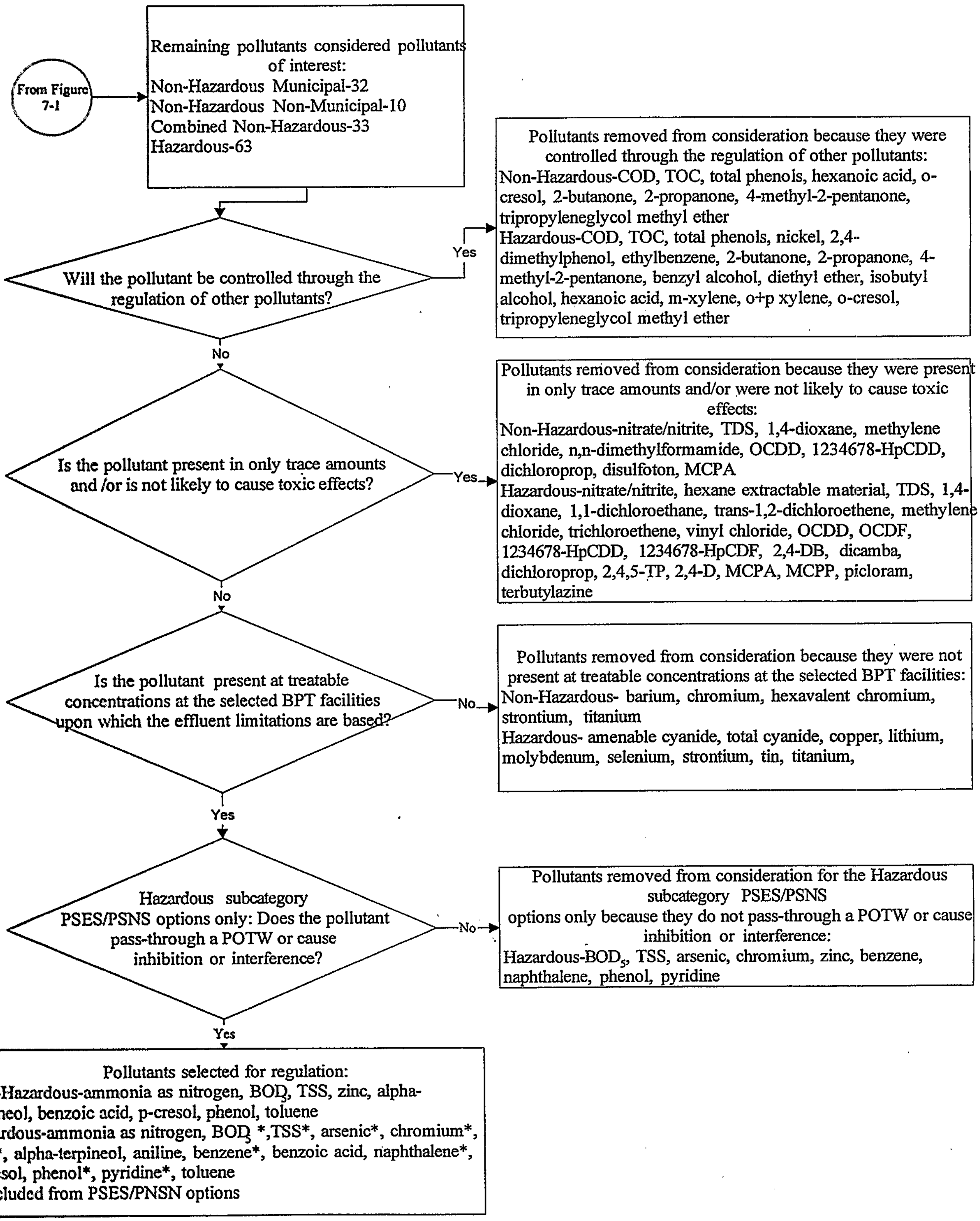


Figure 7-2: Selection of Pollutants to be Regulated



8.0 WASTEWATER TREATMENT TECHNOLOGY DESCRIPTION

This chapter consists of two main parts: Section 8.1 describes the wastewater treatment and sludge handling methods currently in use in the Landfills industry and Section 8.2 presents a discussion on the performance of treatment systems evaluated by EPA using data collected during engineering site visits field sampling programs.

8.1 Available BAT and PSES Technologies

The Landfills industry uses a wide variety of technologies for treating wastewater discharges. These technologies can be classified into the following five areas:

	Section
• Best Management Practices	8.1.1
• Physical/Chemical Treatment	8.1.2
• Biological Treatment	8.1.3
• Sludge Handling	8.1.4
• Zero Discharge options	8.1.5

The EPA's Detailed Technical Questionnaire obtained information on 14 treatment technologies currently in use in the Landfills industry. Table 8-1 presents the technologies most commonly used by in-scope Subtitle D non-hazardous and Subtitle C hazardous landfill facilities by discharge type. The table reports the percent of landfill facilities which use each treatment technology. In addition, EPA collected detailed information on available technologies from engineering plant visits to a number of landfill facilities. The data presented below are based on these data collection efforts.

8.1.1 Best Management Practices

Best management practices with regard to wastewater generation at landfills can be designed to do one of two things: reduce the volume of leachate produced by the landfill or reduce the toxicity of the leachate produced by the landfill. The volume of leachate generated by a landfill is largely dependent on the annual precipitation that falls within the landfill area, percolates through the landfilled waste, and collects in the leachate collection system. Closed landfills are required to install an impermeable cap over the landfill to prevent infiltration of rainwater, which will eventually reduce the volume of wastewater produced by the landfill. Open landfills, however, can similarly use methods to reduce rainwater infiltration to the landfill, and hence reduce wastewater generation. The open face of the landfill is the active area where solid waste is deposited, compacted, and covered with daily fill. This area can act as a collection point for rainwater. By maintaining a small open face on the landfills, along with using impermeable materials on the closed or inactive sections, a landfill operator can reduce the volume of wastewater collected and produced by an open landfill.

Many municipal solid waste landfills and communities have developed programs to prevent toxic materials from being deposited in the landfills. Solid waste generated by households may contain many types of waste which may present an environmental hazard, including paints, pesticides, and batteries. Many communities have developed household hazardous waste collection programs which collect and dispose of these hazardous wastes in an appropriate manner, thus avoiding deposition of hazardous wastes in the municipal landfill, and reducing the risks associated with the leachate produced by the landfill.

8.1.2 Physical/Chemical Treatment

8.1.2.1 Equalization

Wastewater and leachate generation rates at landfills are variable due to their direct relationship to rainfall, storm water run-on and run-off, groundwater entering the waste-containing zone, and the moisture content and absorption capability of the wastes. To allow for the equalization of pollutant loadings and flow rates, leachate and other landfill generated wastewaters are often collected prior to treatment in tanks or ponds with sufficient capacity to hold the peak flows generated at the facility. A constant flow is delivered from these holding tanks in order to dampen the variation in hydraulic and pollutant loadings to the wastewater treatment systems. This reduction in hydraulic and pollutant variability increases the performance and reliability of down stream treatment systems and can reduce the size of subsequent treatment by reducing the maximum flow rates and concentrations of pollutants. Equalization also lowers the operating costs of associated treatment units by reducing instantaneous treatment capacity demand and by optimizing the amount of treatment chemicals required for a less erratic set of treatment variables. National estimates based on EPA's Detailed Questionnaire data show that 23 percent of direct and 11 percent of indirect non-hazardous landfill facilities use some form of equalization as part of wastewater treatment systems.

Equalization systems consist of steel or fiberglass holding tanks or lined ponds that provide sufficient capacity to contain peak flow conditions. Detention times are determined using a mass balance equation and are dependent on site-specific generation rates and treatment design criteria. Data provided by the Landfills industry in questionnaire responses indicated a range in the design detention times of influent equalization systems from less than a day to a high of 90 days with a median value of about two days. A two day detention time is typical of equalization units installed for wastewater treatment systems at landfill facilities selected as the basis for the proposed effluent limitations guidelines. Equalization systems can be equipped to contain either mechanical mixing systems or aeration systems that enhance the equalization process by keeping the tank contents well mixed and prohibiting the settling of solids.

A breakdown of equalization systems used in the Landfills industry based on the responses to the Detailed Questionnaire is as follows:

Equalization Type	% Non-Hazardous Facilities		% Hazardous Facilities
	Direct	Indirect	Indirect
Unstirred	17	6	0
Mechanically Stirred	>1	<1	0
Aerated	10	6	0

A typical equalization system is shown in Figure 8-1.

8.1.2.2 Neutralization

Wastewaters generated by landfills may have a wide range of pH depending on the types of waste deposited in the landfill. In many instances, raw wastewater may require neutralization to eliminate either high or low pH values prior to treatment systems, such as activated sludge biological treatment. However, neutralization systems also are used in conjunction with certain chemical treatment processes, such as chemical precipitation, to adjust the pH of the wastewater to optimize process control. Acids, such as sulfuric acid or hydrochloric acid, are added to reduce pH, and alkalies, such as sodium hydroxides, are added to raise pH values. Neutralization may be performed in a holding tank, rapid mix tank, or an equalization tank. Typically, neutralization systems at the end of a treatment system are designed to control the pH of the discharge to between 6 and 9. National estimates based on EPA's Detailed Questionnaire data show that 33 percent of indirect hazardous landfills, 7 percent of indirect non-hazardous landfills, and 7 percent of direct non-hazardous landfill facilities employ neutralization as part of wastewater treatment systems using a variety of chemical additives to control pH.

Figure 8-2 presents a flow diagram for a typical neutralization system.

8.1.2.3 Flocculation

Flocculation is a treatment technology used to enhance sedimentation or filtration treatment system performance. Flocculation precedes these processes and usually consists of a rapid mix tank, or in-line mixer, and a flocculation tank. The waste stream is initially mixed while a flocculation chemical is added. Flocculants adhere readily to suspended solids and each other to facilitate gravity sedimentation or filtration. Coagulants can be added to reduce the electrostatic surface charges and enhance the formation of complex hydrous oxides. Coagulation allows for the formation of larger, heavier particles, or flocculants (which usually occur in a flocculation chamber), that can settle faster. There are three different types of flocculants commonly used: inorganic electrolytes, natural organic polymers, and synthetic polyelectrolytes. The selection of the specific treatment chemical is highly dependent upon the characteristics and chemical properties of the contaminants. A rapid mix tank is usually designed for a detention time from 15 seconds to several minutes (see reference 3). After mixing, the coagulated wastewater flows to a flocculation basin where slow mixing of the waste occurs. The slow mixing allows for the particles to agglomerate into heavier, more settleable solids. Mixing is provided either by mechanical paddle mixers or by diffused air. Flocculation basins are typically designed for a detention time of 15 to 60 minutes (see reference 3). Since many landfill facilities employ gravity assisted separation and chemical precipitation as part of wastewater treatment systems, EPA assumes that many of these facilities employ flocculation to enhance system performance. However, data on the use of flocculation at landfill facilities were not collected as part of the Detailed Questionnaire survey, and, therefore, this cannot be confirmed definitely.

8.1.2.4 Gravity Assisted Separation

Gravity assisted separation or sedimentation is a simple, economical, and widely used method for the treatment of landfill wastewaters. Clarification systems remove suspended matter, flocculated impurities, and precipitates from wastewater. By allowing the wastewater to become quiescent, the suspended matter, which is heavier than water, can settle to the bottom of the clarifier, forming a sludge blanket which can be removed. This process can occur in specially designed tanks, or in earthen ponds and basins. Clarification systems can also be equipped to allow for the removal of materials lighter than water, such as oils, which are skimmed from the surface and collected for disposal. Sedimentation units at landfills are used as either primary treatment options to remove suspended solids or following a biological or chemical precipitation process. Sedimentation processes are highly sensitive to flow fluctuations and, therefore, usually require equalization at facilities with large flow variations.

Clarifiers can be rectangular, square, or circular in shape. In rectangular or square tanks, wastewater flows from one end of the tank to the other with settled sludge collected into a hopper located at one end of the tank. In circular tanks, flow enters from the center and flows towards the outside edge with sludge collected in a center hopper. Treated wastewater exits the clarifier by flowing over a weir located at the top of the clarifier. Sludge which accumulates at the bottom of the clarifier is periodically removed and is typically stabilized and/or dewatered prior to disposal. National estimates based on EPA's Detailed Questionnaire data suggest that 67 percent of indirect hazardous landfills, 9 percent of indirect non-hazardous landfills, and 32 percent of direct non-hazardous landfill facilities employ some form of gravity assisted separation as part of wastewater treatment systems.

Flocculation systems are commonly used in conjunction with gravity assisted clarification systems to improve their solids removal efficiency. Some clarifiers are designed with a center well to introduce flocculants and allow for coagulation in order to improve removal efficiencies. A schematic of a typical clarification system using coagulation and flocculation is shown in Figure 8-3. The main design parameters used in designing a clarifier are the overflow rate, detention time, and the side water depth. Overflow rate is the measure of the flow as a function of the surface area of the clarifier. Typical design parameters used for both primary and secondary clarifiers are presented below (see reference 7):

Design Parameter	Primary	Secondary
Overflow rate, gpd/sq ft	600-1,000	500-700
Detention time,min	90-150	90-150
Minimum Side water depth, ft	8	10

A variation of conventional clarification process is the chemically-assisted clarification process. Coagulants are added to clarifiers to enhance liquid-solid separation, permitting solids denser than water to settle to the bottom and materials less dense than water (including oil and grease) to flow to the surface. Settled solids form a sludge at the bottom of the clarifier which can be pumped out continuously or intermittently. Oil and grease and other floating materials may be skimmed.

Chemically assisted clarification may be used alone or as part of a more complex treatment process. It also may be used as:

- The first process applied to wastewater containing high levels of settleable suspended solids.
- The second stage of most biological treatment processes to remove the settleable materials, including microorganisms, from the wastewater; the microorganisms then

can be either recycled to the biological reactor or sent to the facility's sludge handling system.

- The final stage of most chemical precipitation (coagulation/flocculation) processes to remove the inorganic flocs from the wastewater.

As discussed in Chapter 9, chemically assisted clarification was a component of the model wastewater treatment technology for estimating the BPT engineering costs of compliance. In developing regulatory compliance costs, chemically assisted clarification processes were used as an additional polishing process after biological treatment. Chemically assisted clarification processes consists of both a clarifier and a polymer feed system. For facilities currently with sedimentation following biological treatment, additional costs were only provided for a polymer feed system. Chemically assisted clarification systems were provided to aid in the settling process following biological treatment to enhance both TSS and BOD_5 removals through the wastewater treatment process. Higher BOD_5 removals can be obtained by the additional removal of microbial floc in the clarifier. Facilities were costed for a chemical assisted clarification system when their current performance for TSS and/or BOD_5 was slightly out of compliance with proposed regulatory levels (up to 10 mg/l for BOD_5 and 50 mg/l for TSS). For instance, if a facility had a aerobic lagoon treatment system and exceeded the regulatory level for TSS by 20 mg/l, the facility was costed for a chemically assisted clarification system.

Although chemical addition was not reported by landfill facilities, chemically assisted clarification is a proven technology for the removal of BOD_5 and TSS in a variety of industrial categories (see reference 19).

National estimates indicate that less than one percent of direct and indirect non-hazardous landfills use an alternative clarification system design based on corrugated plate interceptor (CPI) technology. These systems include a series of small (approximately two inch square) inclined tubes in the clarification settling zone. The suspended matter must only travel a short distance, when settling or floating, before they reach a surface of the tube. At the tubes' surface, the suspended matter further coagulate. Because of the increased surface area provided by the inclined tubes, CPI units can have much smaller settling chambers than standard clarifiers.

8.1.2.5 Chemical Precipitation

Chemical precipitation is used for the removal of metal compounds from wastewater. In the chemical precipitation process, soluble metallic ions and certain anions found in landfill wastewaters are converted to insoluble forms, which precipitate from solution. Most metals are relatively insoluble as hydroxides, sulfides, or carbonates. Coagulation processes are used in conjunction with precipitation to facilitate removal by agglomeration of suspended and colloidal materials. The precipitated metals are subsequently removed from the wastewater stream by liquid filtration or clarification (or some other form of gravity assisted separation). Other treatment processes such as equalization, chemical oxidation or reduction (e.g., hexavalent chromium reduction), usually precede the chemical precipitation process. The performance of the chemical precipitation process is affected by chemical interactions, temperature, pH, solubility of waste contaminants, and mixing effects.

Common precipitates used at landfills facilities include lime, sodium hydroxide, soda ash, sodium sulfide, and alum. Other chemicals used in the precipitation process for pH adjustment and/or coagulation include sulfuric and phosphoric acid, ferric chloride, and polyelectrolytes. Often, facilities use a combination of these chemicals. Precipitation using sodium hydroxide or lime is the conventional method of removing metals from wastewater at landfill facilities. Hydroxide precipitation is effective in removing such metals as antimony, arsenic, chromium, copper, lead, mercury, nickel, and zinc. However, sulfide precipitation also is used instead of hydroxide precipitation to remove specific metal ions such as mercury, lead, and silver. Carbonate precipitation is another method of chemical precipitation and is used primarily to remove antimony and lead. Use of alum as a precipitant/coagulant agent results in the formation of aluminum hydroxides in wastewaters containing calcium or magnesium bicarbonate alkalinity. Aluminum hydroxide is an insoluble gelatinous floc which settles slowly and entraps suspended materials and is effective for metals such as arsenic and cadmium.

Since lime is less expensive than caustic, it is more frequently used at landfill facilities employing hydroxide precipitation. However, lime is more difficult to handle and feed, as it must be slaked, slurried, and mixed, and can often plug the feed system lines. Lime precipitation also produces a larger volume of sludge. The reaction mechanism for precipitation of a divalent metal using lime is shown below:

$$M^{++} + Ca(OH)_2 \rightarrow M(OH)_2 + Ca^{++}$$

And, the reaction mechanism for precipitation of a divalent metal using sodium hydroxide is:

$$M^{++} + 2NaOH \rightarrow M(OH)_2 + 2Na^{++}$$

In addition to the type of treatment chemical chosen, another important design factor in the chemical precipitation operation is pH. Metal hydroxides are amphoteric, meaning they can react chemically as acids or bases. As such, their solubilities increase toward both lower and higher pH levels. Therefore, there is an optimum pH for precipitation for each metal, which corresponds to its point of minimum solubility. Figure 8-4 presents calculated solubilities of metal hydroxides. For example, as demonstrated on this figure, the optimum pH range where zinc is the least soluble is 8 to 10.

Another key consideration in a chemical precipitation application is the detention time in the sedimentation phase of the process, which is specific to the wastewater being treated and the desired effluent quality.

The first step of a chemical precipitation process is pH adjustment and the addition of coagulants. This process usually takes place in separate mixing and flocculation tanks. After mixing the wastewater with treatment chemicals, the resultant mixture is allowed to agglomerate in the flocculation tank which is mixed slowly by either mechanical means, such as mixers, or recirculation pumping. The wastewater then undergoes a separation/dewatering process such as clarification or filtration, where the precipitated metals are removed from solution. In a clarification system, a flocculant, such as a polymer, sometimes is added to aid in the settling process. The resulting sludge from the clarifier or filter must be further treated, disposed, or recycled.

National estimates based on the Detailed Questionnaire data collected suggest that 33 percent of indirect hazardous landfills, 5 percent of indirect non-hazardous landfills, and 11 percent of direct non-hazardous landfill facilities employ chemical precipitation as part of wastewater treatment systems. A typical chemical precipitation system is presented in Figure 8-5.

8.1.2.6 Chemical Oxidation/Reduction

Chemical oxidation treatment processes can be used to remove ammonia, to oxidize cyanide, to reduce the concentration of residual organics, and to reduce the bacterial and viral content of wastewaters. Both chlorine and ozone can be used to destroy residual organics in wastewater. When these chemicals are used for this purpose, disinfection of the wastewater is usually an added benefit. A further benefit of using ozone is the removal of color. Ozone can also be combined with hydrogen peroxide for removing organic compounds in contaminated groundwater. Oxidation also is used to convert pollutants to end products or to intermediate products that are more readily biodegradable or removed more readily by adsorption. National estimates based on the Detailed Questionnaire data show that 33 percent of indirect hazardous landfills, 10 percent of direct non-hazardous landfills, and less than one percent of indirect non-hazardous landfill facilities use chemical oxidation units as part of wastewater treatment systems.

Chemical oxidation is a chemical reaction process in which one or more electrons are transferred from the chemical being oxidized to the chemical initiating the transfer (the oxidizing agent). The electron acceptor may be another element, including an oxygen molecule, or it may be a chemical species containing oxygen, such as hydrogen peroxide, chlorine dioxide, permanganate, or ozone. This process is also effective in destroying cyanide and toxic organic compounds. Figure 8-6 presents a process schematic for a chemical oxidation system that uses an alkaline chlorination process.

Chemical oxidation is a potential treatment option for the removal of certain organic pollutants from leachate or groundwater. The amount of oxidant required in practice is generally greater than the theoretical mass calculated. The reasons for this are numerous and include incomplete oxidant consumption and oxidant demand caused by other species in solution. Oxidation reactions are catalysts and pH dependent; hence, pH control is an important design variable. Since economics are an important factor, partial oxidation followed by additional treatment options may be more efficient and cost effective than using a complete oxidation treatment scheme alone.

According to the Detailed Questionnaire data, landfill facilities use chemical oxidation processes to treat cyanide-bearing wastes, organic pollutants, and as a disinfectant. When treating cyanide or organic wastes, these processes use strong oxidizing chemicals, such as chlorine in elemental or hypochlorite salt form. As a disinfection process, an oxidant (usually chlorine) is added to the wastewater in the form of either chlorine dioxide or sodium hypochlorite. Other disinfectant chemicals include ozone, hydrogen peroxide, sulfur dioxide, and calcium hypochlorite. Once the oxidant is mixed with the wastewater, sufficient detention time (usually 30 minutes) is allowed for the disinfecting reactions to occur (see reference 7).

Chemical reduction processes involve a chemical reaction in which electrons are transferred from one chemical to another to reduce the chemical state of a contaminant. The main application of chemical reduction in leachate treatment is the reduction of hexavalent chromium to trivalent chromium. Chromium reduction is necessary due to the inability of hexavalent chromium to form a hydroxide, thus enabling the trivalent chromium to be precipitated from solution in conjunction with other metallic salts. Figure 8-7 presents a flow diagram of a chromium reduction system. Sulfur dioxide, sodium bisulfate, sodium metabisulfate, and ferrous sulfate are typical reducing agents used at landfill facilities.

8.1.2.7 Stripping

Stripping is an effective treatment method for removing dissolved volatile organic compounds from wastewater. The removal is accomplished by passing air or steam through the agitated waste stream.

The process results in a contaminated off-gas stream which, depending upon the air emissions standards, usually requires air pollution control equipment. National estimates based on EPA's Detailed Questionnaire data indicate that 4 percent of direct and greater than one percent of indirect non-hazardous landfill facilities use air stripping as part of wastewater treatment systems.

8.1.2.7.1 Air Stripping

The driving force of air stripping mass-transfer operation is the difference in concentrations between the air and liquid streams. Pollutants are transferred from the more concentrated wastewater stream to the less concentrated air stream until equilibrium is reached; this equilibrium relationship is known as Henry's Law. The strippability of a pollutant is expressed as its Henry's Law Constant, which is a function of its volatility and solubility.

Air stripping (or steam stripping) can be performed in tanks or in spray or packed towers. Treatment in packed towers is the most efficient application. The packing typically consists of plastic rings or saddles. The two types of towers that are commonly used, cross flow and countercurrent, differ in design only in the location of the air inlets. In the cross flow tower, the air is drawn through the sides for the total length of the packing. The countercurrent tower draws its entire air flow from the bottom. The cross flow towers have been found to be more susceptible to scaling problems and are less efficient than countercurrent towers.

Figure 8-8 presents a flow diagram of a countercurrent air stripper.

8.1.2.8 Filtration

Filtration is a method for separating solid particles from a fluid through the use of a porous medium. The driving force in filtration is a pressure gradient caused by gravity, centrifugal force, or a vacuum. Filtration treatment processes can be used at landfills to remove solids from wastewaters after physical/chemical or biological treatment or as the primary source of leachate treatment. Filtration processes include a broad range of media and membrane separation technologies from ultrafiltration to reverse osmosis. To aid in removal, the filter medium may be precoated with a filtration aid such as ground cellulose or diatomaceous earth.

National estimates based on the Detailed Questionnaire data indicate that 10 percent of direct and less than one percent of indirect non-hazardous landfill facilities have some form of filtration as part of wastewater treatment systems including the following:

Type of Filtration System	% Non-Hazardous Facilities	
	Direct	Indirect
Sand	5	<1
Diatomaceous earth	0	<1
Granular multimedia	6	<1
Membrane	0	1
Fabric	0	<1

Dissolved compounds in landfill wastewaters are sometimes pretreated to convert the compound to an insoluble solid particle prior to filtration. Polymers are sometimes injected into the filter feed piping downstream of feed pumps to enhance flocculation of smaller flocs that may escape an upstream clarifier. Pretreatment for iron and calcium is sometimes necessary to prevent fouling and scaling.

The following sections discuss the various types of filtration in use at landfills facilities.

8.1.2.8.1 Sand Filtration

Sand filtration processes consist of either a fixed or moving bed of media that traps and removes suspended solids from water passing through the media. There are two types of fixed sand bed filters: pressure and gravity. Pressure filters contain media in an enclosed, watertight pressure vessel and require a feed pump to force the water through the media. A gravity filter operates on the basis of differential pressure of a static head of water above the media, which causes flow through the filter. Filter loading rates for sand filters are typically between 2 to 6 gpm/sq ft (see reference 7).

All fixed media filters have influent and effluent distribution systems consisting of pipes and fittings. Strainers in the tank bottom are usually stainless steel screens. Layers of uniformly sized gravel also serve as bottom strainers and as a support for the sand. For both types of filters, the bed builds up head loss over time. Head loss is a measure of solids trapped in the filter. As the filter becomes filled with trapped solids, the efficiency of the filtration process falls off, and the filter must be backwashed. Filters are backwashed by reversing the flow so that the solids in the media are dislodged and can exit the filter; sometimes air is dispersed into the sand bed to scour the media.

Fixed bed filters can be automatically backwashed when the differential pressure exceeds a preset limit or when a timer starts the backwash cycle. Powered valves and a backwash pump are activated and controlled by adjustable cam timers or electronic programmable logic controllers to perform the backwash function. A supply of clean backwash water is required. Backwash water and trapped particles are commonly discharged to an equalization tank upstream of the wastewater treatment system's primary clarifier or screen for removal.

Moving bed filters use an air lift pump and draft tube to recirculate sand from the filter bottom to the top of the filter vessel, which is usually open at the top. Dirty water entering the filter at the bottom must travel upward, countercurrently, through the downward moving fluidized sand bed. Particles are strained from the rising water and carried downward with the sand. Due to the difference in specific gravity, the lighter particles are removed from the filter when the sand is recycled through a separation box at the top of the filter or in a remote location. The heavier sand falls back into the filter, while the lighter particles flow over a weir to waste. Moving bed filters are continuously backwashed and have a constant rate of effluent flow.

8.1.2.8.2 Diatomaceous Earth

These filtration systems use diatomaceous earth, a natural substance, as a precoat on either a vacuum or pressure filter arrangement to enhance removal efficiencies. In these instances, the diatomaceous earth is placed as a thin layer over a screen. The wastewater then is passed through the layer of earth and screen, with the suspended particles being filtered. A vacuum can be drawn across the screen, or pressure applied to the wastewater to help the liquid pass through the filter medium.

8.1.2.8.3 Multimedia Filtration

Multimedia, or granular bed, filtration is used for achieving supplemental removal of residual suspended solids from the effluent of chemical or biological treatment processes. These filters can be operated either by gravity or under pressure in a vessel. In granular bed filtration, the wastewater stream is sent through a bed containing one or more layers of different granular materials. The solids are retained in the voids between the media particles while the wastewater passes through the bed. Typical media used in granular bed filters include anthracite coal, sand, and garnet. These media can be used alone, such as in sand filtration, or in a multimedia combination. Multimedia filters are designed such that the individual layers of media remain fairly discrete. This is accomplished by selecting appropriate filter loading rates, media grain size, and bed density. Hydraulic loading rates for a multi-media filter are between 4 to 10 gpm/sq ft (see reference 7).

A multimedia filter operates with the finer, denser media at the bottom and the coarser, less dense media at the top. A common arrangement is garnet at the bottom of the bed, sand in the middle, and anthracite coal at the top. Some mixing of these layers occurs and is anticipated. During filtration, the removal of the suspended solids is accomplished by a complex process involving one or more mechanisms, such as straining, sedimentation, interception, impaction, and adsorption. The medium size is the principal characteristic that affects the filtration operation. If the medium is too small, much of the driving force will be wasted in overcoming the frictional resistance of the filter bed. If the medium is too large, small particles will travel through the bed, preventing optimum filtration.

The flow pattern of multimedia filters is usually top-to-bottom. Upflow filters, horizontal filters, and biflow filters are also used. A top-to-bottom multimedia filter is represented in Figure 8-9.

8.1.2.8.4 Membrane Filtration

Membrane filtration systems refer to those processes which employ a semi-permeable membrane and a pressure differential. Both reverse osmosis and ultrafiltration are commonly used membrane filtration processes.

8.1.2.8.4.1 Ultrafiltration

Ultrafiltration uses a semi-permeable microporous membrane, through which the wastewater is passed under pressure. Water and low molecular weight solutes, such as salts and surfactants, pass through the membrane and are removed as permeate. Emulsified oils and suspended solids are rejected by the membrane and removed with some of the wastewater as a concentrated liquid. The concentrate is recirculated through the membrane unit until the flow of permeate drops. The permeate can either be discharged or passed along to another treatment unit. The concentrate is contained and held for further treatment or disposal. Several types of ultrafiltration membranes configurations are available; tubular, spiral wound, hollow fiber, and plate and frame. A typical ultrafiltration system is presented in Figure 8-10.

Ultrafiltration is commonly used for the treatment of metal-bearing and oily wastewaters. It can remove substances with molecular weights greater than 500, including suspended solids, oil and grease, large organic molecules, and complexed heavy metals (see reference 8). Ultrafiltration is used when the solute molecules are greater than ten times the size of the solvent molecules and less than one-half micron. The primary design consideration in ultrafiltration is the membrane selection. A membrane pore size is chosen based on the size of the contaminant particles targeted for removal. Other design parameters to be considered are the solids concentration, viscosity, and temperature of the feed stream, and the membrane permeability and thickness.

8.1.2.8.4.2 Reverse Osmosis

Reverse osmosis is a separation process that uses selective semipermeable membranes to remove dissolved solids, such as metal salts, from water. The membranes are more permeable to water than to contaminants or impurities. The water in the feed is forced through a membrane by applied pressure which exceeds the osmotic pressure of the feed and becomes a permeate consisting of treated wastewater. Molecules of water pass through the membrane while contaminants are flushed along the surface of the membrane and exit as concentrate. The concentrate flow from a reverse osmosis system ranges from 10 to 50 percent of the feed flow, with concentrations of dissolved solids and contaminants approaching 10 times that of the feed water (see reference 6). The percentage of water that passes through the membranes is a function of operating pressure, membrane type, and concentration of the contaminants.

Cellulose acetate, aromatic polyamide, and thin-film composites are commonly used membrane materials. Reverse osmosis membranes are configured into tubular, spiral wound, hollow fiber, or plate and frame modules. Modules are inserted into long pressure vessels that can hold one or more modules. Reverse osmosis systems consist of a pretreatment pump, a high pressure feed pump, one or more pressure vessels, controls, and instrumentation. A tubular reverse osmosis module is shown in Figure 8-11.

Membranes have a limited life depending upon application and are replaced when cleaning is no longer effective. Membranes can be cleaned manually or chemically by recirculating the cleaning solution through the membranes to restore performance. Membranes can also be removed from the reverse osmosis system and sent off site for flushing and rejuvenation. Membranes are replaced when cleaning is no longer effective.

Membrane pore sizes for a typical reverse osmosis system range from 0.0005 to 0.002 microns, while pressures of 300 to 400 psi are usually encountered (see reference 39). Therefore, reverse osmosis feed water needs to be very low in turbidity. Pretreatment of landfill wastewaters prior to reverse osmosis treatment may be necessary, including chemical addition and clarification, or cartridge filtration using 5 micron filters to remove suspended particulates from the influent in order to protect pumps and membranes. Carbon adsorption is recommended as pretreatment for membranes sensitive to chlorine. Biofouling can be prevented by chlorination and dechlorination of the feed water. To maintain the solubility of metals such as calcium, magnesium, and iron, the pH can be adjusted with acid. Aside from pH adjustment, chemical requirements include: bactericide, dechlorination, and chelating agents.

One variation of conventional reverse osmosis technology used at landfill facilities is an innovative membrane separation technology using disc tube modules. This innovative process is designed to treat liquid waste that is higher in dissolved solids content, turbidity, and contaminant levels than waste treated by conventional membrane separation processes. This process also reduces the potential for membrane fouling and scaling, which allows it to be the primary treatment for waste streams such as landfill leachate.

The disc tube membrane module features larger feed flow channels and a higher feed flow velocity than typical membrane separation systems (see reference 48). These characteristics allow the disc tube module greater tolerance for dissolved solids and turbidity and a greater resistance to membrane fouling and scaling. The high flow velocity, short feed water path across each membrane, and the circuitous flow path create turbulent mixing to reduce boundary layer effects and minimize membrane fouling and scaling.

Membrane material for the disc tube module is formed into a cushion with a porous spacer material on the inside. The membrane cushions are alternately stacked with hydraulic discs on a tension rod. The hydraulic disks support the membranes and provide the flow channels for the feed liquid to pass over the membranes. After passing through the membrane material, permeate flows through collection channels to a product recovery tank. A stack of cushions and disks is housed in a pressure vessel. The number of disks per module, number of modules, and the membrane materials can be varied to suit the application. Modules are typically combined in a treatment unit or stage. Disc tube module units can be connected in series to improve permeate water quality or in parallel to increase system treatment capacity (see reference 48).

Like all membrane separation processes, reverse osmosis technology reduces the volume of the waste. The degree of volume reduction is dependent on the waste characteristics and the system design. Reverse osmosis technology can treat liquid waste streams containing low molecular weight volatile and semivolatile organics, metals and other inorganic compounds.

8.1.2.8.5 Fabric Filters

Fabric filters consist of a vessel that contains a cloth or paper barrier through which the wastewater must pass. The suspended matter is screened by the fabric, and the effectiveness of the filter depends on the mesh size of the fabric. Fabric filters can either be backwashed, or built as disposable units.

For waters having less than 10 mg/l suspended solids, cartridge fabric filters may be cost effective. Cartridge filters have very low capital cost and can remove particles of 1 micron or larger (see reference 39). Using two-stage cartridge filters (coarse and fine) in series extends the life of the fine cartridge. Disposable or backwashable bag filters also are available and may be quite cost effective for certain applications. Typically, these fabric filters are used to remove suspended solids prior to other filtrations systems to protect membranes and equipment and reduce solids fouling.

8.1.2.9 Carbon Adsorption

Activated carbon adsorption is a physical separation process in which organic and inorganic materials are removed from wastewater by sorption, or attraction, and accumulation of the compounds on the surface of the carbon granules. This process is commonly referred to as granular activited carbon adsorption. While the primary removal mechanism is adsorption, biological degradation and filtration are additional pollutant removal mechanisms provided by the activated carbon filter. Adsorption capacities of 0.5 to 10 percent by weight are typical in industrial applications (see reference 5). Spent carbon can either be regenerated on site, by processes such as wet-air oxidation or steam stripping, or, for smaller operations, it can be regenerated off site or sent directly for disposal. Vendors of carbon can exchange spent carbon with fresh carbon under contract.

Activated carbon systems consist of a vessel containing a bed of carbon (usually 4 to 12 feet in depth), whereby the wastewater is either passed upflow or downflow through the filter bed (see reference 6). Carbon vessels are typically operated under pressure; however, some designs use gravity beds. For smaller applications, granular activated carbon systems also are available in canister systems, which can be readily changed-out and sent for off-site regeneration.

Often more than one carbon vessel is used in series, such that the first column can be used until the carbon is "exhausted" before it is regenerated. The partially exhausted second column is then used as the first column, and a second column is rotated behind it to provide polishing. Up to three columns are typically used in a rotating fashion. When all of the available adsorption sites on the granular activated carbon are occupied, a rise in organic concentrations is observed in the effluent leaving the vessel. At this point the granular activated carbon in the vessel is saturated and is said to have reached break-through.

The key design parameter is the adsorption capacity of the granular activated carbon. This is a measure of the mass of contaminant adsorbed per unit mass of carbon and is a function of the chemical compounds being removed, type of carbon used, and process and operating conditions. The volume of carbon required is based upon the COD and/or pollutant-specific concentrations in the wastewater to be treated and desired frequency of carbon change-outs. The vessel is typically designed for an empty bed contact time of 15 to 60 minutes (see reference 5). Non-polar, high molecular weight organics with low solubility are readily adsorbed using GAC. Certain organic compounds have a competitive advantage for adsorption onto GAC, which results in compounds being preferentially adsorbed or causing other less competitive compounds to be desorbed from the GAC. Most organic copounds and some metals typically found in landfill leachate are effectively removed using GAC.

National estimates based on EPA's Detailed Questionnaire data indicate that one percent of indirect and greater than one percent of direct non-hazardous landfill facilities employ carbon adsorption as part of wastewater treatment systems. Figure 8-12 presents a flow diagram of a typical carbon adsorption vessel.

8.1.2.10 Ion Exchange

Ion exchange is an adsorption process that uses a resin media to remove contaminants from wastewaters. Ion exchange is commonly used for the removal of heavy metals from relatively low-concentration waste streams. A key advantage of the ion exchange process is that it allows for the recovery and reuse of the metal contaminants. Ion exchange also can be designed to be selective to certain metals and can provide effective removal from wastewater having high concentrations of background compounds such as iron, magnesium, and calcium. A disadvantage is that the resins can be fouled by oils and heavy polymers. Pretreatment for groundwater or leachate treated by an ion exchange system typically includes a cartridge filtration unit. Additional tanks and pumps are required for regeneration, chemical feed, and collection of spent solution.

In an ion exchange system, the wastewater stream is passed through a bed of resin. The resin contains bound groups of ionic charge on its surface, which are exchanged for ions of the same charge in the wastewater. Resins are classified by type, either cationic or anionic; the selection is dependent upon the wastewater contaminant to be removed. Cation resins adsorb metals, while anion resins adsorb such contaminants as nitrate and sulfate. A commonly-used type resin is polystyrene copolymerized with divinylbenzene. Key parameters for designing an ion exchange system include a resin bed loading rate of 2 to 4 gallons per minute per cubic foot, and a pressure vessel diameter providing for a cross-sectional area loading rate of 5 to 8 gallons per minute per square foot (see reference 5).

The ion exchange process involves four steps: treatment, backwash, regeneration, and rinse. During the treatment step, wastewater is passed through the resin bed. The ion exchange process continues until pollutant breakthrough occurs. The resin is then backwashed to reclassify the bed and to remove suspended solids. During the regeneration step, the resin is contacted with either an acidic or alkaline solution containing the ion originally present in the resin. This "reverses" the ion exchange process and removes the metal ions from the resin. The bed is then rinsed to remove residual regenerating solution. The resulting contaminated regenerating solution must be further processed for reuse or disposal. Depending upon system size and economics, some facilities choose to remove the spent resin and replace it with resin regenerated off-site instead of regenerating the resin in-place.

Ion exchange equipment ranges from simple, inexpensive systems such as domestic water softeners, to large, continuous industrial applications. A common industrial setup is fixed-bed resin in a vertical column, where the resin is regenerated in-place. Other operating modes include batch and fluidized bed. These systems can be designed so that the regenerant flow is concurrent or countercurrent to the treatment flow. A countercurrent design, although more complex to operate, provides a higher treatment efficiency. The beds can contain a single type of resin for selective treatment, or the beds can be mixed to provide for more complete deionization of the waste stream. Often, individual beds containing different resins are arranged in series, which makes regeneration easier than in the mixed bed system.

National estimates based on the Detailed Questionnaire data show that less than one percent of indirect non-hazardous landfills employ some form of ion exchange as part of wastewater treatment systems. Figure 8-13 presents a flow diagram of a typical ion exchange setup, fixed bed resin in a vertical column.

8.1.3 Biological Treatment

Biological treatment uses microbes which consume, and thereby destroy, organic compounds as a food source. Leachate from landfills can contain large quantities of organic materials that can be readily stabilized using biological treatment processes. In addition to the carbon food source supplied by the organic pollutants, the microbes also require energy and supplemental nutrients for growth, such as nitrogen and phosphorus. Aerobic microbes require oxygen to grow, whereas anaerobic microbes grow in the absence of oxygen. An adaptive type of anaerobic microbe, called a facultative anaerobe, can grow with or without oxygen.

The success of biological treatment in treating wastewaters is also dependent on other factors, such as the pH and temperature of the wastewater, the nature of the pollutants, the nutrient requirements of the microbes, the presence of other inhibiting pollutants (such as toxic heavy metals), and variations in the feed stream loading.

Aerobic biological treatment systems utilize an acclimated community of microorganisms to degrade, coagulate, and remove organic and other contaminants from wastewater. Organic contaminants in the wastewater are used by the treatment organisms for biological synthesis and growth, with a small portion for cellular maintenance. Resulting products from biological treatment include cellular biomass, carbon dioxide, water and, sometimes, the nondegradable fraction of the organic material.

For biological treatment to occur, wastewater is mixed or introduced to the biomass. The microorganisms responsible for stabilization can be maintained in suspended form or can be attached to a solid media. Examples of the suspended growth biological treatment systems include various activated sludge treatment processes and aerobic lagoons. Biological treatment processes which employ the use of fixed film media include trickling filtration, biotowers, and rotating biological contactors.

Anaerobic biological treatment systems can degrade organic matter in wastewater and ultimately convert carbonaceous material into methane and carbon dioxide. Anaerobic systems have been shown to be most effective for high strength leachate (COD over 4,000 mg/l) and for wastewaters containing refractory contaminants because of effectiveness of methanotropic microorganisms in metabolizing these compounds. A disadvantage to anaerobic treatment systems is the sensitivity of the methanotropic microorganisms to certain toxic substances.

Initially, in an anaerobic treatment process, the complex organic matter in the raw waste stream is converted to soluble organics by extra-cellular enzymes. This step facilitates the later conversion of soluble organic matter into simple organic acids. The final step involves the conversion of organic acids into methane and carbon dioxide. The bacteria responsible for the conversions have very slow growth rates. In addition, methanotropic bacteria are very sensitive to environmental conditions, require the complete absence of oxygen, a narrow pH range (6.5 to 7.5), and can be readily inhibited by the presence of toxic compounds such as certain heavy metals.

The number of landfill facilities estimated to use variations of biological treatment as part of wastewater treatment systems is presented below:

Type of Biological Treatment	% Non-Hazardous Facilities		% Hazardous Facilities
	Direct	Indirect	Indirect
Activated Sludge	7	1	33
Aerobic Lagoon Systems	6	3	0
Facultative Lagoons	6	<1	0
Trickling Filters	0	0	0
Anaerobic Systems	2	<1	0
Powdered Activated Carbon Treatment (PACT)*	>1	<1	0
Nitrification Systems	2	<1	0
Rotating Biological Contactors (RBCs)	0	0	0
Sequencing Batch Reactors (SBRs)	>1	0	33
Denitrification Systems	>1	0	0
Other+	11	0	0

* with Activated Sludge

\+ includes aerated submerged fixed film and wetlands

The following sections present a discussion of biological treatment systems in use at landfill facilities.

8.1.3.1 Lagoon Systems

A body of water contained in an earthen dike and designed for biological treatment is termed a lagoon or stabilization pond or oxidation pond. While in the lagoon, wastewater is biologically treated to reduce degradable organics and also to reduce suspended solids through sedimentation. The biological process taking place in the lagoon can be aerobic, anaerobic or both (facultative), depending on the design. Because of the low construction and operating costs, lagoons offer a financial advantage over other treatment methods and are popular where sufficient land is available at reasonable cost.

Lagoons are used in wastewater treatment for stabilization of suspended, dissolved and colloidal organics either as a main biological treatment process or as a polishing treatment process following other biological treatment systems. Aerobic, facultative and aerated lagoons are generally used for wastewater of low and medium organic strength. High strength wastewaters and wastewaters of variable strength often are treated by a series of lagoons; a common configuration is an anaerobic lagoon, followed by a facultative lagoon and an aerobic lagoon.

The performance of lagoons in removing degradable organics depends on detention time, temperature, and the nature of the waste. Aerated lagoons generally provide a high degree of BOD_5 reduction more consistently than aerobic or facultative lagoons. Typical problems associated with lagoons are excessive algae growth, offensive odors from anaerobic lagoons if sulfates are present and the lagoon is not covered, and seasonal variations in effluent quality.

The major classes of lagoons that are based on the nature of biological activities are discussed below. Aerobic lagoons depend on algae photosynthesis and natural aeration to assist in the biological activity. These shallow lagoons (3 to 4 feet in depth) rely on both the natural oxygen transfer occurring through the surface area of the lagoon and the production of oxygen from photosynthetic algae. Aerobic lagoons are generally suitable for treating low to medium strength landfill leachates due to the recommended smaller food to mass ratios. Because of this design limitation, aerobic lagoons are used in combination with other lagoons to treat higher strength landfill leachates to achieve additional organic removal following conventional wastewater treatment processes. The typical hydraulic detention time for an aerobic lagoon is 10 to 40 days, with an organic loading of 60 to 120 pounds of BOD_5 per day per acre (see reference 7).

A variation of the aerobic lagoon is the aerated lagoon. These lagoons do not depend on algae and sunlight to furnish dissolved oxygen, but require additional oxygen to be introduced to prevent anaerobic conditions. In these systems, mechanical or diffused aeration devices are used in the lagoons for oxygen transfer and to create some degree of mixing (see Figure 8-14). Due to this mixing, additional suspended solids removal in the effluent from the lagoon may be required. The recommended hydraulic detention time is 3 to 20 days, with an organic loading of 20 to 400 pounds of BOD_5 per day per acre (see reference 7). Based on these higher design loading rates, aerated lagoons are well suited for treatment of medium strength landfill leachates.

Aerated lagoons are relatively simple to operate. The influent is fed into the basin where it is mixed and aerated with the lagoon contents. Settled sludge is not routinely withdrawn from the lagoon. Lagoons require only periodic cleanings when the settled solids significantly reduce lagoon volume. Since operation requires no sludge recycle, the hydraulic detention time is equal to the sludge retention time. Contaminant reduction in a lagoon system is typically less than other biological treatment systems. As a result, aerobic lagoons are commonly used together with other physical/chemical treatment processes, such as lime addition and settling, to ensure sufficient pollutant removal efficiencies.

Anaerobic lagoons are relatively deep ponds (up to 6 meters) with steep sidewalls in which anaerobic conditions are maintained by keeping organic loading so high that complete deoxygenation is prevalent. Some oxygenation is possible in a shallow surface zone. If floating materials in the waste form an impervious surface layer, complete anaerobic conditions will develop. Treatment or stabilization results from anaerobic digestion of organic wastes by acid-forming bacteria that break down organics. The resultant acids are then converted to carbon dioxide, methane, and other end products. Anaerobic lagoons are capable of providing treatment of high strength wastewaters and are resistant to shock loads.

In the typical anaerobic lagoon, raw wastewater enters near the bottom of the pond (often at the center) and mixes with the active microbial mass in the sludge blanket, which can be as much as 2 meters (6 feet) deep. The discharge is located near one of the sides of the pond, submerged below the liquid surface. Excess sludge is washed out with the effluent and recirculation of waste sludge is not required.

Anaerobic lagoons are customarily contained within earthen dikes. Depending on soil and wastewater characteristics, lining with various impervious materials, such as rubber, plastic, or clay may be necessary. Pond geometry may vary, but surface area-to-volume ratios are minimized to enhance heat retention.

Waste stabilization in a facultative lagoon treatment system is accomplished by a combination of anaerobic microorganisms, aerobic microorganisms, and a preponderance of facultative microorganisms that thrive under anaerobic, as well as aerobic conditions. Facultative systems consist of lagoons of intermediate depth (3 to 8 feet) in which the wastewater is stratified into three zones (see Figure 8-15). These zones consist of an anaerobic bottom layer, an aerobic surface layer, and an intermediate zone dominated by the facultative microorganisms. Stratification is a result of solids settling and temperature-water density variations. Oxygen in the surface zone is provided by natural oxygen transfer and photosynthesis or, as in the case of an aerated facultative lagoon, by mechanical aerators or diffusers. Facultative lagoons usually consist of earthen dikes, but some are lined with various impervious materials, such as synthetic geomembranes or clay.

A facultative lagoon is designed to permit the accumulation of settleable solids on the basin bottom. This sludge at the bottom of the facultative lagoon will undergo anaerobic digestion, producing carbon dioxide and methane. The liquid and gaseous intermediate products from the accumulated solids, together with the dissolved solids furnished in the influent, provide the food for the aerobic and facultative bacteria in the upper layers of the liquid in the lagoon. Recommended hydraulic detention time for a facultative lagoon without aeration is 7 to 30 days, with an organic loading of 15 to 50 pounds of BOD_5 per day per acre (see reference 7).

8.1.3.2 Anaerobic Systems

There are several process variations for anaerobic biological treatment: complex mix anaerobic digestors (see Figure 8-16), contact reactors with sludge recycle, and anaerobic filters. A digestor uses an air tight reactor where wastes are mixed with digestor contents that contain the suspended anaerobic microorganisms. A digestor operated in a complete mix mode without sludge recycling has a hydraulic detention time equal to the solids retention time. Anaerobic digestion in a reactor can also occur with sludge recycling. This permits a much larger solids retention time (SRT) than the hydraulic detention time. System stability is greater at increased SRTs and, since the hydraulic detention time can be decreased, the reactor volume can also be reduced. The anaerobic filter or biotower microbes are maintained in a film on packed solid media within an air tight column. A variation of the anaerobic fixed-film process is a fluidized bed process. The basic tower design is similar to that of an aerobic reactor in that the influent is fed into the reactor at counter-current flow. This process provides for very high SRTs and variable hydraulic detention times.

Stabilization of leachate in an anaerobic treatment unit requires the maintenance of a viable community of anaerobic microbes. Treatment efficiency is dependent on many interrelated factors including: hydraulic detention time, SRT, temperature, and to a lesser extent organic loading, nutrients, and toxics. Microorganisms responsible for degrading the organic waste must remain in the reactor long enough to reproduce. When the microbes spend less time in the system than they require to reproduce, the solids are eventually washed out of the system. Anaerobic treatment facilities are reportedly designed with an SRT of 2 to 10 times the washout time (typical washout time reported for organic acids are about 3.5 days). For degradation of organic acids in leachate, this would yield an SRT of 7 to 35 days (see reference 7). The most common temperature regime for an anaerobic reactor is in the range of 25 to 38 degrees C (see reference 7). Typical loadings for anaerobic systems are from 30 to 100 pounds of COD per 1,000 cubic feet of reactor volume (see reference 7). Since the synthesis of new cellular material is slow, nutrient requirements are not as large as in aerobic systems. Nutrient addition needs to be evaluated, and in the case of leachate with low phosphorus concentrations, will require phosphorus addition.

8.1.3.3 Attached Growth Biological Treatment Systems

Attached growth biological treatment systems are used to biodegrade the organic components of a wastewater. In these systems, the biomass adheres to the surfaces of rigid supporting media. As wastewater contacts the supporting medium, a thin-film biological slime develops and coats the surfaces. As this film (consisting primarily of bacteria, protozoa, and fungi) grows, the slime periodically breaks off the medium and is replaced by new growth. This phenomenon of losing the slime layer is called sloughing and is primarily a function of organic and hydraulic loadings on the system. The effluent form the system is usually discharged to a clarifier to settle and remove the agglomerated solids.

Attached growth biological systems are applicable to industrial wastewaters amenable to aerobic to biological treatment in conjunction with suitable pre- and post-treatment units. These systems are effective for the removal of suspended or colloidal materials.

The three major types of attached growth systems used at landfills facilities are rotating biological contactors, trickling filters, and fluidized bed biological reactors. These processes are described below.

Rotating biological contactors are a form of aerobic attached growth biological system where the biomass adheres to the surface of a rigid media. In a rotating biological contactor, the rigid media usually consists of a plastic disk or corrugated plastic medium mounted on a horizontal shaft (see Figure 8-17). The medium slowly rotates in wastewater (with 40 to 50 percent of its surface immersed) as the wastewater flows past. During the rotation, the medium picks up a thin layer of wastewater, which flows over its surface absorbing oxygen from the air. The biological mass growing on the medium surface absorbs organic pollutants, which then are biodegraded. Excess microorganisms and other solids are continuously removed from the film on the disk by shearing forces created by the rotation of the disk in the wastewater. The sloughed solids are carried with the effluent to a clarifier, where they are separated from the treated effluent.

Rotating biological contactors provide a greater degree of flexibility for landfills with changing leachate characteristics. Modular construction of rotating biological contactors permit their multiple staging to meet increases or decreases in treatment demand. Staging, which employs a number of rotating biological contactors operated in series, enhances biological treatment efficiency, improves shock-handling ability, and also may aid in achieving nitrification.

Typical rotating biological contactor design parameters include a hydraulic loading of 2.0 to 4.0 gallons per square feet per day and an organic loading of 2.0 to 3.5 pounds BOD_5 per 1,000 square feet per day (see reference 12).

Factors which affect the efficiency of rotating biological contactor systems include the type and concentration of organic matter, hydraulic detention time, rotational speed, media surface area submergence, and pre- and post-treatment activities. Variations of the basic rotating biological contactor process design include the addition of air to the tanks, chemicals for pH control, use of molded covers or housing for temperature control, and sludge recycle to enhance nitrification. Rotating biological contactors are reportedly well suited for the treatment of soluble organics and adequate for nitrification. They are low-rate systems capable of handling limited loadings capacity and are not efficient for degrading refractory compounds or removing metals (see reference 7).

Trickling filtration is another aerobic fixed-film biological treatment process that consists of a suitable structure, packed with inert medium, such as rock, wood, or plastic. The wastewater is distributed over the upper surface of the medium by either a fixed spray nozzle system or a rotating distribution system (see Figure 8-18). The inert medium develops a biological slime that absorbs and biodegrades organic pollutants. Air flows through the filter by convection, thereby providing the oxygen needed to maintain aerobic conditions.

Trickling filters are classified as low-rate or high-rate, depending on the organic loading. Typical design organic loading values range from 5 to 25 pounds and 25 to 45 pounds BOD_5 per 1,000 cubic feet per day for low-rate and high-rate, respectively (see reference 11). A low-rate filter generally has a media bed depth of 1.5 to 3 meters and does not use recirculation. A high-rate filter can have a bed depth from 1 to 9 meters and recirculates a portion of the effluent for further treatment (see reference 7).

A variation of a trickling filtration process is the aerobic biotower which can be operated in a continuous or semi-continuous manner. Influent is pumped to the top of a tower, where it flows by gravity through the tower. The tower is packed with media, plastic or redwood, containing the microbial growth. Biological degradation occurs as the wastewater passes over the media. Treated wastewater collects into the bottom of the tower. If needed, additional oxygen is provided via air blowers counter current to the wastewater flow. Alternative variations of this treatment process involve the inoculation of the raw influent with bacteria, adding nutrients, and using upflow biotowers. Wastewater collected in the biotowers is delivered to a clarifier to separate the biological solids from the treated effluent.

An aerobic fluidized bed biological reactor is a variation of a fixed film biological treatment process. Microorganisms are grown on either granular activated carbon or sand media. Influent wastewater enters the reactor through a distributor which is designed to provide for fluidization of the media (see Figure 8-19). As the biofilm grows, the media bed expands, thereby reducing the density of the media. The rising bed is intercepted at a given height with the bulk of the biomass removed from the media. The media then is returned to the reactor. Additional oxygen can be predissolved in the influent to enhance performance. The use of granular activated carbon as a medium integrates biological treatment and carbon adsorption processes, which has the advantage of handling loading fluctuations, as well as greater removals of organic contaminants.

Due to a short hydraulic detention time, this process is favorable for low to moderate levels f contamination. The vertical installation of the reactor and high loading capability reduces conventional land requirements. The maximum design loading is 400 pounds of COD per 1,000 square feet of reactor area per day with a minimum hydraulic detention time of 5 to 10 minutes (see reference 7).

8.1.3.4 Activated Sludge

The activated sludge process is a specific continuous-flow, aerobic biological treatment process that employs suspended-growth aerobic microorganisms to biodegrade organic contaminants. In this process (shown in Figure 8-20), a suspension of aerobic microorganisms is maintained in a relatively homogeneous state by mechanical mixing or turbulence induced by diffused aerators in an aeration basin. This suspension of microorganisms is called the mixed liquor.

Influent is introduced into the basin and is allowed to mix with the tank contents. The biological process often is preceded by gravity settling to remove larger and heavier suspended solids. A series of biochemical reactions is performed in the aeration tank that degrade organics and generate new biomass. Microorganisms oxidize the soluble and suspended organic pollutants to carbon dioxide and water using the available supplied oxygen. These organisms also agglomerate colloidal and particulate solids. After a specific contact period in the aeration basin, the mixture is passed to a settling tank where the microorganisms are separated from the treated water. A portion of the settled solids in the clarifier is recycled back to the aeration system to maintain the desired concentration of microorganisms in the reactor. The remainder of the settled solids is wasted and sent to sludge handling facilities.

To ensure biological stabilization of organic compounds in activated sludge systems, adequate nutrient levels must be available to the biomass. The primary nutrients are nitrogen and phosphorus. Lack of these nutrients can impair biological activity and result in reduced removal efficiencies. Certain leachates can have low concentrations of nitrogen and phosphorus relative to the oxygen demand. As a result, nutrient supplements (e.g., phosphoric acid addition for additional phosphorus) have been used in activated sludge systems at landfill facilities.

The effectiveness of the activated sludge process is governed by several design and operation variables. The key variables are organic loading, sludge retention time, hydraulic or aeration detention time, oxygen requirements, and the biokinetic rate constant (K). The organic loading is described as the food-to-microorganism (F/M) ratio, or kilograms of BOD_5 applied daily to the system per kilogram of mixed liquor suspended solids (MLSS). The MLSS in the aeration tank is determined by the rate and concentration of activated sludge returned to the tank. The organic loading (F/M ratio) affects the BOD_5 removal, oxygen requirements, biomass production, and the settleability of the biomass. The sludge retention time (SRT) or sludge age is a measure of the average retention time of solids in the activated sludge system. Sludge retention time is important in the operating of an activated sludge system as it must be maintained at a level that is greater than the maximum generation time of microorganisms in the system. If adequate sludge retention time is not maintained, the bacteria are washed from the system faster than they can reproduce themselves and the process fails. The SRT also affects the degree of treatment and production of waste sludge. A high SRT results in carrying a high quantity of solids in the system and obtaining a higher degree of treatment and also results in the production of less waste sludge. The hydraulic detention time is used to determine the size of the aeration tank and should be determined by use of F/M ratio, SR and MLSS. The biokinetic rate constant (or K-rate) determines the speed of the biochemical oxygen demand reaction and generally ranges from 0.1 to 0.5 $days^{-1}$ for municipal wastewaters (see reference 11). The value of K for any given organic compound is temperature-dependent; because microorganisms are more active at higher temperatures, the value of K increases with increasing temperature. Oxygen requirements are based on the amount required for BOD_5 synthesis and the amount required for endogenous respiration. The design parameters will vary with the type of wastewater to be treated and are usually determined in a treatability study. The oxygen requirement to satisfy the BOD_5 synthesis is established by the characteristics of the wastewater. The oxygen requirement to satisfy endogenous respiration is established by the total solids maintained in the system and their characteristics.

Modifications of the activated sludge process are common, as the process is extremely versatile and can be adapted for a wide variety of organically contaminated wastewaters. The typical modification may represent a variation in one or more of the key design parameters, including the F/M loading, aeration location and type, sludge return, and contact basin configuration. The modifications in practice have been identified by the major characteristics that distinguish the particular configuration. The characteristic types and modifications are briefly described as follows:

- Conventional. The aeration tanks are long and narrow, with plug flow (i.e., little forward or backwards mixing).

- Complete Mix. The aeration tanks are shorter and wider, and the aerators, diffusers, and entry points of the influent and return sludge are arranged so that the wastewater mixes completely.

- Tapered Aeration. A modification of the conventional process in which the diffusers are arranged to supply more air to the influent end of the tank, where the oxygen demand is highest.

- Step Aeration. A modification of the conventional process in which the wastewater is introduced to the aeration tank at several points, lowering the peak oxygen demand.

- High Rate Activated Sludge. A modification of conventional or tapered aeration in which the aeration times are shorter, the pollutants loadings are higher per unit mass of microorganisms in the tank.. The rate of BOD_5 removal for this process is higher than that of conventional activated sludge processes, but the total removals are lower.

- Pure Oxygen. An activated sludge variation in which pure oxygen instead of air is added to the aeration tanks, the tanks are covered, and the oxygen-containing off-gas is recycled. Compared to normal air aeration, pure oxygen aeration requires a smaller aeration tank volume and treats high-strength wastewaters and widely fluctuating organic loadings more efficiently.

- Extended Aeration. A variation of complete mix in which low organic loadings and long aeration times permit more complete wastewater degradation and partial aerobic digestion of the microorganisms.

- Contact Stabilization. An activated sludge modification using two aeration stages. In the first, wastewater is aerated with the return sludge in the contact tank for 30 to 90 minutes, allowing finely suspended colloidal and dissolved organics to absorb to the activated sludge. The solids are settled out in a clarifier and then aerated in the sludge aeration (stabilization) tank for 3 to 6 hours before flowing into the first aeration tank (see reference 11).

- Oxidation Ditch Activated Sludge. An extended aeration process in which aeration and mixing are provided by brush rotors placed across a race-track-shaped basin. Waste enters the ditch at one end, is aerated by the rotors, and circulates.

Activated sludge systems are effective in the removal of soluble (dissolved) organics by biosorption as well as suspended and colloidal matter typically found in landfill leachate. Suspended matter s removed by entrapment in the biological floc while colloidal matter is removed by physiochemical adsorption to the biological floc. For example, inorganic contaminants, such as heavy metals, that are common in landfill wastewaters, often are precipitated and concentrated in the biological sludges generated from activated sludge systems at landfill facilities. Halogenated organic compounds may be driven off to a certain extent in the aeration process while other less volatile compounds are removed by a combination of biodegradation and air stripping in the aeration basin. Finally, activated sludge systems treating landfill leachates with an excess loading of certain nutrients (i.e. amounts of nitrogen that exceed the requirements of the biomass in the activated sludge system) can be operated so that nitrification of these nutrients can occur in the activated sludge system. For higher concentrations, stand-alone nitrification systems may be required; these systems are discussed later in this chapter.

Conventional, plug flow activated sludge systems can adequately treat the organic loadings found in low to medium strength landfill leachates. Higher strength leachates often are treated at landfill facilities using extended aeration mode of activated sludge treatment. This process allows for a large hydraulic detention time of up to 29 hours and for a sludge detention time of 20 to 30 days (see reference 7). Aerator loading for the complete mix extended aeration process is between 10 to 15 pounds of BOD_5 per 1,000 cubic feet of aerator tank volume (see reference 7). Extended aeration also provides for minimal operator supervision as compared to other activated sludge processes and occasional sludge wasting. EPA sampled a facility (EPA sampling Episode 4759) in the Hazardous subcategory that lined a complete mix extended aeration treatment process for high strength leachate. Design parameters for this system include influent BOD_5 loading of 3520 mg/l with a hydraulic detention time of 28 hours. Higher strength leachates are also occasionally treated with a combination of biological processes, sometimes using a lagoon or attached growth system prior to the activated sludge system to reduce organic loading. Since activated sludge systems are sensitive to the loading and flow variations typically found at landfill facilities, equalization is often require prior to activated sludge systems treatment. Also, activated sludge systems treating landfill leachates typically generate excess amounts of secondary sludge that may require additional stabilization, dewatering and disposal.

8.1.3.5 Powdered Activated Carbon Biological Treatment

In this biophysical treatment process, powdered activated carbon is added to a biological treatment system (usually an activated sludge system). The adsorbent qualities of the powdered carbon aid in the removal of organic compounds, particularly those that may be difficult to biodegrade. Powdered activated carbon also enhances color removal and the settling characteristics of the biological floc.

The mixture of influent, activated sludge biomass, and powdered activated carbon is held in the aeration basin for a sufficient detention time adequate for the desired treatment efficiencies (see Figure 8-21). After contact in the aeration basin, the mixture flows to a clarifier, where settled solids are fed back to the aeration basin to maintain adequate concentrations of microorganisms and carbon. Clear overflow from the clarifiers is either further processed or discharged. Fresh carbon is periodically added to the aeration basin as required and is dependent on desired removal efficiencies. Excess solids are removed directly from the recycled sludge stream. Wasted solids can be processed by conventional dewatering means or by wet-air oxidation for the destruction of organics and regeneration of activated carbon. Regeneration also can be handled off site for smaller applications.

Powdered activated carbon activated sludge treatment combines physical adsorption properties of carbon with biological treatment, achieving a higher degree of treatment than possible by either mode alone. Powdered activated carbon removes the more difficult to degrade refractory organics, enhances solids removal, and buffers the system against loading fluctuations and shock loads. Variations of the powdered activated carbon biological process includes operation in a batch fill and draw mode (similar to a sequencing batch reactor), multiple-stage powdered activated carbon units, and combinations of aerobic and anaerobic powdered activated carbon biological systems. Operation in a batch mode provides for flexibility in the system, by readily allowing for adjustments to the time and aeration mode in each process stage. This mode of operation is particularly applicable to the treatment of leachate with variable composition and strength. The powdered activated carbon biological treatment process is well suited for the treatment of leachate containing high concentrations of soluble organics (particularly with low BOD_5 to COD ratios). It can obtain better color and refractive organics removal than conventional biological processes and can provide for treatment of leachates contaminated with various trace organic compounds.

8.1.3.6 Sequencing Batch Reactors (SBRs)

A sequencing batch reactor is a suspended growth biological system in which the wastewater is mixed with existing biological floc in an aeration basin. SBRs are unique in that a single tank acts as an equalization tank, an aeration tank, and a clarifier (see Figure 8-22). A SBR is operated on a batch basis where the wastewater is mixed and aerated with the biological floc for a specific period of time. The contents of the basin then are allowed to settle and the liquid (or supernatant) is decanted. The batch operation of a sequencing batch reactor makes it applicable to wastewaters that are highly variable because each batch can be treated differently, depending its waste characteristics.

A sequencing batch reactor system has four cycles: fill, react, settle, and decant. The fill cycle has three phases. The first phase, called static fill, introduces the wastewater to the system under static conditions. During this phase, anaerobic conditions can exist. During the second phase, the wastewater is mixed to eliminate the scum layer and to initiate the oxygenation process. The third phase consists of aeration and biological degradation. The react cycle is a time-dependent process that continually mixes and aerates the wastewater while allowing the biological degradation process to complete. Because the reaction is a batch process, the period of time of aeration can vary to match the characteristics and loadings of the wastewater. The settling cycle utilizes a large surface area (entire reactor area) and a lower settling rate than used in conventional sedimentation processes, to allow for settling under quiescent conditions. Next, during the decant cycle, approximately one-third of the tank volume is removed by subsurface withdrawal. This treated effluent then can be further treated or disposed. The period of time that the reactor waits prior to the commencement of another batch processing is the idle period. Excess biomass is periodically removed from the sequencing batch reactor when the quantity exceeds that needed for operation and is usually dewatered prior to disposal.

A sequencing batch reactor carries out all of the functions of a conventional continuous flow activated sludge process, such as equalization, biological treatment, and sedimentation, in a time sequence rather than a space sequence. Detention times and loadings vary with each batch and are highly dependent on the loadings in the raw wastewater at that time. Typically, a sequencing batch reactor operates with a hydraulic detention time of 1 to 10 days with an SRT of 10 to 30 days. The MLSS is maintained at 3,500 to 10,000 mg/l (see reference 7). The overall control of the system can be accomplished automatically by using level sensors or timing devices. By using a single tank to perform all of the required functions associated with biological treatment, a sequencing batch reactor saves on land requirements. It also provides for greater operation flexibility for treating leachate with viable waste characteristics by being able to readily vary detention time and mode of aeration in each stage. Sequencing batch reactors also can be used to achieve complete nitrification/denitrification and phosphorus removal.

8.1.3.7 Nitrification Systems

In this process, nitrifying bacteria are used in an aerobic biological treatment system to convert ammonia compounds to nitrate compounds. Nitrification is usually followed by denitrification (see next section) which converts nitrates to nitrogen gas. Nitrifying bacteria, such as *nitrosomonas* and *nitrobacter*, derive their energy for growth from the oxidation of inorganic nitrogen compounds. *Nitrosomonas* converts ammonia to nitrites, and *nitrobacter* converts nitrites to nitrates.

The nitrification process usually follows a standard biological process that has already greatly reduced the organic content of the wastewater; however, there are some biological systems that can provide organic (BOD_5) removal concurrently with ammonia destruction. The nitrification process can be oriented as either a suspended growth process (e.g. activated sludge system) or a attached growth process (e.g. trickling filter).

8.1.3.8 Denitrification Systems

Denitrification is an anoxic process whereby nitrate nitrogen is converted to gaseous nitrogen, and possibly nitrous oxide and nitric oxide. Denitrification is a two step process in which the first step converts nitrates to nitrites, and the second step converts nitrite to nitrogen gas. The bacteria use nitrogen as an electron source rather than oxygen in digesting a carbon food source. Since the waste stream reaching the denitrification process has low levels of organic material, a carbon source (usually methanol) must be added.

The denitrification process can occur as a suspended growth process or as an attached growth process. Attached growth systems can be designed as either fixed-bed or fluidized bed reactor systems. Effluents from denitrification processes may need to be re-aerated to meet dissolved oxygen discharge requirements.

8.1.3.9 Wetlands Treatment

An alternative and innovative biological treatment technology for treating landfill wastewaters is wetland treatment. Wetlands can either be natural or man-made (artificial) systems and contain vegetation that allow for the natural attenuation of contaminants. Wetlands are designed to provide for a contact time of usually 10 to 30 days. Vegetation in the wetlands transforms nutrients and naturally degrades organics. Certain metals also can be absorbed by vegetation through root systems. Key design variables include loading rates, climatic constraints, and site characteristics. Wetland systems are mainly still experimental and are not a widely accepted or proven treatment technology for the treatment of landfill leachate.

8.1.4 Sludge Handling

Sludges are generated by a number of treatment technologies, including equalization, gravity assisted separation, chemical precipitation, and biological treatment. These sludges are further processed at landfill sites using various methods. The following sections describe each type of sludge handling system used within the Landfills industry.

8.1.4.1 Sludge Slurrying

Sludge slurrying is the process of transporting sludge from one treatment process to another. It only can be applied to liquid sludges that can be pumped through a pipe under pressure. National estimates based on EPA's Detailed Questionnaire data indicate that 33 percent of indirect hazardous landfills and less than one percent of indirect non-hazardous landfills use sludge slurrying systems as part of their wastewater treatment systems.

8.1.4.2 Gravity Thickening

Gravity thickening, as shown in Figure 8-23, consists of placing the sludge in a unit similar to a gravity assisted separator, where the sludge is allowed to settle, with the liquid supernatant remaining at the top. The thickened sludge is then removed, and the separated liquid is returned to the wastewater treatment system for further treatment. Usually sludges that contain two to three percent solids can be thickened to approximately five to ten percent solids using gravity thickening. National estimates based on the Detailed Questionnaire responses show that 67 percent of indirect hazardous landfills, 4 percent of indirect non-hazardous landfills, and 8 percent of direct non-hazardous landfill facilities employ gravity thickening as part of their wastewater treatment systems.

8.1.4.3 Pressure Filtration

Plate and frame pressure filtration systems are used at landfill facilities to dewater sludges from physical/chemical and biological treatment processes. Sludges generated at a total solids concentration of two to five percent by weight are dewatered to a 30 to 50 percent solids mass using plate and frame filtration (see reference 3). Sludges from treatment systems can be thickened by gravity or stabilized prior to dewatering by pressure filtration or may be processed directly with the plate and frame filtration unit.

A pressure filter consists of a series of screens (see Figure 8-24) upon which the sludge is applied under pressure. A precoat material may be applied to the screens to aid in solids removal. The applied pressure forces the liquid through the screen, leaving the solids to accumulate behind the screen. Filtrate which passes through the screen media is recirculated back to the head of the on-site wastewater treatment plant. Screens (also referred to as plates) are held by frames placed side by side and held together with a vice-type mechanism. The unit processes sludge until all of the plates are filled with dry sludge as indicated by a marked rise in the application pressure. Afterwards, the vice holding the plates is loosened and the frames separated. Dried sludge is manually scraped from the plates and collected in a hopper for final disposal. The size of the filter and the number of plates utilized depends not only on the amount of solids produced by treatment processes, but also is highly dependent on the desired operational requirements for the filter. A plate and frame filter can produce a drier sludge than possible with most other methods of sludge dewatering. It is usually not operated continuously, but offers operational flexibility since it can be operated in a batch mode.

Pressure filtration is the most common method of sludge dewatering used at landfill facilities. National estimates indicate that 67 percent of indirect hazardous landfills, 5 percent of indirect non-hazardous landfills, and 8 percent of direct non-hazardous landfill facilities use pressure filtration systems as part of their wastewater treatment systems.

8.1.4.4 Sludge Drying Beds

Sludge drying beds are an economical and effective means of dewatering sludge when land is available. Sludge may be conditioned by thickening or stabilization prior to application on the drying beds, which are typically made up of sand and gravel. Sludge is placed on the beds in an 8 to 12 inch layer and allowed to dry. The drying area is partitioned into individual beds, approximately 20 feet wide by 20 to 100 foot long (see reference 13), or a convenient size so that one or two beds will be filled by the sludge discharge from other sludge handling units or sludge storage facilities. The outer boundaries may be constructed with concrete or earthen embankments for open beds. Open beds are used where adequate area is available and sufficiently isolated to avoid complaints caused by odors. Covered beds with greenhouse types of enclosures are used when it is necessary to dewater sludge continuously throughout the year regardless of the weather and where sufficient isolation does not exist for the installation of open beds.

Sludge is dried by drainage through the sludge mass and supporting sand and by evaporation from the surface exposed to the air. Most of the water leaves the sludge by drainage; thus, the provision of an adequate underdrainage system is essential. Drying beds are equipped with lateral drainage tiles that should be adequately supported and covered with coarse gravel or crushed stone. The sand layer should be from 9 to 12 inches deep (see reference 13) with an allowance for some loss from cleaning operations. Water drained from the sludge is collected and typically recirculated back to the on-site wastewater treatment system. Sludge can be removed from the drying bed after it has drained and dried sufficiently. The moisture content is approximately 60 percent after 10 to 15 days under favorable conditions (see reference 13). Dried sludge is manually removed from the beds and sent for on-site or off-site disposal. Figure 8-25 depicts the cross section of a typical drying bed.

8.1.5 Zero Discharge Treatment Options

In this section, additional treatment processes and disposal methods associated with zero or alternative discharge at landfill facilities are described. Based on the responses to the Detailed Questionnaire, national estimates indicate that 27 percent of all non-hazardous landfill facilities and 96 percent of all hazardous landfill facilities use zero discharge treatment options. The most commonly used zero discharge treatment method employed by these facilities is land application and recirculation. This section describes land application, recirculation, deep well disposal, evaporation, solidification, and off-site disposal.

Land application involves the spreading of the wastewater over an area of land that is capped, closed, or an unused portion of a landfill. The land generally has sufficient percolation characteristics to allow the water to drain adequately into the soil. The area is assessed to insure that the soil can provide adequate biological activity to cause the degradation of organic pollutants and also to provide sufficient binding of any metals present.

Recirculation involves the spraying of recycled landfill leachate over areas of a landfill. Although this process promotes biodegradation and evaporation of the leachate volume, recirculation is primarily used as a means of dust control.

Deep well disposal consists of pumping the wastewater into a disposal well, that then discharges the liquid into a deep aquifer. Normally, these aquifers are thoroughly characterized to insure that they are not hydrogeologically connected to a drinking water supply. The characterization requires the confirmation of the existence of impervious layers of rock above and below the aquifer.

Traditionally used as a method of sludge dewatering, evaporation, or solar evaporation, also can involve the discharge and ultimate storage of wastewater into a shallow, lined, on-site ditch. Since the system is open to the atmosphere, the degree of evaporation is greatly dependent upon climatic conditions.

Solidification is a process in which materials, such as fly ash, cements, and lime, are added to the waste to produce a solid. Depending on both the contaminant and binding material, the solidified waste may be disposed of in a landfill.

Some facilities that have a low leachate generation rate (either because of arid conditions or through capping), transport their wastewater off site to either another landfill facility's wastewater treatment system or to a Centralized Wastewater Treatment (CWT) facility for ultimate disposal.

8.2 Treatment Performance

This section presents an evaluation of performance data on treatment systems collected by EPA during field sampling programs. The results of these EPA sampling episodes assisted the Agency in evaluating the various types of treatment technologies. For those facilities employing the selected technologies, the sampling data were used to develop the effluent limitations. A more detailed discussion of the development of effluent limitations can be found in Chapter 11.

8.2.1 Performance of EPA Sampled Treatment Processes

To collect data on potential BAT treatment technologies, Detailed Questionnaire responses were reviewed to identify candidate facilities that had well-operated and designed wastewater treatment systems. EPA conducted 19 site visits to 18 facilities to evaluate treatment systems. Based on these site visits, a total of six facilities were selected for EPA sampling which consisted of five consecutive days of sampling raw influent wastewaters, and intermediate and effluent points in the wastewater treatment system. One of these week-long episodes (4690) was conducted at a facility that was eventually excluded from the proposed regulations because it was a captive landfill. In addition, the only technology sampled at this facility primarily treated contaminated groundwater. The data collected during this sampling episode were not used in selection of pollutants of interest and in the calculation of effluent limitations and therefore, is not discussed further in this section. For the remaining five selected sampling facilities in both the Non-Hazardous and Hazardous subcategories, EPA collected data on a variety of biological and chemical treatment processes. Technologies evaluated at the selected sampling facilities include hydroxide precipitation, activated sludge, sequencing batch reactors, multimedia filtration and reverse osmosis. Table 4-2 in Chapter 4, presents a summary of the treatment technologies sampled during each EPA sampling episode. Summaries of the treatment system performance data collected by EPA during each of these sampling episodes that were used in the development of the proposed effluent limitations guidelines and standards are presented below.

8.2.1.1 Treatment Performance for Episode 4626

EPA performed a week-long sampling program during episode 4626 to obtain performance data on several treatment technologies including hydroxide precipitation, biological treatment using anaerobic and aerobic biotowers and multimedia filtration. A flow diagram of the landfill wastewater treatment system sampled during episode 4626 is presented in Figure 8-26. The wastewater treatment system used at this Subtitle D municipal facility treats predominately landfill generated wastewaters, including gas condensate. Table 8-2 presents a summary of percent removal data collected at episode 4626 for the performance of the biological treatment system and for the entire treatment system, excluding the multimedia filtration system used to polish the discharge from the effluent holding tank. Percent removal efficiencies for the processes were calculated by first obtaining an average concentration based upon the daily sampling results for each sample collection location (influent and effluent point to the treatment process). Next, the percent removal efficiency of the system was calculated using the following equation:

$$\text{Percent Removal} = \frac{\text{Influent Concentration - Effluent Concentration}}{\text{Influent Concentration}} \times 100$$

Negative percent removals for a treatment process were reported on the table as 0.0 percent removals.

The treatment efficiency of the biological treatment system was determined using the data obtained from sampling points 04 and 07 (see Figure 8-26). As demonstrated on the Table 8-2, the biological treatment system experienced good overall removals for TOC (93.0 percent), COD (90.85 percent), and ammonia as nitrogen (99.14 percent). The biological system did not demonstrate high removals for BOD_5 (10.2 percent), TSS (9.32 percent) or for various metals (generally less than 10 percent removals) because the pollutants were generally not present in the biological treatment system influent at treatable levels. The system influent BOD_5 was 39.2 mg/l, TSS was 11.8 mg/l, and most metals were not at detectable levels even though the raw wastewater at this facility exhibited a BOD_5 concentration of 991 mg/l, TSS of 532 mg/l, and several metals at treatable levels. The biological treatment system influent was weak because this facility employed large aerated equalization tanks and a chemical precipitation system prior to biological treatment. The equalization tanks had a retention time of approximately 15 days and were followed by a chemical precipitation system using sodium hydroxide. Due to the long retention time and wastewater aeration, significant biological activity occurred in these tanks. The resulting insoluble pollutants were removed in the primary clarifier prior to entering the biological towers. Organic pollutant parameters were not detected in the effluent from the biological treatment process with the exception of 1,4-dioxane at a concentration of 13.8 μg/l.

To determine the treatment efficiency of the entire treatment system, the influent concentration was determined by taking a flow-weighted average of the two influent sampling points; sampling points

01 and 02. Effluent from the treatment system was represented by sample point 07. The entire treatment system experienced good removals for the following conventional and nonconventional pollutants parameters; BOD_5, TSS, ammonia as nitrogen, COD, TOC, and total phenols. Each of the organic pollutant parameters identified in the influent to the treatment system was removed to non-detectable levels, with the exception of 1,4-dioxane which still experienced a high percent removal (94.2 percent). Most metals had good percent removals or were removed to non-detectable levels.

8.2.1.2 Treatment Performance for Episode 4667

EPA performed a week-long sampling program during episode 4667 to obtain performance data on various treatment units, including ammonia removal, hydroxide precipitation, biological treatment using a sequencing batch reactor, granular activated carbon adsorption and multimedia filtration. A flow diagram of the landfill wastewater treatment system sampled during episode 4667 is presented in Figure 8-27. The wastewater treatment process used at this Subtitle D non-hazardous facility primarily treats landfill generated wastewaters and a small amount of sanitary wastewater flow from the on-site maintenance facility. Table 8-3 presents a summary of percent removal data collected during episode 4667 for the biological treatment system (SBR) and for the entire treatment system.

The treatment efficiency of the biological treatment system was determined using the data obtained from sampling points 03 and 04 (see Figure 8-27). As demonstrated on Table 8-3, the SBR treatment system experienced moderate overall removals for TOC (43.4 percent), COD (24.7 percent), and BOD_5 (48.7 percent). Improved removal efficiencies were observed for TSS (82.9 percent), total phenols (74.2 percent), and ammonia as nitrogen (80.7 percent). Metals, such as barium, chromium, and zinc, had low removal efficiencies. However, as noted for the previous facility, these metals were observed in the influent to the biological system at low concentrations, near or close to expected effluent levels. Other metals also had poor removal efficiencies including boron and silicon. Non of the organic parameters were detected in the effluent from the SBR treatment process.

The treatment efficiency of the entire treatment system at the facility was determined using the data obtained from sampling points 01 and 06 (see Figure 8-27). Overall the treatment system experienced good removals for BOD_5, TSS, ammonia as nitrogen, COD, TOC and total phenols. Each of the organic pollutants detected in the influent were removed to non-detectable levels in the effluent. Also, each of the metal parameters experienced a good removal rate through the treatment system.

8.2.1.3 Treatment Performance for Episode 4721

EPA performed a week-long sampling program during episode 4721 to obtain performance data on the SBR treatment process installed at this Subtitle C hazardous facility. A flow diagram of the landfill wastewater treatment system sampled during episode 4721 is presented in Figure 8-28. The wastewater treatment process used at this facility treats predominately landfill generated wastewaters. The majority of the landfill wastewater was generated by Subtitle D non-hazardous landfills. However, the facility also commingled wastewater generated by an on-site hazardous waste landfill for treatment. Limited amounts of off-site generated wastewaters also are treated at the on-site treatment plant, primarily from another landfill facility operated by the same entity. Table 8-4 presents a summary of percent removal data collected during episode 4721 for the SBR treatment system.

The treatment efficiency of the biological treatment system was determined using the data obtained from sampling points 01 and 02 (see Figure 8-28). As demonstrated on the Table 8-4, the SBR treatment system experienced good overall removals for a number of convention/nonconventional and organic parameters; including total phenols, BOD_5, aniline, benzoic acid, 2-propanone, 2-butanone, naphthalene, alpha-terpineol, ethylbenzene, p-cresol, m-xylene, 4-methyl-2-pentanone, toluene, phenol, hexanoic acid, and ammonia as nitrogen. All of the organic parameters were observed in the influent were removed to non-detectable levels in the effluent. COD and TOC percent removals were observed at 72.2 and 66.3 percent, respectively. The percent removal for TSS was 72.1 percent. Metals with quantitative percent removals include arsenic (61.9 percent), chromium (46.3 percent), copper (61.2 percent), and zinc (66.3 percent).

8.2.1.4 Treatment Performance for Episode 4759

EPA performed a week-long sampling program during episode 4759 to obtain performance data on various treatment processes installed at this Subtitle C hazardous facility; including chemical precipitation using ferric chloride and sodium hydroxide and biological treatment using an activated sludge process. A flow diagram of the landfill wastewater treatment system sampled during episode 4759 is presented in Figure 8-29. The wastewater treatment process used at this facility treats predominately landfill generated wastewaters, but also handles limited amounts of contaminated storm water from storage containment systems. Table 8-5 presents a summary of percent removal data collected at episode 4759 for the biological treatment system only and for the entire treatment system (combined chemical precipitation and biological treatment processes).

The treatment efficiency of the biological treatment system was determined using the data obtained from sampling points 02 and 03 (see Figure 8-29). As demonstrated on the Table 8-5, the biological treatment system experienced good overall removals for a number of conventional/nonconventional and organic parameters; including BOD_5, COD, TOC, total phenols, aniline, benzoic acid, 2,4-dimethylphenol, 2-propanone, methylene chloride, 2-butanone, benzyl alcohol, isobutyl alcohol, o-cresol, p-cresol, 4-methyl-2-pentanone, phenol, pyridine, toluene and hexanoic acid. Most of the organic parameters detected in the influent were removed to non-detectable levels in the effluent from the biological treatment system. Most of the metal parameters, such as chromium, copper, selenium, titanium, and zinc, were observed at low concentrations in the influent to the biological treatment system and therefore did not demonstrate good percent removals.

The treatment efficiency of the entire treatment system at the facility was determined using the data obtained from sampling points 01 and 03 (see Figure 8-29). As demonstrated on Table 8-5, the entire treatment system experienced good overall removals for a number of convention/nonconventional and organic parameters; including total phenols, BOD_5, 2,4-dimethylphenol, aniline, benzene, benzoic acid, 2-propanone, methylene chloride, 2-butanone, benzyl alcohol, isobutyl alcohol, o-cresol, p-cresol, 4-methyl-2-pentanone, phenol, pyridine, toluene, tripropyleneglycol methyl ether and hexanoic acid. Most of the organic parameters detected in the influent were removed to non-detectable levels in the effluent. COD and TOC percent removals were observed at 76.4 percent and 84.2 percent, respectively. Ammonia as nitrogen and TSS had poor removal rates of 25.7 percent and 26.6 percent, respectively. Metals with quantitative percent removals include arsenic (46.6 percent), chromium (80.2 percent), copper (45.2 percent), strontium (66.8 percent), titanium (89.6 percent), and zinc (62.5 percent). Pesticide/herbicide parameters such as 2,4-DB, dicamba and dichloroprop had good removal efficiencies through the treatment system. Dioxin/furan parameters were not detected in either the influent or effluent samples.

8.2.1.5 Treatment Performance for Episode 4687

EPA performed a week-long sampling program during episode 4687 to obtain performance data on the reverse osmosis treatment process installed at this Non-Hazardous Subtitle D facility. A flow diagram of the landfill wastewater treatment system sampled during episode 4687 is presented in Figure 8-30. The wastewater treatment process used at this facility treats on-site landfill generated wastewaters. Table 8-6 presents a summary of percent removal data collected at episode 4687 for a single-pass reverse osmosis unit including the multi-media filtration unit and the entire treatment system consisting of a second pass RO unit.

The treatment efficiency of the single-pass reverse osmosis treatment system at the facility was determined using the data obtained from sampling points 01 and 02 (see Figure 8-30). As demonstrated on Table 8-6, the single-pass reverse osmosis treatment system experienced good overall removals for a number of conventional/nonconventional and organic parameters; including TSS, TOC, BOD_5, TDS, COD, 4-methyl-2-pentanone, alpha-terpineol, benzoic acid, tripropyleneglycol methyl ether, and hexanoic acid. A number of other organic parameters also were observed to have been removed by the treatment process at various levels lower than 95 percent. Total phenols and ammonia nitrogen percent removals were observed at 75.1 and 76.7 percent, respectively. Metals with quantitative percent removals include arsenic (87.4 percent), boron (54.1 percent), silicon (88.3 percent) and strontium (92.9 percent). All of the pesticide/herbicide parameters detected in the influent, including 2,4,5-TP, 2,4-D, 2,4-DB, dicamba, dichlorprop, MCPA and MCPP, were removed to non-detectable levels.

The treatment efficiency of the entire treatment system at the facility was determined using the data obtained from sampling points 01 and 03 (see Figure 8-30). The additional polishing reverse osmosis unit caused the removal efficiency of most of the conventional and nonconventional parameters to increase. These parameters include BOD_5, ammonia as nitrogen, COD, TDS, TOC and total phenols. The removal efficiency of several organic parameters were observed to increase from the single-pass treatment system including 2-butanone, 2-propanone, phenol, p-cresol and toluene. Boron percent removal also increased from 54.1 percent in the single-pass reverse osmosis system to 94.4 percent in the two-stage reverse osmosis treatment system.

Table 8-1: Wastewater Treatment Technologies Employed at In-Scope Landfill Facilities
(Percent of Landfills Industry)

Treatment Technology	Subtitle D Non-Hazardous		Subtitle C Hazardous
	Direct Discharge	Indirect Discharge	Indirect Discharge
Equalization	23.4	11.2	0.0
Neutralization	7.0	6.6	33.3
Physical/chemical oxidation	10.1	0.5	33.3
Chemical precipitation	11.4	5.3	33.3
Adsorption	1.3	1.3	0.0
Filtration	9.5	1.4	0.0
Stripping	3.8	1.3	0.0
Biological treatment	29.1	3.7	66.7
Gravity assisted separation	32.3	8.5	66.7
Sludge preparation	3.2	0.5	33.3
Sludge dewatering	12.7	5.0	66.7

Table 8-2: Treatment Technology Performance for Facility 4626- Subtitle D Municipal

Pollutant of Interest Subtitle D Municipal	CAS #	Biological Treatment System Only: Sample Points 4 to 7							Entire Treatment System: Sample Points 1 & 2 (flow weighted) to 7					
			Influent		Effluent		%		Influent		Effluent		%
		DL	SP	Conc. (ug/l)	SP	Conc. (ug/l)	Removal	DL	SP	Conc. (ug/l)	SP	Conc. (ug/l)	Removal
Conventional													
BOD	C-002	2,000	04	39,200	07	35,200	10.2	2,000	1+2	991,067	07	35,200	96.5
TSS	C-009	4,000	04	11,800	07	10,700	9.3	4,000	1+2	532,800	07	10,700	98.0
Nonconventional													
Ammonia as Nitrogen	7664417	10.0	04	135,000	07	1,156	99.1	10.0	1+2	193,333	07	1,156	99.4
COD	C-004	5,000	04	1,742,600	07	159,400	90.9	5,000	1+2	4,028,000	07	159,400	96.0
Hexavalent Chromium	18540299	10.0	04	ND	07	ND		10.0	1+2	68.7	07	ND	85.4
Nitrate/Nitrite	C-005	50.0	04	1,535	07	130,500	0.0	50.0	1+2	693	07	130,500	0.0
TDS	C-010		04	5,960,000	07	5,181,000	13.1		1+2	5,012,667	07	5,181,000	0.0
TOC	C-012	1,000	04	758,000	07	52,800	93.0	1,000	1+2	1,316,200	07	52,800	96.0
Total Phenols	C-020	50.0	04	182	07	50.0	72.5	50.0	1+2	1,204	07	50.0	95.9
Organics													
1,4-Dioxane	123911	10.0	04	NS	07	13.8	NS	10.0	1+2	240	07	13.8	94.2
2-Butanone	78933	50.0	04	NS	07	ND	NS	50.0	1+2	227,893	07	ND	100
2-Propanone	67641	50.0	04	NS	07	ND	NS	50.0	1+2	27,655	07	ND	99.8
4-Methyl-2-Pentanone	108101	50.0	04	NS	07	ND	NS	50.0	1+2	598	07	ND	91.6
Alpha-Terpineol	98555	10.0	04	NS	07	ND	NS	10.0	1+2	134	07	ND	92.6
Benzoic Acid	65850	50.0	04	NS	07	ND	NS	50.0	1+2	14,657	07	ND	99.7
Hexanoic Acid	142621	10.0	04	NS	07	ND	NS	10.0	1+2	36,256	07	ND	100
Methylene Chloride	75092	10.0	04	NS	07	ND	NS	10.0	1+2	50.3	07	ND	80.1
N,N-Dimethylformamide	68122	10.0	04	NS	07	ND	NS	10.0	1+2	39.3	07	ND	74.5
O-Cresol	95487	10.0	04	NS	07	ND	NS	10.0	1+2	86.4	07	ND	88.4
P-Cresol	106445	10.0	04	NS	07	ND	NS	10.6 /10.0	1+2	ND	07	ND	
Phenol	108952	10.0	04	NS	07	ND	NS	10.0	1+2	685	07	ND	98.5
Toluene	108883	10.0	04	NS	07	ND	NS	10.0	1+2	1,095	07	ND	99.1
Tripropyleneglycol Methyl Ether	20324338	99.0	04	NS	07	ND	NS	105 /99.0	1+2	ND	07	ND	
Metals													
Barium	7440393	200	04	10.3	07	21.8	0.0	200	1+2	2427	07	21.8	99.1
Boron	7440428	100	04	3,211	07	2,925	8.9	100	1+2	4330	07	2,925	32.5
Chromium	7440473	10.9	04	11.6	07	ND	6.5	10.9	1+2	36.6	07	ND	70.3
Silicon	7440213	100	04	784	07	648	17.4	100	1+2	768	07	648	15.7
Strontium	7440246	80.3	04	ND	07	82.5	0.0	100	1+2	2,912	07	82.5	97.2
Titanium	7440326	4.2	04	4.2	07	ND	1.0	4.2	1+2	13.0	07	ND	67.9
Zinc	7440666	10.6	04	ND	07	12.0	0.0	20.0	1+2	144	07	12.0	91.6
Pesticides/Herbicides													
Dichloroprop	120365	1.0	04	NS	07	NS	NS	1.0	1+2	NS	07	NS	NS
Disulfoton	298044	2.0	04	NS	07	NS	NS	2.0	1+2	NS	07	NS	NS
Dioxins/Furans													
1234678-HpCDD	35822469	50.0 pg/L	04	NS	07	NS	NS	50.0 pg/L	1+2	NS	07	NS	NS
OCDD	3268879	100 pg/L	04	NS	07	NS	NS	100 pg/L	1+2	NS	07	NS	NS

Negative percent removal are recorded as 0.0.
NS: Not Sampled SP: Sample point.
ND: Non-detect DL: Specific detection limits of sample when there is a non-detect, otherwise it is the method detection limi

Table 8-3: Treatment Technology Performances for Facility 4667- Subtitle D Municipal

Pollutant of Interest Subtitle D Municipal	CAS #	Biological Treatment System Only: Sample Points 3 to 4						Entire Treatment System: Sample Points 1 to 6					
		DL	SP	Influent Conc. (ug/l)	SP	Effluent Conc. (ug/l)	% Removal	DL	SP	Influent Conc. (ug/l)	SP	Effluent Conc. (ug/l)	% Removal
Conventional													
BOD	C-002	2,000	03	232,600	04	119,300	48.7	2,000	01	1,088,000	06	201,000	81.5
TSS	C-009	4,000	03	59,600	04	10,200	82.9	4,000	01	93,400	06	ND	95.7
Nonconventional													
Ammonia as Nitrogen	7664417	10.0	03	134,800	04	26,040	80.7	10.0	01	295,900	06	12,060	95.9
COD	C-004	5,000	03	635,000	04	478,200	24.7	5,000	01	2,932,000	06	251,000	91.4
Hexavalent Chromium	18540299	10.0	03	ND	04	ND		10.0	01	26.0	06	ND	61.5
Nitrate/Nitrite	C-005	50.0	03	14,400	04	87,800	0.0	50.0	01	494	06	87,000	0.0
TDS	C-010		03	4,024,000	04	3,987,000	0.9		01	6,232,000	06	3,834,000	38.5
TOC	C-012	1,000	03	212,600	04	120,400	43.4	1,000	01	1,098,600	06	82,000	92.5
Total Phenols	C-020	50.0	03	204	04	52.6	74.2	50.0	01	940	06	ND	94.7
Organics													
1,4-Dioxane	123911	10.0	03	NS	04	ND	NS	10.0	01	323	06	ND	96.9
2-Butanone	78933	50.0	03	NS	04	ND	NS	50.0	01	8,767	06	ND	99.4
2-Propanone	67641	50.0	03	NS	04	ND	NS	50.0	01	13,021	06	ND	99.6
4-Methyl-2-Pentanone	108101	50.0	03	NS	04	ND	NS	50.0	01	1,239	06	ND	96.0
Alpha-Terpineol	98555	10.0	03	NS	04	ND	NS	10.0	01	430	06	ND	97.7
Benzoic Acid	65850	50.0	03	NS	04	ND	NS	50.0	01	33,335	06	ND	99.9
Hexanoic Acid	142621	10.0	03	NS	04	ND	NS	10.0	01	37,256	06	ND	100
Methylene Chloride	75092	10.0	03	NS	04	ND	NS	208 /10.0	01	ND	06	ND	
N,N-Dimethylformamide	68122	10.0	03	NS	04	ND	NS	10.0	01	1,008	06	ND	99.0
O-Cresol	95487	10.0	03	NS	04	ND	NS	10.0	01	2,215	06	ND	99.6
P-Cresol	106445	10.0	03	NS	04	ND	NS	10.0	01	ND	06	ND	
Phenol	108952	10.0	03	NS	04	ND	NS	10.0	01	387	06	ND	97.4
Toluene	108883	10.0	03	NS	04	ND	NS	10.0	01	668	06	ND	98.5
Tripropyleneglycol Methyl Ether	20324338	99.0	03	NS	04	ND	NS	99.0	01	ND	06	ND	
Metals													
Barium	7440393	200	03	19.4	04	32.4	0.0	200	01	283	06	42.6	85.0
Boron	7440428	100	03	2,842	04	2,483	12.6	100	01	6,700	06	2,334	65.2
Chromium	7440473	10.0	03	10.5	04	11.3	0.0	11.1	01	90.6	06	ND	87.7
Silicon	7440213	100	03	5,284	04	6,766	0.0	100	01	27,158	06	6,859	74.7
Strontium	7440246	100	03	193	04	237	0.0	100	01	1,935	06	249	87.1
Titanium	7440326	2.5	03	4.8	04	ND	48.1	2.5	01	69.9	06	ND	96.4
Zinc	7440666	20.0	03	25.2	04	58.6	0.0	20.0	01	494	06	27.1	94.5
Pesticides/Herbicides													
Dichloroprop	120365	1.0	03	NS	04	ND	NS	11.8 /1.0	01	ND	06	ND	
Disulfoton	298044	2.0	03	NS	04	ND	NS	2.0	01	6.1	06	ND	67.2
Dioxins/Furans													
1234678-HpCDD	35822469	50.0 pg/L	03	NS	04	NS	NS	50.0 pg/L	01	NS	06	NS	NS
OCDD	3268879	100 pg/L	03	NS	04	NS	NS	100 pg/L	01	NS	06	NS	NS

Negative percent removal are recorded as 0.0.
NS: Not Sampled DL: Specific detection limits of sample when there is a non-detect, otherwise it is the method detection limi
ND: Non-detect SP: Sample point

Table 8-4: Treatment Technology Performance for Facility 4721- Subtitle C Hazardous

Pollutant of Interest Subtitle C Hazardous	CAS #	Biological Treatment System: Sample Points 1 to 2					
		DL	SP	Influent Conc. (ug/l)	SP	Effluent Conc. (ug/l)	% Removal
Conventional							
BOD	C-002	2,000	01	877,875	02	47,000	94.7
Oil and Grease	C-036	5,000	01	45,442	02	6,792	85.1
TSS	C-009	4,000	01	191,375	02	53,375	72.1
Nonconventional							
Amenable Cyanide	C-025	10.0	01	ND	02	ND	
Ammonia as Nitrogen	7664417	10.0	01	382,250	02	1,433	99.6
COD	C-004	5,000	01	2,033,750	02	565,750	72.2
Nitrate/Nitrite	C-005	50.0	01	1,770	02	333,375	0.0
TDS	C-010		01	12,275,000	02	12,075,000	1.6
TOC	C-012	1,000	01	562,250	02	189,625	66.3
Total Cyanide	57125	20.0	01	54.1	02	46.1	14.8
Total Phenols	C-020	50.0	01	3,195	02	67.6	97.9
Organics							
1,1-Dichloroethane	75343	10.0	01	31.5	02	ND	68.2
1,4-Dioxane	123911	10.0	01	ND	02	ND	
2-Butanone	78933	50.0	01	6,398	02	ND	99.2
2-Propanone	67641	50.0	01	4,398	02	ND	98.9
2,4-Dimethylphenol	105679	10.0	01	79.0	02	ND	87.4
4-Methyl-2-Pentanone	108101	50.0	01	2,175	02	ND	97.7
Alpha-Terpineol	98555	10.0	01	691	02	ND	98.6
Aniline	62533	10.0	01	685	02	ND	98.5
Benzene	71432	10.0	01	127	02	ND	92.2
Benzoic Acid	65850	50.0	01	5,294	02	ND	99.1
Benzyl Alcohol	100516	10.0	01	23.7	02	ND	57.9
Diethyl Ether	60297	50.0	01	104	02	ND	51.8
Ethylbenzene	100414	10.0	01	545	02	ND	98.2
Hexanoic Acid	142621	10.0	01	1,632	02	ND	99.4
Isobutyl Alcohol	78831	10.0	01	ND	02	ND	
M-Xylene	108383	10.0	01	412	02	ND	97.6
Methylene Chloride	75092	10.0	01	49.2	02	ND	79.7
Naphthalene	91203	10.0	01	486	02	ND	97.9
O+P Xylene	136777612	10.0	01	155	02	ND	93.6
O-Cresol	95487	10.0	01	ND	02	ND	
P-Cresol	106445	10.0	01	218	02	ND	95.4
Phenol	108952	10.0	01	1,553	02	ND	99.4
Pyridine	110861	10.0	01	12.0	02	ND	16.5
Toluene	108883	10.0	01	1,468	02	ND	99.3
Trans-1,2-Dichloroethene	156605	10.0	01	52.7	02	ND	81.0
Trichloroethene	79016	10.0	01	ND	02	ND	
Tripropyleneglycol Methyl Ether	20324338	99.0	01	1,756	02	ND	94.4
Vinyl Chloride	75014	10.0	01	15.6	02	ND	36.0
Metals							
Arsenic	7440382	10.0	01	1,492	02	569	61.9
Boron	7440428	100	01	8,839	02	8,449	4.4
Chromium	7440473	10.0	01	86.7	02	46.5	46.4
Copper	7440508	8.0	01	20.6	02	ND	61.2
Lithium	7439932	100	01	277	02	316	0.0
Metals (Cont'd)							
Molybdenum	7439987	10.0	01	227	02	266	0.0

Table 8-4: Treatment Technology Performance for Facility 4721- Subtitle C Hazardous

Pollutant of Interest Subtitle C Hazardous	CAS #	Biological Treatment System: Sample Points 1 to 2					
		DL	SP	Influent Conc. (ug/l)	SP	Effluent Conc. (ug/l)	% Removal
Nickel	7440020	40.0	01	131	02	125	4.1
Selenium	7782492	15.5	01	20.0	02	ND	22.5
Silicon	7440213	100	01	5,518	02	5,024	9.0
Strontium	7440246	100	01	2,846	02	2,494	12.4
Tin	7440315	30.0	01	30.7	02	ND	2.4
Titanium	7440326	5.0	01	64.5	02	5.3	91.7
Zinc	7440666	20.0	01	253	02	85.3	66.3
Pesticides/Herbicides							
2,4-D	94757	1.0	01	1.2	02	ND	14.0
2,4-DB	94826	2.0	01	3.9	02	ND	48.4
2,4,5-TP	93721	0.2	01	0.5	02	ND	55.1
Dicamba	1918009	0.2	01	1.1	02	0.4	64.2
Dichloroprop	120365	1.0	01	2.1	02	1.3	37.7
MCPA	94746	50.0	01	59.1	02	ND	15.3
MCPP	7085190	50.0	01	153	02	51.9	66.1
Picloram	1918021	0.5	01	0.5	02	ND	2.0
Terbuthylazine	5915413	5.0	01	6.0	02	ND	16.8
Dioxins/Furans							
1234678-HpCDD	35822469	50.0 pg/L	01	588 pg/L	02	NS	NS
1234678-HpCDF	67562394	50.0 pg/L	01	63.3 pg/L	02	NS	NS
OCDD	3268879	100.0 pg/L	01	6,148 pg/L	02	NS	NS
OCDF	39001020	100.0 pg/L	01	237 pg/L	02	NS	NS

Negative percent removal are recorded as 0.0.
NS: Not Sampled
ND: Non-detect
DL: Specific detection limits of sample when there is a non-detect, otherwise it is the method detection limi
SP: Sample point.

Table 8-5: Treatment Technology Performance for Facility 4759- Subtitle C Hazardous

Pollutant of Interest Subtitle C Hazardous	CAS #	Biological Treatment System Only: Sample Points 2 to 3						Entire Treatment System Sample Points 1 to 3					
		DL	sp	Influent Conc. (ug/l)	sp	Effluent Conc. (ug/l)	% Removal	DL	sp	Influent Conc. (ug/l)	sp	Effluent Conc. (ug/l)	% Removal
Conventional													
BOD	C-002	2,000	02	2,650,000	03	62,800	97.6	2,000	01	2,664,000	03	62,800	97.6
Oil and Grease	C-036	5,000	02	30,167	03	9,333	69.1	5,000	01	37,333	03	9,333	75.0
TSS	C-009	4,000	02	47,300	03	90,000	0.0	4,000	01	122,600	03	90,000	26.6
Nonconventional													
Amenable Cyanide	C-025	20.0	02	NS	03	271	NS	20.0	01	3,990	03	271	93.2
Ammonia as Nitrogen	7664417	10.0	02	194,400	03	155,500	20.0	10.0	01	209,400	03	155,500	25.7
COD	C-004	5,000	02	5,200,000	03	1,180,000	77.3	5,000	01	5,006,000	03	1,180,000	76.4
Nitrate/Nitrite	C-005	50.0	02	263,196	03	240,423	8.7	50.0	01	259,242	03	240,423	7.3
TDS	C-010		02	17,230,000	03	15,680,000	9.0		01	16,360,000	03	15,680,000	4.2
TOC	C-012	1,000	02	1,800,000	03	284,700	84.2	1,000	01	1,804,000	03	284,700	84.2
Total Cyanide	57125	20.0	02	869	03	796	8.5	20.0	01	9,756	03	796	91.9
Total Phenols	C-020	50.0	02	97,340	03	155	99.8	50.0	01	97,860	03	155	99.8
Organics													
1,1-Dichloroethane	75343	10.0	02	23.8	03	ND	58.0	10.0	01	26.7	03	ND	62.5
1,4-Dioxane	123911	10.0	02	1,935	03	702	63.7	10.0	01	2,003	03	702	65.0
2-Butanone	78933	50.0	02	1,633	03	ND	96.9	50.0	01	1,724	03	ND	97.1
2-Propanone	67641	50.0	02	3,254	03	65.0	98.0	50.0	01	3,634	03	65.0	98.2
2,4-Dimethylphenol	105679	10.0	02	1,798	03	201	88.8	10.0	01	1,550	03	201	87.0
4-Methyl-2-Pentanone	108101	50.0	02	1,009	03	ND	95.1	50.0	01	1,027	03	ND	95.1
Alpha-Terpineol	98555	10.0	02	ND	03	ND		10.0	01	ND	03	ND	
Aniline	62533	10.0	02	577	03	ND	98.3	10.0	01	533	03	ND	98.1
Benzene	71432	10.0	02	32.0	03	ND	68.7	10.0	01	36.2	03	ND	72.4
Benzoic Acid	65850	50.0	02	70,690	03	ND	99.9	50.0	01	64,957	03	ND	99.9
Benzyl Alcohol	100516	10.0	02	859	03	ND	98.8	10.0	01	878	03	ND	98.9
Diethyl Ether	60297	50.0	02	ND	03	ND		50.0	01	ND	03	ND	
Ethylbenzene	100414	10.0	02	13.8	03	ND	27.3	10.0	01	15.8	03	ND	36.5
Hexanoic Acid	142621	10.0	02	5,266	03	ND	99.8	10.0	01	3,640	03	ND	99.7
Isobutyl Alcohol	78831	10.0	02	127	03	ND	92.1	10.0	01	138	03	ND	92.8
M-Xylene	108383	10.0	02	10.6	03	ND	5.3	10.0	01	10.7	03	ND	6.2
Methylene Chloride	75092	10.0	02	604	03	10.3	98.3	10.0	01	661	03	10.3	98.4
Naphthalene	91203	10.0	02	22.0	03	ND	54.6	10.0	01	24.8	03	ND	59.6
O+P Xylene	136777612	10.0	02	ND	03	ND		10.0	01	ND	03	ND	
O-Cresol	95487	10.0	02	61.2	03	ND	83.7	10.0	01	188	03	ND	94.7
P-Cresol	106445	10.0	02	5,119	03	ND	99.8	10.0	01	5,022	03	ND	99.8
Phenol	108952	10.0	02	54,808	03	29.7	100	10.0	01	65,417	03	29.7	100
Pyridine	110861	10.0	02	309	03	ND	96.8	10.0	01	301	03	ND	96.7
Toluene	108883	10.0	02	120	03	ND	91.7	10.0	01	136	03	ND	92.6
Trans-1,2-Dichloroethene	156605	10.0	02	ND	03	ND		10.0	01	ND	03	ND	
Trichloroethene	79016	10.0	02	ND	03	ND		10.0	01	ND	03	ND	
Tripropyleneglycol Methyl Ether	20324338	99.0	02	ND	03	ND		99.0	01	1,021	03	ND	90.3
Vinyl Chloride	75014	10.0	02	ND	03	ND		10.0	01	ND	03	ND	
Metals													
Arsenic	7440382	10.0	02	389	03	312	19.9	10.0	01	584	03	312	46.6
Boron	7440428	100	02	2,706	03	2,486	8.1	100	01	2,918	03	2,486	14.8
Chromium	7440473	10.0	02	158	03	82.4	47.8	10.0	01	415	03	82.4	80.2

Table 8-5 (continued): Treatment Technology Performance for Facility 4759- Subtitle C Hazardous

Pollutant of Interest Subtitle C Hazardous	CAS #	Biological Treatment System Only: Sample Points 2 to 3						Entire Treatment System Sample Points 1 to 3					
		DL	sp	Influent Conc. (ug/l)	sp	Effluent Conc. (ug/l)	% Removal	DL	sp	Influent Conc. (ug/l)	sp	Effluent Conc. (ug/l)	% Removal
Metals (cont.)													
Copper	7440508	25.0	02	61.1	03	76.4	0.0	25.0	01	139	03	76.4	45.2
Lithium	7439932	100	02	253	03	239	5.5	100	01	266	03	239	10.2
Molybdenum	7439987	10.0	02	13,710	03	13,130	4.2	10.0	01	13,260	03	13,130	1.0
Nickel	7440020	40.0	02	2,014	03	1,878	6.8	40.0	01	2,060	03	1,878	8.8
Selenium	7782492	5.0	02	191	03	190	0.2	5.0	01	178	03	190	0.0
Silicon	7440213	100	02	6,924	03	6,153	11.1	100	01	6,036	03	6,153	0.0
Strontium	7440246	100	02	105	03	94.4	9.9	100	01	284	03	94.4	66.8
Tin	7440315	30.0	02	800	03	723	9.5	30.0	01	908	03	723	20.4
Titanium	7440326	5.0	02	5.1	03	2.4	52.1	5.0	01	23.3	03	2.4	89.6
Zinc	7440666	20.0	02	26.7	03	47.2	0.0	20.0	01	126	03	47.2	62.5
Pesticides/Herbicides													
2,4-D	94757	1.0	02	NS	03	11.8	NS	1.0	01	11.2	03	11.8	0.0
2,4-DB	94826	2.0	02	NS	03	4.3	NS	2.0	01	43.8	03	4.3	90.2
2,4,5-TP	93721	0.2	02	NS	03	0.4	NS	0.2	01	0.5	03	0.4	18.3
Dicamba	1918009	0.2	02	NS	03	0.9	NS	0.2	01	41.6	03	0.9	97.9
Dichloroprop	120365	1.0	02	NS	03	4.7	NS	1.0	01	18.3	03	4.7	74.3
MCPA	94746	50.0	02	NS	03	182	NS	50.0	01	332	03	182	45.3
MCPP	7085190	50.0	02	NS	03	288	NS	50.0	01	662	03	288	56.5
Picloram	1918021	0.5	02	NS	03	2.5	NS	0.5	01	4.5	03	2.5	45.2
Terbuthylazine	5915413	5.0	02	NS	03	28.4	NS	5.0	01	97.6	03	28.4	70.9
Dioxins/Furans													
1234678-HpCDD	35822469	50.0 pg/L	02	NS	03	ND	NS	50.0 pg/L	01	ND	03	ND	
1234678-HpCDF	67562394	50.0 pg/L	02	NS	03	ND	NS	50.0 pg/L	01	ND	03	ND	
OCDD	3268879	100 pg/L	02	NS	03	ND	NS	100 pg/L	01	ND	03	100 pg/L	
OCDF	39001020	100 pg/L	02	NS	03	ND	NS	100 pg/L	01	ND	03	ND	

Negative percent removal are recorded as 0.0.
NS: Not Sampled
ND: Non-detect
DL: Specific detection limits of sample when there is a non-detect, otherwise it is the method detection limit
SP: Sample point.

Table 8-6: Treatment Technology Performance for Facility 4687- Subtitle D Municipal

Pollutant of Interest Subtitle D Municipal	CAS #	Single-Stage Reverse Osmosis Treatment System Only: Sample Point 1 to 2						Entire Treatment System: Sample Point 1 to 3					
		DL	SP	Influent Conc. (ug/l)	SP	Effluent Conc. (ug/l)	% Removal	DL	SP	Influent Conc. (ug/l)	SP	Effluent Conc. (ug/l)	% Removal
Conventional													
BOD	C-002	2,000	01	1,182,000	02	54,000	95.4	2,000	01	1,182,000	03	5,400	99.5
TSS	C-009	4,000	01	171,800	02	ND	97.7	4,000	01	171,800	03	ND	97.7
Noconventional													
Ammonia as Nitrogen	7664417	10.0	01	58,480	02	13,600	76.7	10.0	01	58,480	03	608	99.0
COD	C-004	5,000	01	1,526,000	02	72,200	95.3	5,000	01	1,526,000	03	11,400	99.3
Hexavalent Chromium	18540299	10.0	01	28.0	02	ND	64.3	10.0	01	28.0	03	ND	64.3
Nitrate/Nitrite	C-005	50.0	01	1,300	02	666	48.8	50.0	01	1,300	03	502	61.4
TDS	C-010		01	2,478,000	02	116,600	95.3	10,000	01	2,478,000	03	ND	99.6
TOC	C-012	1,000	01	642,600	02	25,000	96.1	10,000	01	642,600	03	ND	98.4
Total Phenols	C-020	50.0	01	1,262	02	316	75.0	50.0	01	1,262	03	62.8	95.0
Organics													
1,4-Dioxane	123911	10.8 /14.9	01	ND	02	ND		10.8 /10.0	01	ND	03	ND	
2-Butanone	78933	50.0	01	3,250	02	1,774	45.4	50.0	01	3,250	03	372	88.6
2-Propanone	67641	50.0	01	1,580	02	1,842	0.0	50.0	01	1,580	03	470	70.3
4-Methyl-2-Pentanone	108101	50.5	01	382	02	ND	86.8	50.0	01	382	03	ND	86.9
Alpha-Terpineol	98555	10.0	01	44.5	02	ND	77.5	10.0	01	44.5	03	ND	77.5
Benzoic Acid	65850	50.0	01	7,685	02	96.3	98.8	50.0	01	7,685	03	ND	99.4
Hexanoic Acid	142621	10.0	01	5,818	02	118	98.0	10.0	01	5,818	03	ND	99.8
Methylene Chloride	75092	10.0	01	ND	02	ND		10.0	01	ND	03	ND	
N,N-Dimethylformamide	68122	10.0	01	ND	02	ND		10.0	01	ND	03	ND	
O-Cresol	95487	10.0	01	ND	02	ND		10.0	01	ND	03	ND	
P-Cresol	106445	10.0	01	797	02	253	68.3	10.0	01	797	03	22.3	97.2
Phenol	108952	10.0	01	702	02	185	73.6	10.0	01	702	03	29.3	95.8
Toluene	108883	10.0	01	376	02	112	70.2	10.0	01	376	03	15.1	96.0
Tripropyleneglycol Methyl Ether	20324338	99.0	01	1,207	02	ND	91.8	99.0	01	1,207	03	ND	91.8
Metals													
Barium	7440393	200	01	280	02	5.6	98.0	200	01	280	03	1.4	99.5
Boron	7440428	100	01	1,808	02	830	54.1	100	01	1,808	03	101	94.4
Chromium	7440473	9.0	01	ND	02	ND		9.0	01	ND	03	ND	
Silicon	7440213	100	01	4,362	02	511	88.3	100	01	4,362	03	355	91.9
Strontium	7440246	100	01	1,406	02	ND	92.9	100	01	1,406	03	ND	92.9
Titanium	7440326	4.0	01	ND	02	ND		4.0	01	ND	03	ND	
Zinc	7440666	10.9 /9.0	01	ND	02	ND		10.9 /10.0	01	ND	03	ND	
Pesticides/Herbicides													
Dichloroprop	120365	1.0	01	6.1	02	ND	83.6	1.0	01	6.1	03	ND	83.6
Disulfoton	298044	2.0	01	14.3	02	ND	86.1	2.0	01	14.3	03	ND	86.1
Dioxins/Furans													
1234678-HpCDD	35822469	49.8 pg/L	01	ND	02	NS	NS	49.8 pg/L	01	ND	03	NS	NS
OCDD	3268879	99.5 pg/L	01	ND	02	NS	NS	99.5 pg/L	01	ND	03	NS	NS

Negative percent removal are recorded as 0.0.
NS: Not Sampled   DL: Specific detection limits of sample when there is a non-detect, otherwise it is the method detection limi
ND: Non-detect   SP: Sample point.

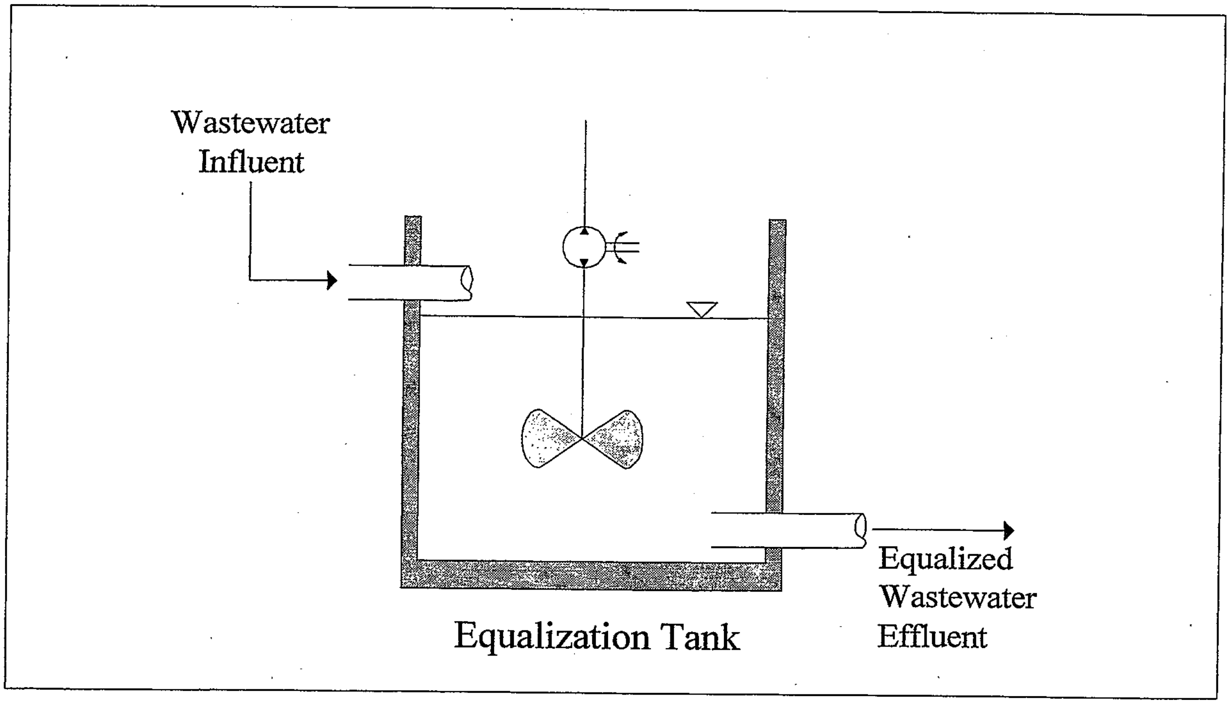


Figure 8-1: Equalization

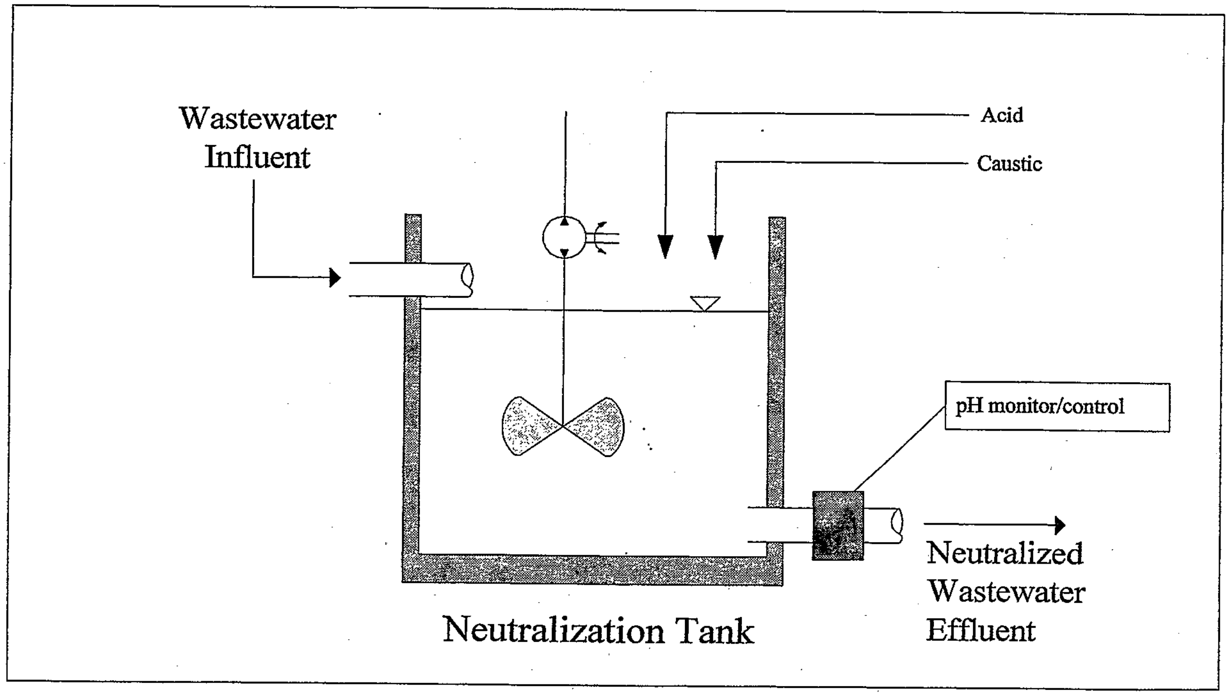


Figure 8-2: Neutralization

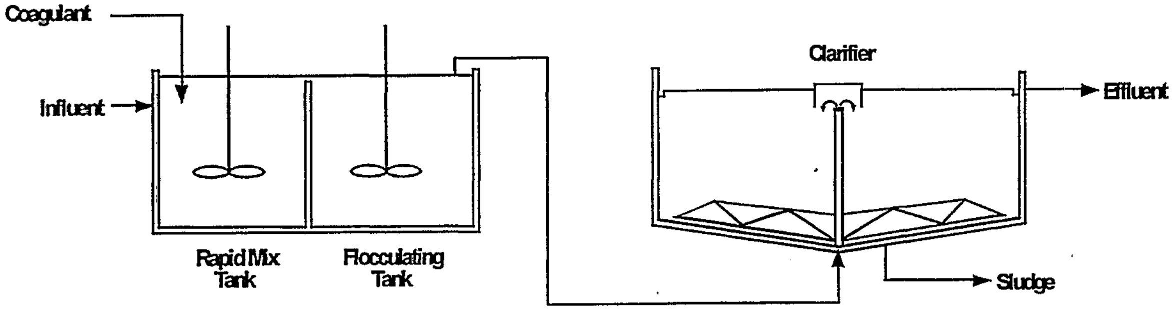


Figure 8-3: Clarification System Incorporating Coagulation and Flocculation

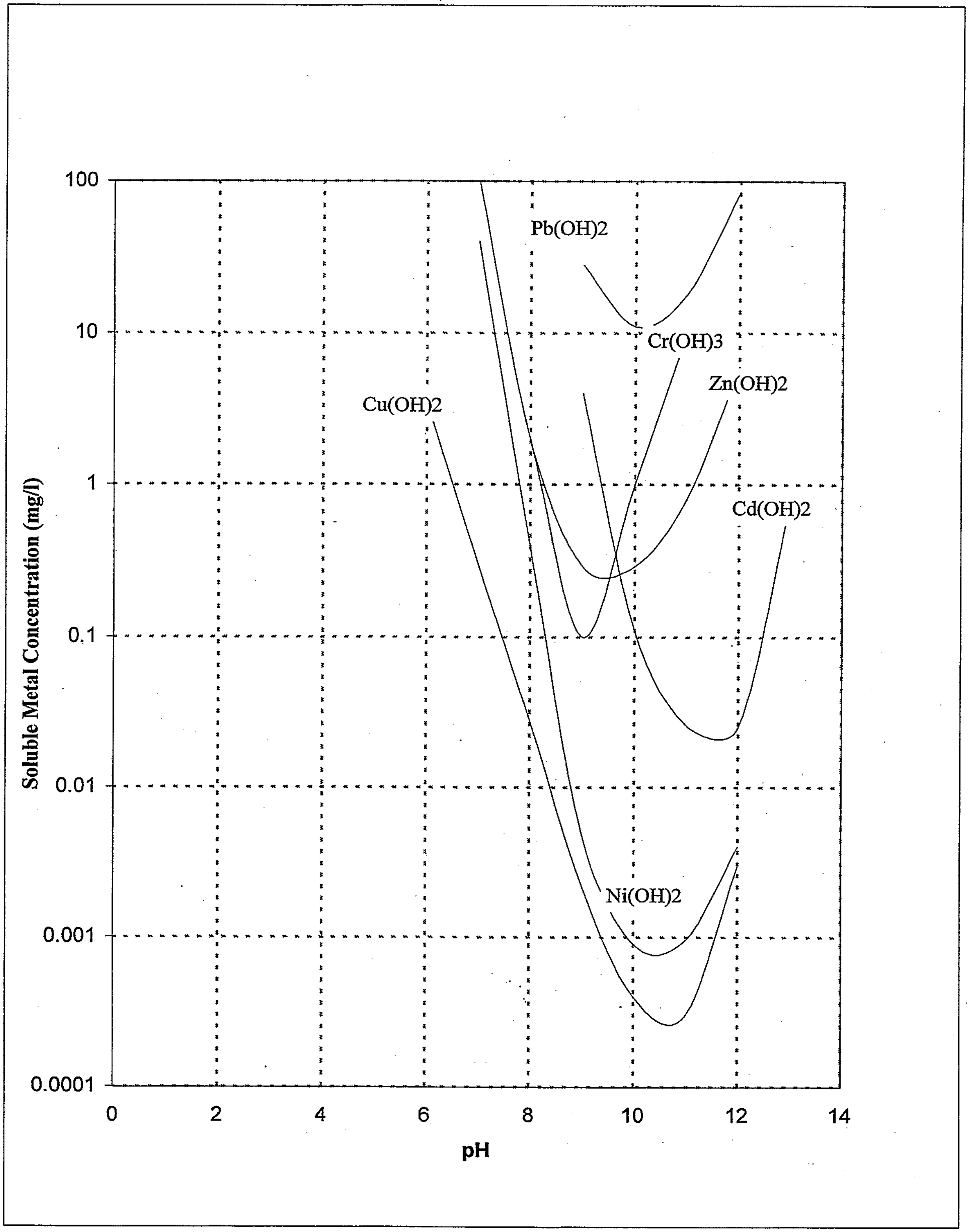


Figure 8-4: Calculated Solubilities of Metal Hydroxides

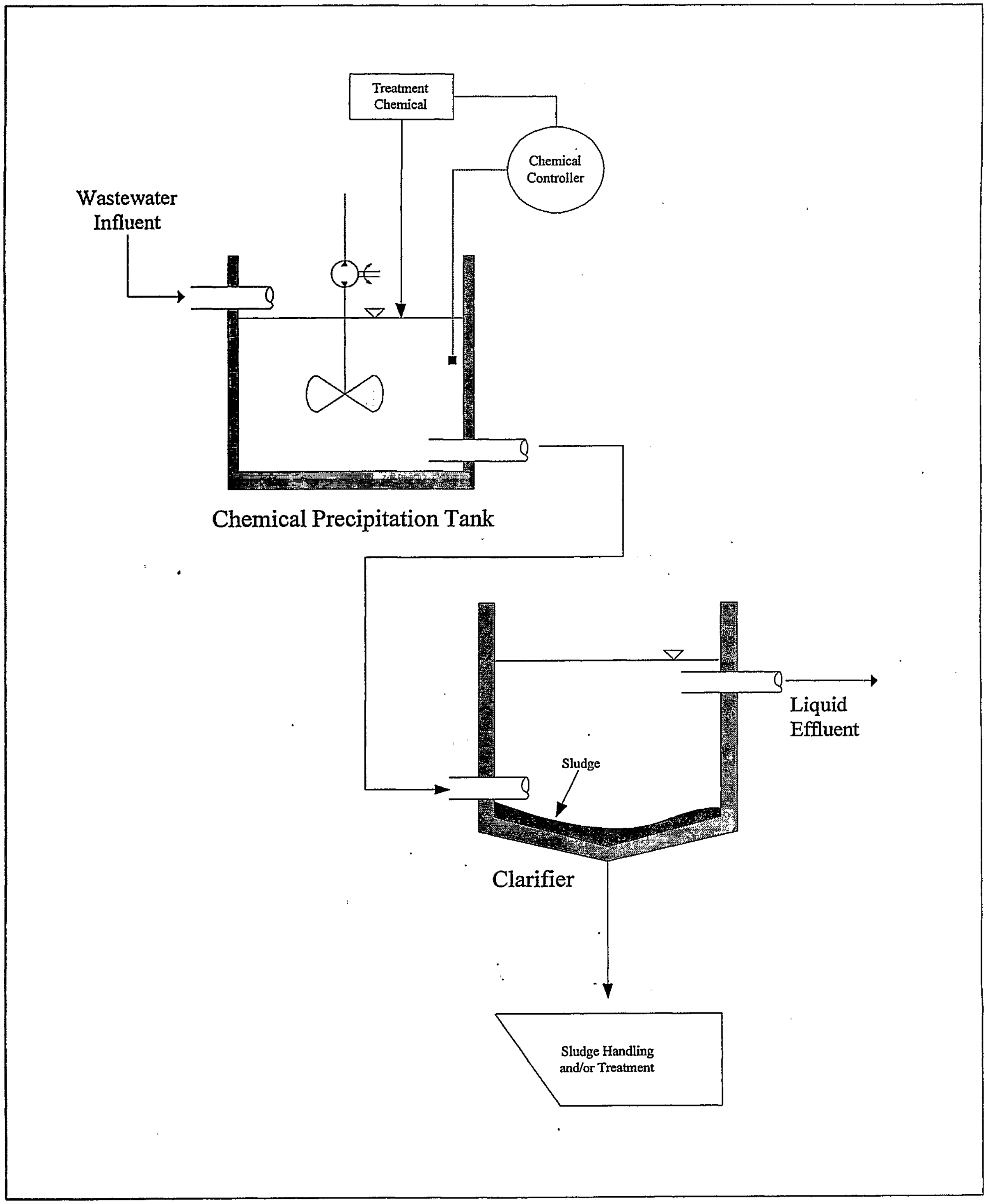


Figure 8-5: Chemical Precipitation System Design

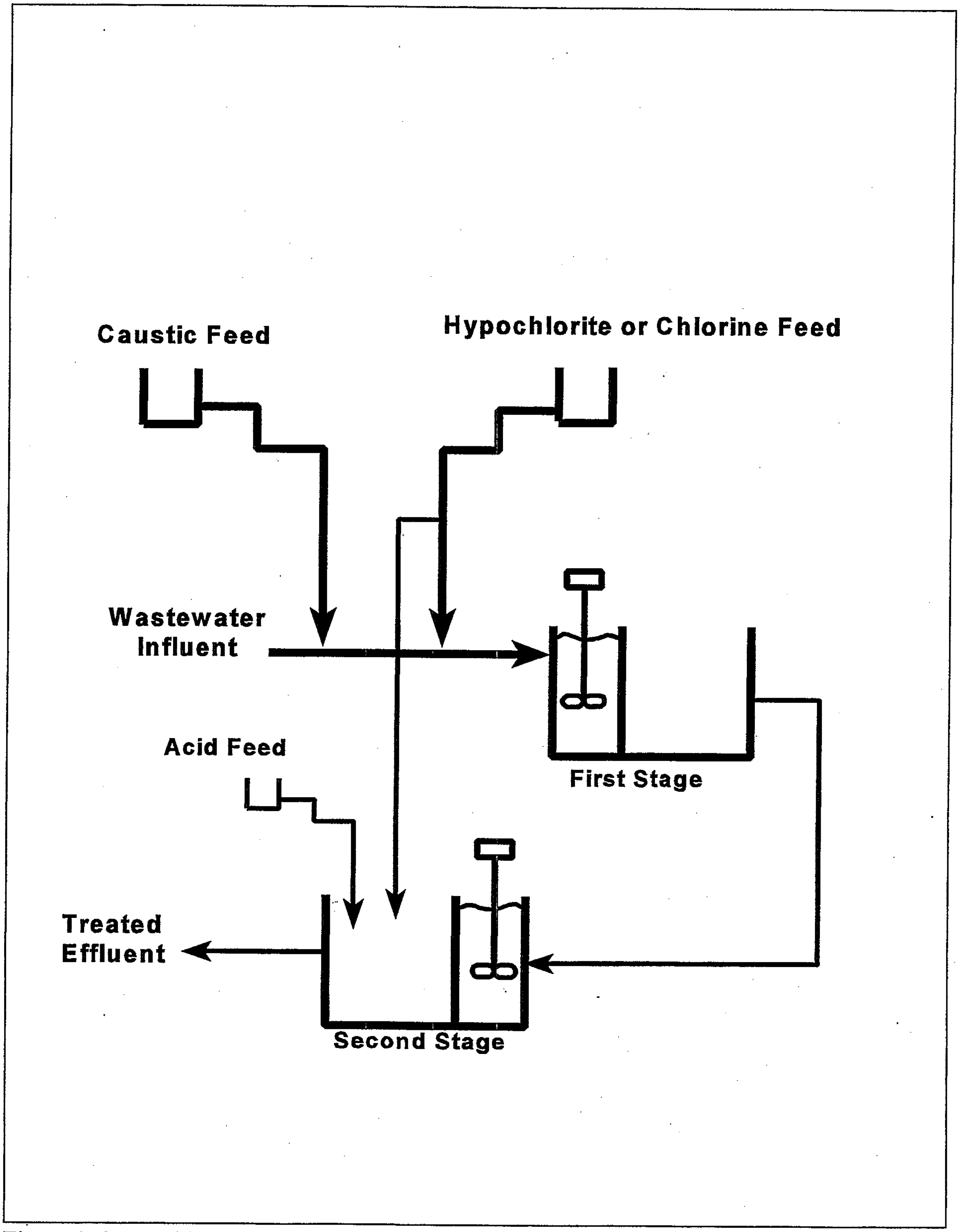


Figure 8-6: Cyanide Destruction

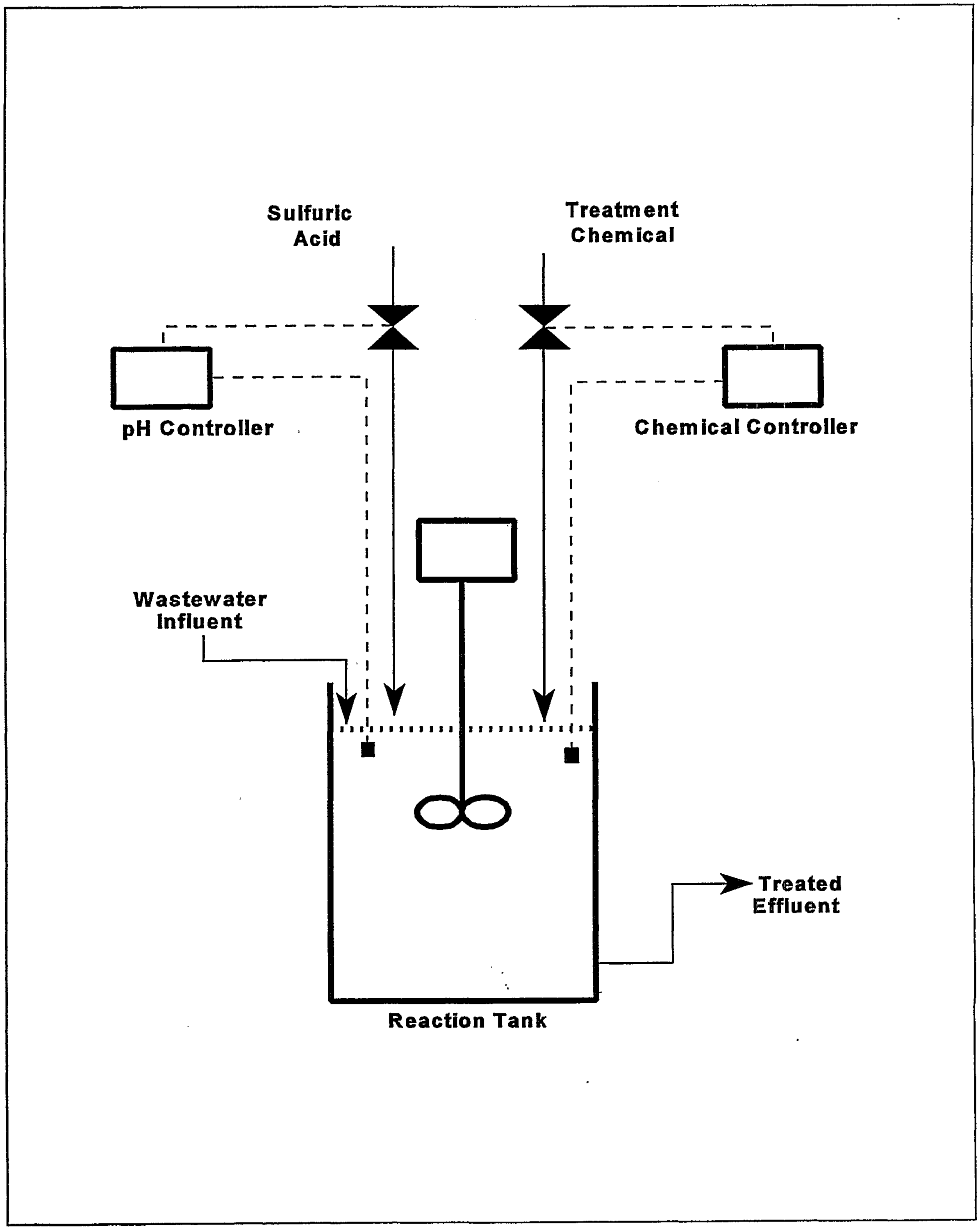


Figure 8-7: Chromium Reduction

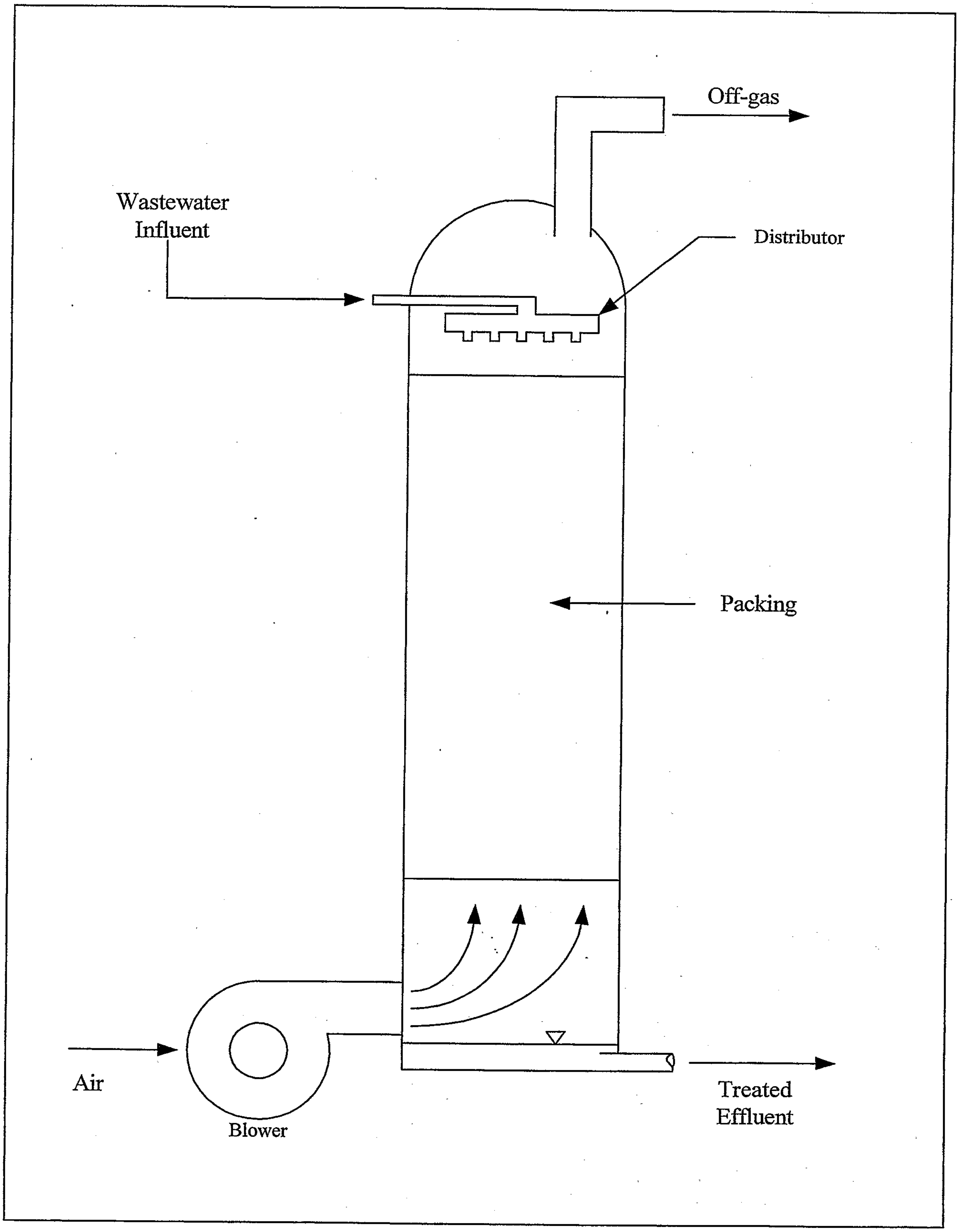


Figure 8-8: Typical Air Stripping System

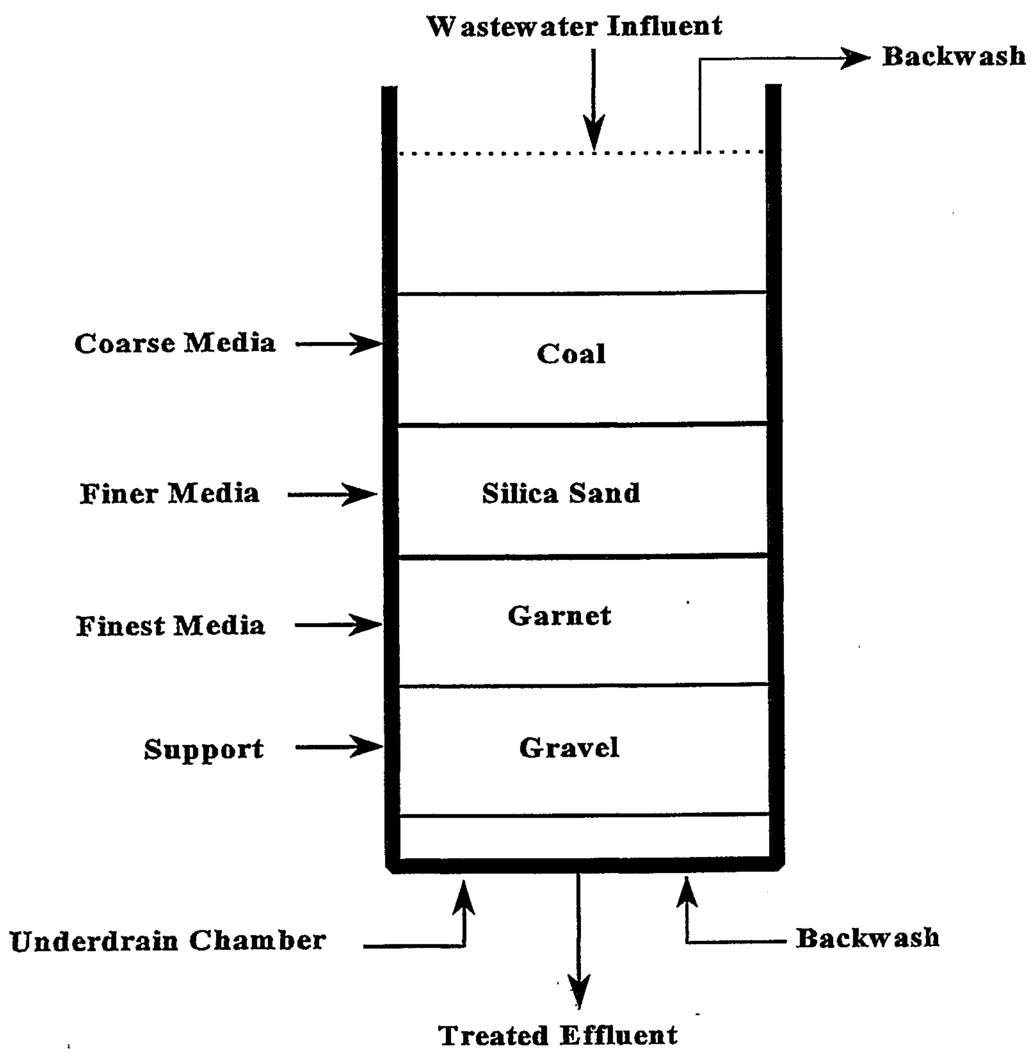


Figure 8-9: Multimedia Filtration

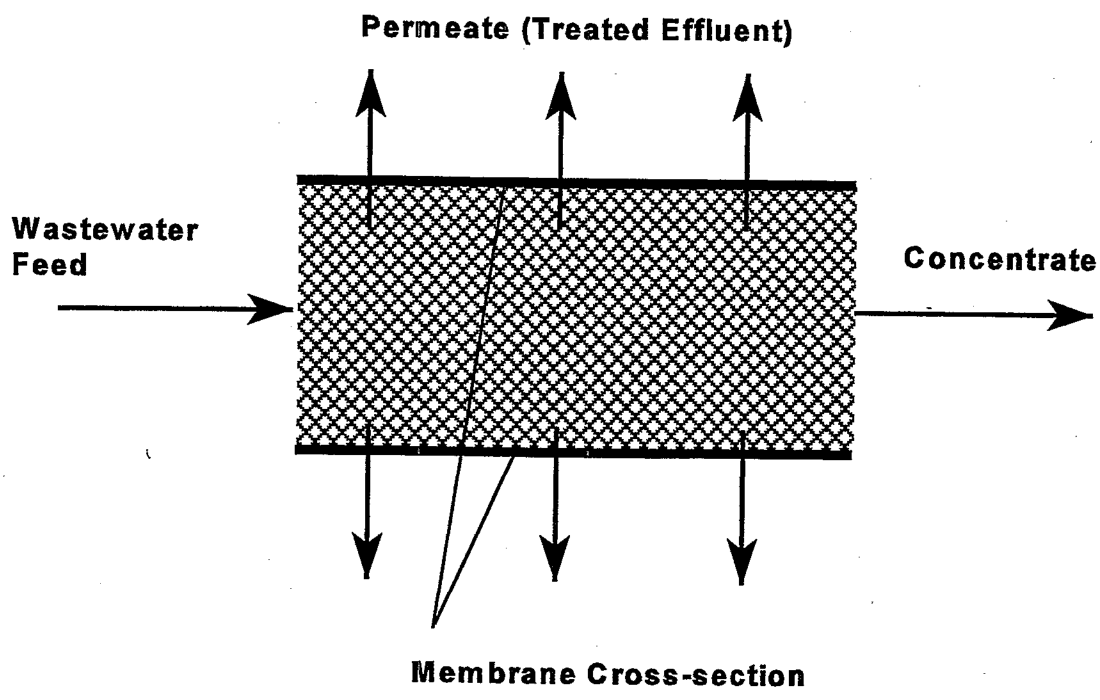


Figure 8-10: Ultrafiltration System Diagram

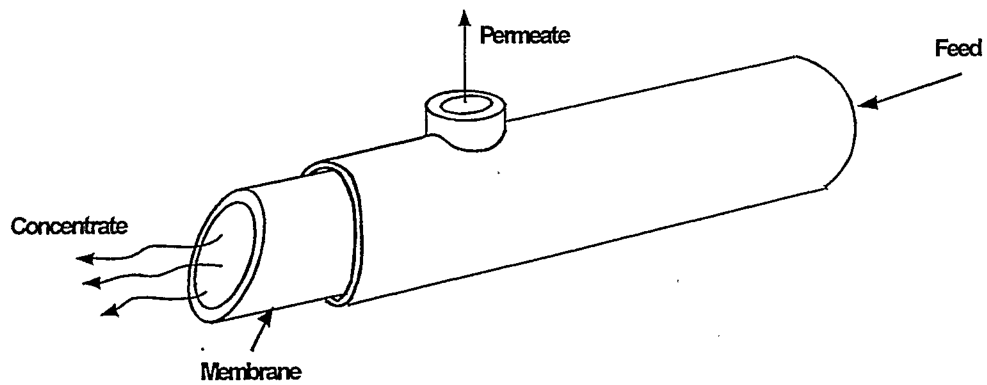


Figure 8-11: Tubular Reverse Osmosis Module

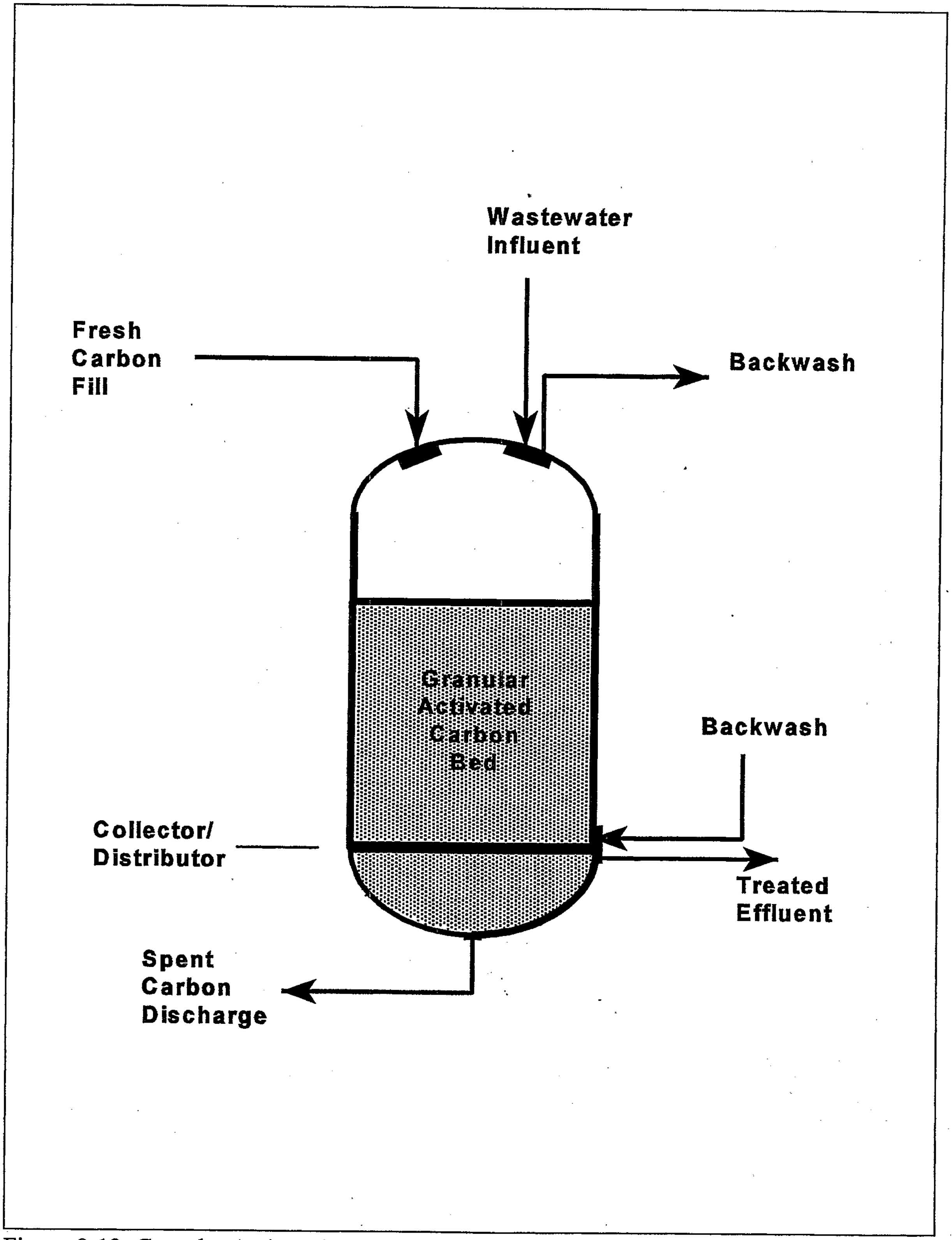


Figure 8-12: Granular Activated Carbon Adsorption

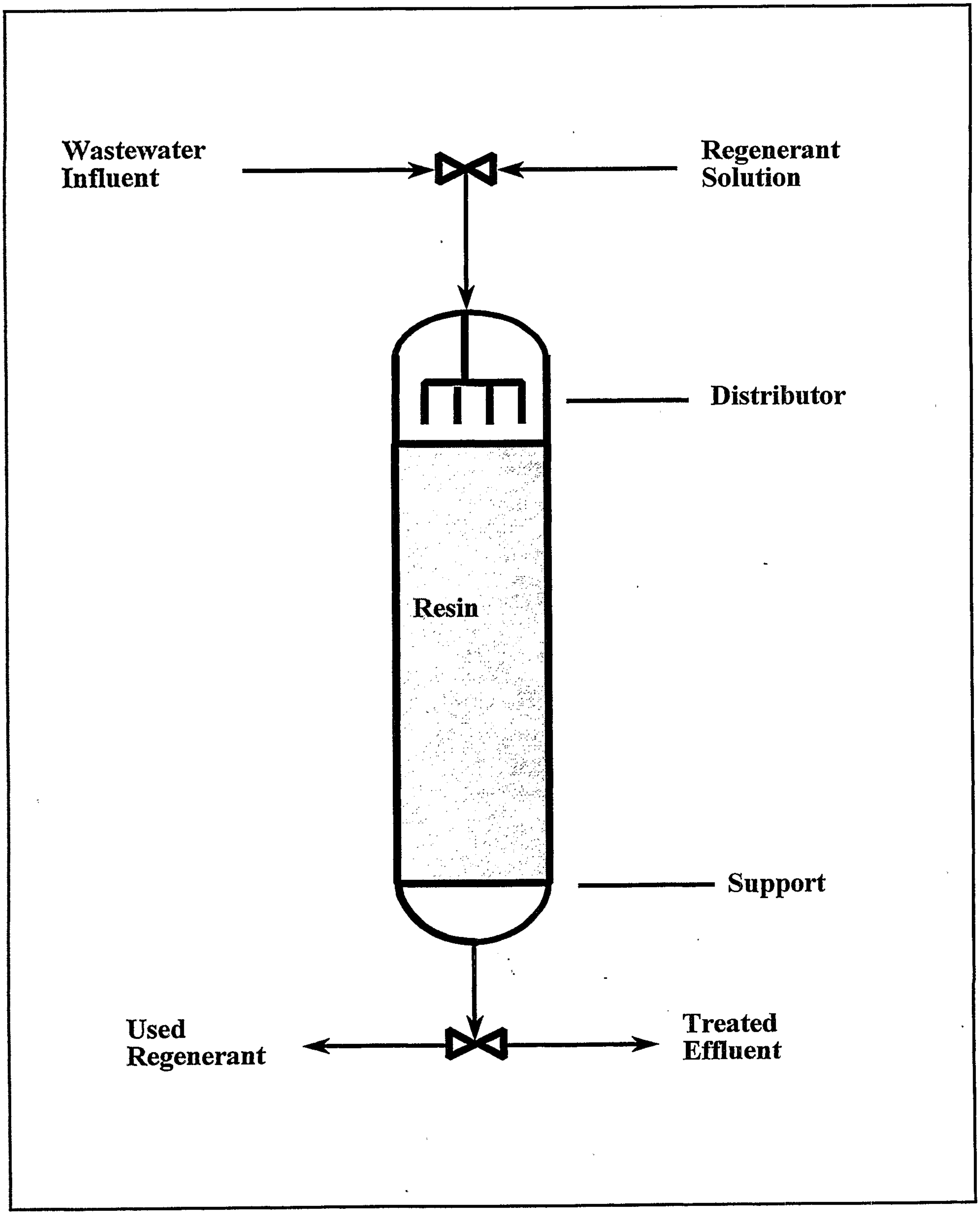


Figure 8-13: Ion Exchange

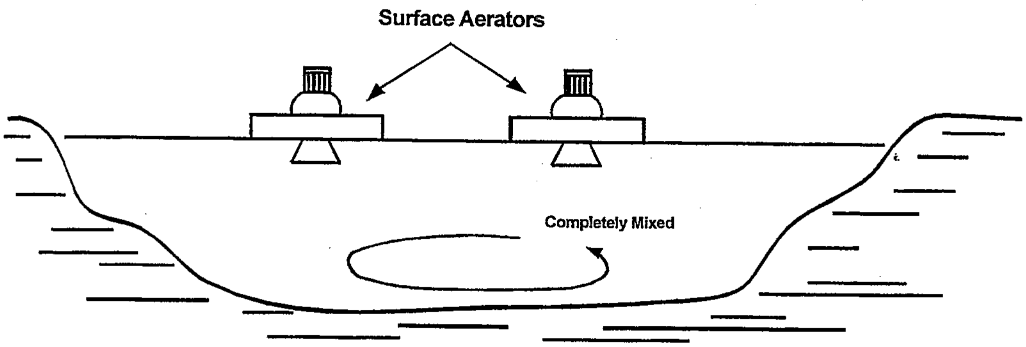


Figure 8-14: Aerated Lagoon

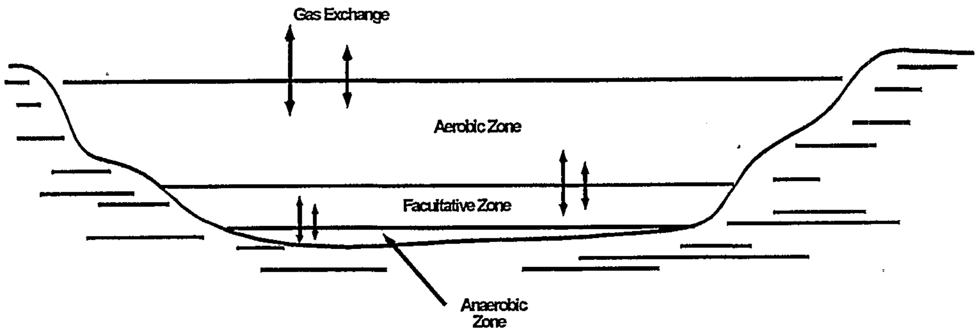


Figure 8-15: Facultative Pond

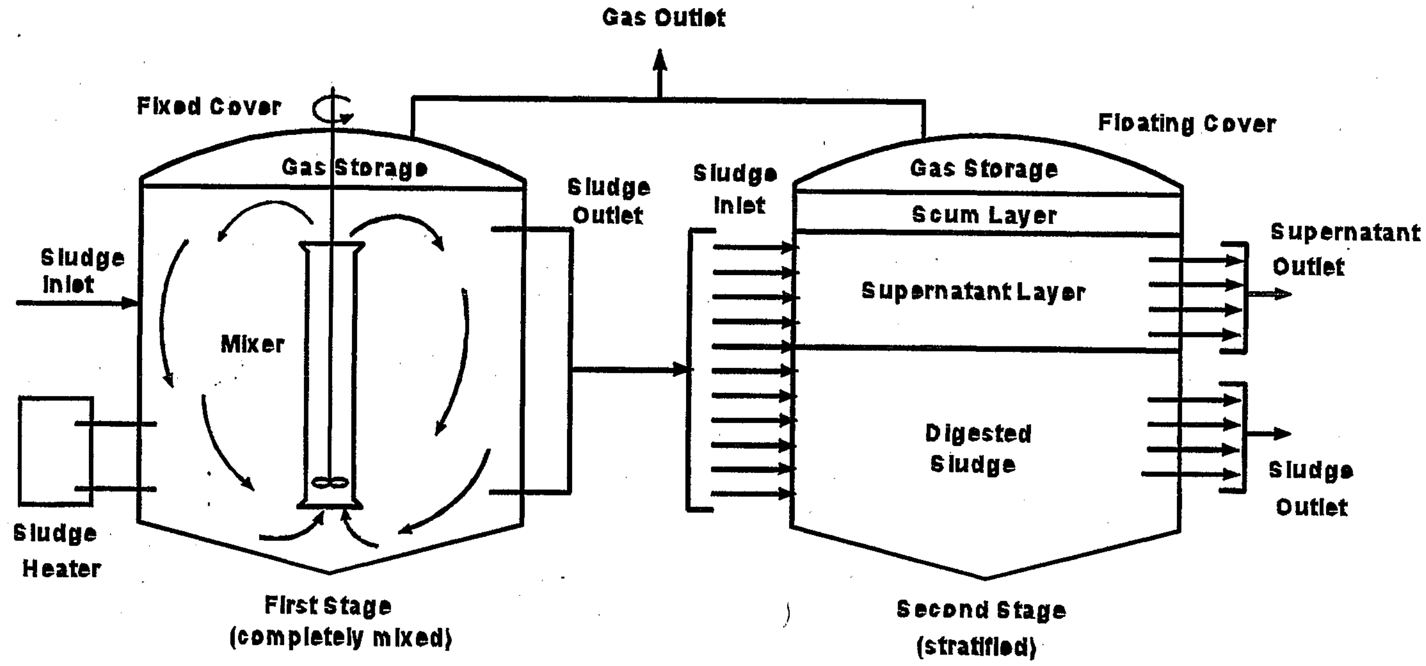


Figure 8-16: Completely Mixed Digestor System

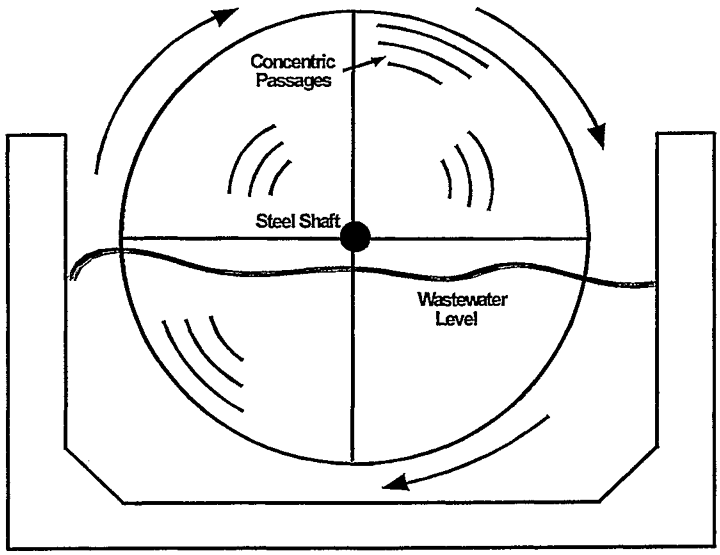


Figure 8-17: Rotating Biological Contactor Cross-Section

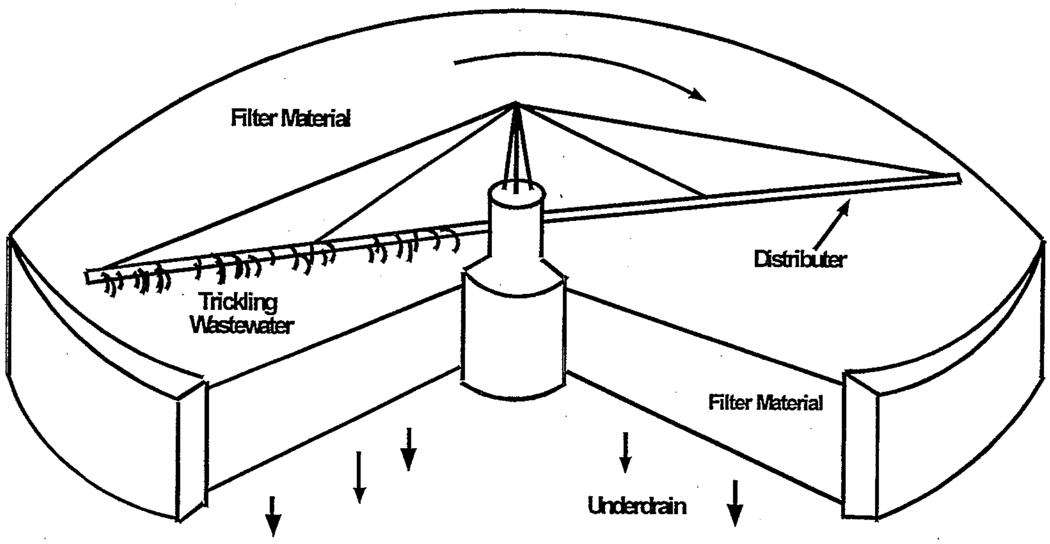


Figure 8-18: Trickling Filter

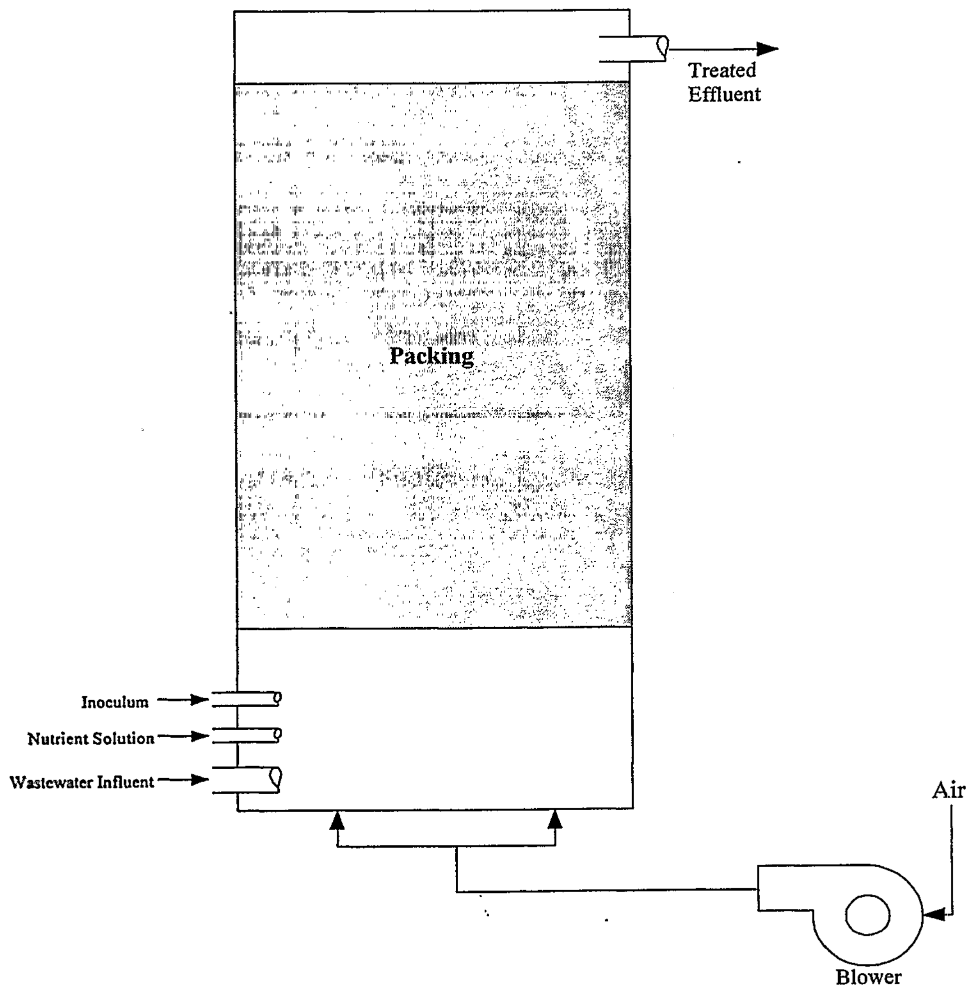


Figure 8-19: Fluidized Bed Reactor

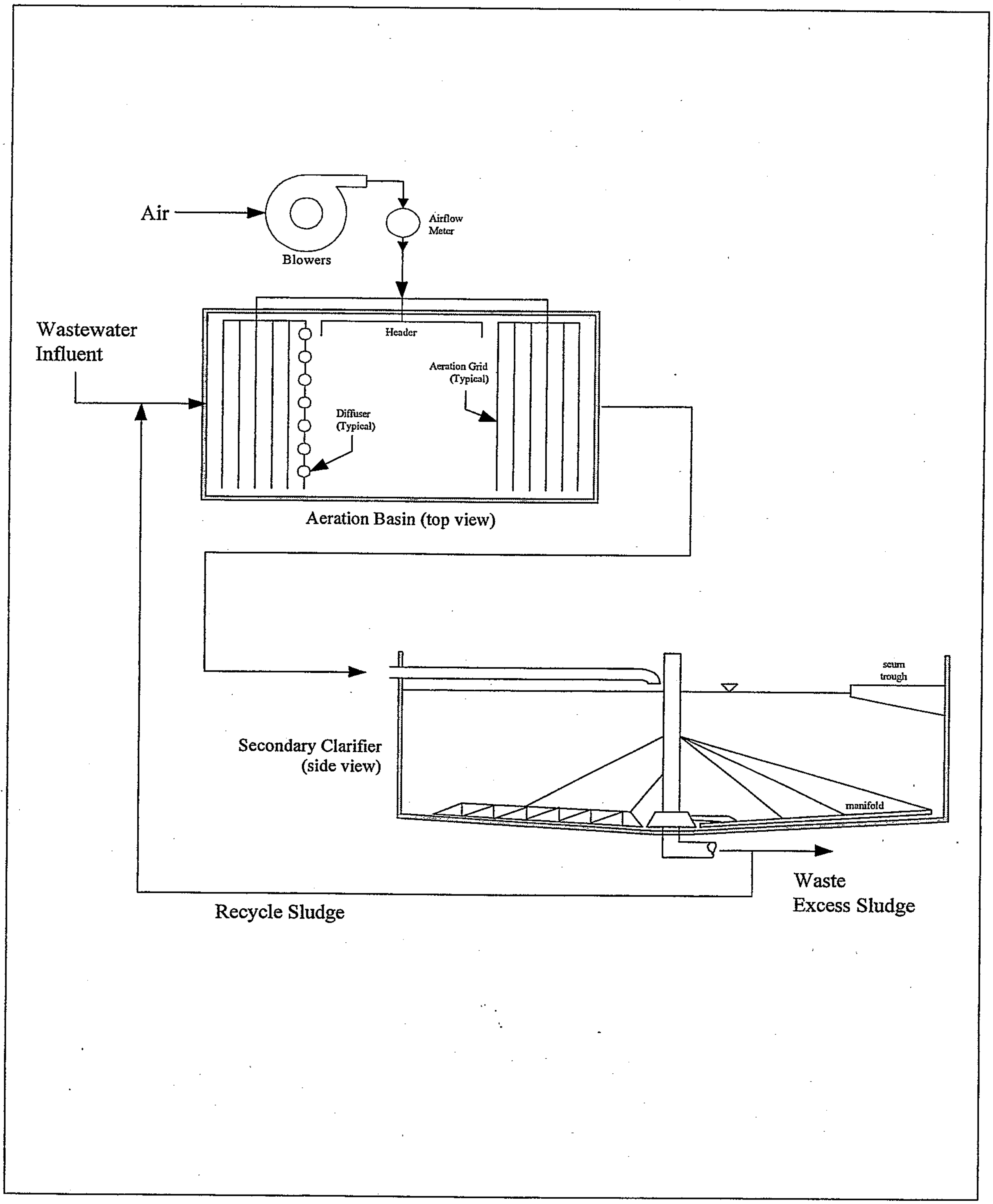


Figure 8-20: Activated Sludge System

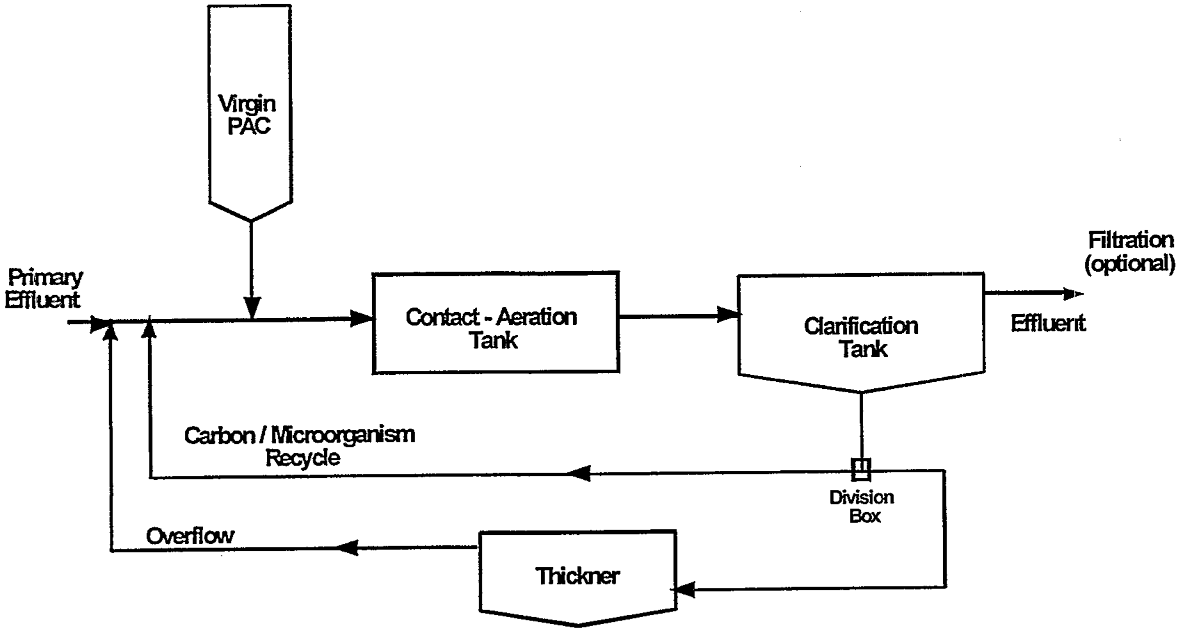


Figure 8-21: Powder Activated Carbon Treatment System

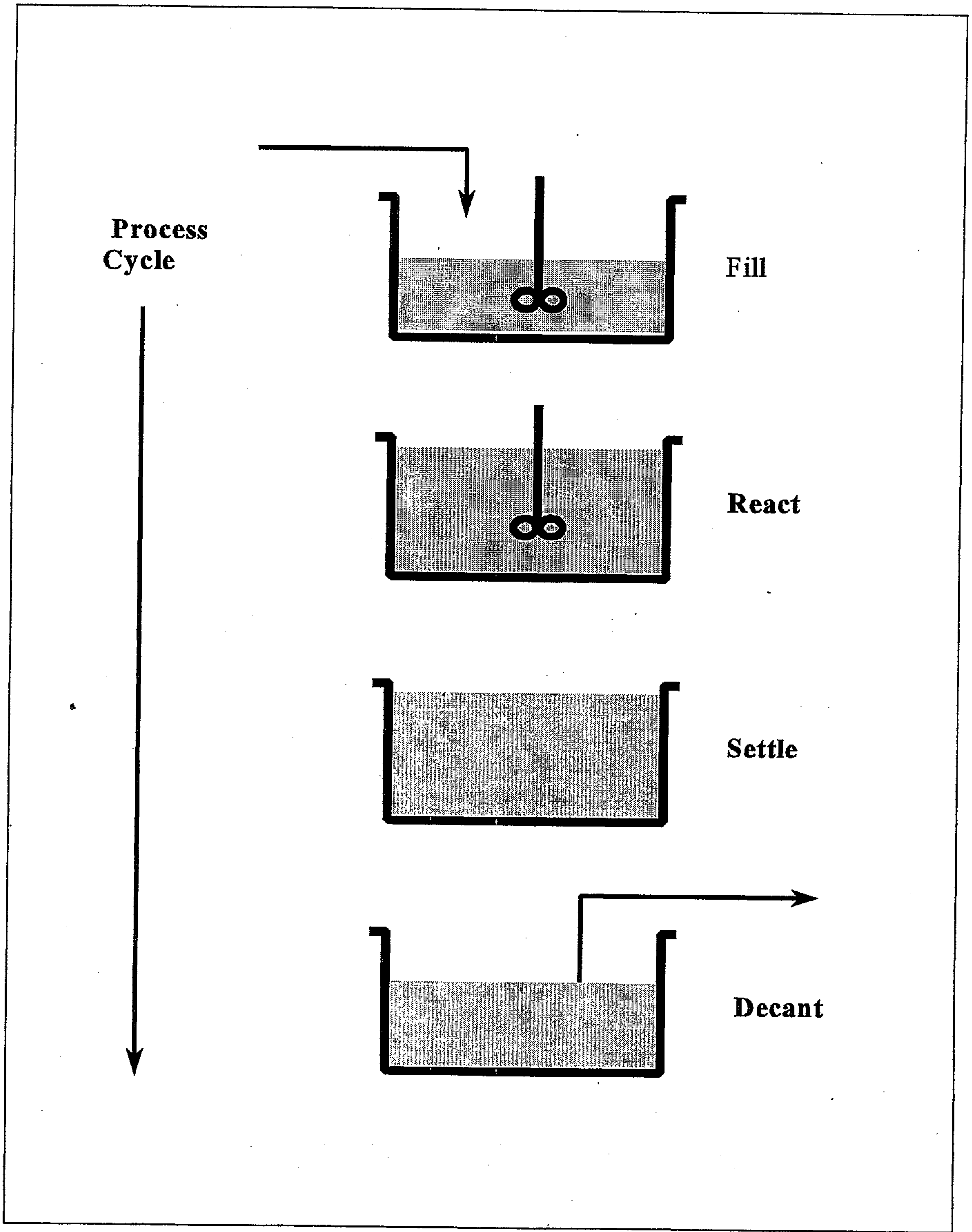


Figure 8-22: Sequencing Batch Reactor Process Diagram

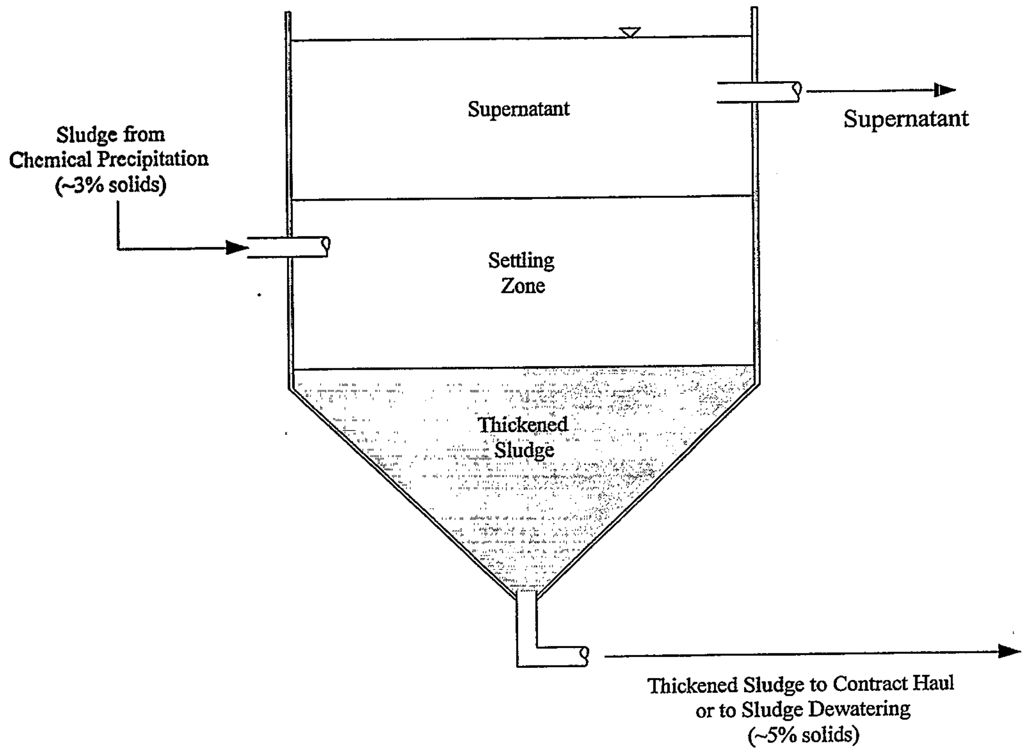


Figure 8-23: Gravity Thickening

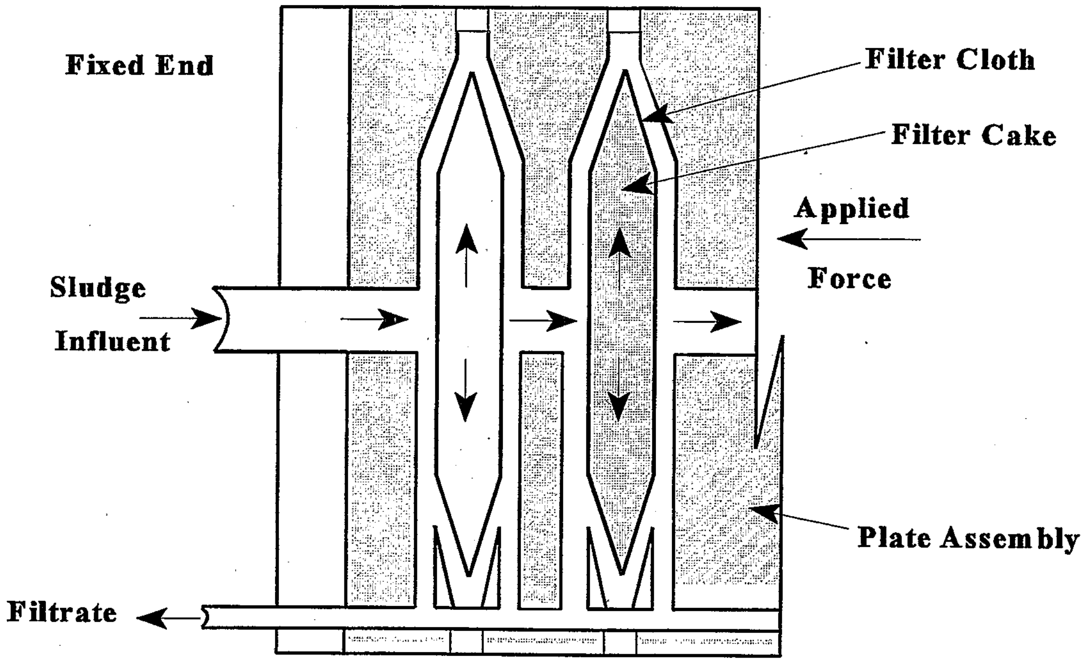


Figure 8-24: Plate and Frame Pressure Filtration System Diagram

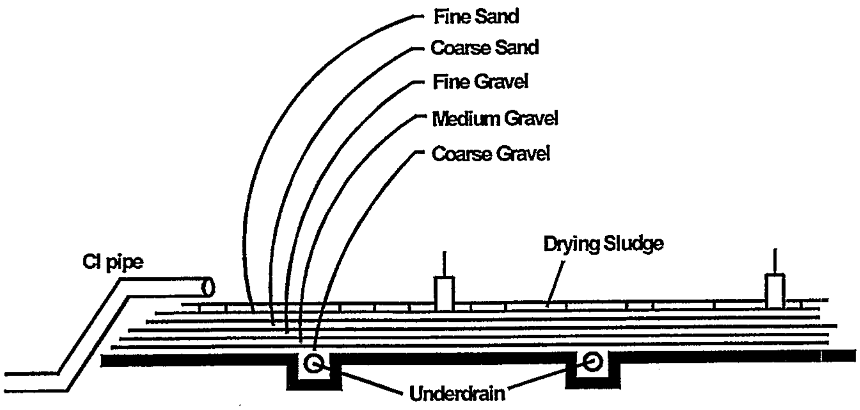


Figure 8-25: Drying Bed

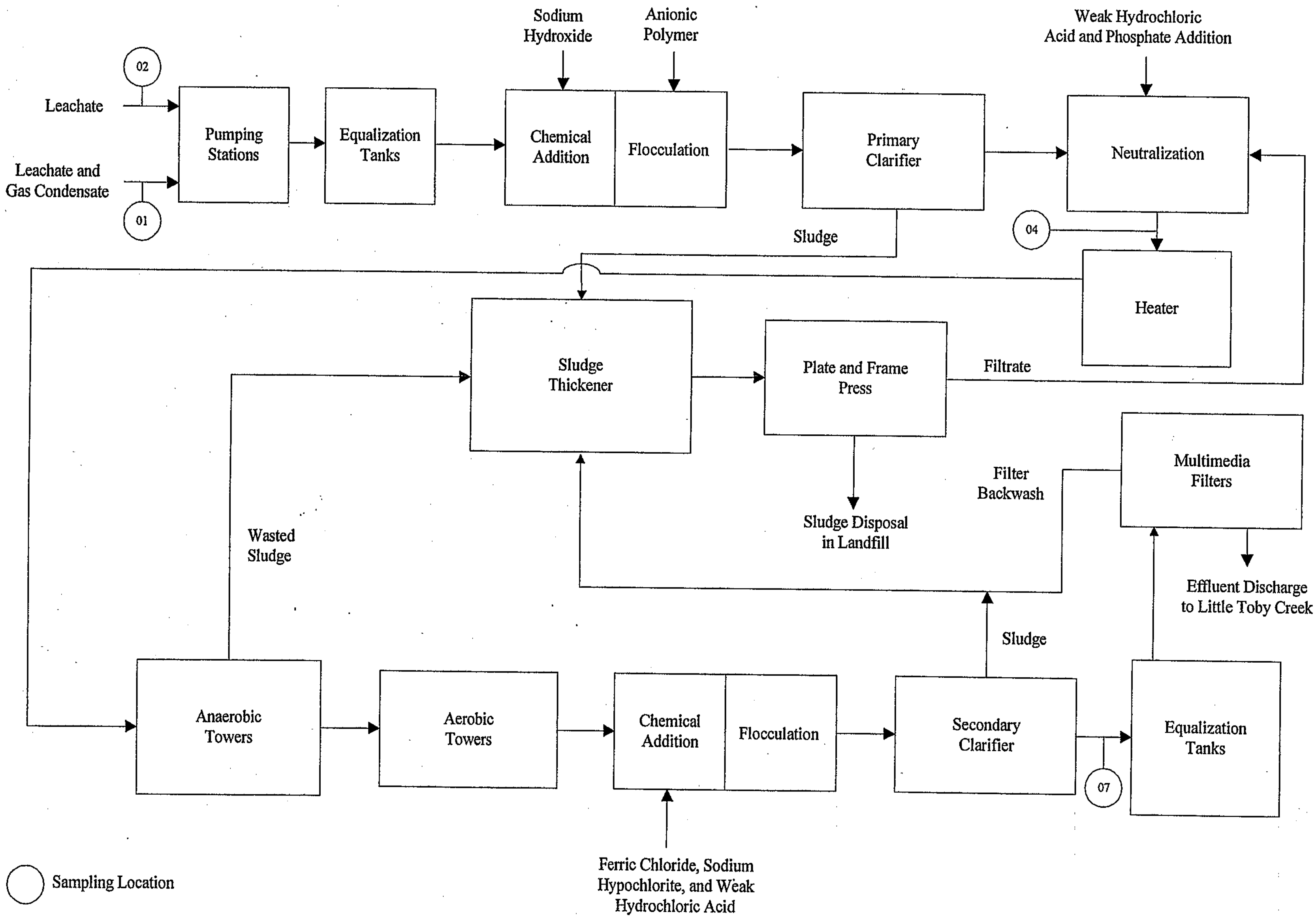


Figure 8-26: EPA Sampling Episode 4626 - Landfill Waste Treatment System Block Flow Diagram with Sampling Locations

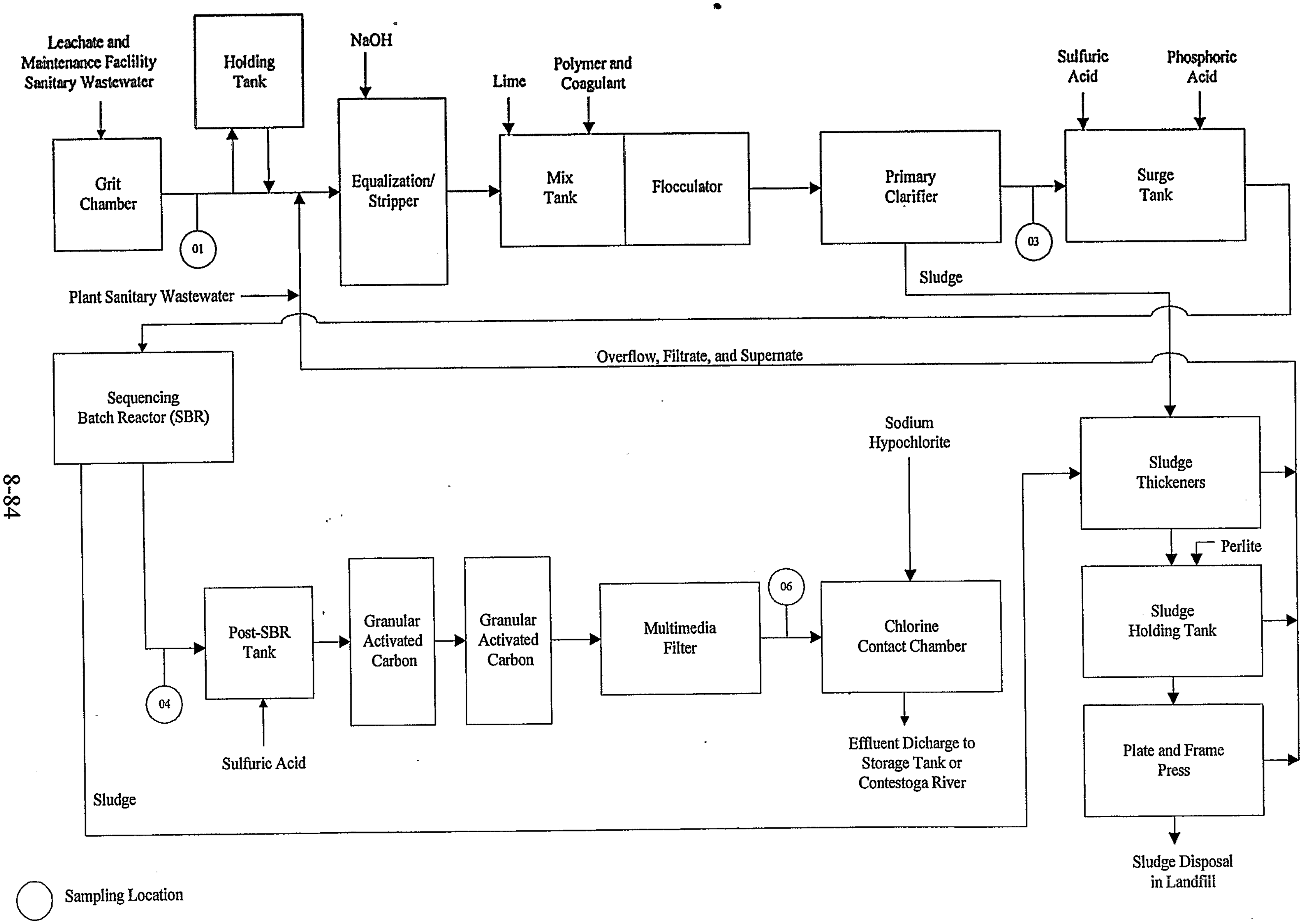


Figure 8-27: EPA Sampling Episode 4667 - Landfill Waste Treatment System Block Flow Diagram with Sampling Locations

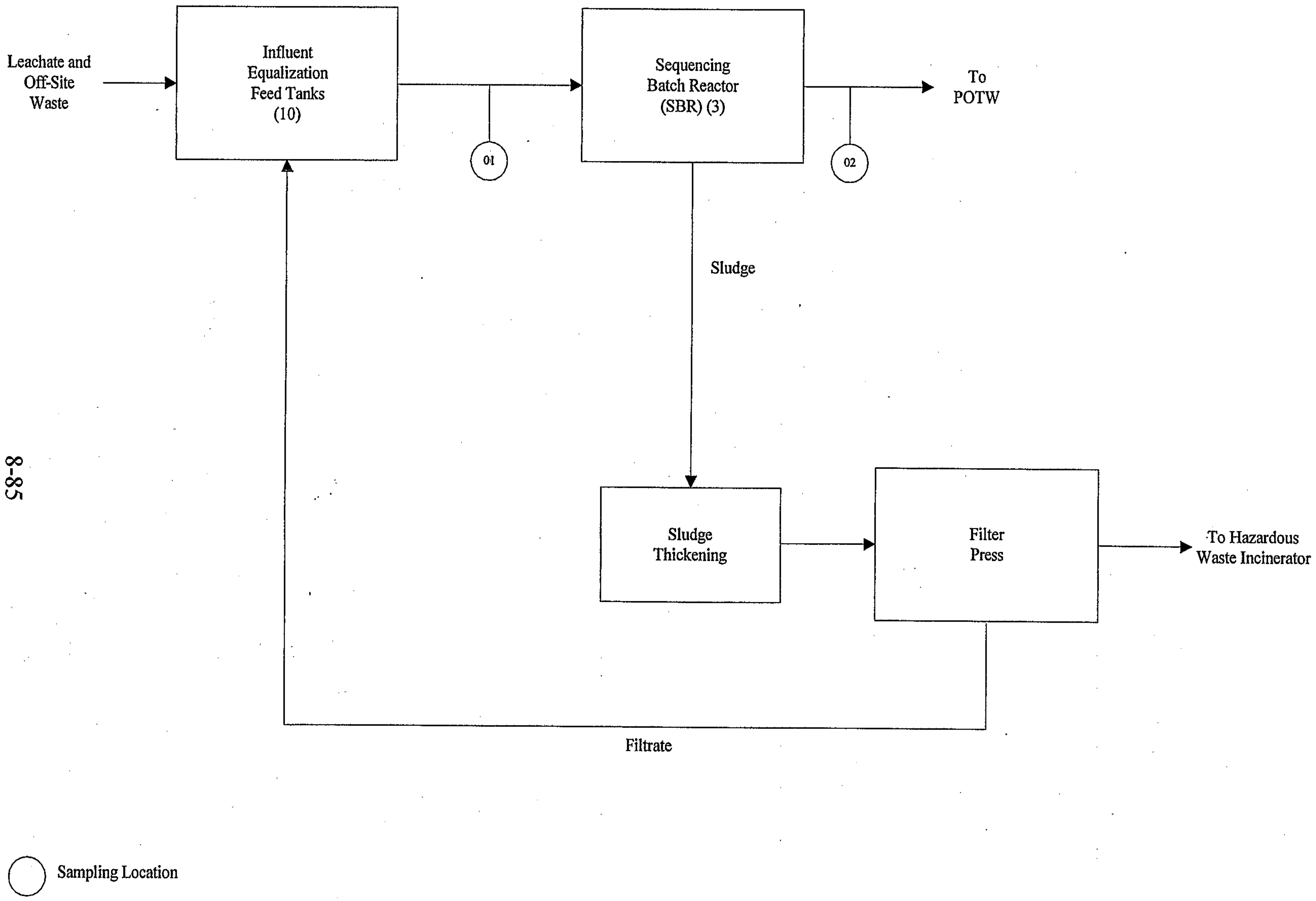


Figure 8-28: EPA Sampling Episode 4721 - Landfill Waste Treatment System Block Flow Diagram with Sampling Locations

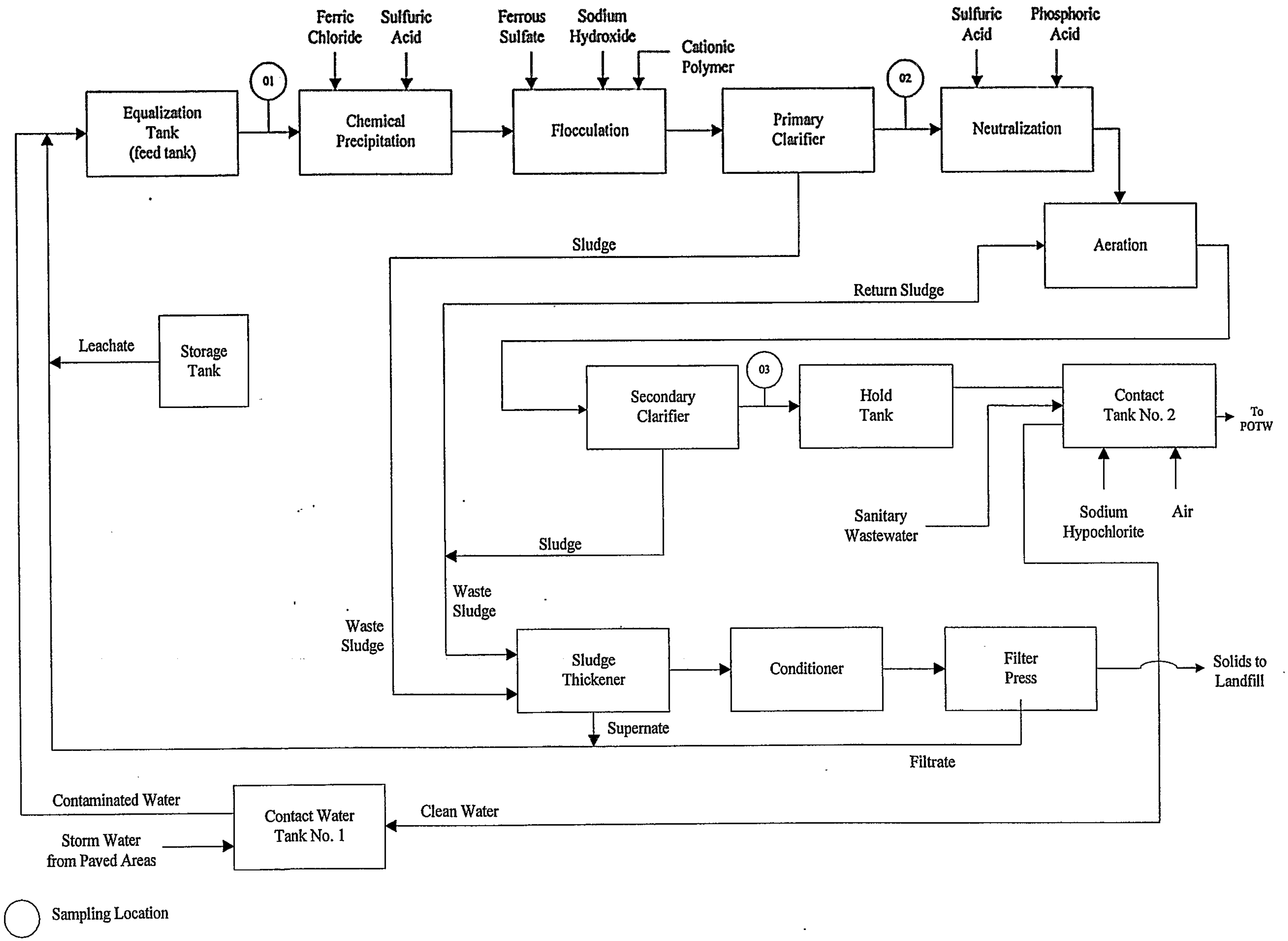


Figure 8-29: EPA Sampling Episode 4759 - Landfill Waste Treatment System Block Flow Diagram with Sampling Locations

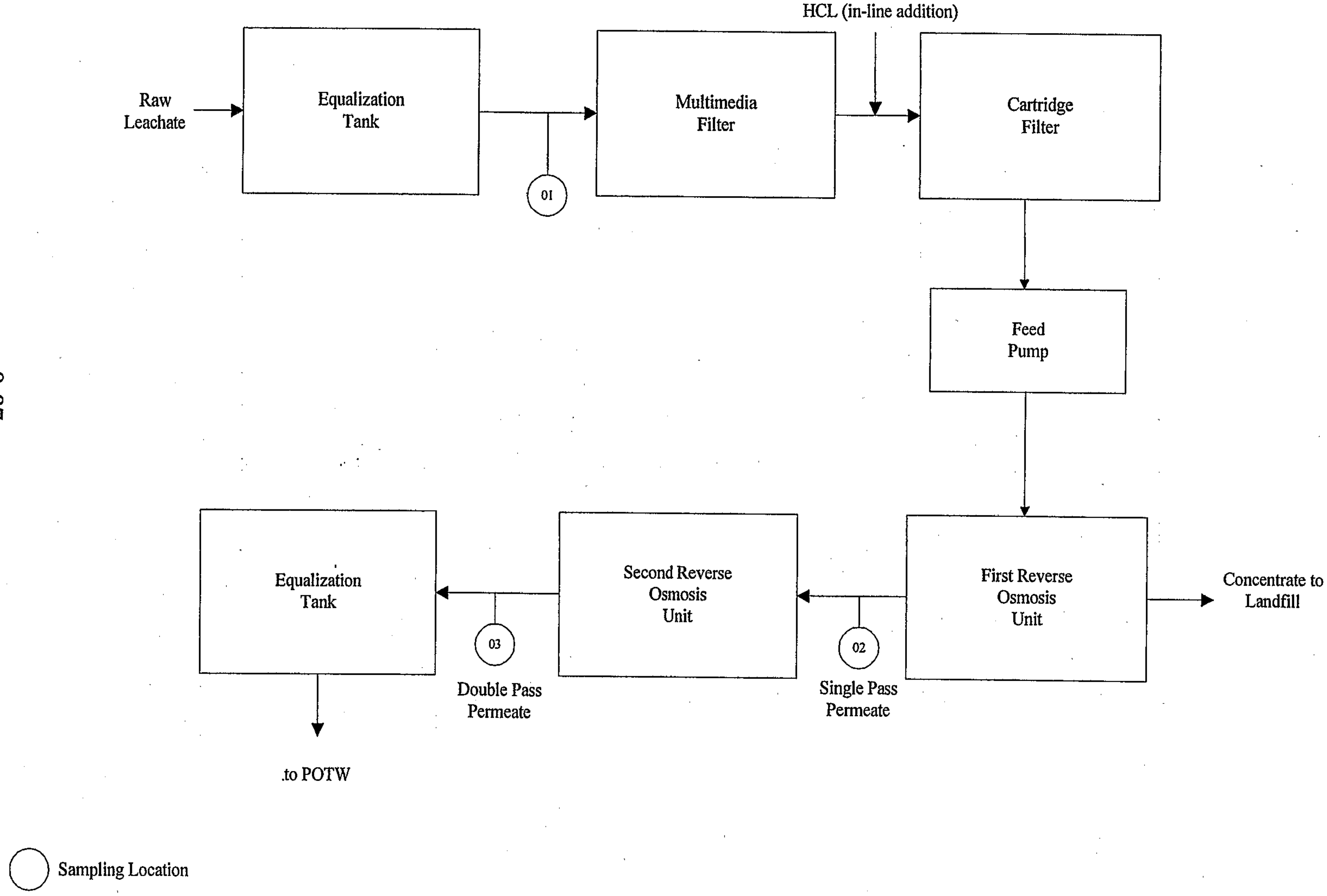


Figure 8-30: EPA Sampling Episode 4687 - Landfill Waste Treatment System Block Flow Diagram with Sampling Locations

9.0 ENGINEERING COSTS

This chapter presents the costs estimated for compliance with the proposed effluent limitations guidelines and standards for the Landfills industry. Section 9.1 provides a discussion of the cost estimation methodologies considered by EPA including evaluation of two cost estimation models. Section 9.2 presents a discussion of the types of cost estimates developed, while in Section 9.3, the development of capital costs, operating and maintenance (O&M) costs and other related costs is described in detail. Section 9.4 summarizes the compliance costs for each regulatory option considered by EPA.

9.1 Evaluation of Cost Estimation Techniques

This section presents a discussion of the cost estimation techniques considered by EPA, including evaluation of two cost estimation models. The criteria used by EPA to evaluate these techniques as well as the results of a benchmark analysis to compare the accuracy of these techniques are presented. The selected cost estimation techniques also are presented.

9.1.1 Cost Models

Development of compliance cost estimates for leachate treatment systems is required to determine the economic impact of the regulation. EPA has identified existing cost estimation models to facilitate the development of compliance cost estimates. In a mathematical cost model, various design and vendor data on a variety of treatment technologies are combined and cost equations that describe costs as a function of system parameters, such as flow, are developed for each treatment technology. Using these types of models allows for the generation of compliance cost estimates for several regulatory options that are based on the iterative addition of treatment technologies which can assist EPA in the selection of options as the basis for the proposed regulations.

Two well known cost models were evaluated for use in developing costs:

- Computer-Assisted Procedure for the Design and Evaluation of Wastewater Treatment Systems (CAPDET), developed by the U.S. Army Corps of Engineers.
- W/W Costs Program (WWC), Version 2.0, developed by CWC Engineering Software.

CAPDET is intended to provide planning level cost estimates to analyze alternatives in the design of wastewater treatment systems. Modules are used to develop cost estimates for a variety of physical, chemical, and biological treatment unit processes and can be linked together to represent entire treatment trains. Equations in each of these modules are based upon common engineering principles used for wastewater treatment system design. The CAPDET algorithm generates a design based on input parameters selected by the user, calculates cost estimates for various treatment trains and ranks them based on present worth, capital, operating, or energy costs.

The WWC cost model was developed by Culp/Wesner/Culp from a variety of engineering sources, including vendor supplied data, actual plant construction data, unit takeoffs from actual and conceptual designs, and published data. The model calculates cost estimates for a variety of individual treatment technology units that can be combined together to develop compliance cost estimates for the complete treatment systems. The WWC model does not design each treatment technology unit but rather prompts the user to provide design input parameters that form the basis for the cost estimate. The WWC model includes a separate spreadsheet program that provides design criteria guidelines to assist in developing the input parameters to the cost estimating program. The spreadsheet includes treatment component design equations and is supplied with default parameters that are based upon accepted design criteria used in wastewater treatment, to assist in the design of particular treatment units. The spreadsheet also is flexible enough to allow selected design parameters to be modified to estimate industry-specific factors accurately. Once design inputs are entered into the program, the WWC model calculates both construction and operation and maintenance (O&M) costs for the selected wastewater treatment system.

9.1.2 Vendor Data

For certain wastewater treatment technology units, the cost model was not considered the most accurate estimate of costs. For these instances, EPA determined that actual equipment and operation and maintenance costs obtained directly from equipment vendors often can provide accurate cost estimates.

Information on landfill wastewater characteristics was provided to vendors to determine the appropriate treatment unit and accurate sizing. Quotes obtained from vendors included equipment costs that were factored up to total capital costs by the Agency to account for site preparation, mobilization costs, and engineering contingencies. Vendor quotes also were obtained for operation and maintenance costs including utility usage and cost. Vendor quotes were used to determine cost curves for equalization, multi-media filtration, and reverse osmosis. The cost curves used for these treatment technologies are based on direct vendor quotes, commercial costing guides, or cost information developed from vendor quotes as part of the Centralized Waste Treatment (CWT) effluent guidelines effort.

9.1.3 Other EPA Effluent Guideline Studies

Other EPA effluent studies, such as the Organic Chemicals and Plastics and Synthetic Fibers (OCPSF) industry effluent guidelines, were reviewed to obtain additional costing background and supportive information. However, costs developed as part of other industrial effluent guidelines are not used in costing for this industry, with the exception of the CWT effluent guideline data referenced in Section 9.1.2.

9.1.4 Benchmark Analysis and Evaluation Criteria

A benchmark analysis was performed to evaluate the accuracy of each cost estimation technique. This benchmark analysis used actual costs provided in the 308 Questionnaires and compared them to costs generated each cost estimation technique. Four landfill facilities (Questionnaire ID numbers (QIDs) 16122, 16125, 16041, and 16087) with wastewater treatment systems that were considered as a basis for BPT/BAT/NSPS/PSES/PSNS limitations were selected by EPA for benchmarking. Cost estimates were developed for wastewater treatment units that make up the treatment systems at these landfill facilities using the WWC and CAPDET models and vendor quotes. Next, EPA compared these cost estimates to the actual component costs provided in the 308 Questionnaires to evaluate the accuracy of each methodology in estimating capital and operation and maintenance costs. This cost comparison is presented in Table 9-1. Treatment technologies that were used in this benchmark analysis include:

- equalization,
- chemical precipitation,
- activated sludge,
- sedimentation, and
- multi-media filtration.

EPA also benchmarked cost estimates developed using these techniques against actual costs for wastewater treatment systems that included equalization, chemical precipitation, and multi-media filtration, that were obtained from industrial waste combustor facilities as part of that effluent guidelines effort. EPA believes that the wastewater characteristics being treated by these treatment systems, i.e., inorganic contaminants and solids in an uncomplexed matrix, are similar for both landfills and industrial waste combustor facilities and that this additional comparison provides a more thorough evaluation of the Agency's cost estimation methodologies. Table 9-2 presents a comparison of the capital and O&M costs obtained for the wastewater treatment systems at four industrial waste combustor facilities to the cost estimates obtained using each technique, i.e., the WWC and CAPDET models, and vendor quotes.

As shown in Tables 9-1 and 9-2, EPA has determined that, based on the results of the benchmark analyses for both data sources, the WWC model generated cost estimates that are considered more accurate than the CAPDET model when compared to actual treatment technology costs as provided in 308 Questionnaire responses. In all instances, the WWC model estimated the more accurate treatment system capital and O&M costs as compared to CAPDET and vendor costs. For several facilities, such as QIDs 16087, 16122, and 16125, the WWC model generated capital costs to within approximately 32 percent of costs provided in the questionnaires. O&M costs for several facilities, including QIDs 16041, 16087, and 16122, were estimated to within approximately 18 percent of costs provided in the 308 Questionnaires.

EPA used the following criteria to evaluate each cost estimation technique and to select the appropriate option for developing a methodology for estimating compliance costs for the Landfills industry:

- Does the model contain costing modules representative of the various wastewater technologies in use or planned for use in the Landfills industry?
- Can the model produce costs in the expected flow range experienced in this industry?
- Can the model be adapted to cost entire treatment trains used in the Landfills industry?
- Is sufficient documentation available regarding the assumptions and sources of data so that costs are credible and defensible?
- Is the model capable of providing detailed capital and operation and maintenance costs with unit costing breakdowns?
- Is the model capable of altering the default design criteria in order to accurately represent actual design criteria indicative of the Landfills industry?

9.1.5 Selection of Final Cost Estimation Techniques

Based upon the results of the benchmark analysis, the WWC model was selected for estimating costs for the majority of the treatment technologies that form the basis for BPT/BAT/NSPS/PSES/PSNS effluent limitations and standards. It was determined that the WWC model is capable of producing accurate capital and O&M costs for a wide range of treatment technologies. The CAPDET model was not considered capable of generating cost estimates for many of the technologies that form the basis for BPT/BAT/NSPS/PSES/PSNS effluent limitations and standards for the Landfills industry and was determined not to be as accurate in estimating technology costs for landfill facilities. Therefore, EPA decided not to use the CAPDET model for estimating compliance costs.

It was determined that the WWC model best satisfies the selection criteria. The program can estimate costs for a wide range of typical and innovative treatment technologies and can combine these costs of each technology to develop system costs. Since the WWC model is a computer based program, it readily allows for the iterative development of costs for a number of facilities and regulatory options. The program utilizes cost modules that can accommodate the range of flows and design input parameters needed to develop cost estimates for landfill facilities. Cost estimates generated by this model are based upon a number of sources, including actual construction and operation costs, as well as published data and are presented in a breakdown summary table that contains unit costs and totals. Finally, the WWC model can be adapted to estimate costs based upon specified design criteria and wastewater flow rates.

EPA notes that there were particular technologies for which WWC model did not produce accurate cost estimates; these technologies included equalization, multi-media filtration, and reverse osmosis. In low flow situations, costs developed for these treatment technologies were excessively high as compared to industry provided costs in 308 Questionnaire responses. For these technologies, EPA determined that vendor quotes provided a more accurate estimate of compliance costs and would be used in the final engineering costing methodology for these technologies.

9.2 Engineering Costing Methodology

This section presents the costing methodology used to develop treatment costs for BPT, BCT, BAT, and PSES options for the Landfills industry. This section also presents a description of additional costs, such as monitoring costs, that were developed by EPA. The following discussion presents a detailed summary of the technical approach used to estimate the compliance costs for each landfill facility. Total capital and annual operation and maintenance costs were developed for each facility in EPA's database to upgrade their existing wastewater treatment system, or to install new treatment technologies, to comply with the long term averages for each proposed option. Development of the long term averages is discussed in Chapter 11 of this document and in the Statistical Support documents. Facilities were costed primarily using the WWC model and on occasion, from cost curves developed from vendor quotes. Table 9-3 presents a breakdown of the cost estimation method used for each treatment technology. Additional costs were developed for monitoring, Resource Conservation and Recovery Act (RCRA) permit modifications, and residual disposal. Total facility compliance costs under each proposed BPT, BCT, BAT, and PSES option then were developed by adding treatment costs with these additional costs. Cost estimates for zero or alternative discharge facilities were not developed for any of the regulatory options.

9.2.1 Treatment Costing Methodology

The methodology used to develop facility-specific BPT, BCT, BAT, and PSES option compliance costs is presented graphically on the flow diagram in Figure 9-1. Facilities were costed for an entire new treatment system, whether or not they had existing treatment at the facility, if the collected flow subject to this guideline was less than 85 percent of the total facility flow rate.

For each proposed regulatory option, each landfill facility in the Detailed Technical Questionnaire database was evaluated to determine if the facility would incur costs in order to comply with the proposed regulations. EPA compared the current discharge concentrations of the facility's effluent with the long term averages from each proposed regulatory option. If the facility's current discharge concentration was less than the long term average, it was considered to be in compliance. A facility considered to be in compliance was projected to incur costs only for additional monitoring requirements. If a facility was not in compliance but had treatment unit operations in-place capable of complying with the proposed long term averages, the facility was costed for system upgrades that would bring the facility into compliance.

For facilities that did not have BPT, BCT, BAT, or PSES treatment systems or the equivalent, cost estimates were developed for the additional unit operations and/or system upgrades necessary to meet each long term average. Facilities that were already close to compliance with the long term averages only required an upgrade to achieve compliance with proposed limitations for a regulatory option. Upgrade costs were developed using the WWC model whenever possible, and included either additional equipment to be installed as part of an existing wastewater treatment system, expansion of existing equipment, or operational changes. Examples of upgrade costs include such items as new or expanded chemical feed systems and improved or expanded aeration systems. If a facility had no treatment system (or one that could not achieve desired levels with upgrades or minor additions) cost estimates for an entire BPT, BCT, BAT, or PSES treatment system were developed for that facility.

The first step in using the WWC model was to use the design criteria guidelines spreadsheet to develop input parameters for the computer program. Actual pollutant loadings from the facility were used whenever possible. If pollutant loadings were not available for a particular parameter, the estimates of pollutant concentrations in untreated landfill wastewater were used (see Chapter 6). The facility's baseline flow rate and the regulatory option long term averages also were used in the design of the unit operation. Certain parameters such as BOD_5, TSS, and ammonia are used directly in the WWC model and the design criteria guideline spreadsheet to design the various treatment unit operations. Metals included as pollutants of interest were selected to assist in the design of chemical precipitation systems. The metals to be treated typically control the type and amount of precipitating agents, which govern the chemical feed system design. A more detailed discussion of the design parameters and costs associated with individual treatment technologies is presented in Section 9.3.

The design parameters from the design criteria spreadsheet then were input in the WWC model to generate installed capital and O&M costs. O&M costs for treatment chemicals, labor, materials, electricity, and fuel are included in the WWC model O&M costs. Treatment costs developed using the WWC model were corrected to 1992 dollars using the Engineering News Record published indexes. After the installed capital and annual O&M costs were developed for each facility, selected cost factors, as shown in Table 9-4, were applied to the results to develop total capital and O&M costs.

To complete the estimation of compliance costs for each regulatory option, cost estimates for other than treatment component costs were developed. The assessment must take into account other costs associated with compliance with the proposed effluent limitations guidelines and standards including:

- land,
- residual disposal,

- RCRA permit modifications, and
- monitoring.

Each of these additional costs are further discussed and defined in the following sections.

Final capital costs were developed for each facility, then amortized using a seven percent interest rate over 15 years. This annualized capital cost then was added to the annual O&M cost to develop a total annual cost for each regulatory option.

9.2.1.1 Retrofit Costs

A retrofit cost factor was applied when additional equipment or processes were required for existing systems. Retrofit costs cover the need for system modifications and components, such as piping, valves, controls, etc., that are necessary to connect new treatment units and processes to an existing treatment facility. Retrofit costs were estimated at 20 percent of the installed capital cost of the equipment.

9.2.2 Land Costs

Land costs were not included in this analysis because EPA has determined that landfills have adequate land to accommodate additional treatment systems. Typically, the size of the required treatment system is small when compared to the land areas occupied by landfills. Landfills, as required by regulation and permit, have buffer zones around the fill areas. New treatment systems, or upgrades to an existing system, can be installed readily in this buffer zone or elsewhere at the landfill without the need to acquire new land.

9.2.3 Residual Disposal Costs

For each of the proposed treatment system additions or upgrades, a cost for residual disposal also was estimated. Two approaches were used: the first addressed facilities with current sludge handling capabilities, and the second addressed facilities without current sludge handling capabilities. Residual disposal costs were prepared on an annualized basis and added to the total O&M costs.

For facilities with sludge handling capabilities, the present solids treatment/dewatering system was evaluated to determine if it was capable of handling the additional sludge expected to be produced under a particular regulatory option. For facilities with insufficient capacity to handle the additional solids loadings, upgrade costs for sludge conditioning and dewatering were developed to account for the additional solids. For facilities with sufficient solids treatment capability, no additional sludge treatment costs were provided. For facilities without installed sludge conditioning and dewatering facilities, cost estimates for a sludge conditioning and dewatering system were developed.

Dewatered sludge is assumed to be disposed of on-site in the landfill. EPA's cost estimate also includes the costs associated with the handling and transportation of the sludge to the on-site landfill.

9.2.4 Permit Modification Costs

A cost associated with the modification of an existing RCRA Part B permit was included for all hazardous waste facilities requiring an upgrade or additional treatment processes. Legal, administrative, public relations, and engineering fees are included in this cost. This cost was added to the installed capital for the new or modified equipment and ranged from $50,000 to $250,000, based upon $50,000 for each piece of new or modified equipment.

9.2.5 Monitoring Costs

Costs were developed for the monitoring of treatment system effluent. Costs were developed for both direct and indirect dischargers and were based upon the following assumptions:

- Monitoring costs are based on the number of outfalls through which leachate/groundwater is discharged. The costs associated with a single outfall is multiplied by the total number of outfalls to arrive at the total cost for a facility. Monitoring costs estimated by EPA are incremental to the costs already incurred by the facility.
- The capital costs for flow monitoring equipment are included in EPA's estimates.

- Sample collection costs (equipment and labor) and sample shipment costs are not included in EPA's estimates because EPA assumes that the facility is already conducting these activities as part of its current permit requirements.

Based upon a review of current monitoring practices at landfills, many conventional and nonconventional parameters, as well as several metals, are already being monitored on a routine basis. EPA developed monitoring costs based upon BOD_5 and TSS monitoring 20 times per month and weekly monitoring of ammonia and other toxic and nonconventional pollutants. In general, these frequencies are higher than currently required. Table 9-5 presents the monitoring cost per sample for the landfill facilities.

9.2.6 Off-Site Disposal Costs

EPA evaluated whether it would be more cost effective for small flow facilities to have their landfill wastewater hauled off site and treated at a centralized waste treatment facility, as opposed to on-site treatment. Total annual costs for new or upgraded wastewater treatment facilities were compared to the costs for off-site treatment at a centralized waste treatment facility. Off-site disposal costs were estimated at $0.25 per gallon of wastewater treated. Transportation costs were added to the off-site treatment costs at a rate of $3.00 per loaded mile using an average distance of 250 miles to the treatment facility. Transportation costs were based upon the use of a 5,000-gallon tanker truck load. Facilities that treat their wastewaters off site are considered zero or alternative dischargers and hence do not incur ancillary costs such as residual disposal, monitoring and permit modifications. EPA then used the lower of the two costs either on-site or off-site treatment. Table 9-6 presents the facilities that were costed using off-site treatment.

9.3 Development of Cost Estimates for Individual Treatment Technologies

In Chapter 8, EPA identified and described the wastewater control and treatment technologies used in the Landfills industry and how they were assembled into proposed regulatory options. The following sections describe how EPA developed cost estimates for each of the treatment technologies used in the proposed regulatory options. Specific assumptions regarding the equipment used, flow ranges, input and design parameters, design and cost calculations are discussed for each treatment technology. Table 9-3, previously referenced, presented the method used to estimate costs for each of treatment technologies used in the proposed BPT, BCT, BAT, and PSES options. Table 9-7 presents a summary of the cost estimation techniques used to estimate costs for each treatment technology for the BPT, BCT, BAT, and PSES regulatory options, including the WWC treatment module numbers.

To facilitate the costing of many facilities, capital and O&M cost curves were developed for specific technologies and system components. These curves, which represent cost as a function of flow rate or other system design parameters, were developed using a commercial statistical software package (Slidewrite Plus Version 2.1). First, costs were developed using the WWC model for each technology or component using as a design basis, five different flow rates or other system design parameters (depending upon the governing design parameter). For instance, a technology costed on the basis of flow would have costs estimated using the WWC model at 0.01 million gallons per day (MGD), 0.05 MGD, 0.1 MGD, 0.5 MGD, and 1.0 MGD. Ranges for the five selected points were based upon a review of the flow or technology design parameters for landfill facilities and were selected to bracket the range from low to high. Next, these five data points (flow/design parameter and associated cost) were entered into a commercial statistical software program . Cost curves to model the total capital and O&M costs then were developed by the program using curve fitting routines. A second order natural log equation format was used to develop all curves. All cost curves yielded total capital and O&M costs, unless otherwise noted.

9.3.1 Equalization

EPA conducted a review of questionnaire responses to determine the typical hydraulic detention time for equalization. Based upon of review of industry furnished data, a detention time of 48 hours was selected.

Equalization costs developed for each regulatory option are based on published price quotes for storage tanks. These costs were taken from the 1996 Environmental Restoration Unit Cost Book published by R.S. Means, Inc. A cost curve as a function of flow was developed from these tank quotes. Construction costs were based upon published data for an above ground circular steel tank. Additional costs associated with a wastewater pumping system and diffused aeration to provide sufficient mixing of tank contents to prohibit settling also were included. The capital cost curve developed for equalization is presented as Equation 9-1 and is graphically presented in Figure 9-2.

Capital Costs

$$\ln(Y) = 15.177382 + 1.981547\ln(X) + 0.15768\ln(X)^2 \qquad (9\text{-}1)$$

where:

X = Flow Rate (MGD), and

Y = Capital Cost (1992 $)

The O&M cost for the equation was taken as a function of the capital cost and is based upon 10 percent of the total capital cost per year.

9.3.2 Flocculation

A cost curve was developed for flocculation using the WWC model. WWC unit process 72 was used. Costs for flocculation were a function of flow at a hydraulic detention time of 20 minutes. The capital and O&M cost curves developed for flocculation are presented as Equations 9-2 and 9-3:

Capital Costs

$$\ln(Y) = 11.744579 + 0.633178\ln(X) - 0.015585\ln(X)^2 \qquad (9\text{-}2)$$

O&M Costs

$$\ln(Y) = 8.817304 + 0.533382\ln(X) + 0.002427\ln(X)^2 \qquad (9\text{-}3)$$

where:

X = Flow Rate (MGD), and

Y = Cost (1992 $)

Figures 9-3 and 9-4 graphically present the flocculation capital and O&M cost curves, respectively.

Cost estimates for flocculation basins are based on rectangular-shaped, reinforced concrete structures with a depth of 12 feet and length-to-width ratio of 4:1. Common wall construction was used where the total basin volume exceeded 12,500 cubic feet. Vertical turbine flocculators have higher structural costs than horizontal paddle flocculators because they require structural support above the basin. Horizontal paddles are less expensive and more efficient for use in larger basins, particularly when tapered flocculation is practiced. Manufactured equipment costs are based on a G value 80 (G is the mean temporal velocity gradient that describes the degree of mixing; i.e., the greater the value of G the greater the degree of mixing). Cost estimates for drive units are based on variable speed drives for maximum flexibility, and although common drives for two or more parallel basins are often utilized, the costs are based on individual drives for each basin.

Energy requirements are based on a G value 80 and an overall motor/mechanism efficiency of 60 percent. Labor requirements are based on routine operation and maintenance of 15 minutes/day/basin (maximum basin volume 12,500 cubic ft.) and a 4 hour oil change every 6 months.

9.3.3 Chemical Feed Systems

The following section presents the methodology used to calculate the chemical addition feed rates used with each applicable regulatory option. Table 9-8 is a breakdown of the design process used for each type of chemical feed. Chemical costs were taken from the September 1992 Chemical Marketing Reporter and are presented in Table 9-9.

For facilities with existing chemical precipitation systems, an evaluation was made to determine if the system was achieving the regulatory option long term averages. If the existing system was achieving long term averages, no additional chemical costs were necessary. However, if the facility was not achieving the long term averages for an option, costs were estimated for an upgrade to the chemical precipitation system. First, the stoichiometric requirements were determined to remove each metal pollutant of interest to the long term average level. If the current feed rates were within the calculated feed rates, no additional costs were calculated. For facilities currently feeding less than the calculated amounts, costs were estimated for an upgrade to add additional precipitation chemicals, such as a coagulant, or expand their existing chemical feed system to accommodate larger dosage rates.

Facilities without an installed chemical precipitation system were costed for an entire metals precipitation system. The chemical feed rates used at a particular facility for either an upgrade or a new system were based upon stoichiometric requirements, pH adjustments, and the buffering ability of the raw influent.

In the CWT industry guideline, it was determined that the stoichiometric requirements for chemical addition far outweighed the pH and buffer requirements. EPA determined that 150 percent of the stoichiometric requirement would sufficiently account for pH adjustment and buffering of the solution. An additional 50 percent of the stoichiometric requirement was included to react with metals not on the pollutant of interest list. Finally, an additional 10 percent was added as excess.

<u>Sodium Hydroxide Feed Systems</u>

The stoichiometric requirement for either lime or hydroxide to remove a particular metal is based upon the generic equation:

$$lb_{treatment\ chemical} = \left(\frac{lb_{M\ removed}}{year}\right)\left(\frac{valence_M}{MW_M}\right)\left(\frac{MW_{treatment\ chemical}}{valence_{Na/Ca}}\right)$$

where, M is the target metal and MW is the molecular weight.

The calculated amounts of sodium hydroxide to remove a pound of each of the selected metal pollutants of concern are presented in Table 9-10.

Sodium hydroxide chemical feed system costs were developed for many facilities using the WWC model. Actual facility loadings were used to establish the sodium hydroxide dosage requirement. WWC unit process 45 was used to develop capital and O&M costs for sodium hydroxide feed systems. The capital and O&M cost curves developed for sodium hydroxide feed systems based upon the calculated dosage are presented as Equations 9-4 and 9-5, respectively.

Capital Costs

$$\ln(Y) = 10.653 - 0.184\ln(X) + 0.040\ln(X)^2 \tag{9-4}$$

O&M Costs

$$\ln(Y) = 8.508 - 0.0464\ln(X) + 0.014\ln(X)^2 \tag{9-5}$$

where:

X = Dosage Rate (lb/day), and

Y = Cost (1992 $)

Figures 9-5 and 9-6 graphically present the sodium hydroxide feed system capital and O&M cost curves, respectively.

Cost estimates for a sodium hydroxide feed system estimated using WWC unit process 45 are based on a sodium hydroxide feed rate of between 10 to 10,000 lb/day, with dry sodium hydroxide used at rates less than 200 lb/day, and liquid sodium hydroxide used at higher feed rates.

The WWC model assumes that dry sodium hydroxide (98.9 percent pure) is delivered in drums and mixed to a 10 percent solution on site. A volumetric feeder is used to feed sodium hydroxide to one of two tanks; one for mixing the 10 percent solution, and one for feeding. Two tanks are necessary for this process because of the slow rate of sodium hydroxide addition due to the high heat of solution. Each tank is equipped with a mixer and a dual-head metering pump, used to convey the 10 percent solution to the point of application. Pipe and valving is required to convey water to the dry sodium hydroxide solution mixing tanks and between the metering pumps and the point of application.

A 50 percent sodium hydroxide solution is purchased premixed and delivered by bulk transport for feed rates greater than 200 lb/day. The 50 percent solution contains 6.38 pounds of sodium hydroxide per gallon, that is stored for 15 days in fiberglass reinforced polyester (FRP) tanks. Dual-head metering pumps are used to convey the liquid solution to the point of application, and a standby metering pump is provided in all systems. The storage tanks are located indoors, since 50 percent sodium hydroxide begins to crystallize at temperatures less than 54°F.

Phosphoric Acid Feed Systems

In the Subtitle C Hazardous subcategory, phosphoric acid is necessary to neutralize the waste stream and to provide phosphorus to biological treatment systems.

The phosphoric acid feed system was costed using the WWC unit process 46. The amount of phosphoric acid necessary to provide nutrient phosphorus was determined to be the controlling factor over the amount required for pH adjustment. A ratio of BOD_5 removed to the amount of phosphorus present in the influent waste stream (100 pounds BOD_5 removed to one pound phosphorus) was used to determine the amount of phosphoric acid to be added as a nutrient feed to biological treatment system. To allow for solution buffering, 10 percent excess phosphoric acid was added. The capital and O&M cost curves developed for phosphoric acid feed systems based upon the calculated dosage are presented as Equations 9-6 and 9-7, respectively.

Capital Costs

$$\ln(Y) = 10.042 - 0.155\ln(X) + 0.049\ln(X)^2 \quad (9\text{-}6)$$

O&M Costs

$$\ln(Y) = 7.772 - 0.086\ln(X) + 0.041\ln(X)^2 \quad (9\text{-}7)$$

where:

X = Dosage Rate (gpd), and

Y = Cost (1992 $)

Figures 9-7 and 9-8 graphically present the phosphoric acid feed system capital and O&M cost curves, respectively.

Costs are based on systems capable of metering 93 percent concentrated acid from a storage tank directly to the point of application. For feed rates up to 200 gpd, the concentrated acid is delivered in drums and stored indoors. At higher flow rates, the acid is delivered in bulk and stored outdoors in FRP tanks. Phosphoric acid is stored for 15 days, and a standby metering pump is included for all installations.

Polymer Feed Systems

WWC unit process 34 was used to cost for polymer feed systems based upon a dosage rate of 2 mg/l. Although this module estimates costs for a liquid alum feed system, costs generated by this module were determined to be more reasonable and accurate in developing polymer system costs than the WWC unit process 43 for polymer feed systems. The capital and O&M unloaded cost curves developed for polymer feed systems are presented as Equations 9-8 and 9-9, respectively.

Capital Costs

$$\ln(Y) = 10.539595 - 0.13771\ln(X) + 0.052403\ln(X)^2 \quad (9\text{-}8)$$

O&M Costs

$$\ln(Y) = 9.900596 + 0.99703\ln(X) + 0.00019\ln(X)^2 \quad (9\text{-}9)$$

where:

X = Dosage Rate (lb/hr), and

Y = Cost (1992 $)

Figures 9-9 and 9-10 graphically present the polymer feed system capital and O&M cost curves, respectively.

Polymer is stored for 15 days in fiberglass reinforced polyester tanks. For smaller installations, the tanks are located indoors and left uncovered and for larger installations, the tanks are covered and vented, with insulation and heating provided. Dual-head metering pumps deliver the polymer from the storage tank and meters the flow to the point of application. Feed costs include 150 feet of 316 stainless steel pipe, along with fittings and valves for each metering pump. A standby metering pump is included for each installation.

9.3.4 Primary Clarification

Cost curves were developed for primary clarification using the WWC model. WWC unit process 118 for a rectangular basin with a 12 foot side wall depth was used. Costs for primary clarification were based upon a function of flow at an overflow rate of 900 gallons per day per square feet tank size. The capital and O&M cost curves developed for primary clarification are presented as Equations 9-10 and 9-11, respectively.

Capital Costs

$$\ln(Y) = 12.517967 + 0.575652\ln(X) + 0.009396\ln(X)^2 \qquad (9\text{-}10)$$

O&M Costs

$$\ln(Y) = 10.011664 + 0.268272\ln(X) + 0.00241\ln(X)^2 \qquad (9\text{-}11)$$

where:

X = Flow Rate (MGD), and

Y = Cost (1992 $)

Figures 9-11 and 9-12 graphically present the primary clarification capital and O&M cost curves, respectively.

Estimated costs are based on rectangular basins with a 12 feet side water depth (SWD) and chain and flight sludge collectors. Costs for the structure assumed multiple units with common wall construction and include the chain and flight collector, collector drive mechanism, weirs, the reinforced concrete structure complete with inlet and outlet troughs, a sludge sump, and sludge withdrawal piping. Yard piping to and from the clarifier is not included in the cost estimates.

9.3.5 Activated Sludge Biological Treatment

Costs for biological treatment systems using the activated sludge process were estimated using the WWC unit process 18 for a rectangular aeration basin with an 10 foot SWD. Basin size was determined using a 24 hour hydraulic detention time. Basin volume was calculated using Equation 9-12.

$$X = ((24 \text{ Hours} \times 3600) \times (Z))/1{,}000 \qquad (9\text{-}12)$$

where:

X = Basin Volume (1,000 cu ft)

Z = Flow Rate (cfs)

The WWC model assumes zero O&M costs for the aeration basins only. The unloaded (without engineering cost factors applied) capital cost curve developed for aeration basins with an 10 foot SWD is presented as Equation 9-13.

$$\ln(Y) = -1.033901 + 3.722693\ln(X) - 0.197016\ln(X)^2 \qquad (9\text{-}13)$$

where:

X = Basin Volume (in thousands of cubic feet), and

Y = Capital Cost (1992 $)

Figure 9-13 graphically presents the aeration basin capital cost curve.

Aeration using diffused air was costed for the basin using WWC unit process 26 and actual facility loading conditions. Aeration requirements were calculated using the facility BOD_5 and ammonia loadings and was determined using Equation 9-14.

$$X = ((A + B)/0.075 \times C \times 0.232 \times 1440)/1{,}000 \quad (9\text{-}14)$$

where:

X = Air Requirement (1,000 standard cubic feet per minute [scfm])

A = BOD_5 to Aeration Basin (lb/day) based on 1.8 lb O_2 /lb BOD_5 influent

B = Ammonia to Aeration Basin (lb/day) based on 4.6 lb O_2/lb ammonia influent

C = Transfer Efficiency at 9 percent

The unloaded capital and O&M cost curves developed for air diffusion systems are presented as Equations 9-15 and 9-16, respectively.

Capital Costs

$$\ln(Y) = 11.034417 + 0.992985\ln(X) - 0.002521\ln(X)^2 \quad (9\text{-}15)$$

O&M Costs

$$\ln(Y) = 9.497546 + 0.549715\ln(X) - 0.004216\ln(X)^2 \quad (9\text{-}16)$$

where:

X = Air Requirement (1,000 scfm), and

Y = Cost (1992 $)

Figures 9-14 and 9-15 graphically present the air diffusion system capital and O&M cost curves, respectively.

The costs for aeration basins include all equipment, piping, electrical, and labor for installation. The air supply system costs include piping from air source to aeration basin, blowers, controls, and housing. Aeration basin cost estimates include excavation, concrete walkways, in-basin process piping, and handrails and attendant costs, but excludes the cost of aeration equipment, electrical and instrumentation work. EPA considered providing for heated aeration basins for facilities located in cold weather climates. Based upon data collected by EPA, biological treatment of landfill generated wastewater was not adversely affected by climate conditions.

9.3.6 Secondary Clarification

Cost curves were developed for secondary clarification using the WWC model. WWC unit process 118 for a rectangular basin with a 12 foot side wall depth, and chain and flight collectors was used. Costs for secondary clarification were based upon a function of flow, at an overflow rate of 900 gallons per day per square feet tank size. The capital and O&M cost curves developed for secondary clarification are presented as Equations 9-17 and 9-18, respectively.

Capital Costs

$$\ln(Y) = 12.834601 + 0.688675\ln(X) + 0.035432\ln(X)^2 \qquad (9\text{-}17)$$

O&M Costs

$$\ln(Y) = 10.197762 + 0.339952\ln(X) + 0.015822\ln(X)^2 \qquad (9\text{-}18)$$

where:

X = Flow Rate (MGD), and
Y = Cost (1992 $)

Figures 9-16 and 9-17 graphically present the secondary clarification capital and O&M cost curves, respectively.

Costs for the structure assumed multiple units with common wall construction, and include the chain and flight collector, collector drive mechanism, weirs, the reinforced concrete structure complete with inlet and outlet troughs, a sludge sump, and sludge withdrawal piping. Yard piping to and from the clarifier is not included in the cost estimates.

9.3.7 Multimedia Filtration

Cost curves as a function of flow rate were developed for a multi-media filtration system using vendor supplied quotes. The cost curves were developed as part of the CWT effluent guidelines effort. The capital and O&M cost curves developed for multi-media filtration are presented as Equations 9-19 and 9-20, respectively.

Capital Costs

$$\ln(Y) = 12.265 + 0.658\ln(X) + 0.036\ln(X)^2 \qquad (9\text{-}19)$$

O&M Costs

$$\ln(Y) = 10.851 + 0.168\ln(X) + 0.018\ln(X)^2 \qquad (9\text{-}20)$$

where:

X = Flow Rate (MGD), and

Y = Cost (1992 $)

Figures 9-18 and 9-19 graphically present the multi-media filtration capital and O&M cost curves, respectively.

The total capital costs for the multi-media filtration systems represent equipment and installation costs. The total construction cost includes the costs of the filter, instrumentation and controls, pumps, piping, and installation. The operation and maintenance costs include energy usage, maintenance, labor, and taxes and insurance. Energy costs include electricity to run the pumps, lighting, and instrumentation and controls. The labor requirement for the multi-media filtration system was four hours per day.

9.3.8 Reverse Osmosis

Capital and O&M cost curves as a function of flow rate were developed for reverse osmosis treatment using vendor supplied quotes. Costs were based on one single-pass system using disk tube module technology. The capital cost curve developed for reverse osmosis is presented as Equation 9-21.

$$\ln(Y) = 14.904 - 0.0142\ln(X) - 0.0687\ln(X)^2 \qquad (9\text{-}21)$$

where:

X = Flow Rate (MGD), and

Y = Capital Cost (1992 $)

Figure 9-20 graphically presents the reverse osmosis capital cost curves. Based upon vendor supplied costs, O&M costs were taken at $0.02/gallon.

Costs for a standard reverse osmosis system generally include the following components: filter booster pump, sand or carbon filter, cartridge filter, high-pressure pump and control system, reverse osmosis module permeators, pure water deacidification filter, inbuilt closed circuit cleaning system, automatic pure water membrane flushing system, power and control system with microprocessor, full instrumentation and measurement equipment, comprehensive fail-safe system, fault indication, and modular skid frame construction. The costs did not take into account the following optional equipment: main raw-water supply pump, pure water tank and distribution pump, chlorine dosing system, ultra-violet disinfection system, containerized/mobile systems, self contained power supply, and anti-magnetic systems.

9.3.9 Sludge Dewatering

Costs estimated for sludge dewatering were based upon sludge drying beds. Each facility was costed separately using the WWC unit process 128. Required bed area was based upon influent characteristics at a loading of 15 gallons per day of sludge per square foot bed area. Drying bed area was calculated using Equation 9-22.

$$X = (A \times 365)/B \qquad (9\text{-}22)$$

where:

X = Area (sq ft)

A = Total Dry Solids (lb/day) based on 0.8 lb solids/lb BOD_5 influent

B = 15 lb per year sludge/sq ft

The unloaded capital and O&M cost curves developed for sludge drying beds are presented as Equations 9-23 and 9-24, respectively.

Capital Costs

$$\ln(Y) = 4.488639 + 0.716471\ln(X) + 0.00000531\ln(X)^2 \qquad (9\text{-}23)$$

O&M Costs

$$\ln(Y) = 6.95049 + 0.33155\ln(X) + 0.002882\ln(X)^2 \qquad (9\text{-}24)$$

where:

X = Area (sq ft), and

Y = Cost (1992 \$)

Figures 9-21 and 9-22 graphically present the sludge drying bed capital and O&M cost curves, respectively.

Included in the costs are sludge distribution piping, nine inches of sand media overlying nine inches of gravel media, two foot concrete dividers between beds, and an underdrain system to remove percolating water. Land costs are excluded from the cost estimates.

Energy requirements are based on: a front-end loader to remove dried sludge from the beds and prepare the bed for the next sludge application; cleaning and preparation time of 3 hours for a 4,000 square foot bed; diesel fuel consumption of 4 gallons per hour; and 20 cleanings/bed/year.

9.4 Costs for Regulatory Options

The following sections present the costs estimated for compliance with BPT, BCT, BAT, PSES, NSPS, and PSNS effluent limitations guidelines and standards for the Subtitle D Non-Hazardous and Subtitle C Hazardous subcategories. Costs for each of the regulatory options are presented below for only the facilities in the 308 Questionnaire database, as well as, for all of the facilities in the Landfills industry based on national estimates (see Chapter 3, Section 3.2.1 for an explanation of national estimates). All costs estimates in this section are expressed in terms of 1992 dollars, unless otherwise noted.

9.4.1 BPT Regulatory Costs

Preliminary cost effectiveness analyses were developed by EPA using interim costing rounds to select proposed BPT regulatory options. The BPT costs for each subcategory are presented below.

9.4.1.1 Subtitle D Non-Hazardous Subcategory BPT Costs

Once current discharge and untreated landfill wastewater pollutant concentrations were developed for facilities in the Subtitle D Non-Hazardous subcategory, EPA evaluated two options; BPT Option I and II.

BPT Option I: Equalization and activated sludge biological treatment with sludge dewatering. For the facilities in the 308 Questionnaire database, Table 9-11 presents the total capital ($3,201,715) and annual O&M costs ($927,555) for this option, as well as, the total amortized annual cost for each facility. Based on national estimates, BPT Option I for the Subtitle D Non-Hazardous subcategory is estimated to have total annualized pre-tax and post-tax costs of $5.97 and $5.43 million (based on 1992 dollars), respectively.

BPT Option II: Equalization, activated sludge biological treatment, and multi-media filtration with sludge dewatering. For the facilities in the 308 Questionnaire database, Table 9-12 presents the total capital ($3,801,954) and annual O&M ($1,197,169) costs for this option, as well as, the total amortized annual cost for each facility. Based on national estimates, BPT Option II for the Subtitle D Non-Hazardous subcategory is estimated to have total annualized pre-tax and post-tax costs of $7.73 and $6.85 million (based on 1992 dollars), respectively.

9.4.1.2 Subtitle C Hazardous Subcategory BPT Costs

Once current discharge and untreated landfill wastewater pollutant concentrations were developed for facilities in the Subtitle C Hazardous subcategory, EPA evaluated one BPT option; BPT Option I.

BPT Option I: Equalization, chemical precipitation, and activated sludge biological treatment with sludge dewatering. Since EPA has estimated that there are no direct discharge facilities in the Subtitle C Hazardous subcategory database, there are no costs associated with this option.

9.4.2 BCT Regulatory Costs

Preliminary cost effectiveness analyses were developed by EPA using interim costing rounds to select proposed BCT regulatory options. The BCT costs for each subcategory are presented below.

9.4.2.1 Subtitle D Non-Hazardous Subcategory BCT Costs

Once current discharge and untreated landfill wastewater pollutant concentrations were developed for facilities in the Subtitle D Non-Hazardous subcategory, EPA evaluated two options; BCT Option I and II.

BCT Option I: Equalization and activated sludge biological treatment with sludge dewatering. This option is equivalent to BPT Option I for the Non-Hazardous subcategory with costs previously provided in Section 9.4.1.1 above.

BCT Option II: Equalization, activated sludge biological treatment, and multi-media filtration with sludge dewatering. This option is equivalent to BPT Option II for the Non-Hazardous subcategory with costs previously provided in Section 9.4.1.1 above.

9.4.2.2 Subtitle C Hazardous Subcategory BCT Costs

Once current discharge and untreated landfill wastewater pollutant concentrations were developed for facilities in the Subtitle C Hazardous subcategory, EPA evaluated one option; BCT Option I.

BCT Option I: Equalization, chemical precipitation, and activated sludge biological treatment with sludge dewatering. This option is equivalent to BPT Option I for the Subtitle C Hazardous subcategory, and therefore, has no associated costs.

9.4.3 BAT Regulatory Costs

Preliminary cost effectiveness analyses were developed by EPA using interim costing rounds to select proposed BAT regulatory options. The BAT costs for each subcategory are presented below.

9.4.3.1 Subtitle D Non-Hazardous Subcategory BAT Costs

EPA costed three BAT options for the Subtitle D Non-Hazardous subcategory; BAT Options I, II and III.

BAT Option I: Equalization and activated sludge biological treatment with sludge dewatering. This option is equivalent to BPT Option I for the Non-Hazardous subcategory with costs previously provided in Section 9.4.1.1 above.

BAT Option II: Equalization, activated sludge biological treatment, and multi-media filtration with sludge dewatering. This option is equivalent to BPT Option II for the Non-Hazardous subcategory with costs previously provided in Section 9.4.1.1 above.

BAT Option III: Equalization, activated sludge biological treatment, multi-media filtration, and reverse osmosis with sludge dewatering. For facilities in the 308 Questionnaire database, Table 9-13 presents the total capital ($38,952,560) and annual O&M ($6,481,452) costs for this option, as well as, the total amortized annual cost for each facility. Based on national estimates, BAT Option III for the Subtitle D Non-Hazardous subcategory is estimated to have a total annualized post-tax cost of $29.16 million (based on 1992 dollars). For comparison with other regulations for other industries, the total annualized pre-tax cost for this option is estimated at $21.97 million (based on 1981 dollars).

9.4.3.2 Subtitle C Hazardous Subcategory BAT Costs

Once current discharge and untreated landfill wastewater pollutant concentrations were developed for facilities in the Subtitle C Hazardous subcategory, EPA evaluated one BAT option; BPT Option I.

BAT Option I: Equalization, chemical precipitation, and activated sludge biological treatment with sludge dewatering. This option is equivalent to BPT Option I for the Hazardous subcategory, and therefore has no associated costs.

9.4.4 PSES Regulatory Costs

Preliminary cost effectiveness analyses were developed by EPA using interim costing rounds to select proposed PSES regulatory options. The PSES costs for each subcategory are presented below.

9.4.4.1 Subtitle D Non-Hazardous Subcategory PSES Costs

EPA estimates compliance costs for facilities in the Subtitle D Non-Hazardous subcategory for one PSES option; PSES Option I.

PSES Option I: Equalization and activated sludge biological treatment with sludge dewatering. For facilities in the 308 Questionnaire database, Table 9-14 presents the total capital ($11,764,213) and annual O&M ($1,957,211) costs for this option, as well as, the total amortized annual cost for each facility. Based on national estimates, the cost for this PSES option is estimated at $28.2 million (based on 1992 dollars).

9.4.4.2 Subtitle C Hazardous Subcategory PSES Costs

For the Subtitle C Hazardous subcategory, EPA evaluated one PSES option; PSES Option I.

PSES Option I: Equalization, chemical precipitation, and activated sludge biological treatment with sludge dewatering. All of the landfills in the Hazardous subcategory which indirectly discharge their wastewaters in EPA's survey of the industry are expected to be in compliance with the baseline treatment standards established for indirect dischargers. Therefore, EPA has projected that there will be no costs associated with compliance for the proposed PSES regulation for this subcategory.

9.4.5 NSPS Regulatory Costs

Preliminary cost effectiveness analyses were developed by EPA using interim costing rounds to select proposed NSPS regulatory options. The NSPS costs for each subcategory are presented below.

9.4.5.1 Subtitle D Non-Hazardous Subcategory NSPS Costs

EPA is proposing NSPS for the Subtitle D Non-Hazardous subcategory to be equivalent to the limitations proposed for BPT Option II for this subcategory, which also is the basis for BCT, BAT, and PSES Option II.

NSPS: Equalization, activated sludge biological treatment and multi-media filtration with sludge dewatering. The total NSPS annual cost for the Non-Hazardous subcategory is $49,600 assuming an average facility flow of 10,000 gpd.

9.4.5.2 Subtitle C Hazardous Subcategory NSPS Costs

EPA is proposing NSPS for the Subtitle C Hazardous subcategory to be equivalent to the limitations proposed for BPT Option I for this subcategory, which also is the basis for BCT, BAT, and PSES Option I.

NSPS: Equalization, chemical precipitation, and activated sludge biological treatment with sludge dewatering. The total NSPS annual cost for the Hazardous subcategory is $152,700 assuming an average facility flow of 10,000 gpd.

9.4.6 PSNS Regulatory Costs

Preliminary cost effectiveness analyses were developed by EPA using interim costing rounds to select proposed PSNS regulatory options. The PSNS costs for each subcategory are provided below.

9.4.6.1 Subtitle D Non-Hazardous Subcategory PSNS Costs

Since EPA is not proposing PSNS standards for Subtitle D Non-Hazardous subcategory, there are no costs associated with this requirement.

9.4.6.2 Subtitle C Hazardous Subcategory PSNS Costs

EPA is proposing PSNS for the Subtitle C Hazardous subcategory to be equivalent to the limitations proposed for BPT Option I for this subcategory, which also is the basis for BCT, BAT, and PSES Option I.

PSNS: Equalization, chemical precipitation, and activated sludge biological treatment with sludge dewatering. The total PSNS annual cost for the Hazardous subcategory is $141,400 assuming an average facility flow of 5,600 gpd.

Table 9-1: Cost Comparison

Facility QID	Treatment Train	CAPDET Computer Run		WWC Engineering Software		Vendor Quotes		Questionnaire Responses	
		Capital Cost 1992	O&M Costs	Capital Cost 1992	O&M Costs	Capital Cost 1992	O&M Costs	Capital Cost 1992	O&M Costs
16122	Chemical Precipitation	$232,366	$178,773	$190,308	$41,883	$177,504	$163,397	NA	$22,858
	Above+Anaerobic&Aerobic Bio	$1,217,370	$353,181	$836,433	$79,898	$794,343	$305,669	NA	$133,314
	Above+2nd Chemical Precipitation	$1,449,732	$587,637	$908,201	$91,295	$971,847	$469,066	NA	$133,872
	Above+Equalization+Multimedia Filter	$1,517,811	$715,088	$1,573,621	$91,295	$1,553,010	$543,840	NA	$133,872
	Equalization	$58,478	$69,475	$692,252	$1,997	$526,532	$36,442	NA	$3,388
	Entire Treatment Train	$1,576,289	$784,563	$2,782,188	$317,747	$2,154,117	$586,240	$4,113,628	$311,400
16125	Equalization+Air Stripping	$57,717	$61,556	$394,570	$20,718	$243,800	$54,147	$588,714	$8,247
	Chemical Precipitation+SBR	$282,073	$255,294	$1,928,245	$103,100	(a)	(a)	$2,067,188	$31,534
	Above+Carbon+Multimedia Filter	$478,266	$460,622	$2,492,431	$145,949	(b)	(b)	$2,534,242	$34,883
16087	Entire Treatment Train	NA	NA	$2,519,307	$816,351	(c)	(c)	$2,423,057	$992,578
16041	SBR+Sludge Equipment	$159,908	$115,066	$2,378,898	$436,879	NA	NA	$6,293,919	$460,050

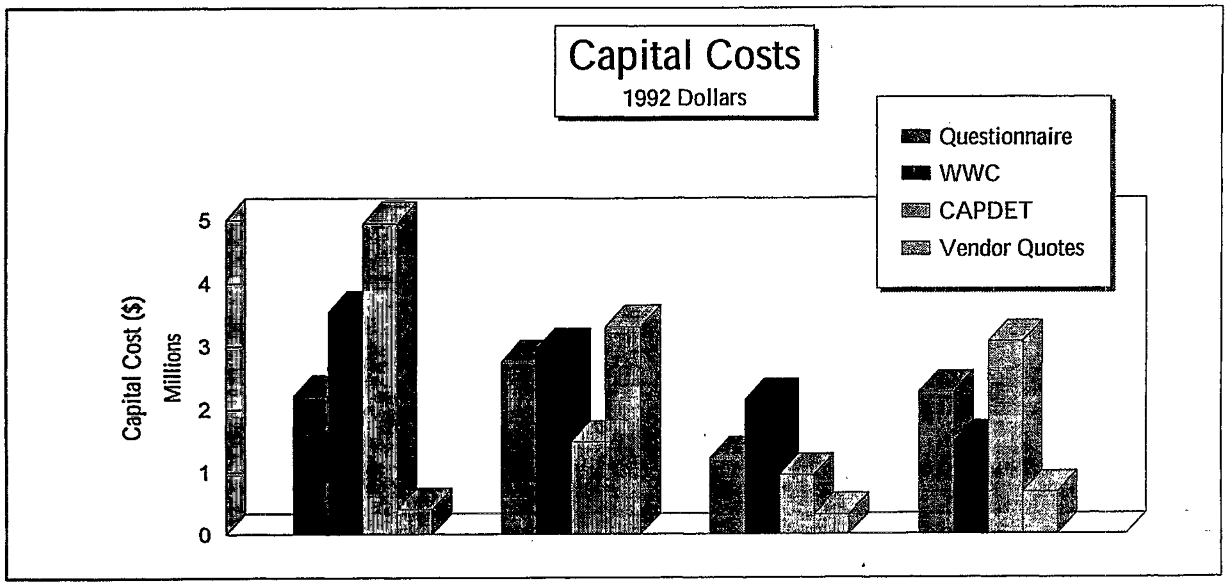
NA: Not Available

(a): capital O&M costs without the SBR are $82,675 and $56,972, respectively

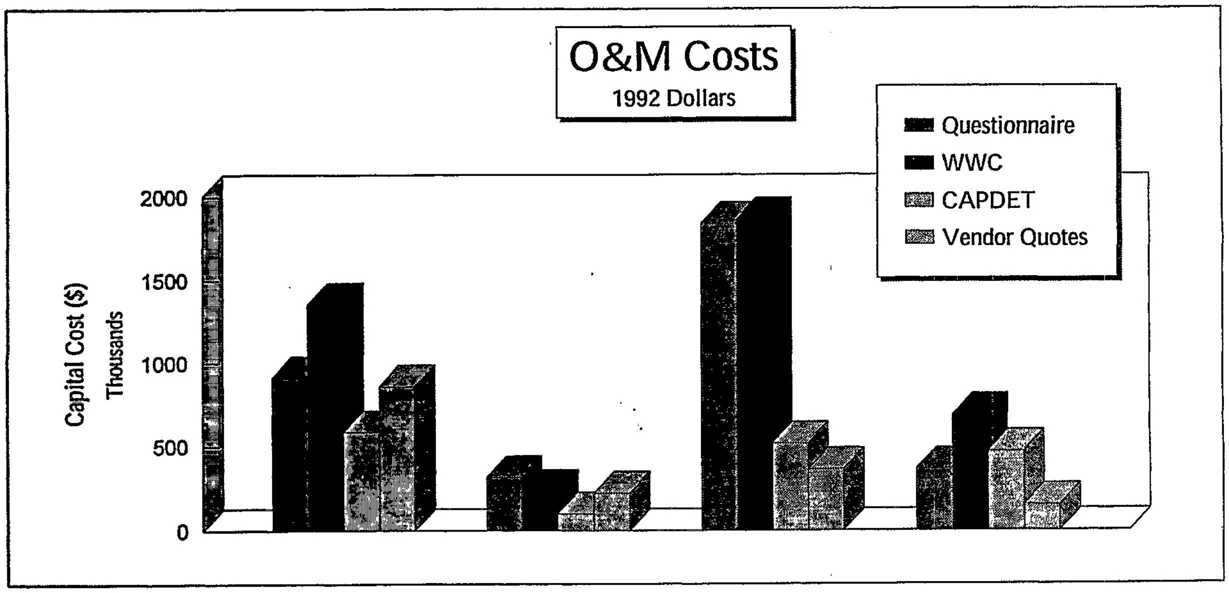
(b): capital O&M costs without the SBR are $140,078 and $106,642, respectively

(c): capital O&M costs without the activated sludge system and chlorine addition are $189,120 and $100,849, respectively

Table 9-2. Costing Source Comparison



	Chem Precip	Chem Precip and Filtration	Chem Precip	2-stage Chem Precip
Questionnaire	2,206,980	2,751,204	1,214,563	2,265,009
WWC	3,543,264	2,950,035	2,144,446	1,476,821
CAPDET	4,948,779	1,475,480	942,216	3,072,253
Vendor Quotes	399,878	3,314,930	319,206	670,158



	Chem Precip	Chem Precip and Filtration	Chem Precip	2-stage Chem Precip
Questionnaire	910,000	315,000	1,837,000	363,000
WWC	1,355,505	231,728	1,864,219	686,360
CAPDET	585,855	99,036	515,859	466,848
Vendor Quotes	860,867	222,135	361,623	151,889

Table 9-3: Breakdown of Costing Method by Treatment Technology

Treatment Technology	Cost Using WWC Program	Cost Using Vendor Quotes	Key Design Parameter(s)
Equalization		X(a)	Flow rate
Flocculation	X		Flow rate
Chemical Feed System	X		Flow rate & Pollutant of Interest Metals
Primary & Secondary Clarification	X		Flow rate
Activated Sludge	X		Flow rate, BOD_5, & Ammonia
Reverse Osmosis		X	Flow rate
Multimedia Filtration		X(b)	Flow rate
Sludge Drying Beds	X		Flow rate, TSS & BOD_5

(a) Based upon costs provided in Environmental Restoration Unit Cost Book

(b) Cost curves developed using vendor quotes in the CWT guideline effort

Table 9-4: Additional Cost Factors

Type	Factor	Percent of Capital Cost
Capital	Site Work & Interface Piping	18
	General Contractor Overhead	10
	Engineering	12
	Instrumentation & Controls	13
	Buildings	6
	Site Improvements	10
	Legal, Fiscal, & Administrative	2
	Interest During Construction	9
	Contingency	8
	Retrofit (if necessary)	20
O&M	Taxes & Insurance	2[1]

(1) 2 percent of total capital costs, which includes WWC costs and capital costs listed above.

Table 9-5: Analytical Monitoring Costs

Pollutants	Cost/Sample ($)[1]
Subtitle D Non-Hazardous	
Ammonia as N	18.00
BOD_5	15.00
TSS	6.00
Metals & Organics	105.00
Subtitle C Hazardous	
Ammonia as N	18.00
BOD_5	15.00
TSS	6.00
Metals & Volatile/Semi-Volatile Organics	1600.00

Notes:

(1) Cost based on 1995 analytical laboratory costs adjusted to 1992 dollars.

Table 9-6: Subtitle D Non-Hazardous Facilities Costed for Off-Site Disposal

Facility QID	Flow (gpd)	Off-Site Disposal Cost ($/yr)
16048	5	730
16055	8	1168
16062	50	7300
16139	50	7300
16148	77	11242
16160	137	20002
16250	200	29200

Table 9-7: Unit Process Breakdown by Regulatory Option

Treatment Technology Description	Subcategory		WWC Unit Process #*	WWC Unit Process # Description
	Non-Hazardous	Hazardous		
Equalization & activated sludge	BPT/BCT/BAT/ PSES/PSNS Option I		NA	equalization
			18	aeration basin
			26	aeration system
			118	secondary clarification
			128	sludge dewatering
Equalization, activated sludge & multimedia filtration	BPT/BCT/BAT/ Option II NSPS		NA	equalization
			18	aeration basin
			26	aeration system
			118	secondary clarification
			NA	multi-media filtration
			128	sludge dewatering
Equalization, activated sludge, multimedia filtration & single-stage reverse osmosis	BAT Option III		NA	equalization
			18	aeration basin
			26	aeration system
			118	secondary clarification
			NA	multi-media filtration
			NA	single-stage reverse osmosis
			128	sludge dewatering
Equalization, chemical precipitation & activated sludge		BPT/BCT/BAT/ PSES Option I NSPS & PSNS	NA	equalization
			72	flocculation tank
			45	sodium hydroxide feed system
			34	polymer feed system
			118	primary clarification
			46	phosphoric acid feed system
			18	aeration basin
			26	aeration system
			118	secondary clarification
			128	sludge dewatering

*NA=Not Applicable-Vendor Quotes Used

Table 9-8: Chemical Addition Design Method

Chemical	Basis for Design	
	Stoichiometry	Reference[1] (mg/L)
Sodium Hydroxide	X	
Polymer		2.0
Phosphoric Acid	X	

(1) From: Industrial Water Pollution Control, 2nd Edition.

Table 9-9: Treatment Chemical Costs

Treatment Chemical	Cost
Sodium Hydroxide	$350/ton
Polymer	$2.25/lb
Phosphoric Acid	$300/ton

Table 9-10: Sodium Hydroxide Requirements for Chemical Precipitation

Pollutant	Dosage Rate Sodium Hydroxide (lb/lb metal removed)
Cadmium	0.71
Chromium, total	2.31
Iron	2.15
Nickel	2.04
Zinc	1.22
Phosphorus	6.46

Table 9-11 - BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16001	0.0793	153,015	2,004	31,004	0	0	186,023	20,424
16003	0.004715	0	0	0	0	0	0	0
16009	0.01613	0	0	0	0	0	0	0
16011	0	0	0	0	0	0	0	0
16012	0.002205	0	0	0	0	0	0	0
16013	0.015	0	0	0	0	0	0	0
16014	0	0	0	0	0	0	0	0
16015	0.0005	0	0	0	0	0	0	0
16016	0.002304	0	0	0	0	0	0	0
16020	0.045814	0	0	0	0	0	0	0
16023	0.057344	0	0	0	0	0	0	0
16024	0.005918	61,218	2,004	12,644	0	0	75,866	8,330
16025	0	0	0	0	0	0	0	0
16026	0	0	0	0	0	0	0	0
16027	0	0	0	0	0	0	0	0
16028	0.01985	0	0	0	0	0	0	0
16029	0.025	0	0	0	0	0	0	0
16033	0.0091	0	0	0	0	0	0	0
16035	0	0	0	0	0	0	0	0
16038	0.008219	55,167	2,004	0	0	0	57,171	6,277
16039	0.00178	0	0	0	0	0	0	0
16043	0.002177	46,342	2,004	0	0	0	48,346	5,308
16046	0	0	0	0	0	0	0	0
16047	0.001148	38,175	2,004	0	0	0	40,179	4,411
16048	5.0E-06	0	0	0	0	0	0	0
16049	0.0017	35,037	2,004	7,408	0	0	44,449	4,880
16050	0.01	58,533	2,004	0	0	0	60,537	6,647
16052	0.0546	217,678	5,563	44,648	0	0	267,889	29,413
16053	0.00124	39,625	2,004	0	0	0	41,629	4,571
16054	0.00075	16,544	2,004	3,710	0	0	22,258	2,444
16055	8.0E-06	0	0	0	0	0	0	0
16056	0.001367	40,636	2,004	0	0	0	42,640	4,682
16058	0.003	44,348	2,004	9,270	0	0	55,622	6,107
16059	0.0011	38,017	2,004	0	0	0	40,021	4,394
16060	0.0018	43,919	2,004	0	0	0	45,923	5,042

Table 9-11 - BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16061	0	0	0	0	0	0	0	0
16062	0.00005	0	0	0	0	0	0	0
16063	0.0067	75,309	2,004	0	0	0	77,313	8,489
16064	0.011967	62,083	2,004	0	0	0	64,087	7,036
16065	0.008	71,448	2,004	14,690	0	0	88,143	9,678
16070	0.001328	0	0	0	0	0	0	0
16071	0.006	0	0	0	0	0	0	0
16073	0.0182	0	0	0	0	0	0	0
16074	0	0	0	0	0	0	0	0
16075	0.010209	58,917	2,004	0	0	0	60,922	6,689
16076	0	0	0	0	0	0	0	0
16077	0.00816	0	0	0	0	0	0	0
16078	0.00499	0	0	0	0	0	0	0
16079	0.112474	344,770	0	68,954	0	0	413,724	45,425
16083	0.001	29,000	2,004	6,201	0	0	37,205	4,085
16084	0.006427	0	0	0	0	0	0	0
16085	0.03	0	0	0	0	0	0	0
16088	0.03621	0	0	0	0	0	0	0
16090	0.003929	0	0	0	0	0	0	0
16091	0.232098	0	0	0	0	0	0	0
16092	0.006682	0	0	0	0	0	0	0
16093	0.081575	222,598	0	44,520	0	0	267,118	29,328
16097	0.019	0	0	0	0	0	0	0
16098	0	0	0	0	0	0	0	0
16099	0.01533	0	0	0	0	0	0	0
16102	0.01394	110,824	0	22,165	0	0	132,989	14,602
16103	0.037558	0	0	0	0	0	0	0
16107	0.001286	0	0	0	0	0	0	0
16109	0.050559	0	0	0	0	0	0	0
16111	0.0072	53,157	2,004	0	0	0	55,161	6,056
16113	0	0	0	0	0	0	0	0
16114	0.00864	0	0	0	0	0	0	0
16115	0.004071	0	0	0	0	0	0	0
16116	0.0042	0	0	0	0	0	0	0
16117	0.04	0	0	0	0	0	0	0

Table 9-11 - BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16118	0.0288	0	0	0	0	0	0	0
16119	0.007288	0	0	0	0	0	0	0
16120	0.042775	0	0	0	0	0	0	0
16121	0.080284	0	0	0	0	0	0	0
16122	0.0255	0	0	0	0	0	0	0
16123	0.04608	206,903	8,080	42,997	0	0	257,980	28,325
16124	0.016662	129,217	14,551	0	0	0	143,768	15,785
16125	0.014193	0	0	0	0	0	0	0
16127	0.003627	48,545	2,004	10,110	0	0	60,659	6,660
16128	0.003963	0	0	0	0	0	0	0
16129	0.00469	0	0	0	0	0	0	0
16130	0.0003	0	0	0	0	0	0	0
16131	0.03	0	0	0	0	0	0	0
16132	0.03	0	0	0	0	0	0	0
16135	0.011487	0	0	0	0	0	0	0
16137	0	0	0	0	0	0	0	0
16139	0.00005	0	0	0	0	0	0	0
16148	0.000077	0	0	0	0	0	0	0
16149	0	0	0	0	0	0	0	0
16150	0.045778	0	0	0	0	0	0	0
16151	0.002049	0	0	0	0	0	0	0
16152	0	0	0	0	0	0	0	0
16153	0.008	0	0	0	0	0	0	0
16154	0.010224	0	0	0	0	0	0	0
16155	0.00831	0	0	0	0	0	0	0
16156	0.173	0	0	0	0	0	0	0
16158	0.014275	0	0	0	0	0	0	0
16159	0.225	0	0	0	0	0	0	0
16160	0.000137	0	0	0	0	0	0	0
16161	0.053	0	0	0	0	0	0	0
16162	0.0009	0	0	0	0	0	0	0
16163	0	0	0	0	0	0	0	0
16164	0.01	0	0	0	0	0	0	0
16165	0.030218	0	0	0	0	0	0	0
16166	0.003416	0	0	0	0	0	0	0

Table 9-11 - BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16170	0.0048	55,201	2,004	11,441	0	0	68,647	7,537
16171	0.024	0	0	0	0	0	0	0
16173	0.025	0	0	0	0	0	0	0
16174	0.0072	0	0	0	0	0	0	0
16175	0	0	0	0	0	0	0	0
16176	0.037272	0	0	0	0	0	0	0
16177	0	0	0	0	0	0	0	0
16180	0	0	0	0	0	0	0	0
16185	0	0	0	0	0	0	0	0
16186	0.00304	0	0	0	0	0	0	0
16187	0.003	0	0	0	0	0	0	0
16189	0	0	0	0	0	0	0	0
16191	0	0	0	0	0	0	0	0
16193	0.002303	0	0	0	0	0	0	0
16196	0.012233	108,110	11,645	0	0	0	119,755	13,148
16199	0.0008	0	0	0	0	0	0	0
16200	0.011416	0	0	0	0	0	0	0
16201	0.001881	0	0	0	0	0	0	0
16202	0.013007	0	0	0	0	0	0	0
16203	0.02	0	0	0	0	0	0	0
16204	0	0	0	0	0	0	0	0
16205	0	0	0	0	0	0	0	0
16206	0.057389	0	0	0	0	0	0	0
16208	0.003342	0	0	0	0	0	0	0
16211	0.15	0	0	0	0	0	0	0
16212	0.0007	33,574	2,004	0	0	0	35,578	3,906
16215	0	0	0	0	0	0	0	0
16217	0	0	0	0	0	0	0	0
16219	0.025438	0	0	0	0	0	0	0
16220	0.030405	0	0	0	0	0	0	0
16221	0.006616	0	0	0	0	0	0	0
16222	0.01548	0	0	0	0	0	0	0
16223	0.029041	178,211	7,768	0	0	0	185,979	20,419
16224	0	0	0	0	0	0	0	0
16225	0.031	0	0	0	0	0	0	0

Table 9-11 - BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16228	0.000719	0	0	0	0	0	0	0
16230	0	0	0	0	0	0	0	0
16233	0.0097	94,269	9,868	0	0	0	104,137	11,434
16234	0.030827	0	0	0	0	0	0	0
16236	0.005946	0	0	0	0	0	0	0
16239	0	0	0	0	0	0	0	0
16240	0.005597	0	0	0	0	0	0	0
16241	0	0	0	0	0	0	0	0
16242	0.0005	0	0	0	0	0	0	0
16245	0	0	0	0	0	0	0	0
16246	0.001353	0	0	0	0	0	0	0
16248	0.01	0	0	0	0	0	0	0
16249	0	0	0	0	0	0	0	0
16250	0.0002	0	0	0	0	0	0	0
16251	0.0007	0	0	0	0	0	0	0
16252	0.005	0	0	0	0	0	0	0
16253	0.01776	0	0	0	0	0	0	0
TOTALS	2.694	2,770,390	101,563	329,762	0	0	3,201,715	351,531

(a) Amortization assuming 7% interest over 15 year period.

Table 9-11 - BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory (Cont'd)

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16001	0.0793	19,637	4,078	11,540	35,255	55,679
16003	0.004715	0	0	0	0	0
16009	0.01613	0	0	0	0	0
16011	0	0	0	0	0	0
16012	0.002205	0	0	0	0	0
16013	0.015	0	0	0	0	0
16014	0	0	0	0	0	0
16015	0.0005	0	0	0	0	0
16016	0.002304	0	0	0	0	0
16020	0.045814	0	0	0	0	0
16023	0.057344	0	0	0	0	0
16024	0.005918	9,934	3,377	11,540	24,851	33,181
16025	0	0	0	0	0	0
16026	0	0	0	0	0	0
16027	0	0	0	0	0	0
16028	0.01985	0	0	0	0	0
16029	0.025	0	0	0	0	0
16033	0.0091	0	0	0	0	0
16035	0	0	0	0	0	0
16038	0.008219	11,226	1,516	9,876	22,618	28,895
16039	0.00178	0	0	0	0	0
16043	0.002177	9,333	3,173	10,500	23,006	28,314
16046	0	0	0	0	0	0
16047	0.001148	8,760	1,917	11,540	22,217	26,628
16048	5.0000E-06	0	0	0	0	730
16049	0.0017	8,302	2,208	11,540	22,050	26,930
16050	0.01	11,672	1,917	11,540	25,129	31,776
16052	0.0546	17,799	6,897	11,072	35,768	65,180

Table 9-11 - BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory (Cont'd)

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16053	0.00124	9,002	1,917	11,540	22,459	27,030
16054	0.00075	5,276	1,917	11,357	18,550	20,994
16055	8.0000E-06	0	0	0	0	1,168
16056	0.001367	8,921	1,917	11,540	22,378	27,060
16058	0.003	8,936	1,917	0	10,853	16,960
16059	0.0011	8,730	1,917	11,540	22,187	26,581
16060	0.0018	9,178	2,208	11,540	22,926	27,968
16061	0	0	0	0	0	0
16062	0.00005	0	0	0	0	7,300
16063	0.0067	11,152	3,562	11,540	26,254	34,742
16064	0.011967	12,127	3,931	11,540	27,598	34,634
16065	0.008	10,481	3,231	11,090	24,802	34,480
16070	0.001328	0	0	0	0	0
16071	0.006	0	0	0	0	0
16073	0.0182	0	0	0	0	0
16074	0	0	0	0	0	0
16075	0.010209	11,672	1,516	10,500	23,688	30,377
16076	0	0	0	0	0	0
16077	0.00816	0	0	0	0	0
16078	0.00499	0	0	0	0	0
16079	0.112474	23,219	0	11,180	34,399	79,824
16083	0.001	7,835	1,735	11,540	21,110	25,195
16084	0.006427	0	0	0	0	0
16085	0.03	0	0	0	0	0
16088	0.03621	0	0	0	0	0
16090	0.003929	0	0	0	0	0
16091	0.232098	0	0	0	0	0
16092	0.006682	0	0	0	0	0

Table 9-11 - BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory (Cont'd)

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16093	0.081575	30,361	0	11,180	41,541	70,869
16097	0.019	0	0	10,520	10,520	10,520
16098	0	0	0	0	0	0
16099	0.01533	0	0	0	0	0
16102	0.01394	13,163	0	11,540	24,703	39,304
16103	0.037558	0	0	0	0	0
16107	0.001286	0	0	0	0	0
16109	0.050559	0	0	0	0	0
16111	0.0072	10,980	1,516	10,500	22,996	29,052
16113	0	0	0	0	0	0
16114	0.00864	0	0	0	0	0
16115	0.004071	0	0	0	0	0
16116	0.0042	0	0	0	0	0
16117	0.04	0	0	9,908	9,908	9,908
16118	0.0288	0	0	0	0	0
16119	0.007288	0	0	11,117	11,117	11,117
16120	0.042775	0	0	9,200	9,200	9,200
16121	0.080284	0	0	0	0	0
16122	0.0255	0	0	9,948	9,948	9,948
16123	0.04608	19,430	8,365	11,540	39,335	67,660
16124	0.016662	15,985	11,381	11,540	38,906	54,691
16125	0.014193	0	0	10,712	10,712	10,712
16127	0.003627	9,190	2,756	11,540	23,486	30,146
16128	0.003963	0	0	0	0	0
16129	0.00469	0	0	11,540	11,540	11,540
16130	0.0003	0	0	11,540	11,540	11,540
16131	0.03	0	0	0	0	0
16132	0.03	0	0	0	0	0

Table 9-11 - BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory (Cont'd)

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16135	0.011487	0	0	0	0	0
16137	0	0	0	0	0	0
16139	0.00005	0	0	0	0	0
16148	0.000077	0	0	0	0	0
16149	0	0	0	0	0	0
16150	0.045778	0	0	0	0	0
16151	0.002049	0	0	0	0	0
16152	0	0	0	0	0	0
16153	0.008	0	0	0	0	0
16154	0.010224	0	0	0	0	0
16155	0.00831	0	0	0	0	0
16156	0.173	0	0	0	0	0
16158	0.014275	0	0	0	0	0
16159	0.225	0	0	0	0	0
16160	0.000137	0	0	0	0	0
16161	0.053	0	0	0	0	0
16162	0.0009	0	0	0	0	0
16163	0	0	0	0	0	0
16164	0.01	0	0	0	0	0
16165	0.030218	0	0	0	0	0
16166	0.003416	0	0	0	0	0
16170	0.0048	9,594	4,078	11,235	24,907	32,444
16171	0.024	0	0	0	0	0
16173	0.025	0	0	0	0	0
16174	0.0072	0	0	0	0	0
16175	0	0	0	0	0	0
16176	0.037272	0	0	0	0	0
16177	0	0	0	0	0	0

Table 9-11 - BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory (Cont'd)

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16180	0	0	0	0	0	0
16185	0	0	0	0	0	0
16186	0.00304	0	0	0	0	0
16187	0.003	0	0	0	0	0
16189	0	0	0	0	0	0
16191	0	0	0	0	0	0
16193	0.002303	0	0	0	0	0
16196	0.012233	14,487	10,115	11,540	36,142	49,290
16199	0.0008	0	0	0	0	0
16200	0.011416	0	0	0	0	0
16201	0.001881	0	0	0	0	0
16202	0.013007	0	0	0	0	0
16203	0.02	0	0	0	0	0
16204	0	0	0	0	0	0
16205	0	0	0	0	0	0
16206	0.057389	0	0	0	0	0
16208	0.003342	0	0	0	0	0
16211	0.15	0	0	0	0	0
16212	0.0007	8,386	1,516	10,500	20,402	24,308
16215	0	0	0	0	0	0
16217	0	0	0	0	0	0
16219	0.025438	0	0	0	0	0
16220	0.030405	0	0	0	0	0
16221	0.006616	0	0	0	0	0
16222	0.01548	0	0	0	0	0
16223	0.029041	18,591	8,212	10,500	37,303	57,723
16224	0	0	0	0	0	0
16225	0.031	0	0	0	0	0

Table 9-11 - BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory (Cont'd)

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16228	0.000719	0	0	0	0	0
16230	0	0	0	0	0	0
16233	0.0097	13,366	9,277	11,540	34,183	45,617
16234	0.030827	0	0	0	0	0
16236	0.005946	0	0	0	0	0
16239	0	0	0	0	0	0
16240	0.005597	0	0	0	0	0
16241	0	0	0	0	0	0
16242	0.0005	0	0	0	0	0
16245	0	0	0	0	0	0
16246	0.001353	0	0	0	0	0
16248	0.01	0	0	0	0	0
16249	0	0	0	0	0	0
16250	0.0002	0	0	0	0	0
16251	0.0007	0	0	0	0	0
16252	0.005	0	0	0	0	0
16253	0.01776	0	0	11,068	11,068	11,068
TOTALS	2.694	386,724	108,068	432,763	927,555	1,288,284

(b) Off-site disposal costs used for low flow facilities 16048, 16055, and 16062

Table 9-12 - BPT/BCT/BAT Option II Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16001	0.0793	203,456	2,004	41,092	0	0	246,552	27,070
16003	0.004715	0	0	0	0	0	0	0
16009	0.01613	0	0	0	0	0	0	0
16011	0	0	0	0	0	0	0	0
16012	0.002205	0	0	0	0	0	0	0
16013	0.015	0	0	0	0	0	0	0
16014	0	0	0	0	0	0	0	0
16015	0.0005	0	0	0	0	0	0	0
16016	0.002304	0	0	0	0	0	0	0
16020	0.045814	0	0	0	0	0	0	0
16023	0.057344	0	0	0	0	0	0	0
16024	0.005918	79,930	2,004	16,387	0	0	98,321	10,795
16025	0	0	0	0	0	0	0	0
16026	0	0	0	0	0	0	0	0
16027	0	0	0	0	0	0	0	0
16028	0.01985	0	0	0	0	0	0	0
16029	0.025	0	0	0	0	0	0	0
16033	0.0091	0	0	0	0	0	0	0
16035	0	0	0	0	0	0	0	0
16038	0.008219	75,820	2,004	0	0	0	77,824	8,545
16039	0.00178	0	0	0	0	0	0	0
16043	0.002177	60,876	2,004	0	0	0	62,880	6,904
16046	0	0	0	0	0	0	0	0
16047	0.001148	51,650	2,004	0	0	0	53,654	5,891
16048	5.0000E-06	0	0	0	0	0	0	0
16049	0.0017	48,843	2,004	10,169	0	0	61,017	6,699
16050	0.01	58,533	2,004	0	0	0	60,537	6,647
16052	0.0546	217,678	5,563	44,648	0	0	267,889	29,413
16053	0.00124	39,625	2,004	0	0	0	41,629	4,571
16054	0.00075	30,019	2,004	6,405	0	0	38,427	4,219
16055	8.0000E-06	0	0	0	0	0	0	0
16056	0.001367	54,111	2,004	0	0	0	56,115	6,161
16058	0.003	44,348	2,004	9,270	0	0	55,622	6,107
16059	0.0011	51,492	2,004	0	0	0	53,496	5,874
16060	0.0018	57,885	2,004	0	0	0	59,889	6,575
16061	0	0	0	0	0	0	0	0
16062	0.00005	0	0	0	0	0	0	0
16063	0.0067	94,714	2,004	0	0	0	96,718	10,619
16064	0.011967	62,083	2,004	0	0	0	64,087	7,036

Table 9-12 - BPT/BCT/BAT Option II Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16065	0.008	91,929	2,004	18,787	0	0	112,719	12,376
16070	0.001328	0	0	0	0	0	0	0
16071	0.006	0	0	0	0	0	0	0
16073	0.0182	0	0	0	0	0	0	0
16074	0	0	0	0	0	0	0	0
16075	0.010209	81,055	2,004	0	0	0	83,059	9,119
16076	0	0	0	0	0	0	0	0
16077	0.00816	0	0	0	0	0	0	0
16078	0.00499	0	0	0	0	0	0	0
16079	0.112474	356,066	0	71,213	0	0	427,279	46,913
16083	0.001	42,475	2,004	8,896	0	0	53,374	5,860
16084	0.006427	0	0	0	0	0	0	0
16085	0.03	0	0	0	0	0	0	0
16088	0.03621	0	0	0	0	0	0	0
16090	0.003929	0	0	0	0	0	0	0
16091	0.232098	0	0	0	0	0	0	0
16092	0.006682	0	0	0	0	0	0	0
16093	0.081575	222,598	0	44,520	0	0	267,118	29,328
16097	0.019	0	0	0	0	0	0	0
16098	0	0	0	0	0	0	0	0
16099	0.01533	0	0	0	0	0	0	0
16102	0.01394	135,429	0	27,086	0	0	162,514	17,843
16103	0.037558	0	0	0	0	0	0	0
16107	0.001286	0	0	0	0	0	0	0
16109	0.050559	0	0	0	0	0	0	0
16111	0.0072	72,986	2,004	0	0	0	74,990	8,234
16113	0	0	0	0	0	0	0	0
16114	0.00864	0	0	0	0	0	0	0
16115	0.004071	0	0	0	0	0	0	0
16116	0.0042	0	0	0	0	0	0	0
16117	0.04	37,048	0	7,410	0	0	44,458	4,881
16118	0.0288	0	0	0	0	0	0	0
16119	0.007288	0	0	0	0	0	0	0
16120	0.042775	0	0	0	0	0	0	0
16121	0.080284	0	0	0	0	0	0	0
16122	0.0255	0	0	0	0	0	0	0
16123	0.04608	246,283	8,080	50,873	0	0	305,236	33,513
16124	0.016662	155,438	14,551	0	0	0	169,989	18,664
16125	0.014193	0	0	0	0	0	0	0

Table 9-12 - BPT/BCT/BAT Option II Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16127	0.003627	55,540	2,004	11,509	0	0	69,053	7,582
16128	0.003963	0	0	0	0	0	0	0
16129	0.00469	0	0	0	0	0	0	0
16130	0.0003	0	0	0	0	0	0	0
16131	0.03	0	0	0	0	0	0	0
16132	0.03	0	0	0	0	0	0	0
16135	0.011487	0	0	0	0	0	0	0
16137	0	0	0	0	0	0	0	0
16139	0.00005	0	0	0	0	0	0	0
16148	0.000077	0	0	0	0	0	0	0
16149	0	0	0	0	0	0	0	0
16150	0.045778	0	0	0	0	0	0	0
16151	0.002049	0	0	0	0	0	0	0
16152	0	0	0	0	0	0	0	0
16153	0.008	0	0	0	0	0	0	0
16154	0.010224	0	0	0	0	0	0	0
16155	0.00831	0	0	0	0	0	0	0
16156	0.173	0	0	0	0	0	0	0
16158	0.014275	0	0	0	0	0	0	0
16159	0.225	0	0	0	0	0	0	0
16160	0.000137	0	0	0	0	0	0	0
16161	0.053	0	0	0	0	0	0	0
16162	0.0009	0	0	0	0	0	0	0
16163	0	0	0	0	0	0	0	0
16164	0.01	0	0	0	0	0	0	0
16165	0.030218	0	0	0	0	0	0	0
16166	0.003416	0	0	0	0	0	0	0
16170	0.0048	55,201	2,004	11,441	0	0	68,647	7,537
16171	0.024	0	0	0	0	0	0	0
16173	0.025	0	0	0	0	0	0	0
16174	0.0072	0	0	0	0	0	0	0
16175	0	0	0	0	0	0	0	0
16176	0.037272	0	0	0	0	0	0	0
16177	0	0	0	0	0	0	0	0
16180	0	0	0	0	0	0	0	0
16185	0	0	0	0	0	0	0	0
16186	0.00304	0	0	0	0	0	0	0
16187	0.003	0	0	0	0	0	0	0
16189	0	0	0	0	0	0	0	0

Table 9-12 - BPT/BCT/BAT Option II Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16191	0	0	0	0	0	0	0	0
16193	0.002303	0	0	0	0	0	0	0
16196	0.012233	131,628	11,645	0	0	0	143,273	15,731
16199	0.0008	0	0	0	0	0	0	0
16200	0.011416	0	0	0	0	0	0	0
16201	0.001881	0	0	0	0	0	0	0
16202	0.013007	0	0	0	0	0	0	0
16203	0.02	0	0	0	0	0	0	0
16204	0	0	0	0	0	0	0	0
16205	0	0	0	0	0	0	0	0
16206	0.057389	0	0	0	0	0	0	0
16208	0.003342	0	0	0	0	0	0	0
16211	0.15	0	0	0	0	0	0	0
16212	0.0007	47,049	2,004	0	0	0	49,053	5,386
16215	0	0	0	0	0	0	0	0
16217	0	0	0	0	0	0	0	0
16219	0.025438	0	0	0	0	0	0	0
16220	0.030405	0	0	0	0	0	0	0
16221	0.006616	0	0	0	0	0	0	0
16222	0.01548	0	0	0	0	0	0	0
16223	0.029041	210,653	7,768	0	0	0	218,421	23,981
16224	0	0	0	0	0	0	0	0
16225	0.031	0	0	0	0	0	0	0
16228	0.000719	0	0	0	0	0	0	0
16230	0	0	0	0	0	0	0	0
16233	0.0097	116,040	9,868	0	0	0	125,908	13,824
16234	0.030827	0	0	0	0	0	0	0
16236	0.005946	0	0	0	0	0	0	0
16239	0	0	0	0	0	0	0	0
16240	0.005597	0	0	0	0	0	0	0
16241	0	0	0	0	0	0	0	0
16242	0.0005	0	0	0	0	0	0	0
16245	0	0	0	0	0	0	0	0
16246	0.001353	0	0	0	0	0	0	0
16248	0.01	0	0	0	0	0	0	0
16249	0	0	0	0	0	0	0	0
16250	0.0002	0	0	0	0	0	0	0
16251	0.0007	0	0	0	0	0	0	0
16252	0.005	0	0	0	0	0	0	0

Table 9-12 - BPT/BCT/BAT Option II Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16253	0.01776	26,840	0	5,368	0	0	32,208	3,536
TOTALS	2.694	3,315,319	101,563	385,072	0	0	3,801,954	417,434

(a) Amortization assuming 7% interest over 15 year period.

Table 9-12 - BPT/BCT/BAT Option II Subtitle D Non-Hazardous Subcategory Cont'd

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16001	0.0793	44,857	4,078	11,540	60,475	87,545
16003	0.004715	0	0	0	0	0
16009	0.01613	0	0	0	0	0
16011	0	0	0	0	0	0
16012	0.002205	0	0	0	0	0
16013	0.015	0	0	0	0	0
16014	0	0	0	0	0	0
16015	0.0005	0	0	0	0	0
16016	0.002304	0	0	0	0	0
16020	0.045814	0	0	0	0	0
16023	0.057344	0	0	0	0	0
16024	0.005918	19,290	3,377	11,540	34,207	45,002
16025	0	0	0	0	0	0
16026	0	0	0	0	0	0
16027	0	0	0	0	0	0
16028	0.01985	0	0	0	0	0
16029	0.025	0	0	0	0	0
16033	0.0091	0	0	0	0	0
16035	0	0	0	0	0	0
16038	0.008219	21,553	1,516	9,876	32,945	41,490
16039	0.00178	0	0	0	0	0
16043	0.002177	16,600	3,173	10,500	30,273	37,177
16046	0	0	0	0	0	0
16047	0.001148	15,497	1,917	11,540	28,954	34,845
16048	5.00E-06	0	0	0	0	730
16049	0.0017	15,205	2,208	11,540	28,953	35,653
16050	0.01	11,672	1,917	11,540	25,129	31,776
16052	0.0546	17,799	6,897	11,072	35,768	65,180

Table 9-12 - BPT/BCT/BAT Option II Subtitle D Non-Hazardous Subcategory Cont'd

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16053	0.00124	9,002	1,917	11,540	22,459	27,030
16054	0.00075	12,013	1,917	11,357	25,287	29,506
16055	8.00E-06	0	0	0	0	1,168
16056	0.001367	15,659	1,917	11,540	29,116	35,277
16058	0.003	8,936	1,917	0	10,853	16,960
16059	0.0011	15,468	1,917	11,540	28,925	34,798
16060	0.0018	16,161	2,208	11,540	29,909	36,484
16061	0	0	0	0	0	0
16062	0.00005	0	0	0	0	7,300
16063	0.0067	20,855	3,562	11,540	35,957	46,576
16064	0.011967	12,127	3,931	11,540	27,598	34,634
16065	0.008	20,721	3,231	11,090	35,042	47,418
16070	0.001328	0	0	0	0	0
16071	0.006	0	0	0	0	0
16073	0.0182	0	0	0	0	0
16074	0	0	0	0	0	0
16075	0.010209	22,741	1,516	10,500	34,757	43,877
16076	0	0	0	0	0	0
16077	0.00816	0	0	0	0	0
16078	0.00499	0	0	0	0	0
16079	0.112474	27,018	0	11,180	38,198	85,111
16083	0.001	14,573	1,735	11,540	27,848	33,708
16084	0.006427	0	0	0	0	0
16085	0.03	0	0	0	0	0
16088	0.03621	0	0	0	0	0
16090	0.003929	0	0	0	0	0
16091	0.232098	0	0	0	0	0
16092	0.006682	0	0	0	0	0

Table 9-12 - BPT/BCT/BAT Option II Subtitle D Non-Hazardous Subcategory Cont'd

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16093	0.081575	30,361	0	11,180	41,541	70,869
16097	0.019	0	0	10,520	10,520	10,520
16098	0	0	0	0	0	0
16099	0.01533	0	0	0	0	0
16102	0.01394	25,465	0	11,540	37,005	54,848
16103	0.037558	0	0	0	0	0
16107	0.001286	0	0	0	0	0
16109	0.050559	0	0	0	0	0
16111	0.0072	20,895	1,516	10,500	32,911	41,144
16113	0	0	0	0	0	0
16114	0.00864	0	0	0	0	0
16115	0.004071	0	0	0	0	0
16116	0.0042	0	0	0	0	0
16117	0.04	18,524	0	9,908	28,432	33,313
16118	0.0288	0	0	0	0	0
16119	0.007288	0	0	11,117	11,117	11,117
16120	0.042775	0	0	9,200	9,200	9,200
16121	0.080284	0	0	0	0	0
16122	0.0255	0	0	9,948	9,948	9,948
16123	0.04608	39,120	8,365	11,540	59,025	92,538
16124	0.016662	29,096	11,381	11,540	52,017	70,681
16125	0.014193	0	0	10,712	10,712	10,712
16127	0.003627	11,684	2,756	11,540	25,980	33,562
16128	0.003963	0	0	0	0	0
16129	0.00469	0	0	11,540	11,540	11,540
16130	0.0003	0	0	11,540	11,540	11,540
16131	0.03	0	0	0	0	0
16132	0.03	0	0	0	0	0

Table 9-12 - BPT/BCT/BAT Option II Subtitle D Non-Hazardous Subcategory Cont'd

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16135	0.011487	0	0	0	0	0
16137	0	0	0	0	0	0
16139	0.00005	0	0	0	0	0
16148	0.000077	0	0	0	0	0
16149	0	0	0	0	0	0
16150	0.045778	0	0	0	0	0
16151	0.002049	0	0	0	0	0
16152	0	0	0	0	0	0
16153	0.008	0	0	0	0	0
16154	0.010224	0	0	0	0	0
16155	0.00831	0	0	0	0	0
16156	0.173	0	0	0	0	0
16158	0.014275	0	0	0	0	0
16159	0.225	0	0	0	0	0
16160	0.000137	0	0	0	0	0
16161	0.053	0	0	0	0	0
16162	0.0009	0	0	0	0	0
16163	0	0	0	0	0	0
16164	0.01	0	0	0	0	0
16165	0.030218	0	0	0	0	0
16166	0.003416	0	0	0	0	0
16170	0.0048	9,594	4,078	11,235	24,907	32,444
16171	0.024	0	0	0	0	0
16173	0.025	0	0	0	0	0
16174	0.0072	0	0	0	0	0
16175	0	0	0	0	0	0
16176	0.037272	0	0	0	0	0
16177	0	0	0	0	0	0

Table 9-12 - BPT/BCT/BAT Option II Subtitle D Non-Hazardous Subcategory Cont'd

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16180	0	0	0	0	0	0
16185	0	0	0	0	0	0
16186	0.00304	0	0	0	0	0
16187	0.003	0	0	0	0	0
16189	0	0	0	0	0	0
16191	0	0	0	0	0	0
16193	0.002303	0	0	0	0	0
16196	0.012233	26,246	10,115	11,540	47,901	63,632
16199	0.0008	0	0	0	0	0
16200	0.011416	0	0	0	0	0
16201	0.001881	0	0	0	0	0
16202	0.013007	0	0	0	0	0
16203	0.02	0	0	0	0	0
16204	0	0	0	0	0	0
16205	0	0	0	0	0	0
16206	0.057389	0	0	0	0	0
16208	0.003342	0	0	0	0	0
16211	0.15	0	0	0	0	0
16212	0.0007	15,123	1,516	10,500	27,139	32,525
16215	0	0	0	0	0	0
16217	0	0	0	0	0	0
16219	0.025438	0	0	0	0	0
16220	0.030405	0	0	0	0	0
16221	0.006616	0	0	0	0	0
16222	0.01548	0	0	0	0	0
16223	0.029041	34,812	8,212	10,500	53,524	77,505
16224	0	0	0	0	0	0
16225	0.031	0	0	0	0	0

Table 9-12 - BPT/BCT/BAT Option II Subtitle D Non-Hazardous Subcategory Cont'd

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16228	0.000719	0	0	0	0	0
16230	0	0	0	0	0	0
16233	0.0097	24,252	9,277	11,540	45,069	58,893
16234	0.030827	0	0	0	0	0
16236	0.005946	0	0	0	0	0
16239	0	0	0	0	0	0
16240	0.005597	0	0	0	0	0
16241	0	0	0	0	0	0
16242	0.0005	0	0	0	0	0
16245	0	0	0	0	0	0
16246	0.001353	0	0	0	0	0
16248	0.01	0	0	0	0	0
16249	0	0	0	0	0	0
16250	0.0002	0	0	0	0	0
16251	0.0007	0	0	0	0	0
16252	0.005	0	0	0	0	0
16253	0.01776	13,420	0	11,068	24,488	28,024
TOTALS	2.694	656,338	108,068	432,763	1,197,169	1,623,801

(b) Off-site disposal costs used for low flow facilities 16048, 16055, and 16062

Table 9-13 - BAT Option III Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16001	0.0793	2,183,593	2,004	437,119	0	0	2,622,716	287,960
16003	0.004715	0	0	0	0	0	0	0
16009	0.01613	0	0	0	0	0	0	0
16011	0	0	0	0	0	0	0	0
16012	0.002205	0	0	0	0	0	0	0
16013	0.015	0	0	0	0	0	0	0
16014	0	0	0	0	0	0	0	0
16015	0.0005	0	0	0	0	0	0	0
16016	0.002304	0	0	0	0	0	0	0
16020	0.045814	0	0	0	0	0	0	0
16023	0.057344	0	0	0	0	0	0	0
16024	0.005918	603,823	2,004	121,165	0	0	726,993	79,820
16025	0	0	0	0	0	0	0	0
16026	0	0	0	0	0	0	0	0
16027	0	0	0	0	0	0	0	0
16028	0.01985	0	0	0	0	0	0	0
16029	0.025	0	0	0	0	0	0	0
16033	0.0091	0	0	0	0	0	0	0
16035	0	0	0	0	0	0	0	0
16038	0.008219	728,256	2,004	0	0	0	730,260	80,179
16039	0.00178	0	0	0	0	0	0	0
16043	0.002177	306,037	2,004	0	0	0	308,041	33,821
16046	0	0	0	0	0	0	0	0
16047	0.001148	191,967	2,004	0	0	0	193,971	21,297
16048	5.0000E-06	46,193	0	0	0	0	46,193	5,072
16049	0.0017	247,768	2,004	49,954	0	0	299,726	32,908
16050	0.01	797,074	2,004	0	0	0	799,078	87,734
16052	0.0546	1,949,079	5,563	390,928	0	0	2,345,571	257,531
16053	0.00124	190,146	2,004	0	0	0	192,150	21,097
16054	0.00075	123,852	2,004	25,171	0	0	151,028	16,582
16055	8.0000E-06	32,864	0	0	0	0	32,864	3,608
16056	0.001367	218,417	2,004	0	0	0	220,421	24,201
16058	0.003	361,815	2,004	72,764	0	0	436,583	47,934
16059	0.0011	186,408	2,004	0	0	0	188,412	20,687
16060	0.0018	266,809	2,004	0	0	0	268,813	29,514
16061	0	0	0	0	0	0	0	0
16062	0.00005	36,642	0	0	0	0	36,642	4,023
16063	0.0067	664,889	2,004	0	0	0	666,893	73,221
16064	0.011967	885,558	2,004	0	0	0	887,562	97,450

Table 9-13 - BAT Option III Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16065	0.008	733,057	2,004	147,012	0	0	882,073	96,847
16070	0.001328	0	0	0	0	0	0	0
16071	0.006	0	0	0	0	0	0	0
16073	0.0182	0	0	0	0	0	0	0
16074	0	0	0	0	0	0	0	0
16075	0.010209	829,084	2,004	0	0	0	831,088	91,249
16076	0	0	0	0	0	0	0	0
16077	0.00816	0	0	0	0	0	0	0
16078	0.00499	0	0	0	0	0	0	0
16079	0.112474	2,562,809	0	512,562	0	0	3,075,371	337,659
16083	0.001	165,966	2,004	33,594	0	0	201,564	22,131
16084	0.006427	0	0	0	0	0	0	0
16085	0.03	0	0	0	0	0	0	0
16088	0.03621	0	0	0	0	0	0	0
16090	0.003929	0	0	0	0	0	0	0
16091	0.232098	0	0	0	0	0	0	0
16092	0.006682	0	0	0	0	0	0	0
16093	0.081575	2,221,423	0	444,285	0	0	2,665,708	292,680
16097	0.019	1,067,839	0	213,568	0	0	1,281,407	140,692
16098	0	0	0	0	0	0	0	0
16099	0.01533	0	0	0	0	0	0	0
16102	0.01394	1,035,581	0	207,116	0	0	1,242,698	136,442
16103	0.037558	0	0	0	0	0	0	0
16107	0.001286	0	0	0	0	0	0	0
16109	0.050559	0	0	0	0	0	0	0
16111	0.0072	671,271	2,004	0	0	0	673,275	73,922
16113	0	0	0	0	0	0	0	0
16114	0.00864	0	0	0	0	0	0	0
16115	0.004071	0	0	0	0	0	0	0
16116	0.0042	0	0	0	0	0	0	0
16117	0.04	1,562,645	0	312,529	0	0	1,875,174	205,884
16118	0.0288	0	0	0	0	0	0	0
16119	0.007288	603,122	0	120,624	0	0	723,746	79,463
16120	0.042775	1,569,551	0	313,910	0	0	1,883,461	206,794
16121	0.080284	0	0	0	0	0	0	0
16122	0.0255	1,240,783	0	248,157	0	0	1,488,939	163,478
16123	0.04608	1,864,917	8,080	374,599	0	0	2,247,596	246,774
16124	0.016662	1,150,263	14,551	0	0	0	1,164,814	127,890
16125	0.014193	909,456	0	181,891	0	0	1,091,347	119,824

Table 9-13 - BAT Option III Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16127	0.003627	423,029	2,004	85,007	0	0	510,040	56,000
16128	0.003963	0	0	0	0	0	0	0
16129	0.00469	444,502	0	88,900	0	0	533,403	58,565
16130	0.0003	36,269	0	7,254	0	0	43,523	4,779
16131	0.03	0	0	0	0	0	0	0
16132	0.03	0	0	0	0	0	0	0
16135	0.011487	0	0	0	0	0	0	0
16137	0	0	0	0	0	0	0	0
16139	0.00005	0	0	0	0	0	0	0
16148	0.000077	0	0	0	0	0	0	0
16149	0	0	0	0	0	0	0	0
16150	0.045778	0	0	0	0	0	0	0
16151	0.002049	0	0	0	0	0	0	0
16152	0	0	0	0	0	0	0	0
16153	0.008	0	0	0	0	0	0	0
16154	0.010224	0	0	0	0	0	0	0
16155	0.00831	0	0	0	0	0	0	0
16156	0.173	0	0	0	0	0	0	0
16158	0.014275	0	0	0	0	0	0	0
16159	0.225	0	0	0	0	0	0	0
16160	0.000137	0	0	0	0	0	0	0
16161	0.053	0	0	0	0	0	0	0
16162	0.0009	0	0	0	0	0	0	0
16163	0	0	0	0	0	0	0	0
16164	0.01	0	0	0	0	0	0	0
16165	0.030218	0	0	0	0	0	0	0
16166	0.003416	0	0	0	0	0	0	0
16170	0.0048	507,196	2,004	101,840	0	0	611,040	67,089
16171	0.024	0	0	0	0	0	0	0
16173	0.025	0	0	0	0	0	0	0
16174	0.0072	0	0	0	0	0	0	0
16175	0	0	0	0	0	0	0	0
16176	0.037272	0	0	0	0	0	0	0
16177	0	0	0	0	0	0	0	0
16180	0	0	0	0	0	0	0	0
16185	0	0	0	0	0	0	0	0
16186	0.00304	0	0	0	0	0	0	0
16187	0.003	0	0	0	0	0	0	0
16189	0	0	0	0	0	0	0	0

Table 9-13 - BAT Option III Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16191	0	0	0	0	0	0	0	0
16193	0.002303	0	0	0	0	0	0	0
16196	0.012233	965,897	11,645	0	0	0	977,542	107,329
16199	0.0008	0	0	0	0	0	0	0
16200	0.011416	0	0	0	0	0	0	0
16201	0.001881	0	0	0	0	0	0	0
16202	0.013007	0	0	0	0	0	0	0
16203	0.02	0	0	0	0	0	0	0
16204	0	0	0	0	0	0	0	0
16205	0	0	0	0	0	0	0	0
16206	0.057389	0	0	0	0	0	0	0
16208	0.003342	0	0	0	0	0	0	0
16211	0.15	0	0	0	0	0	0	0
16212	0.0007	134,753	2,004	0	0	0	136,757	15,015
16215	0	0	0	0	0	0	0	0
16217	0	0	0	0	0	0	0	0
16219	0.025438	0	0	0	0	0	0	0
16220	0.030405	0	0	0	0	0	0	0
16221	0.006616	0	0	0	0	0	0	0
16222	0.01548	0	0	0	0	0	0	0
16223	0.029041	1,531,517	7,768	0	0	0	1,539,285	169,005
16224	0	0	0	0	0	0	0	0
16225	0.031	0	0	0	0	0	0	0
16228	0.000719	0	0	0	0	0	0	0
16230	0	0	0	0	0	0	0	0
16233	0.0097	840,751	9,868	0	0	0	850,619	93,393
16234	0.030827	0	0	0	0	0	0	0
16236	0.005946	0	0	0	0	0	0	0
16239	0	0	0	0	0	0	0	0
16240	0.005597	0	0	0	0	0	0	0
16241	0	0	0	0	0	0	0	0
16242	0.0005	0	0	0	0	0	0	0
16245	0	0	0	0	0	0	0	0
16246	0.001353	0	0	0	0	0	0	0
16248	0.01	0	0	0	0	0	0	0
16249	0	0	0	0	0	0	0	0
16250	0.0002	0	0	0	0	0	0	0
16251	0.0007	0	0	0	0	0	0	0
16252	0.005	0	0	0	0	0	0	0

Table 9-13 - BAT Option III Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16253	0.01776	1,056,810	0	211,362	0	0	1,268,173	139,239
TOTALS	2.694	34,149,683	101,563	4,701,313	0	0	38,952,560	4,276,782

(a) Amortization assuming 7% interest over 15 year period.

Table 9-13 - BAT Option III Subtitle D Non-Hazardous Subcategory Cont'd

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16001	0.0793	623,747	4,078	11,540	639,365	927,325
16003	0.004715	0	0	0	0	0
16009	0.01613	0	0	0	0	0
16011	0	0	0	0	0	0
16012	0.002205	0	0	0	0	0
16013	0.015	0	0	0	0	0
16014	0	0	0	0	0	0
16015	0.0005	0	0	0	0	0
16016	0.002304	0	0	0	0	0
16020	0.045814	0	0	0	0	0
16023	0.057344	0	0	0	0	0
16024	0.005918	62,491	3,377	11,540	77,408	157,228
16025	0	0	0	0	0	0
16026	0	0	0	0	0	0
16027	0	0	0	0	0	0
16028	0.01985	0	0	0	0	0
16029	0.025	0	0	0	0	0
16033	0.0091	0	0	0	0	0
16035	0	0	0	0	0	0
16038	0.008219	81,552	1,516	9,876	92,944	173,123
16039	0.00178	0	0	0	0	0
16043	0.002177	32,492	3,173	10,500	46,165	79,987
16046	0	0	0	0	0	0
16047	0.001148	23,878	1,917	11,540	37,335	58,632
16048	5.0000E-06	14,452	0	0	14,452	20,254
16049	0.0017	27,615	2,208	11,540	41,363	74,272
16050	0.01	84,672	1,917	11,540	98,129	185,864
16052	0.0546	416,379	6,897	11,072	434,348	691,879

Table 9-13 - BAT Option III Subtitle D Non-Hazardous Subcategory Cont'd

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16053	0.00124	18,054	1,917	11,540	31,511	52,609
16054	0.00075	17,488	1,917	11,357	30,762	47,344
16055	8.0000E-06	7,737	0	0	7,737	12,513
16056	0.001367	25,638	1,917	11,540	39,095	63,296
16058	0.003	30,836	1,917	0	32,753	80,688
16059	0.0011	23,498	1,917	11,540	36,955	57,641
16060	0.0018	29,301	2,208	11,540	43,049	72,563
16061	0	0	0	0	0	0
16062	0.00005	8,043	0	0	8,043	19,366
16063	0.0067	69,765	3,562	11,540	84,867	158,088
16064	0.011967	99,486	3,931	11,540	114,957	212,406
16065	0.008	79,121	3,231	11,090	93,442	190,289
16070	0.001328	0	0	0	0	0
16071	0.006	0	0	0	0	0
16073	0.0182	0	0	0	0	0
16074	0	0	0	0	0	0
16075	0.010209	97,267	1,516	10,500	109,283	200,532
16076	0	0	0	0	0	0
16077	0.00816	0	0	0	0	0
16078	0.00499	0	0	0	0	0
16079	0.112474	848,079	0	11,180	859,259	1,196,918
16083	0.001	21,873	1,735	11,540	35,148	57,279
16084	0.006427	0	0	0	0	0
16085	0.03	0	0	0	0	0
16088	0.03621	0	0	0	0	0
16090	0.003929	0	0	0	0	0
16091	0.232098	0	0	0	0	0
16092	0.006682	0	0	0	0	0

Table 9-13 - BAT Option III Subtitle D Non-Hazardous Subcategory Cont'd

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16093	0.081575	625,858	0	11,180	637,038	929,719
16097	0.019	138,700	0	10,520	149,220	289,912
16098	0	0	0	0	0	0
16099	0.01533	0	0	0	0	0
16102	0.01394	127,227	0	11,540	138,767	275,208
16103	0.037558	0	0	0	0	0
16107	0.001286	0	0	0	0	0
16109	0.050559	0	0	0	0	0
16111	0.0072	73,455	1,516	10,500	85,471	159,393
16113	0	0	0	0	0	0
16114	0.00864	0	0	0	0	0
16115	0.004071	0	0	0	0	0
16116	0.0042	0	0	0	0	0
16117	0.04	310,524	0	9,908	320,432	526,316
16118	0.0288	0	0	0	0	0
16119	0.007288	53,202	0	11,117	64,319	143,783
16120	0.042775	312,258	0	9,200	321,458	528,251
16121	0.080284	0	0	0	0	0
16122	0.0255	186,150	0	9,948	196,098	359,576
16123	0.04608	375,504	8,365	11,540	395,409	642,183
16124	0.016662	150,728	11,381	11,540	173,649	301,540
16125	0.014193	103,609	0	10,712	114,321	234,145
16127	0.003627	38,161	2,756	11,540	52,457	108,457
16128	0.003963	0	0	0	0	0
16129	0.00469	34,237	0	11,540	45,777	104,342
16130	0.0003	2,190	0	11,540	13,730	18,509
16131	0.03	0	0	0	0	0
16132	0.03	0	0	0	0	0

Table 9-13 - BAT Option III Subtitle D Non-Hazardous Subcategory Cont'd

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16135	0.011487	0	0	0	0	0
16137	0	0	0	0	0	0
16139	0.00005	0	0	0	0	0
16148	0.000077	0	0	0	0	0
16149	0	0	0	0	0	0
16150	0.045778	0	0	0	0	0
16151	0.002049	0	0	0	0	0
16152	0	0	0	0	0	0
16153	0.008	0	0	0	0	0
16154	0.010224	0	0	0	0	0
16155	0.00831	0	0	0	0	0
16156	0.173	0	0	0	0	0
16158	0.014275	0	0	0	0	0
16159	0.225	0	0	0	0	0
16160	0.000137	0	0	0	0	0
16161	0.053	0	0	0	0	0
16162	0.0009	0	0	0	0	0
16163	0	0	0	0	0	0
16164	0.01	0	0	0	0	0
16165	0.030218	0	0	0	0	0
16166	0.003416	0	0	0	0	0
16170	0.0048	44,634	4,078	11,235	59,947	127,036
16171	0.024	0	0	0	0	0
16173	0.025	0	0	0	0	0
16174	0.0072	0	0	0	0	0
16175	0	0	0	0	0	0
16176	0.037272	0	0	0	0	0
16177	0	0	0	0	0	0

Table 9-13 - BAT Option III Subtitle D Non-Hazardous Subcategory Cont'd

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16180	0	0	0	0	0	0
16185	0	0	0	0	0	0
16186	0.00304	0	0	0	0	0
16187	0.003	0	0	0	0	0
16189	0	0	0	0	0	0
16191	0	0	0	0	0	0
16193	0.002303	0	0	0	0	0
16196	0.012233	115,547	10,115	11,540	137,202	244,531
16199	0.0008	0	0	0	0	0
16200	0.011416	0	0	0	0	0
16201	0.001881	0	0	0	0	0
16202	0.013007	0	0	0	0	0
16203	0.02	0	0	0	0	0
16204	0	0	0	0	0	0
16205	0	0	0	0	0	0
16206	0.057389	0	0	0	0	0
16208	0.003342	0	0	0	0	0
16211	0.15	0	0	0	0	0
16212	0.0007	20,233	1,516	10,500	32,249	47,264
16215	0	0	0	0	0	0
16217	0	0	0	0	0	0
16219	0.025438	0	0	0	0	0
16220	0.030405	0	0	0	0	0
16221	0.006616	0	0	0	0	0
16222	0.01548	0	0	0	0	0
16223	0.029041	246,811	8,212	10,500	265,523	434,528
16224	0	0	0	0	0	0
16225	0.031	0	0	0	0	0

Table 9-13 - BAT Option III Subtitle D Non-Hazardous Subcategory Cont'd

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16228	0.000719	0	0	0	0	0
16230	0	0	0	0	0	0
16233	0.0097	95,062	9,277	11,540	115,879	209,272
16234	0.030827	0	0	0	0	0
16236	0.005946	0	0	0	0	0
16239	0	0	0	0	0	0
16240	0.005597	0	0	0	0	0
16241	0	0	0	0	0	0
16242	0.0005	0	0	0	0	0
16245	0	0	0	0	0	0
16246	0.001353	0	0	0	0	0
16248	0.01	0	0	0	0	0
16249	0	0	0	0	0	0
16250	0.0002	0	0	0	0	0
16251	0.0007	0	0	0	0	0
16252	0.005	0	0	0	0	0
16253	0.01776	143,068	0	11,068	154,136	293,374
TOTALS	2.694	5,940,621	108,068	432,763	6,481,452	10,767,432

(b) Off-site disposal costs used for low flow facilities 16048, 16055, and 16062

Table 9-14 - PSES Option I Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16001	0.0793	0	0	0	0	0	0	0
16003	0.004715	47,897	2,004	0	0	0	49,901	5,479
16009	0.01613	125,436	6,492	0	0	0	131,927	14,485
16011	0	0	0	0	0	0	0	0
16012	0.002205	41,812	2,004	0	0	0	43,816	4,811
16013	0.015	120,535	13,491	0	0	0	134,026	14,715
16014	0	0	0	0	0	0	0	0
16015	0.0005	1,914	0	383	0	0	2,297	252
16016	0.002304	42,070	2,004	0	0	0	44,074	4,839
16020	0.045814	237,707	14,181	0	0	0	251,888	27,656
16023	0.057344	292,033	35,254	0	0	0	327,287	35,934
16024	0.005918	0	0	0	0	0	0	0
16025	0	0	0	0	0	0	0	0
16026	0	0	0	0	0	0	0	0
16027	0	0	0	0	0	0	0	0
16028	0.01985	81,397	0	16,279	0	0	97,676	10,724
16029	0.025	165,849	19,449	0	0	0	185,298	20,345
16033	0.0091	17,601	0	3,520	0	0	21,121	2,319
16035	0	0	0	0	0	0	0	0
16038	0.008219	0	0	0	0	0	0	0
16039	0.00178	40,483	9,041	9,905	0	0	59,429	6,525
16043	0.002177	0	0	0	0	0	0	0
16046	0	0	0	0	0	0	0	0
16047	0.001148	0	0	0	0	0	0	0
16048	5.0000E-06	0	0	0	0	0	0	0
16049	0.0017	0	0	0	0	0	0	0
16050	0.01	0	0	0	0	0	0	0
16052	0.0546	0	0	0	0	0	0	0
16053	0.00124	0	0	0	0	0	0	0
16054	0.00075	0	0	0	0	0	0	0
16055	8.0000E-06	0	0	0	0	0	0	0
16056	0.001367	0	0	0	0	0	0	0
16058	0.003	0	0	0	0	0	0	0
16059	0.0011	0	0	0	0	0	0	0
16060	0.0018	0	0	0	0	0	0	0
16061	0	0	0	0	0	0	0	0
16062	0.00005	0	0	0	0	0	0	0
16063	0.0067	0	0	0	0	0	0	0
16064	0.011967	0	0	0	0	0	0	0

Table 9-14 - PSES Option I Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16065	0.008	0	0	0	0	0	0	0
16070	0.001328	40,086	2,393	0	0	0	42,480	4,664
16071	0.006	72,865	6,992	0	0	0	79,856	8,768
16073	0.0182	130,976	0	26,195	0	0	157,171	17,257
16074	0	0	0	0	0	0	0	0
16075	0.010209	0	0	0	0	0	0	0
16076	0	0	0	0	0	0	0	0
16077	0.00816	15,799	0	3,160	0	0	18,959	2,082
16078	0.00499	39,516	2,004	8,304	0	0	49,824	5,470
16079	0.112474	0	0	0	0	0	0	0
16083	0.001	0	0	0	0	0	0	0
16084	0.006427	73,692	2,640	0	0	0	76,332	8,381
16085	0.03	67,242	2,004	13,849	0	0	83,095	9,123
16088	0.03621	174,944	25,359	40,061	0	0	240,364	26,391
16090	0.003929	58,795	5,166	0	0	0	63,961	7,023
16091	0.232098	910,395	94,859	0	0	0	1,005,254	110,371
16092	0.006682	12,956	0	2,591	0	0	15,548	1,707
16093	0.081575	0	0	0	0	0	0	0
16097	0.019	0	0	0	0	0	0	0
16098	0	0	0	0	0	0	0	0
16099	0.01533	29,441	0	5,888	0	0	35,329	3,879
16102	0.01394	0	0	0	0	0	0	0
16103	0.037558	192,741	53,744	49,297	0	0	295,781	32,475
16107	0.001286	39,769	2,004	8,355	0	0	50,128	5,504
16109	0.050559	266,696	32,214	0	0	0	298,909	32,819
16111	0.0072	0	0	0	0	0	0	0
16113	0	0	0	0	0	0	0	0
16114	0.00864	87,346	9,092	0	0	0	96,437	10,588
16115	0.004071	0	0	0	0	0	0	0
16116	0.0042	53,455	14,284	13,548	0	0	81,287	8,925
16117	0.04	0	0	0	0	0	0	0
16118	0.0288	15,429	0	3,086	0	0	18,515	2,033
16119	0.007288	0	0	0	0	0	0	0
16120	0.042775	0	0	0	0	0	0	0
16121	0.080284	19,873	0	3,975	0	0	23,848	2,618
16122	0.0255	0	0	0	0	0	0	0
16123	0.04608	0	0	0	0	0	0	0
16124	0.016662	0	0	0	0	0	0	0
16125	0.014193	0	0	0	0	0	0	0

Table 9-14 - PSES Option I Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16127	0.003627	0	0	0	0	0	0	0
16128	0.003963	37,727	2,004	7,946	0	0	47,677	5,235
16129	0.00469	0	0	0	0	0	0	0
16130	0.0003	0	0	0	0	0	0	0
16131	0.03	157,251	24,649	36,380	0	0	218,279	23,966
16132	0.03	51,813	0	10,363	0	0	62,175	6,827
16135	0.011487	22,158	0	4,432	0	0	26,589	2,919
16137	0	0	0	0	0	0	0	0
16139	0.00005	0	0	0	0	0	0	0
16148	0.000077	0	0	0	0	0	0	0
16149	0	0	0	0	0	0	0	0
16150	0.045778	118,519	2,004	0	0	0	120,523	13,233
16151	0.002049	45,631	3,256	0	0	0	48,887	5,368
16152	0.152866	622,947	71,188	0	0	0	694,135	76,212
16153	0.008	82,232	3,068	0	0	0	85,300	9,365
16154	0.010224	93,576	2,049	0	0	0	95,626	10,499
16155	0.00831	83,819	2,004	0	0	0	85,823	9,423
16156	0.173	344,298	2,004	0	0	0	346,302	38,022
16158	0.014275	97,602	2,600	20,040	0	0	120,242	13,202
16159	0.225	528,407	18,860	109,453	0	0	656,721	72,104
16160	0.000137	0	0	0	0	0	0	0
16161	0.053	222,783	28,208	50,198	0	0	301,188	33,069
16162	0.0009	30,262	2,004	6,453	0	0	38,720	4,251
16163	0	0	0	0	0	0	0	0
16164	0.01	85,263	0	17,053	0	0	102,316	11,234
16165	0.030218	177,387	71,231	49,724	0	0	298,343	32,756
16166	0.003416	55,354	2,004	0	0	0	57,359	6,298
16170	0.0048	0	0	0	0	0	0	0
16171	0.024	135,954	19,101	31,011	0	0	186,065	20,429
16173	0.025	165,849	19,449	0	0	0	185,298	20,345
16174	0.0072	67,584	2,004	13,918	0	0	83,506	9,169
16175	0	0	0	0	0	0	0	0
16176	0.037272	176,340	15,283	38,324	0	0	229,946	25,247
16177	0	0	0	0	0	0	0	0
16180	0	0	0	0	0	0	0	0
16185	0	0	0	0	0	0	0	0
16186	0.00304	52,785	4,305	0	0	0	57,091	6,268
16187	0.003	52,349	4,271	0	0	0	56,621	6,217
16189	0	0	0	0	0	0	0	0

Table 9-14 - PSES Option I Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
16191	0	0	0	0	0	0	0	0
16193	0.002303	47,410	3,512	0	0	0	50,922	5,591
16196	0.012233	0	0	0	0	0	0	0
16199	0.0008	35,016	2,004	0	0	0	37,020	4,065
16200	0.011416	101,014	3,967	0	0	0	104,981	11,526
16201	0.001881	33,243	0	6,649	0	0	39,891	4,380
16202	0.013007	111,523	12,179	0	0	0	123,701	13,582
16203	0.02	144,527	16,567	0	0	0	161,094	17,687
16204	0	0	0	0	0	0	0	0
16205	0.015179	121,242	13,596	0	0	0	134,839	14,805
16206	0.057389	292,102	35,284	0	0	0	327,385	35,945
16208	0.003342	54,851	4,598	0	0	0	59,449	6,527
16211	0.15	610,433	70,224	0	0	0	680,657	74,732
16212	0.0007	0	0	0	0	0	0	0
16215	0.017641	133,355	15,142	0	0	0	148,497	16,304
16217	0	0	0	0	0	0	0	0
16219	0.025438	167,563	19,685	0	0	0	187,248	20,559
16220	0.030405	189,093	22,378	0	0	0	211,470	23,218
16221	0.006616	76,285	7,505	0	0	0	83,790	9,200
16222	0.01548	121,001	4,950	0	0	0	125,951	13,829
16223	0.029041	0	0	0	0	0	0	0
16224	0	0	0	0	0	0	0	0
16225	0.031	191,293	22,688	0	0	0	213,981	23,494
16228	0.000719	34,183	2,004	0	0	0	36,187	3,973
16230	0	0	0	0	0	0	0	0
16234	0.030827	190,707	22,601	0	0	0	213,308	23,420
16236	0.005946	72,751	6,937	0	0	0	79,688	8,749
16239	0	0	0	0	0	0	0	0
16240	0.005597	70,635	6,659	0	0	0	77,294	8,486
16241	0	0	0	0	0	0	0	0
16242	0.0005	31,581	2,004	0	0	0	33,585	3,687
16245	0	0	0	0	0	0	0	0
16246	0.001353	40,163	2,393	0	0	0	42,556	4,672
16248	0.01	94,149	3,689	0	0	0	97,838	10,742
16249	0	0	0	0	0	0	0	0
16250	0.0002	0	0	0	0	0	0	0
16251	0.0007	34,106	2,004	0	0	0	36,110	3,965
16252	0.005	65,403	6,149	0	0	0	71,553	7,856
16253	0.01776	0	0	0	0	0	0	0

Table 9-14 - PSES Option I Subtitle D Non-Hazardous Subcategory

ID#	FLOW (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)
		EQUIPMENT	SLUDGE HANDLING	RETROFIT	PERMIT MODIFICATION	LAND	TOTAL CAPITAL	
TOTALS	2.870	10,088,267	966,939	610,339	0	0	11,665,545	1,280,814

(a) Amortization assuming 7% interest over 15 year period.

Table 9-14 - PSES Option I Subtitle D Non-Hazardous Subcategory Cont'd

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16001	0.0793	0	0	0	0	0
16003	0.004715	10,302	1,516	4,888	16,706	22,185
16009	0.01613	15,436	7,462	4,888	27,786	42,271
16011	0	0	0	0	0	0
16012	0.002205	9,418	2,340	936	12,694	17,505
16013	0.015	15,170	10,919	936	27,025	41,740
16014	0	0	0	0	0	0
16015	0.0005	2,916	0	0	2,916	3,168
16016	0.002304	9,459	2,340	936	12,735	17,575
16020	0.045814	21,738	11,225	4,408	37,371	65,027
16023	0.057344	26,759	18,170	936	45,865	81,799
16024	0.005918	0	0	0	0	0
16025	0	0	0	0	0	0
16026	0	0	0	0	0	0
16027	0	0	0	0	0	0
16028	0.01985	20,673	0	756	21,429	32,154
16029	0.025	18,458	13,245	936	32,639	52,983
16033	0.0091	8,050	0	936	8,986	11,305
16035	0	0	0	0	0	0
16038	0.008219	0	0	0	0	0
16039	0.00178	10,095	8,859	810	19,765	26,289
16043	0.002177	0	0	0	0	0
16046	0	0	0	0	0	0
16047	0.001148	0	0	0	0	0
16048	5.0000E-06	0	0	0	0	0
16049	0.0017	0	0	0	0	0
16050	0.01	0	0	0	0	0
16052	0.0546	0	0	0	0	0

Table 9-14 - PSES Option I Subtitle D Non-Hazardous Subcategory Cont'd

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16053	0.00124	0	0	0	0	0
16054	0.00075	0	0	0	0	0
16055	8.0000E-06	0	0	0	0	0
16056	0.001367	0	0	0	0	0
16058	0.003	0	0	0	0	0
16059	0.0011	0	0	0	0	0
16060	0.0018	0	0	0	0	0
16061	0	0	0	0	0	0
16062	0.00005	0	0	0	0	0
16063	0.0067	0	0	0	0	0
16064	0.011967	0	0	0	0	0
16065	0.008	0	0	0	0	0
16070	0.001328	8,891	4,482	936	14,309	18,973
16071	0.006	11,667	7,762	936	20,366	29,133
16073	0.0182	17,121	0	936	18,057	35,313
16074	0	0	0	0	0	0
16075	0.010209	0	0	0	0	0
16076	0	0	0	0	0	0
16077	0.00816	7,649	0	936	8,585	10,667
16078	0.00499	9,485	2,340	936	12,761	18,232
16079	0.112474	0	0	0	0	0
16083	0.001	0	0	0	0	0
16084	0.006427	11,060	4,704	4,888	20,652	29,033
16085	0.03	12,747	2,340	936	16,024	25,147
16088	0.03621	17,236	15,248	936	33,420	59,811
16090	0.003929	10,144	6,636	936	17,716	24,739
16091	0.232098	68,857	31,154	936	100,947	211,319
16092	0.006682	6,966	0	936	7,902	9,609

Table 9-14 - PSES Option I Subtitle D Non-Hazardous Subcategory Cont'd

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16093	0.081575	0	0	0	0	0
16097	0.019	0	0	0	0	0
16098	0	0	0	0	0	0
16099	0.01533	10,297	0	774	11,071	14,950
16102	0.01394	0	0	0	0	0
16103	0.037558	19,970	22,855	936	43,761	76,236
16107	0.001286	9,029	2,340	936	12,305	17,809
16109	0.050559	25,134	17,323	936	43,393	76,212
16111	0.0072	0	0	0	0	0
16113	0	0	0	0	0	0
16114	0.00864	12,507	8,896	936	22,339	32,927
16115	0.004071	0	0	864	864	864
16116	0.0042	10,147	11,266	936	22,349	31,273
16117	0.04	0	0	0	0	0
16118	0.0288	2,848	0	936	3,784	5,816
16119	0.007288	0	0	0	0	0
16120	0.042775	0	0	0	0	0
16121	0.080284	3,431	0	936	4,367	6,986
16122	0.0255	0	0	0	0	0
16123	0.04608	0	0	0	0	0
16124	0.016662	0	0	0	0	0
16125	0.014193	0	0	0	0	0
16127	0.003627	0	0	0	0	0
16128	0.003963	9,222	2,340	936	12,498	17,733
16129	0.00469	0	0	0	0	0
16130	0.0003	0	0	0	0	0
16131	0.03	16,531	15,013	936	32,480	56,446
16132	0.03	9,900	0	936	10,836	17,662

Table 9-14 - PSES Option I Subtitle D Non-Hazardous Subcategory Cont'd

ID#	FLOW (MGD)	O & M COSTS ($/YR) EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	TOTAL ANNUAL COST ($/YR)(b)
16135	0.011487	8,983	0	936	9,919	12,838
16137	0	0	0	0	0	0
16139	0.00005	0	0	900	900	8,200
16148	0.000077	0	0	936	936	12,178
16149	0	0	0	0	0	0
16150	0.045778	17,873	2,340	936	21,150	34,383
16151	0.002049	9,271	5,223	936	15,429	20,797
16152	0.152866	48,773	26,710	936	76,419	152,631
16153	0.008	11,559	5,073	4,888	21,520	30,885
16154	0.010224	12,203	4,115	936	17,254	27,753
16155	0.00831	11,652	3,826	936	16,414	25,837
16156	0.173	39,529	2,340	936	42,805	80,828
16158	0.014275	11,764	4,667	864	17,295	30,497
16159	0.225	30,252	13,047	936	44,234	116,339
16160	0.000137	0	0	936	936	20,938
16161	0.053	19,793	16,123	864	36,781	69,850
16162	0.0009	7,964	2,340	936	11,241	15,492
16163	0	0	0	0	0	0
16164	0.01	12,685	0	936	13,621	24,854
16165	0.030218	19,950	26,711	936	47,597	80,354
16166	0.003416	9,926	2,777	936	13,639	19,937
16170	0.0048	0	0	0	0	0
16171	0.024	14,992	13,125	882	28,999	49,428
16173	0.025	18,458	13,245	936	32,639	52,983
16174	0.0072	10,280	3,608	936	14,824	23,992
16175	0	0	0	0	0	0
16176	0.037272	16,993	11,653	882	29,527	54,774
16177	0	0	0	0	0	0

Table 9-14 - PSES Option I Subtitle D Non-Hazardous Subcategory Cont'd

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16180	0	0	0	0	0	0
16185	0	0	0	0	0	0
16186	0.00304	9,758	6,039	936	16,733	23,002
16187	0.003	9,736	6,003	936	16,675	22,892
16189	0	0	0	0	0	0
16191	0	0	0	0	0	0
16193	0.002303	9,400	5,444	936	15,780	21,371
16196	0.012233	0	0	0	0	0
16199	0.0008	8,486	3,680	936	13,101	17,166
16200	0.011416	13,278	5,778	4,888	23,944	35,470
16201	0.001881	8,505	0	936	9,441	13,821
16202	0.013007	14,681	10,345	936	25,962	39,543
16203	0.02	17,086	12,156	936	30,179	47,866
16204	0	0	0	0	0	0
16205	0.015179	15,211	10,958	936	27,105	41,910
16206	0.057389	26,765	18,206	936	45,908	81,853
16208	0.003342	9,893	6,264	936	17,093	23,620
16211	0.15	47,788	26,498	936	75,221	149,954
16212	0.0007	0	0	0	0	0
16215	0.017641	16,209	11,613	0	27,821	44,126
16217	0	0	0	0	0	0
16219	0.025438	18,548	13,323	936	32,806	53,365
16220	0.030405	20,127	14,263	936	35,326	58,545
16221	0.006616	11,873	8,062	936	20,871	30,070
16222	0.01548	14,843	6,488	936	22,267	36,096
16223	0.029041	0	0	0	0	0
16224	0	0	0	0	0	0
16225	0.031	20,243	14,379	936	35,558	59,051

Table 9-14 - PSES Option I Subtitle D Non-Hazardous Subcategory Cont'd

ID#	FLOW (MGD)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		EQUIPMENT	SOLIDS HANDLING	MONITORING	TOTAL O & M	
16228	0.000719	8,412	3,572	936	12,920	16,893
16230	0	0	0	0	0	0
16234	0.030827	20,210	14,340	936	35,486	58,906
16236	0.005946	11,653	7,725	936	20,314	29,063
16239	0	0	0	0	0	0
16240	0.005597	11,529	7,573	936	20,038	28,525
16241	0	0	0	0	0	0
16242	0.0005	8,182	3,101	936	12,219	15,907
16245	0	0	0	0	0	0
16246	0.001353	8,905	4,482	936	14,323	18,995
16248	0.01	12,894	5,593	4,888	23,375	34,117
16249	0	0	0	0	0	0
16250	0.0002	0	0	936	936	30,136
16251	0.0007	8,396	3,497	936	12,830	16,794
16252	0.005	10,560	7,273	936	18,768	26,624
16253	0.01776	0	0	0	0	0
TOTALS	2.870	1,205,386	624,354	104,044	1,933,783	3,282,341

(b) Off-site disposal costs used for low flow facilities 16139, 16148, 16160, 16250

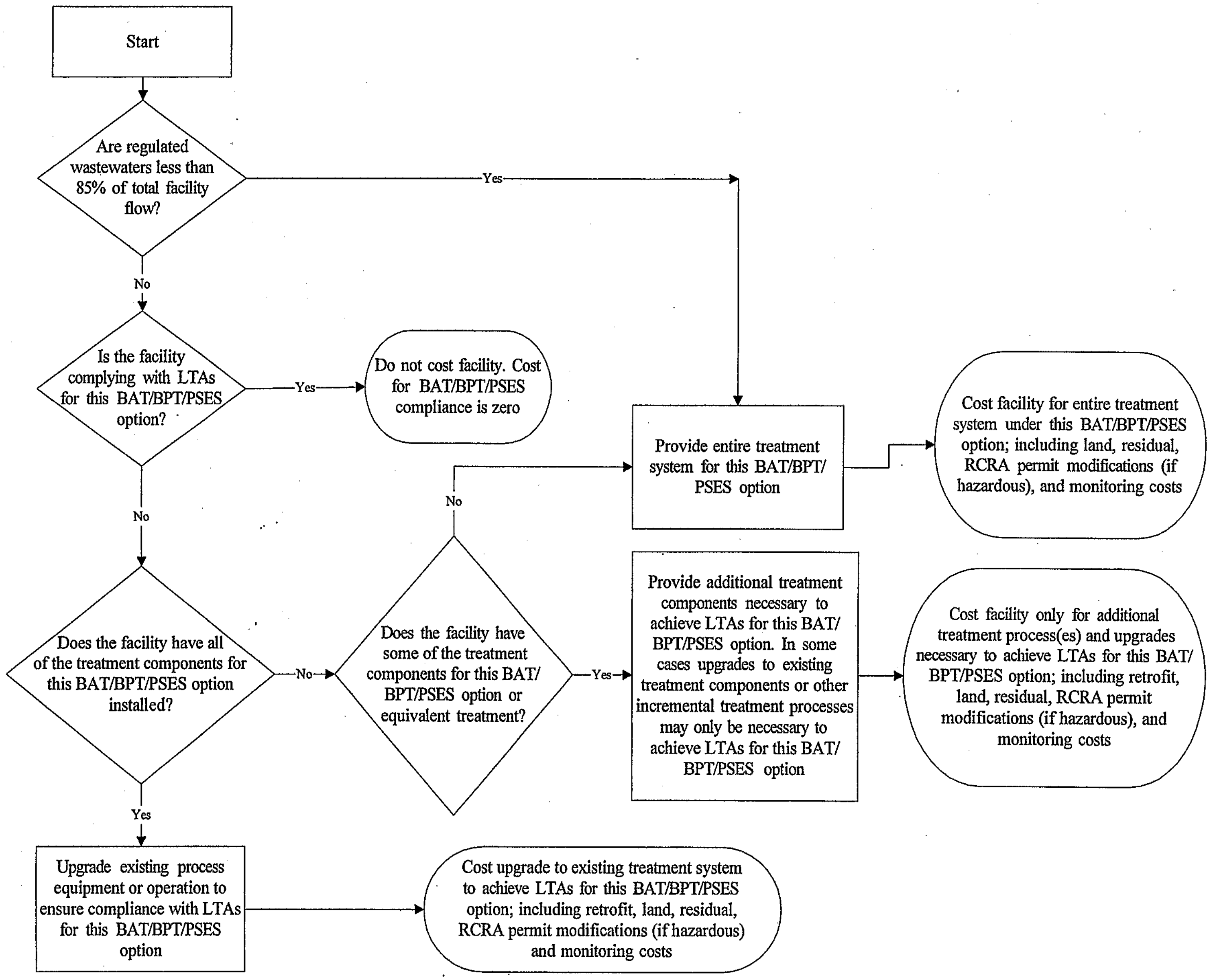


Figure 9-1: Option-Specific Costing Logic Flow Diagram

Figure 9-2
Equalization Capital Cost Curve

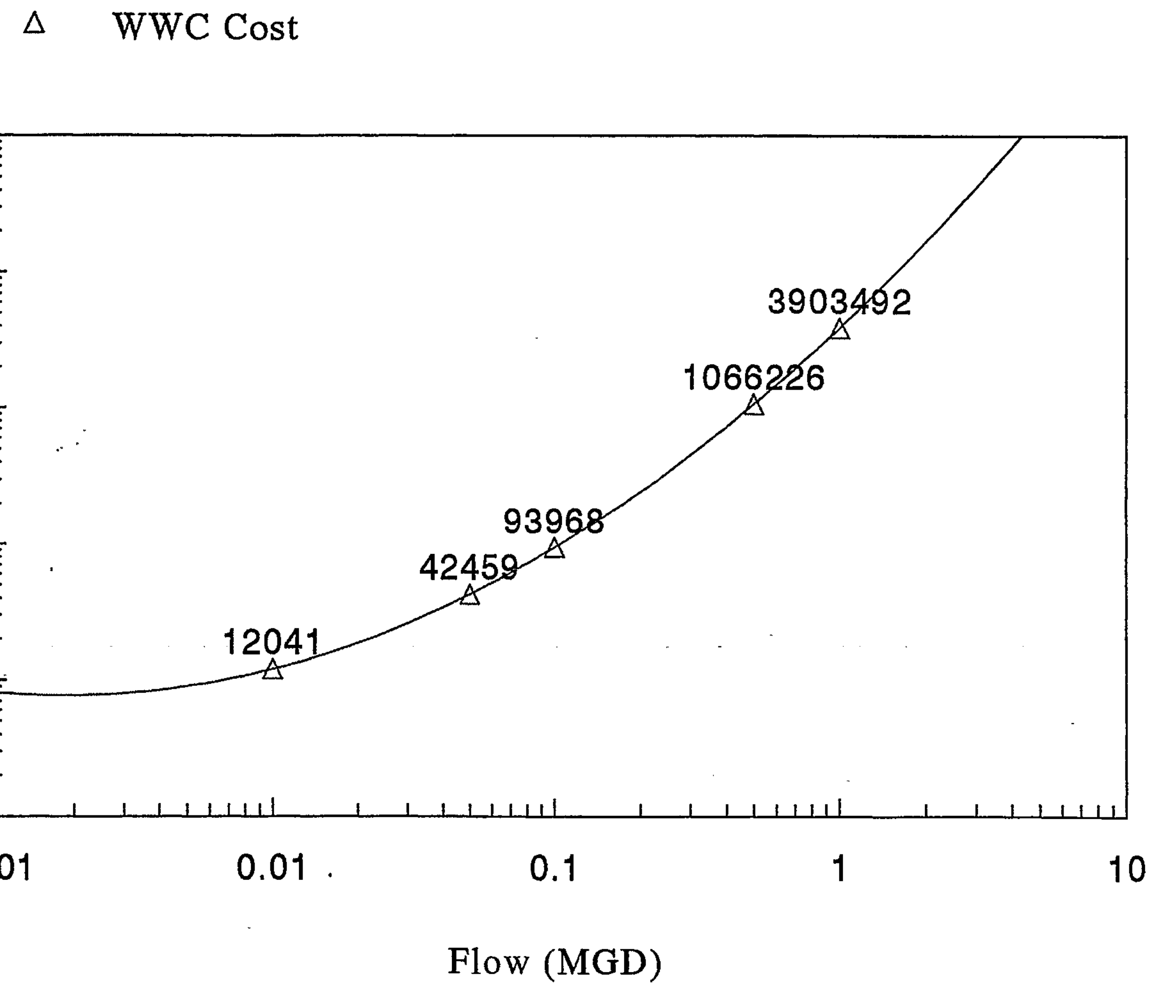


Figure 9-3
Flocculation Capital Cost Curve

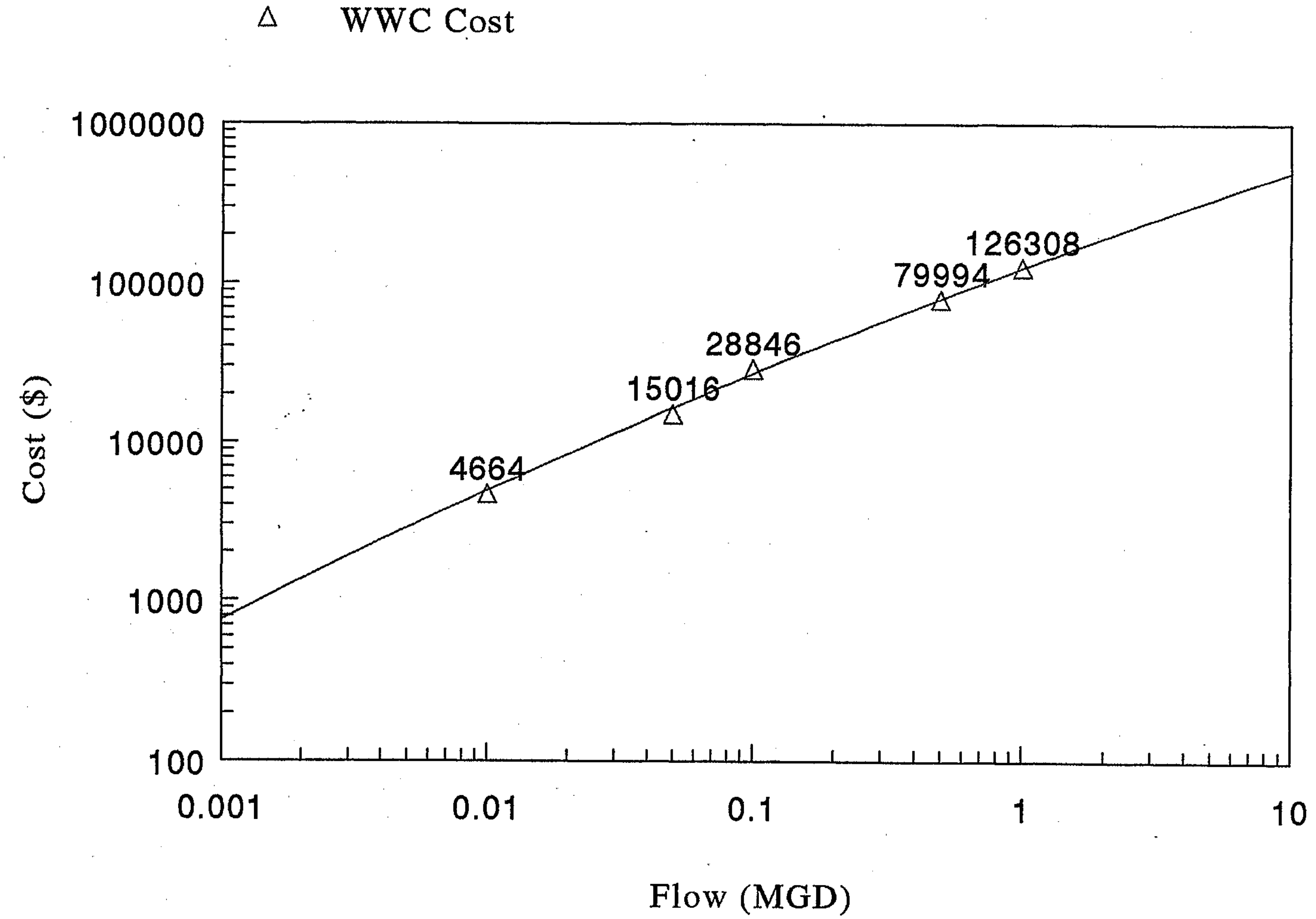


Figure 9-4
Flocculation O&M Cost Curve

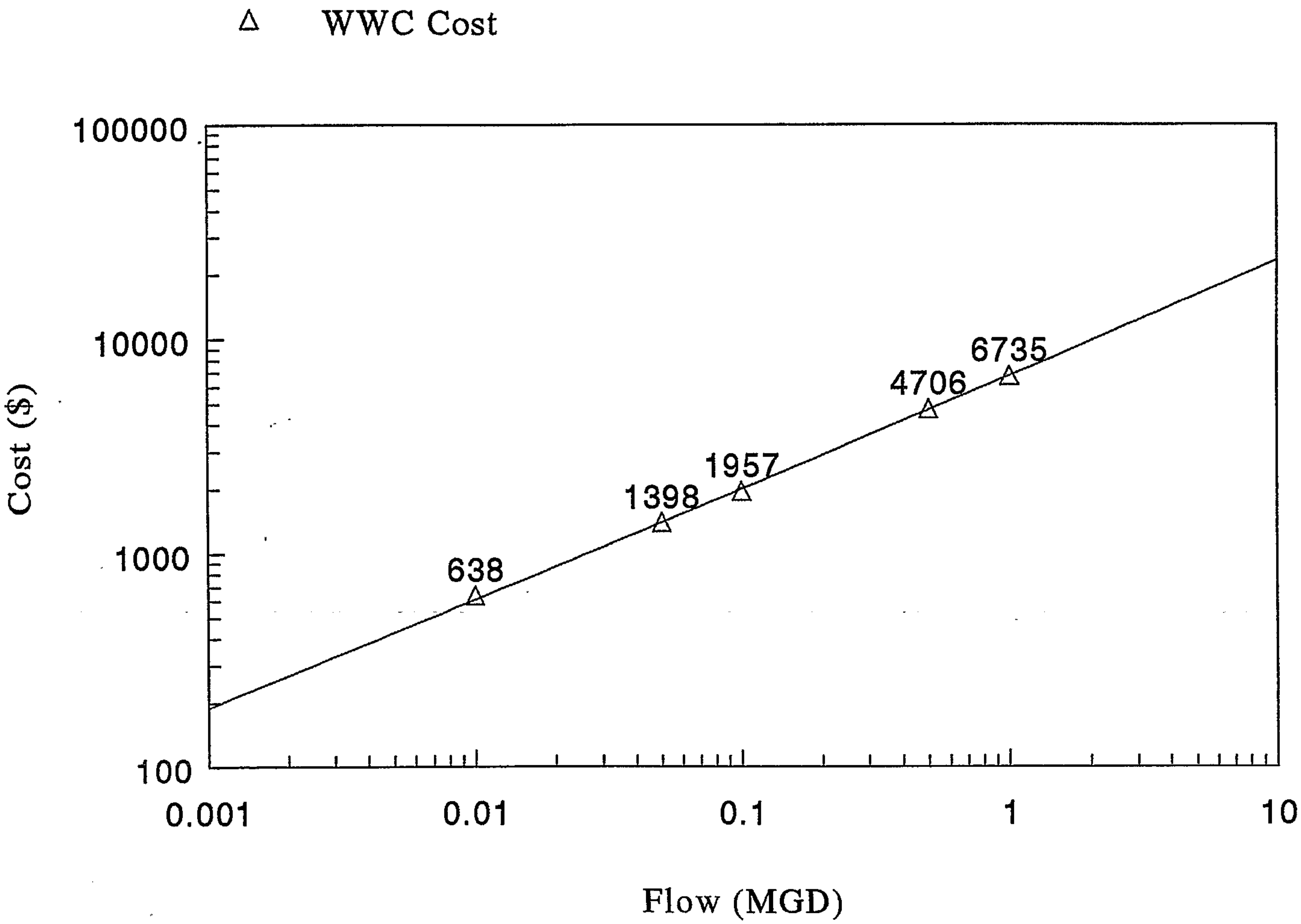


Figure 9-5
Sodium Hydroxide Capital Cost Curve

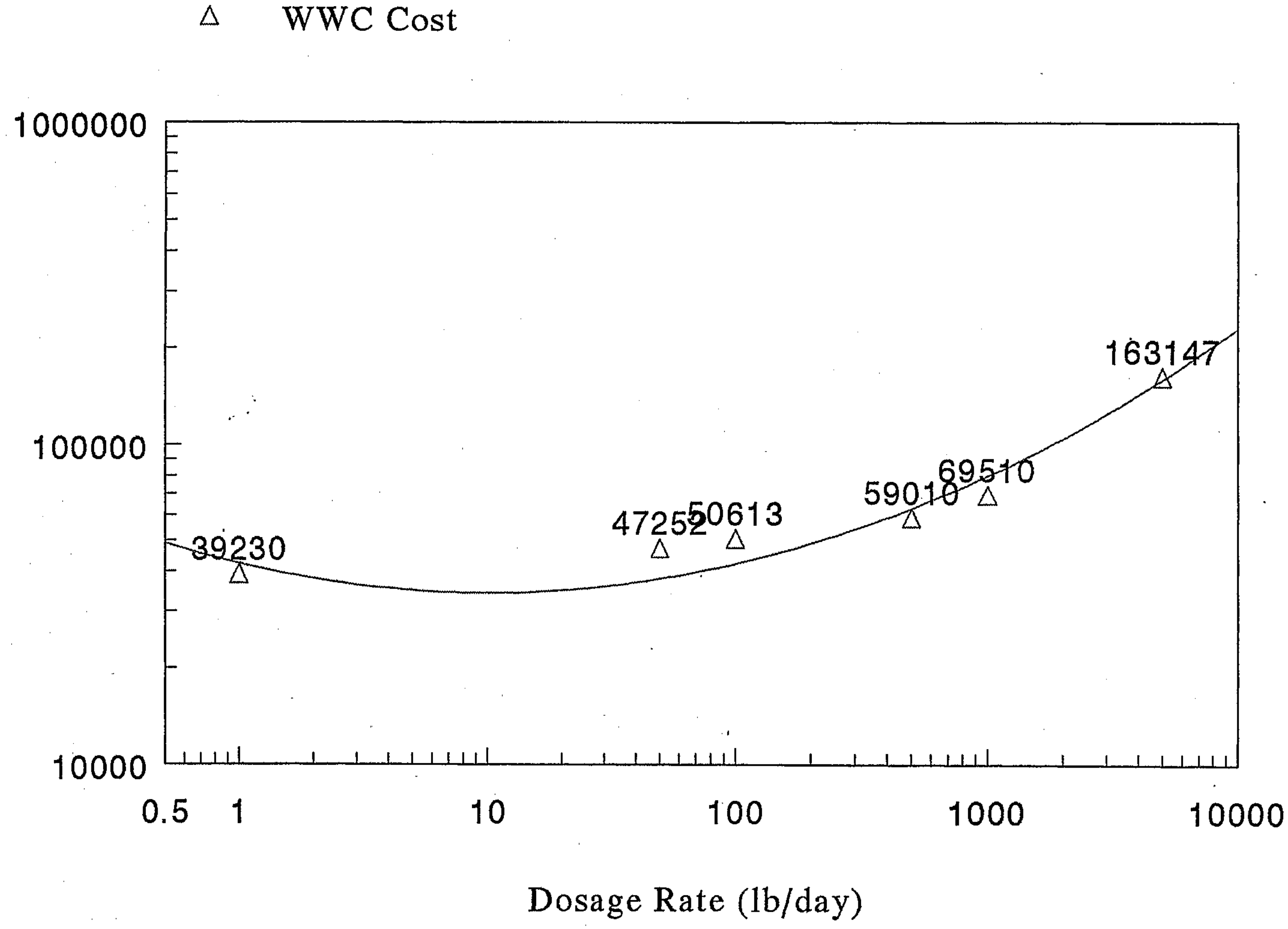


Figure 9-6
Sodium Hydroxide O&M Cost Curve

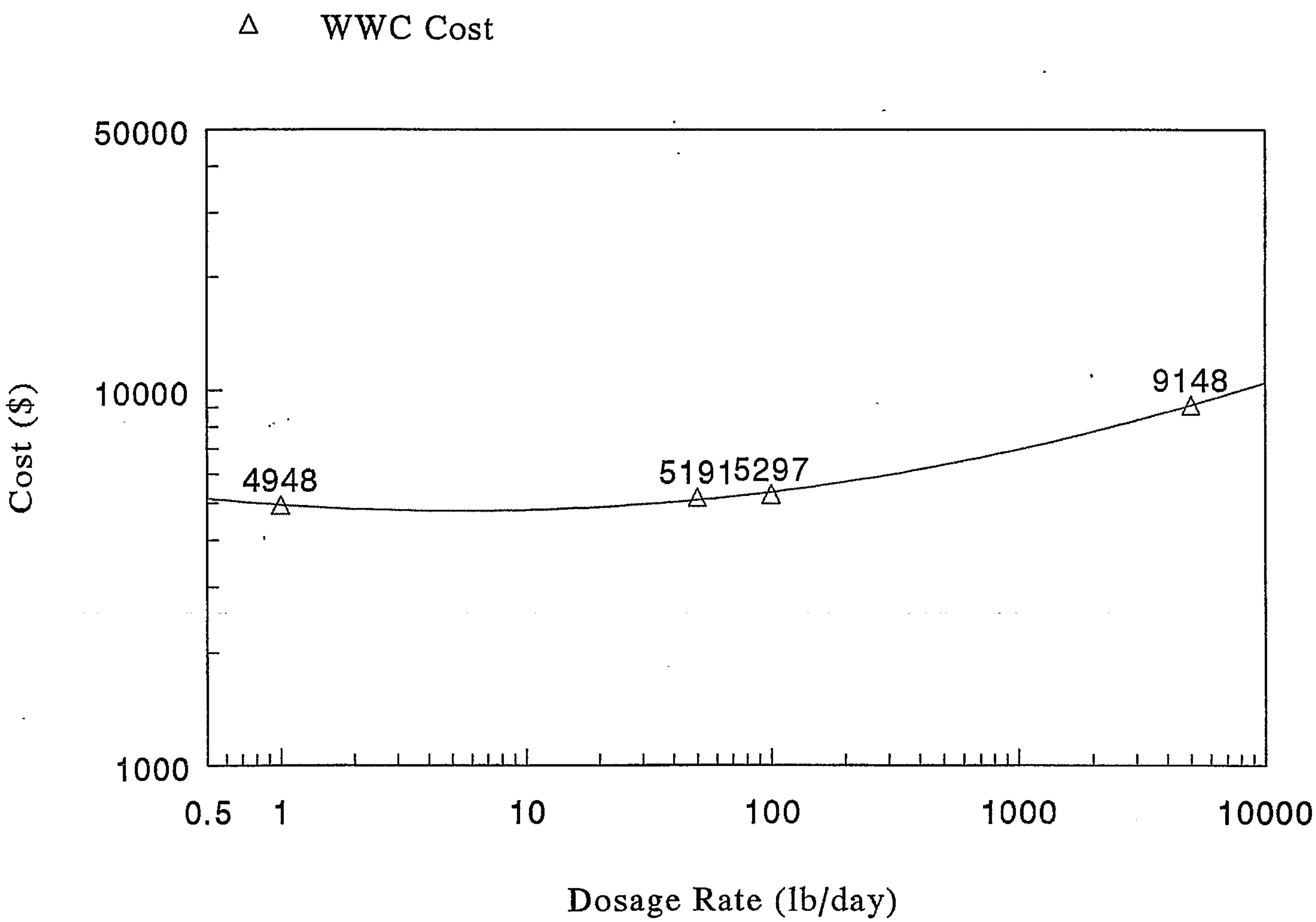


Figure 9-7
Phosphoric Acid Feed Capital Cost Curve

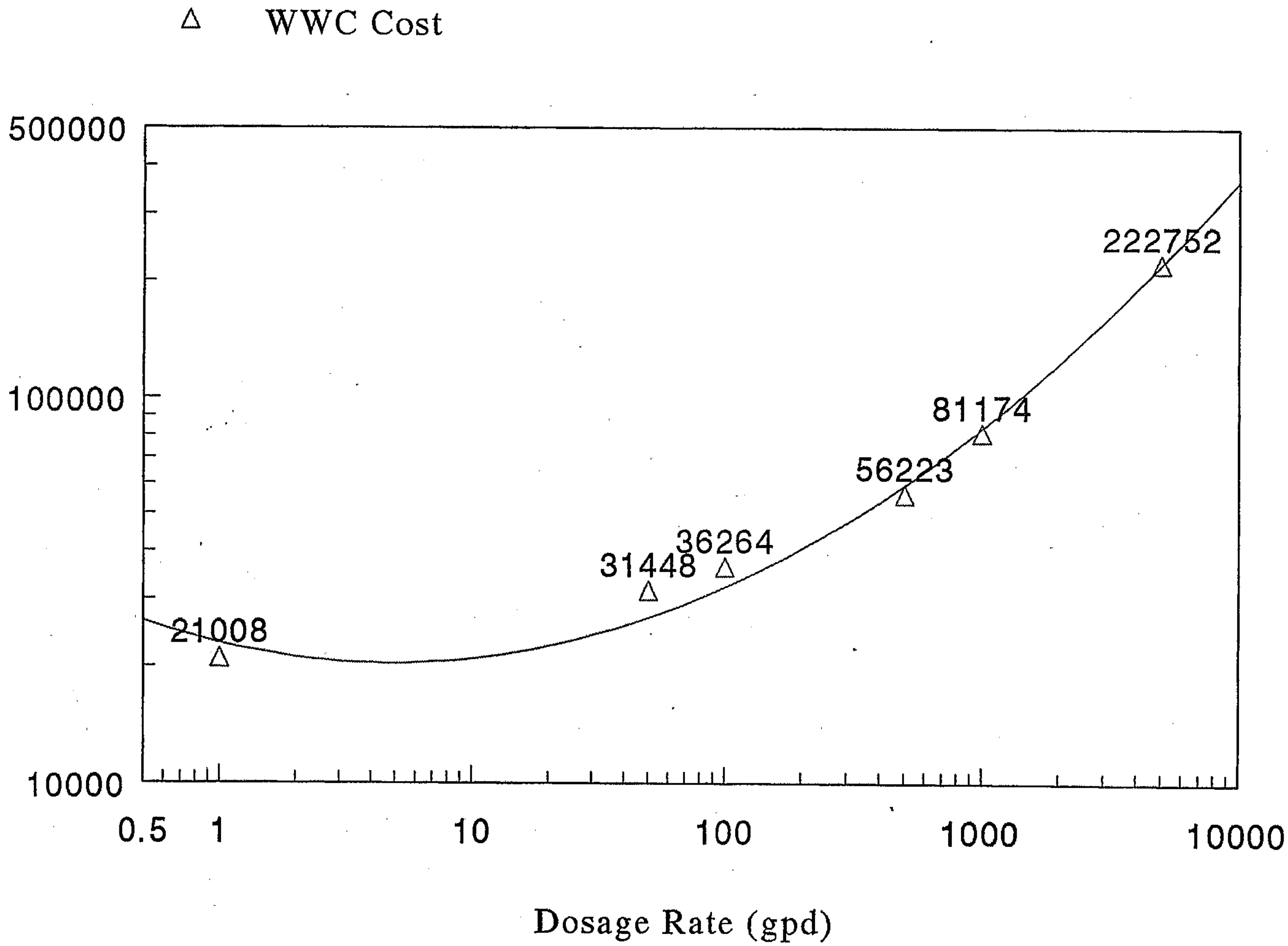


Figure 9-8
Phosphoric Acid Feed O&M Cost Curve

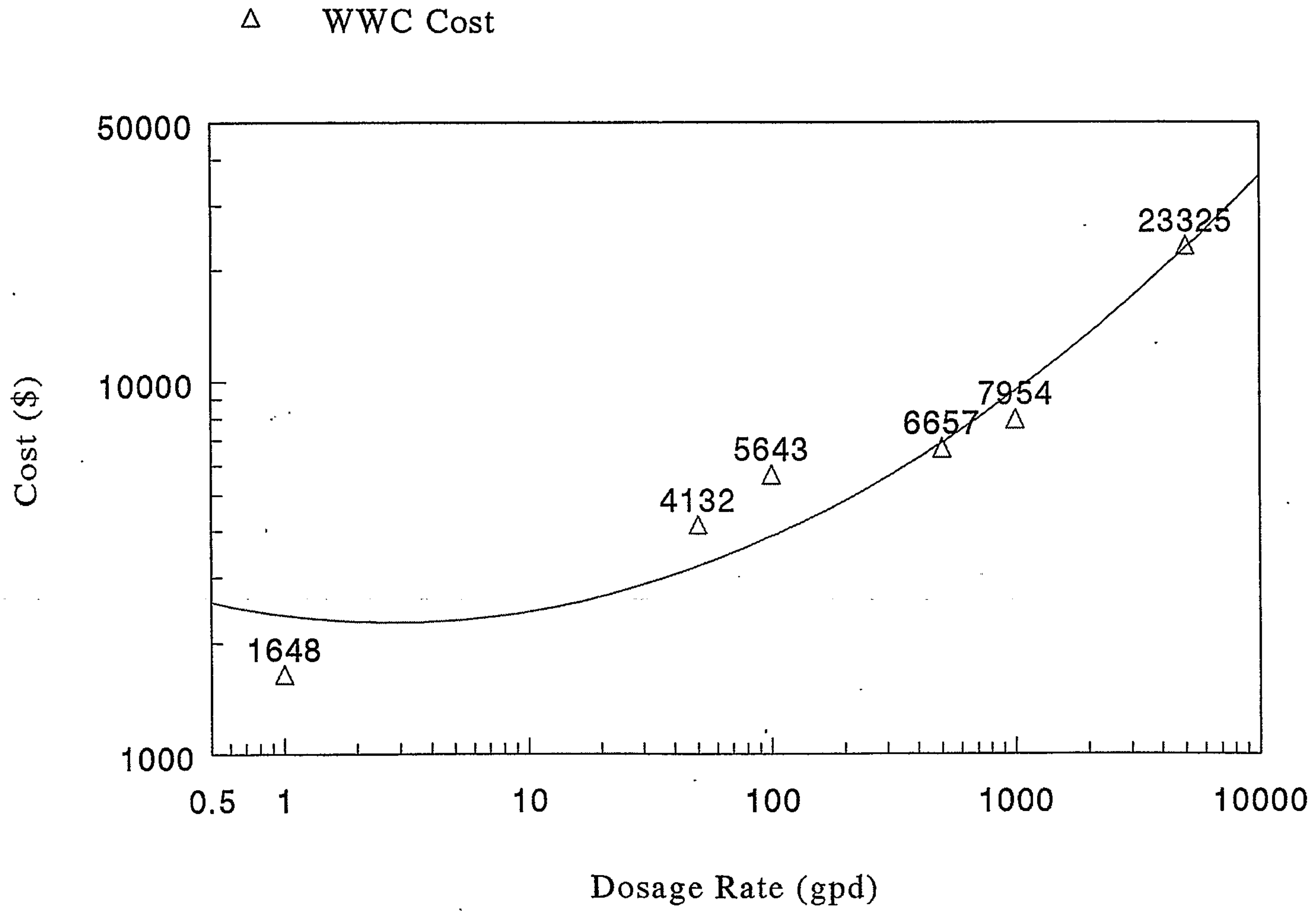


Figure 9-9

Polymer Feed Capital Cost Curve

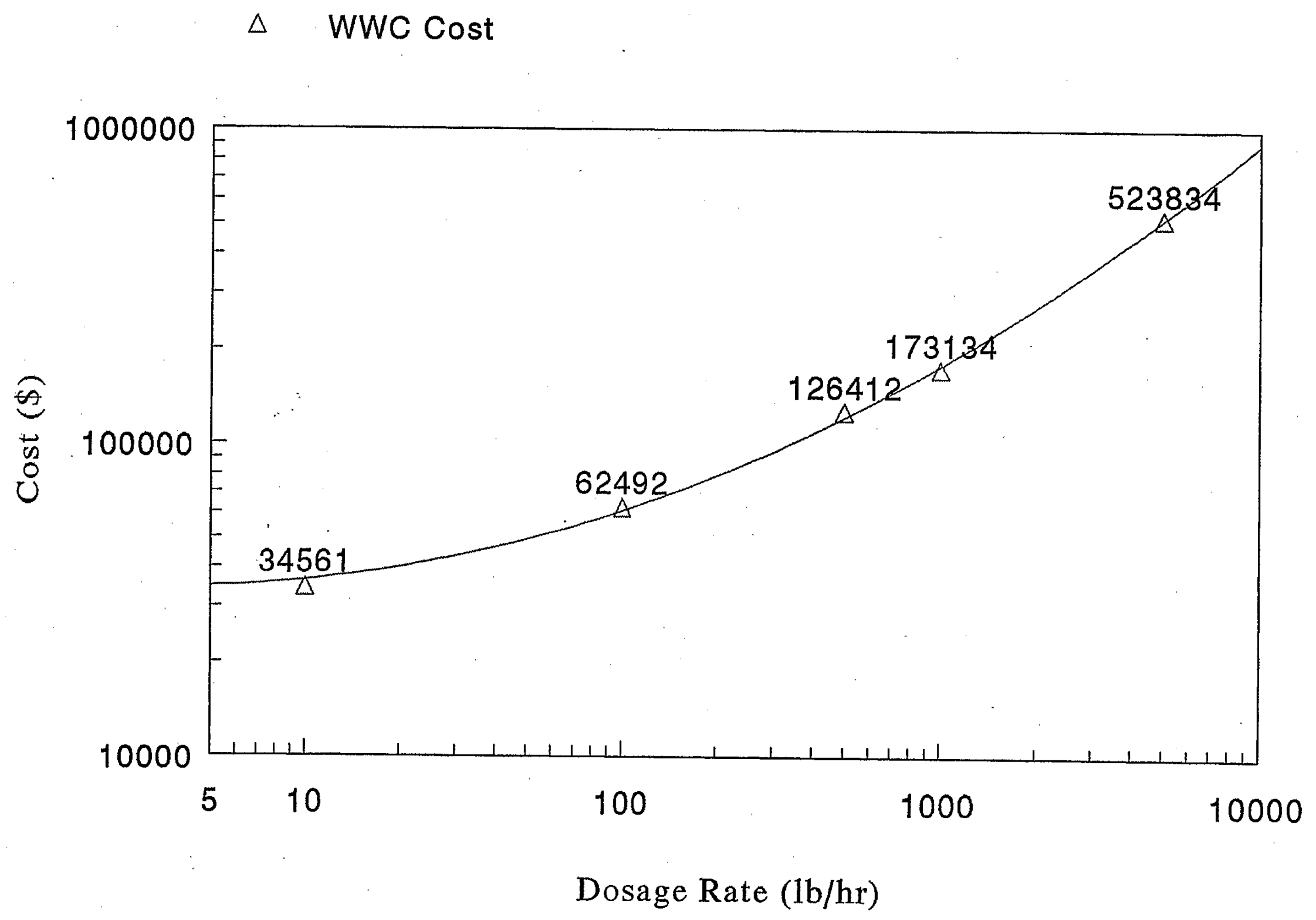


Figure 9-10
Polymer Feed O&M Cost Curve

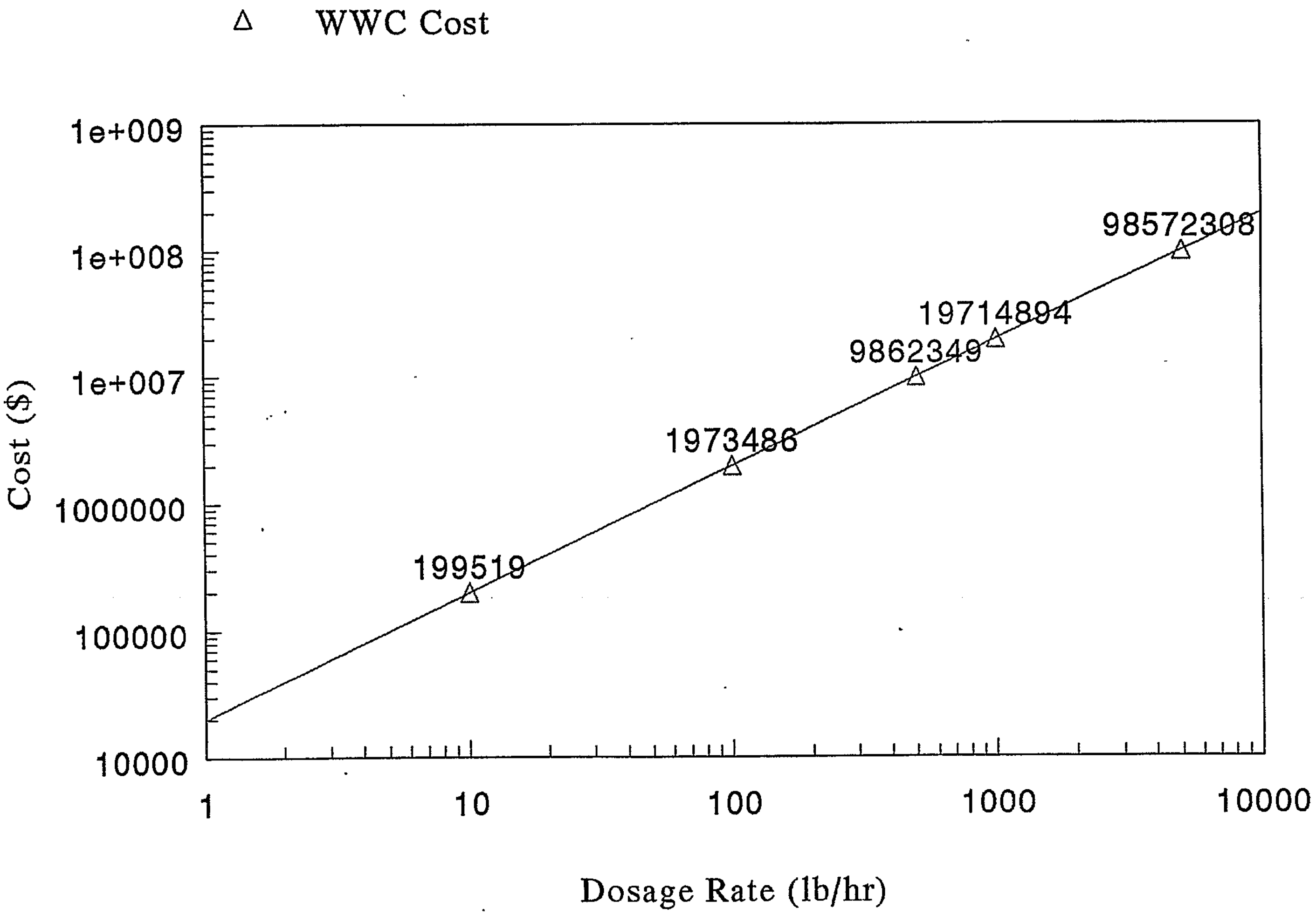


Figure 9-11

Primary Clarifier Capital Cost Curve

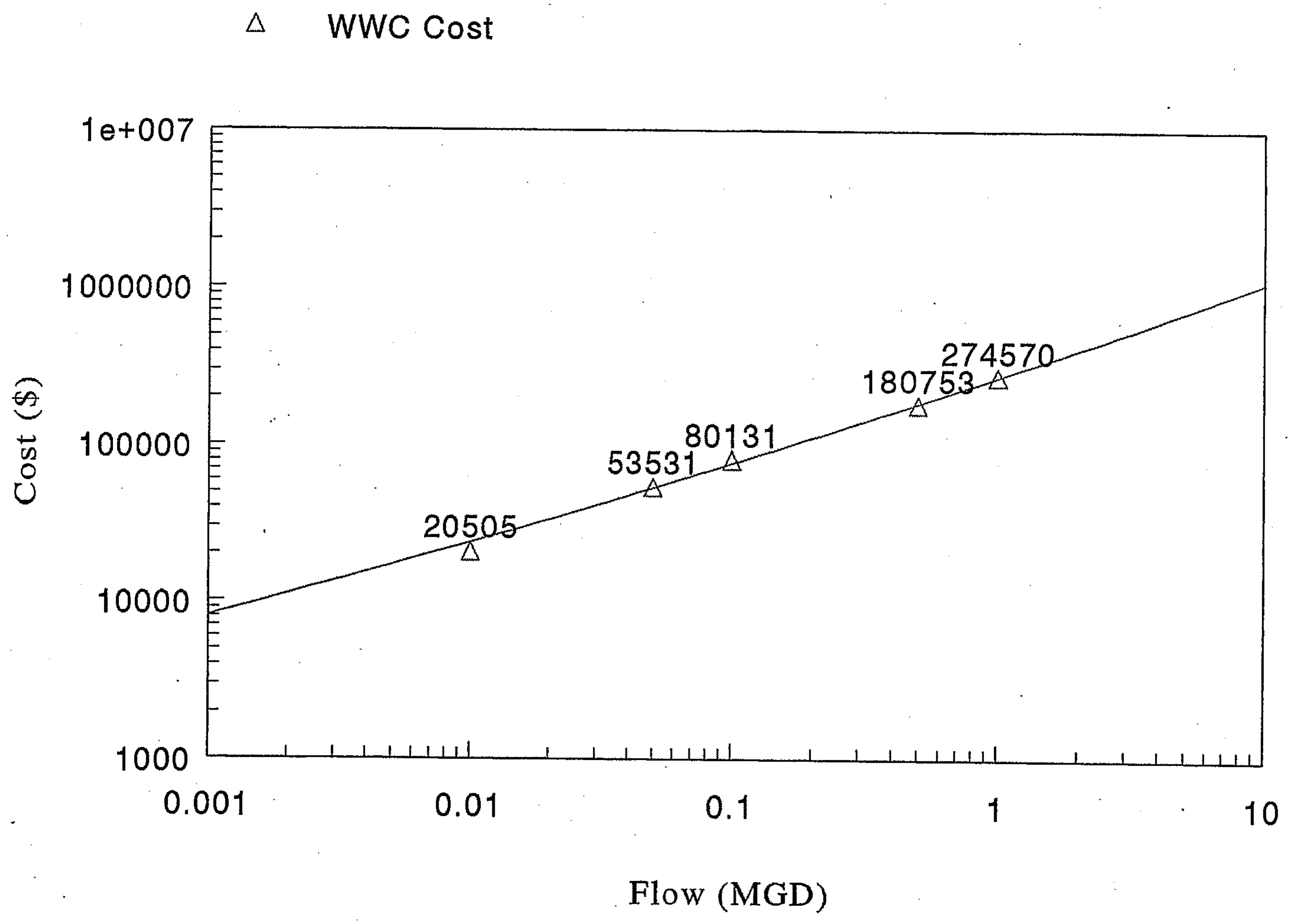


Figure 9-12

Primary Clarifier O&M Cost Curve

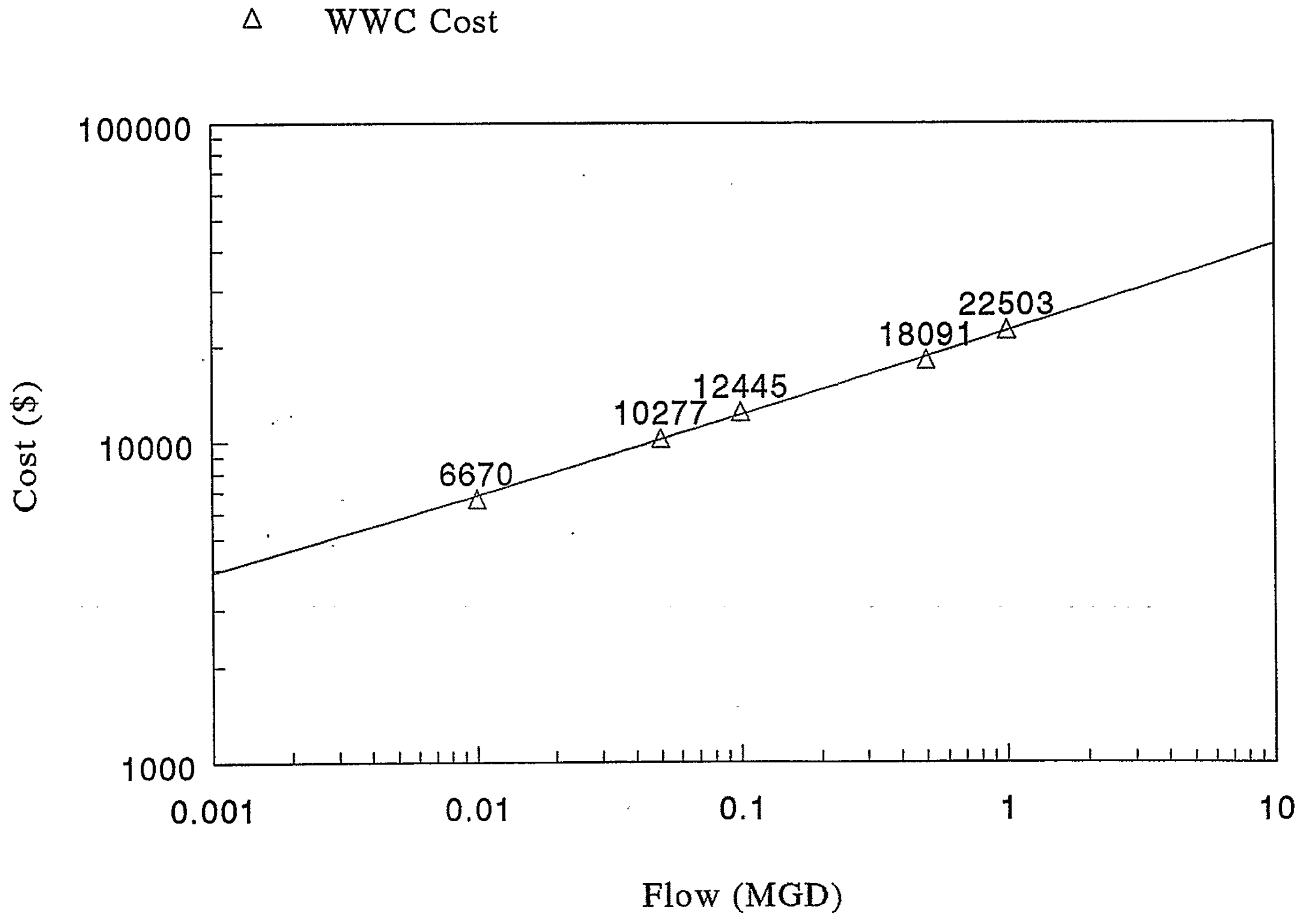


Figure 9-13
Aeration Basin Capital Cost Curve

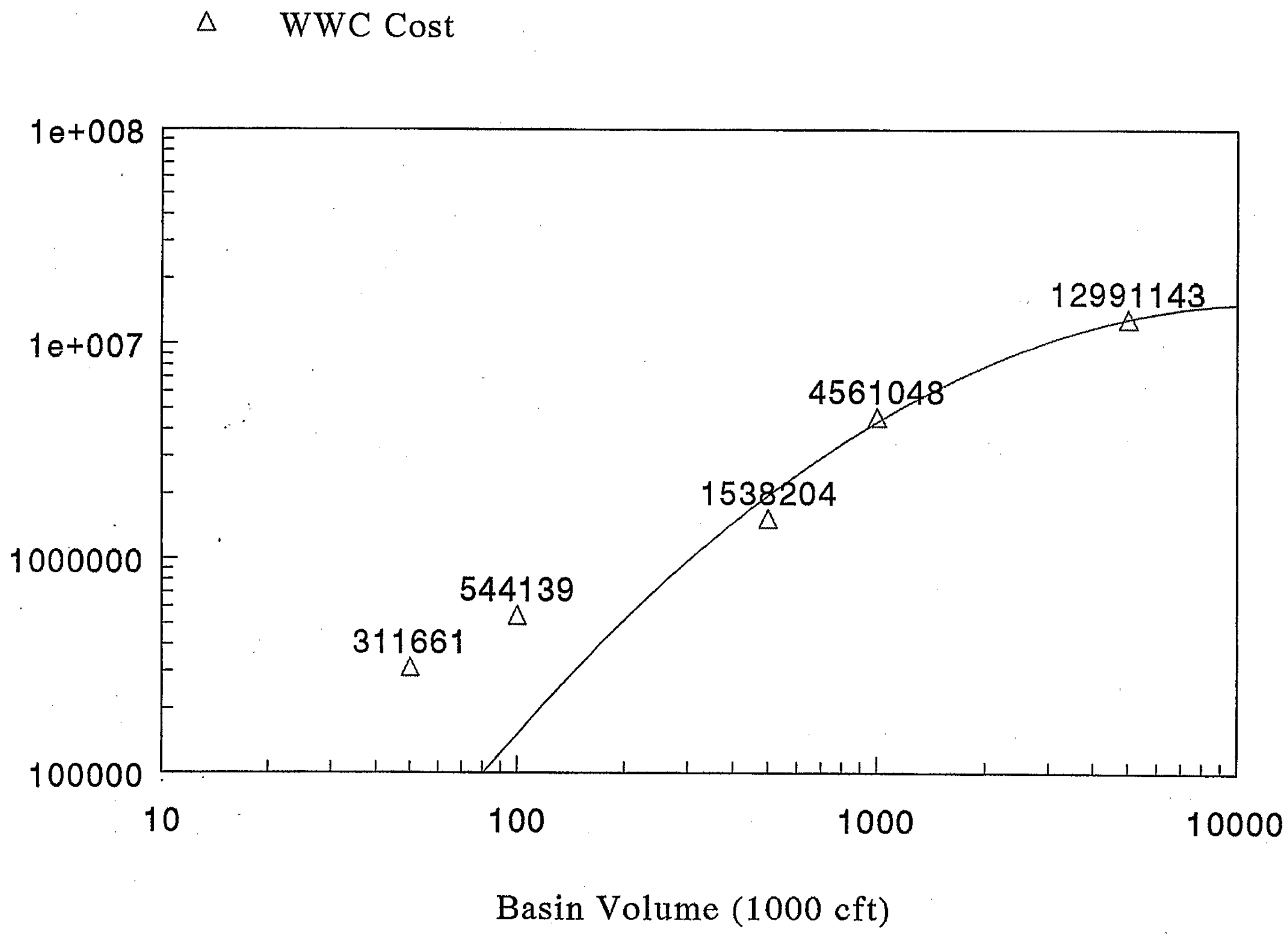


Figure 9-14

Air Diffusion System Capital Cost Curve

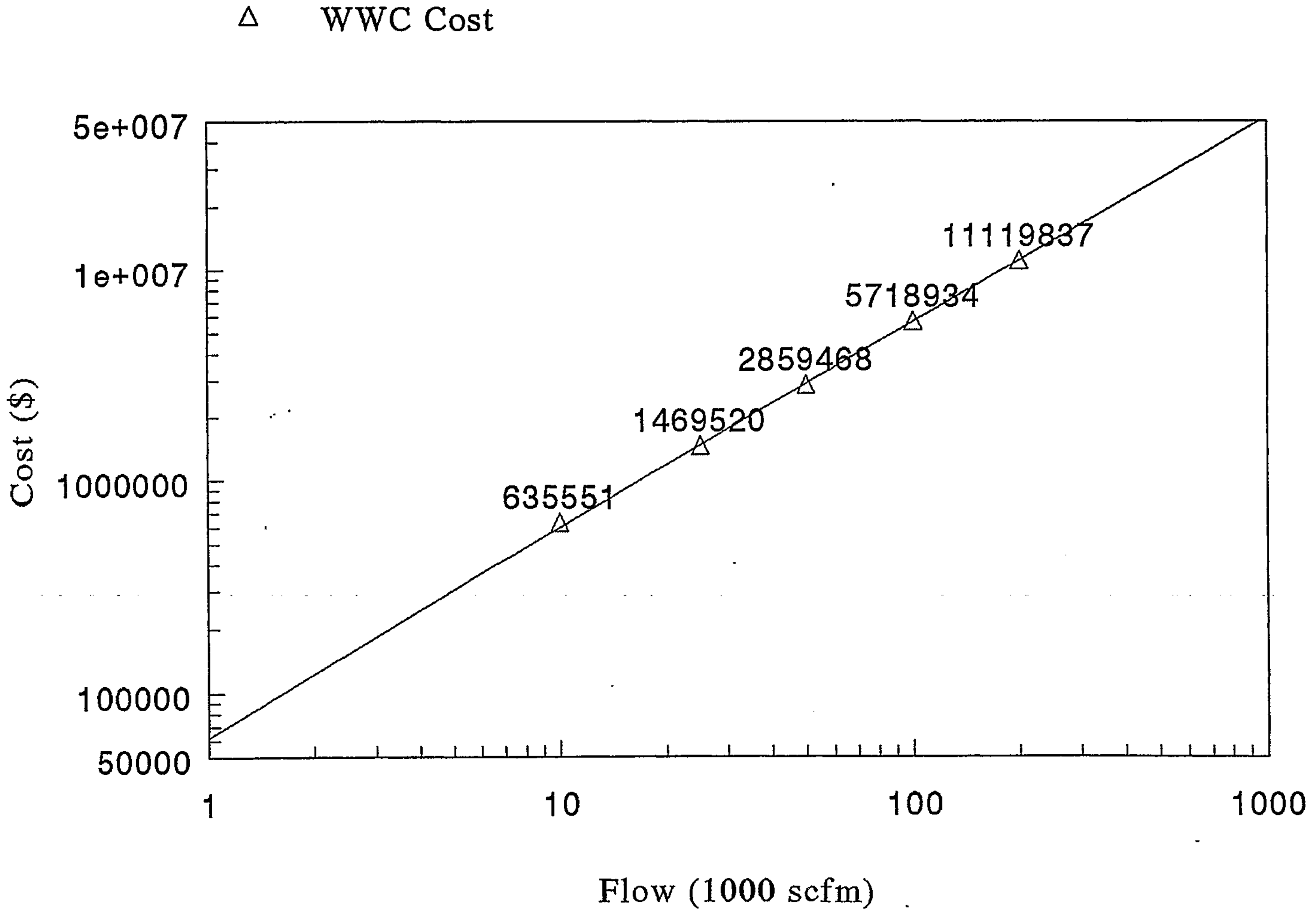


Figure 9-15
Air Diffusion System O&M Cost Curve

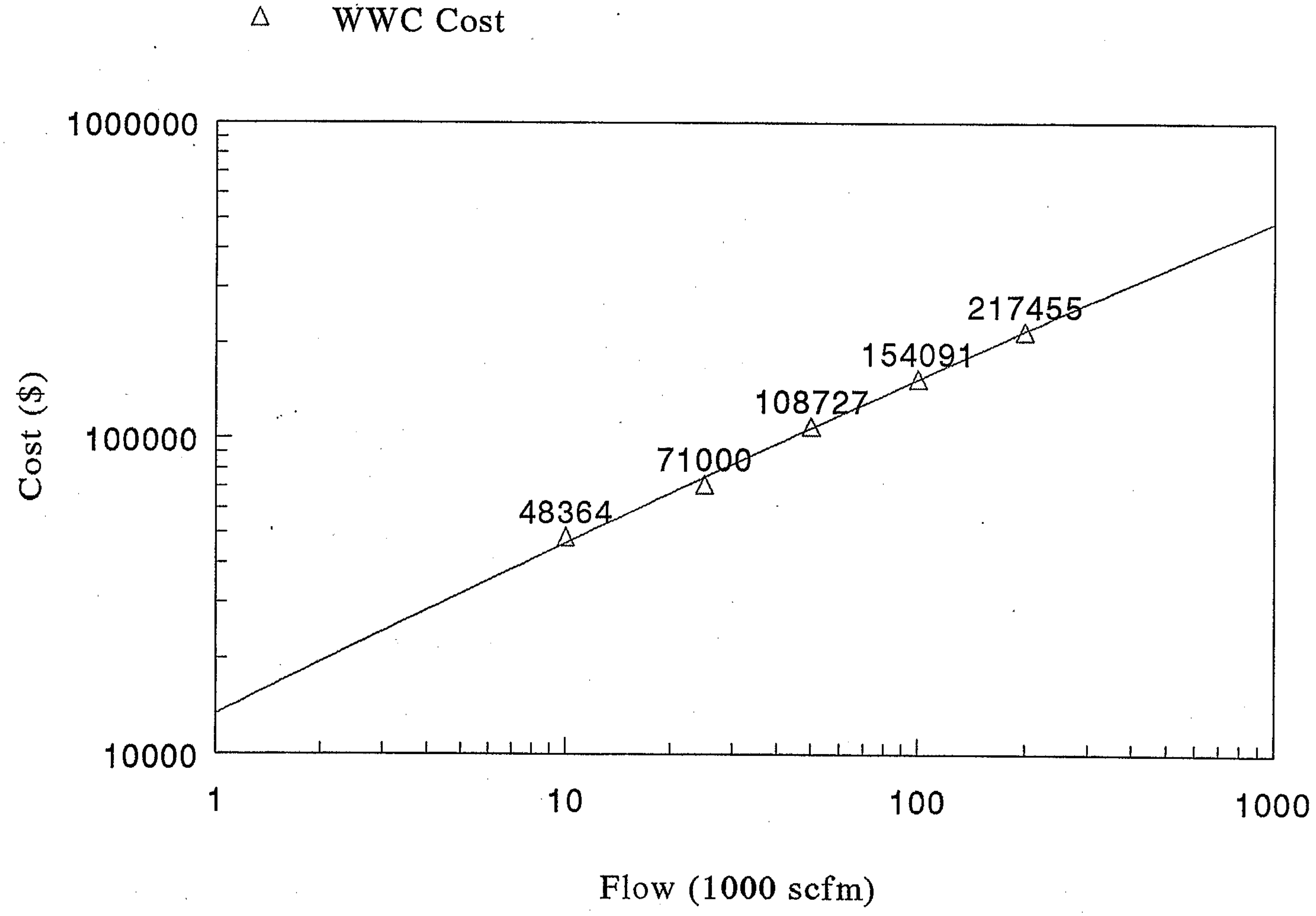


Figure 9-16
Secondary Clarifier Capital Cost Curve

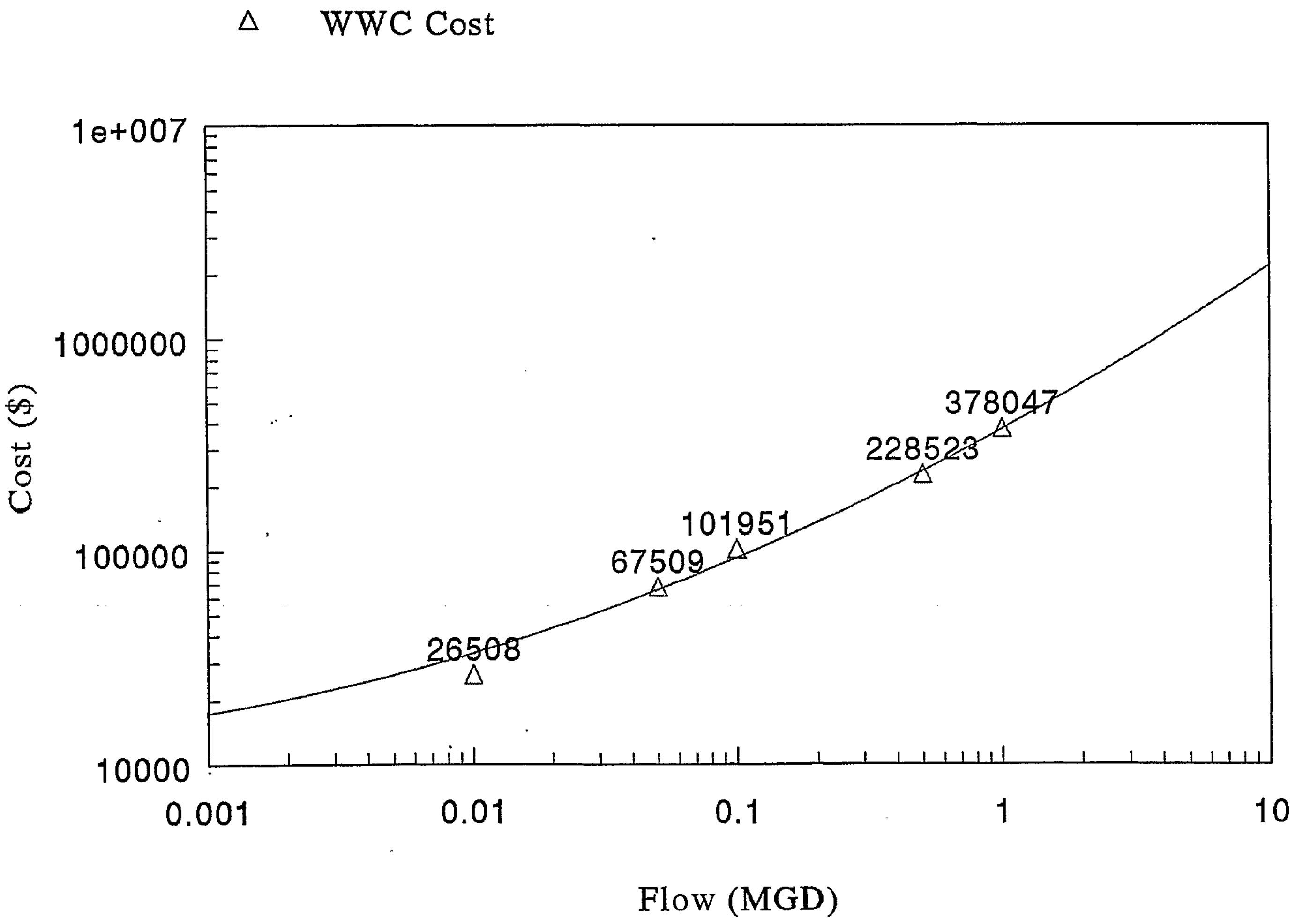


Figure 9-17
Secondary Clarifier O&M Cost Curve

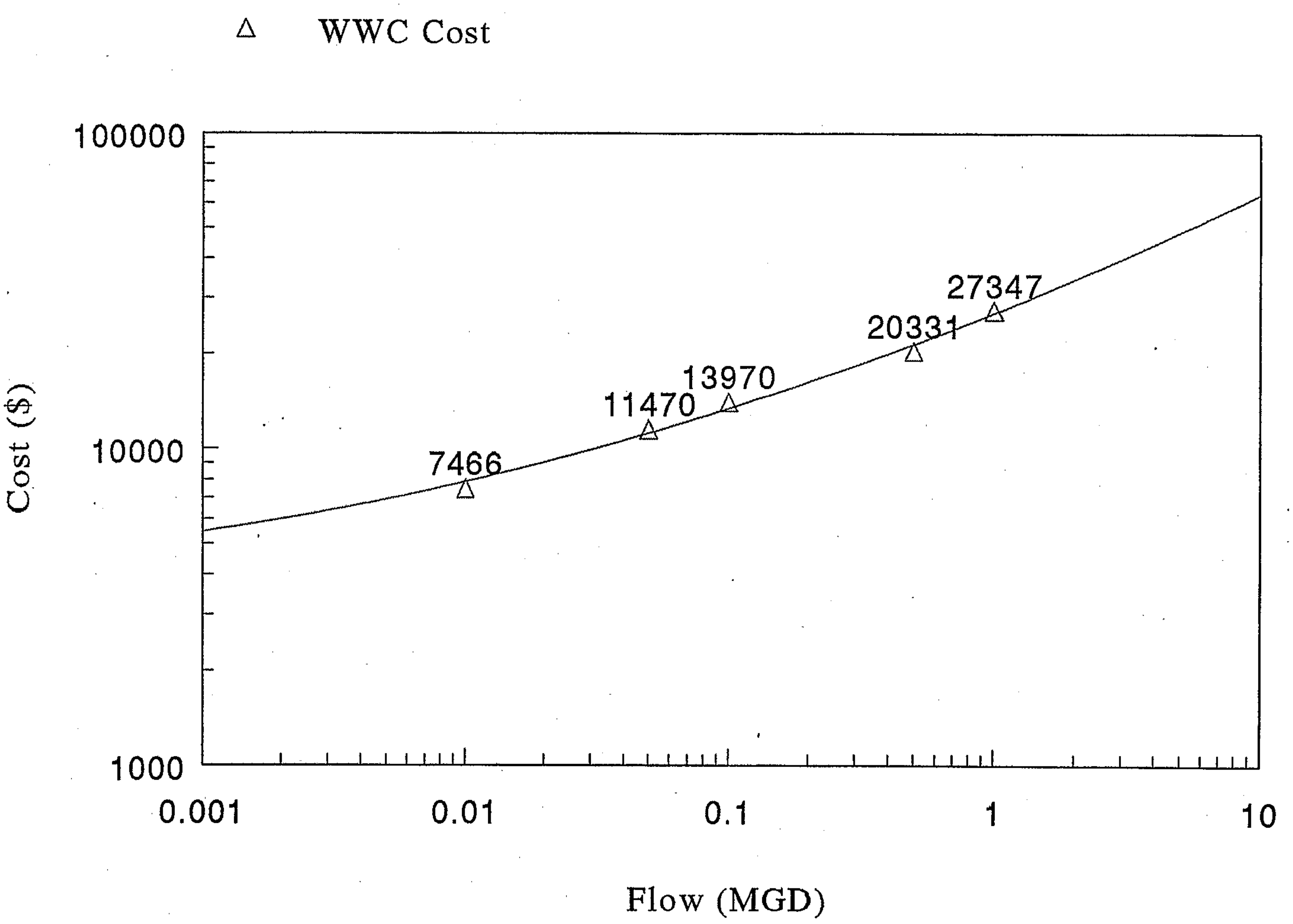


Figure 9-18
Multimedia Filtration Capital Cost Curve

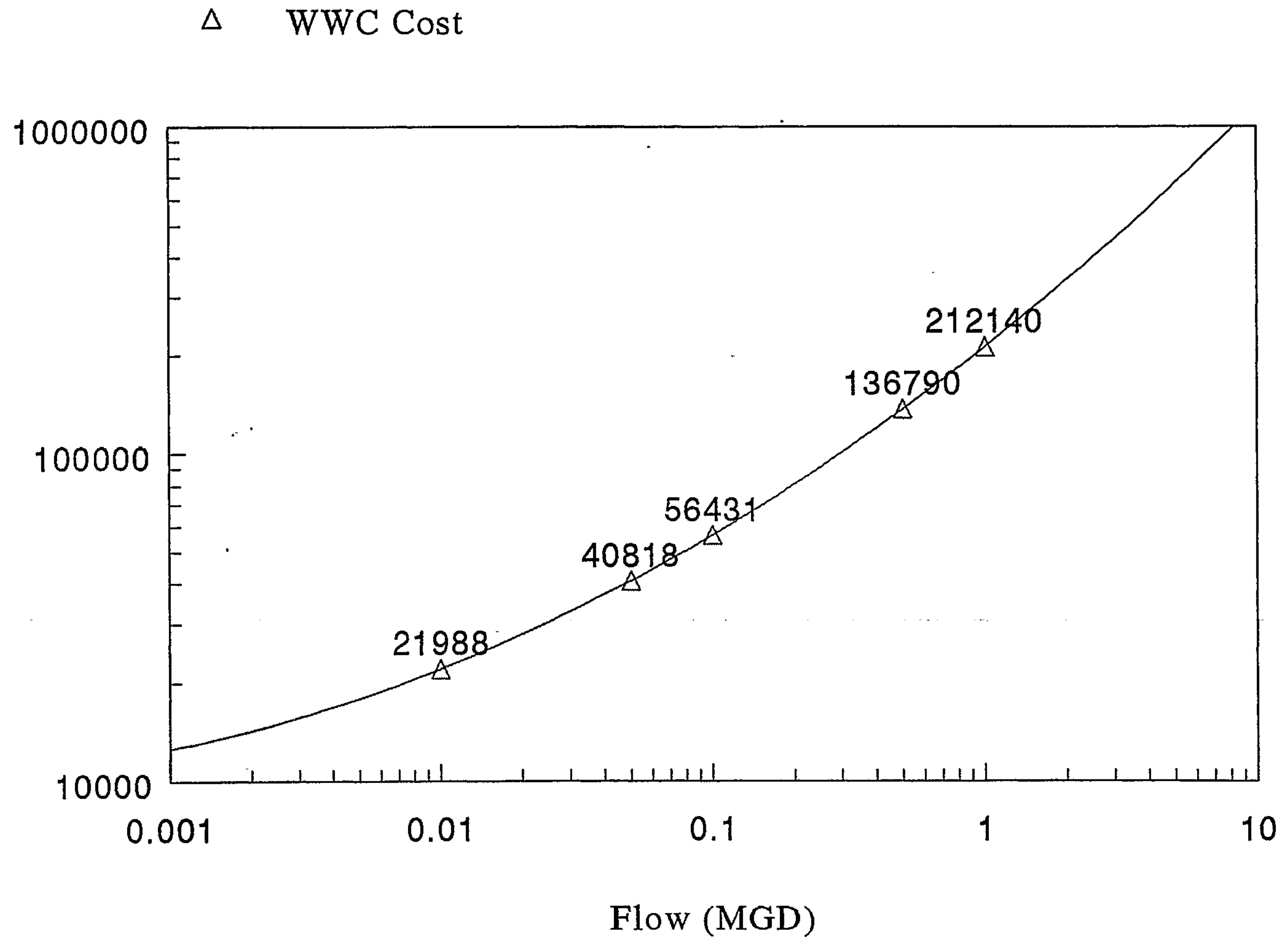


Figure 9-19

Multimedia Filtration O&M Cost Curve

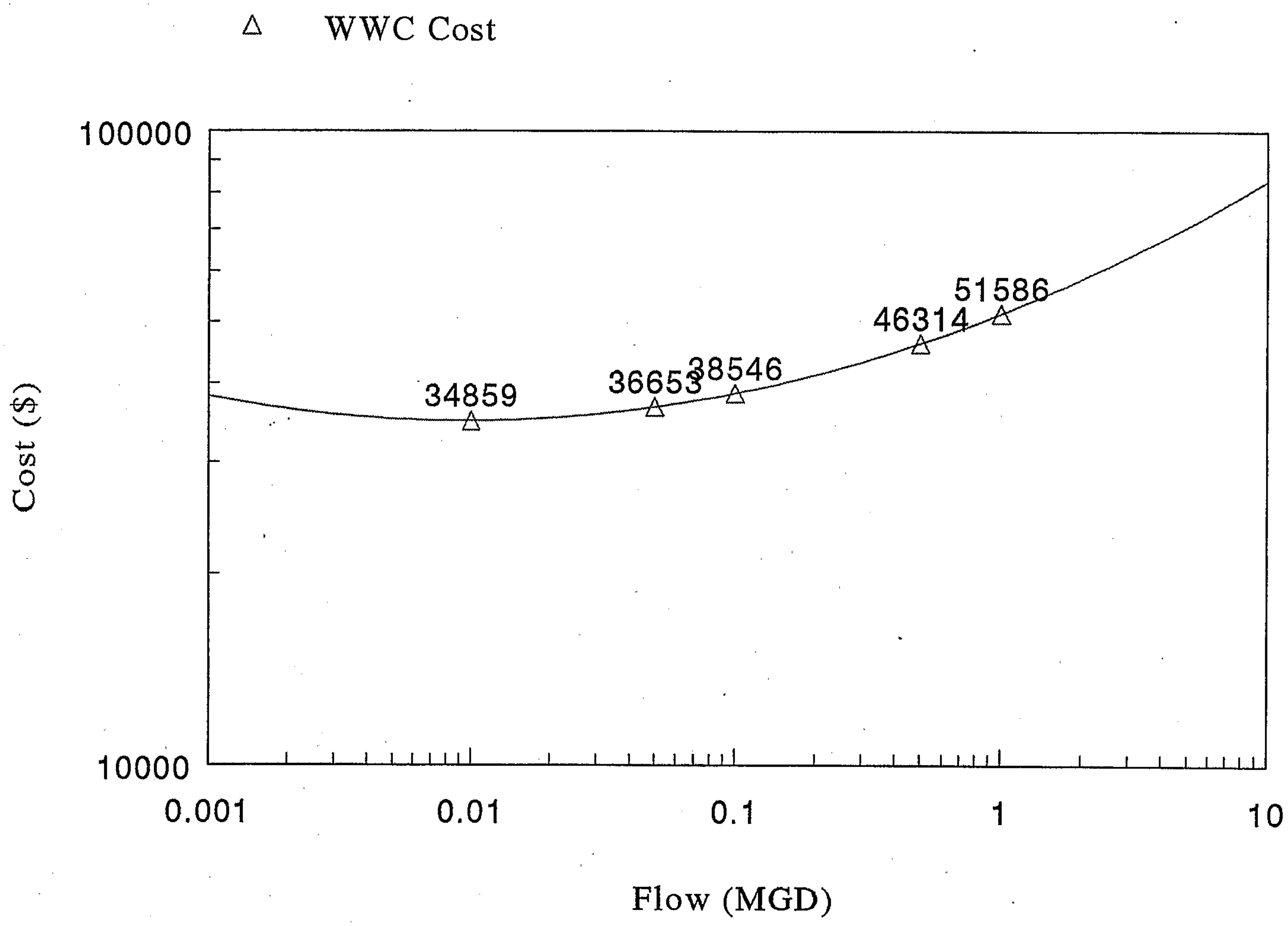


Figure 9-20
Reverse Osmosis Capital Cost Curve

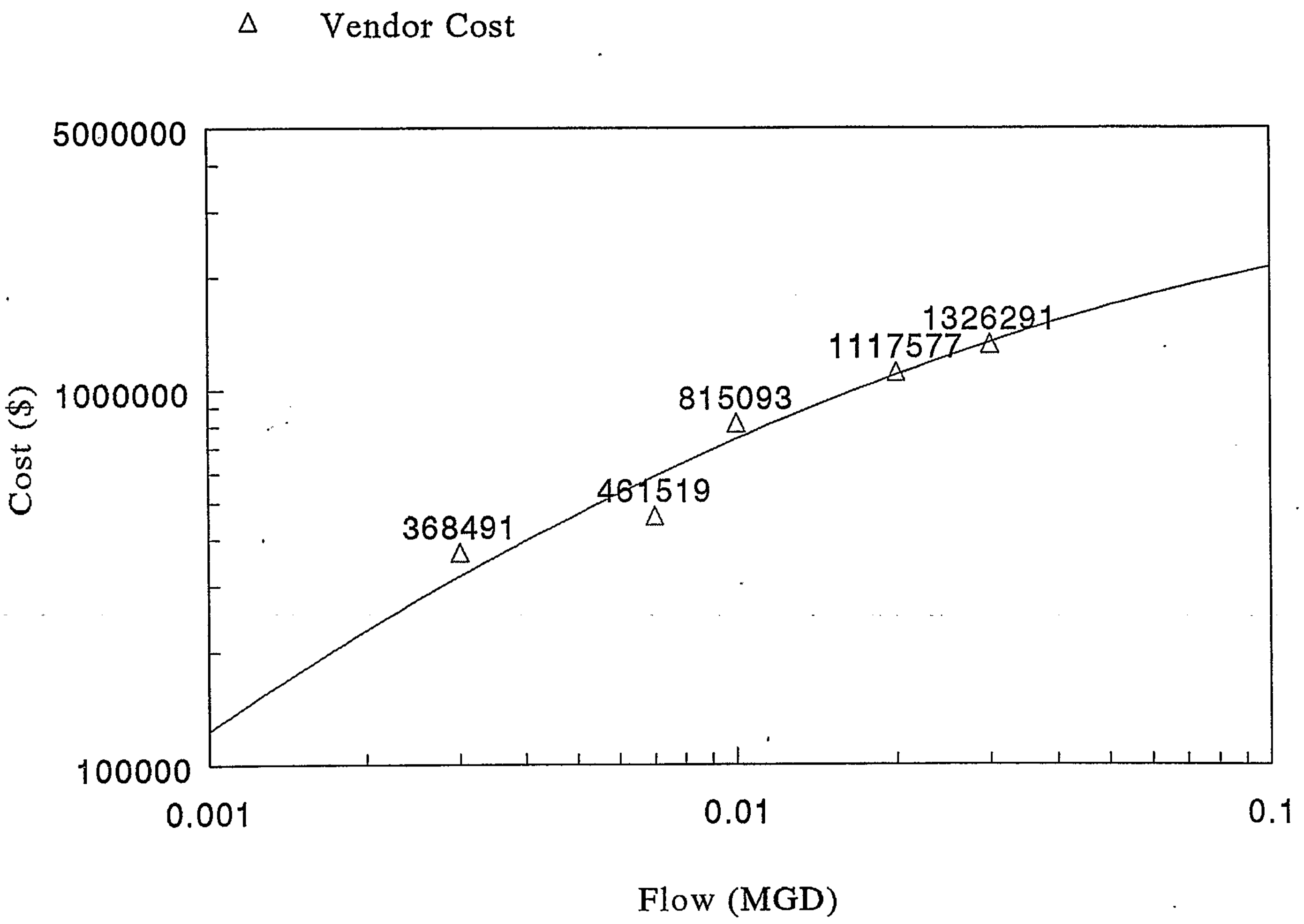


Figure 9-21
Sludge Drying Beds Capital Cost Curve

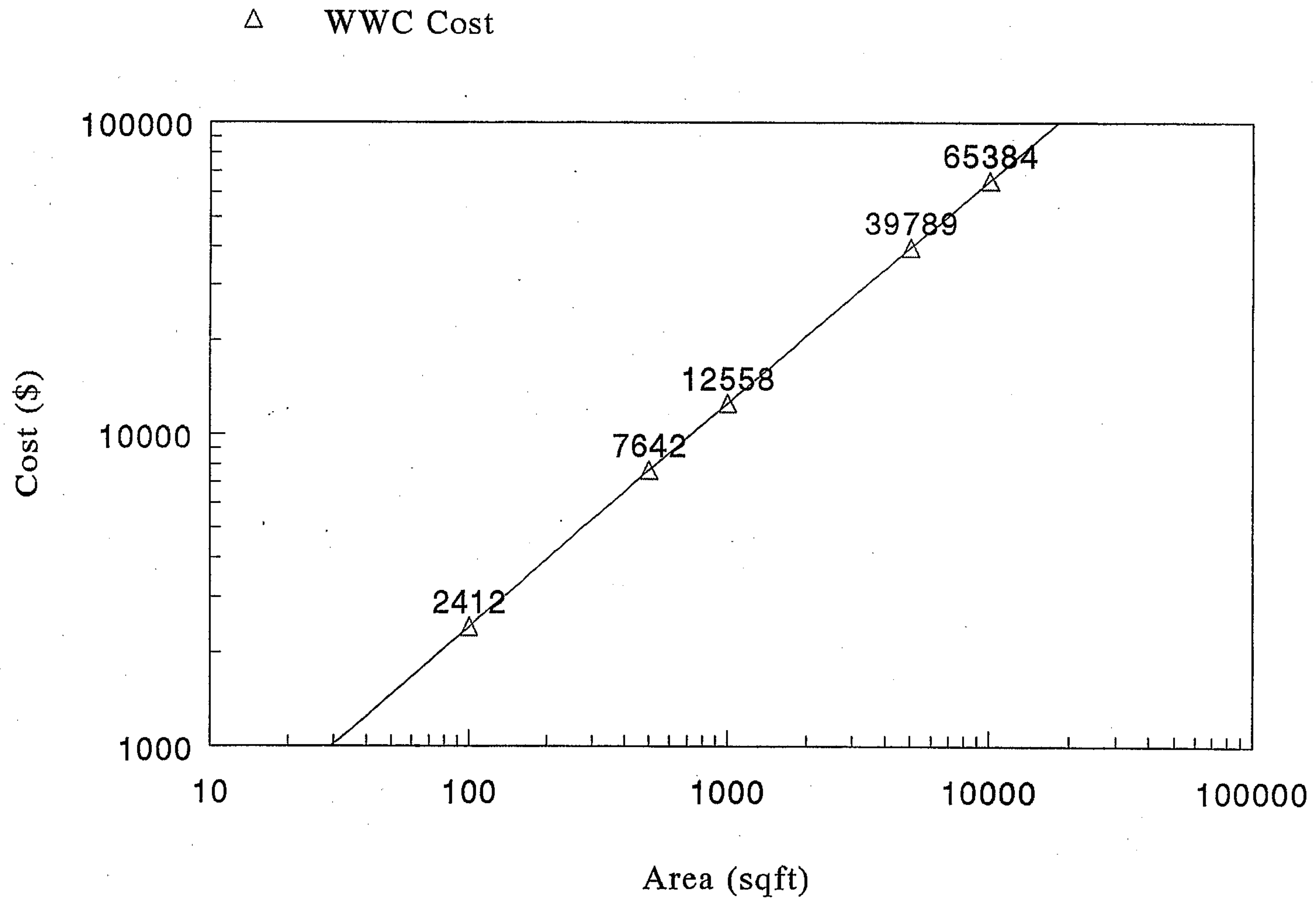
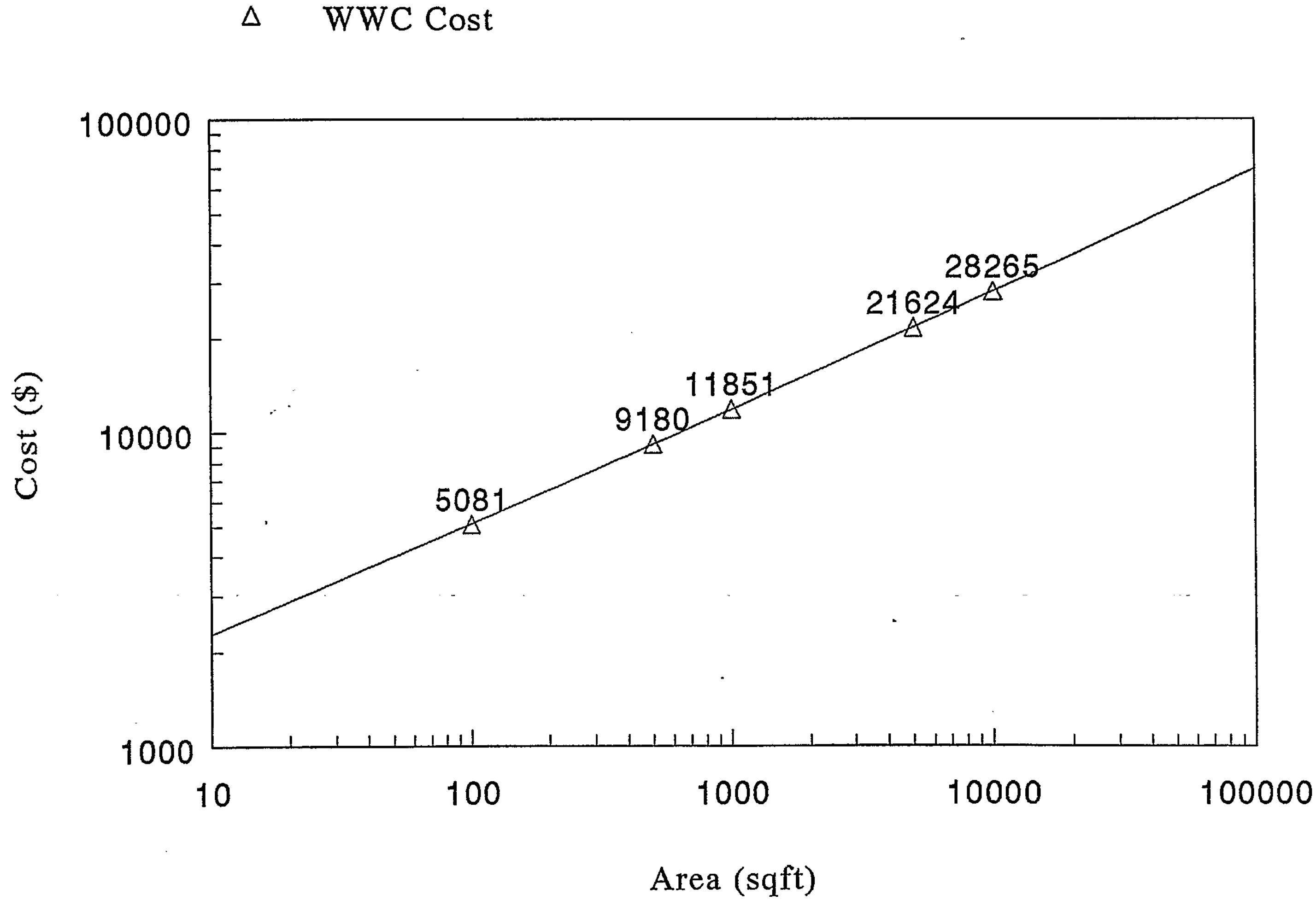


Figure 9-22
Sludge Drying Beds O&M Cost Curve



10.0 NON-WATER QUALITY IMPACTS

The operation of wastewater treatment systems has the potential for causing an environmental impact through the generation of solid and hazardous residuals, air emissions, and the energy consumption of the wastewater treatment equipment.

The elimination or reduction of one form of pollution may create or aggravate other environmental problems. Therefore, Sections 304(b) and 306 of the Clean Water Act (CWA) require EPA to consider the non-water quality environmental impacts and energy requirements of effluent limitations guidelines and standards. Pursuant to these requirements, EPA has considered the effect of promulgating the proposed BPT, BCT, BAT, NSPS, PSES and PSNS regulations for the Landfills industry in regard to the creation of additional air pollution, solid and hazardous waste, and energy consumption.

While it is difficult to balance environmental impacts across all media and energy use, the Agency determined that the impacts identified below do not outweigh the benefits associated with compliance with the limitations and standards.

10.1 Air Pollution

The primary source of air pollution from landfills is due to the microbial breakdown of organic wastes from within the landfill. Landfills are known to be major sources of greenhouse gas emissions such as methane and carbon dioxide. These emissions are now regulated under the Clean Air Act (CAA) as a result of the municipal solid waste landfill Standards of Performance for New Stationary Sources and Guidelines for Control of Existing Sources, promulgated by the EPA on March 12, 1996 (Federal Register: Volume 61, Number 49) and codified in 40 CFR 60 Subpart CC-Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills and Subpart WWW-Standards of Performance for Municipal Solid Waste Landfills. In accordance with these regulations, many non-hazardous solid waste landfills are required to install systems to collect gases generated in the landfill.

Wastewater collected from within the landfill contains organic compounds which include volatile organic compounds and hazardous air pollutants. These wastewaters must be collected, treated, and stored in units which are often open to the atmosphere and will result in the volatilization of certain compounds. Organic pollutants volatilize in reaching an equilibrium with the vapor phase above the wastewater. These volatile organic compounds are emitted to the ambient air surrounding the collection and treatment units. The magnitude of volatile organic compound emissions is dependent on factors such as the physical properties of the pollutants, the temperature of the wastewater, and the design of the individual collection and treatment units. The proposed regulations for the Landfills industry were based on the use of an aerated biological system. Wastewater aeration may increase the volatilization of certain organic compounds. However, the increase in air emissions due to this proposed regulation will be minimal and will not significantly increase the air emissions from landfills. Chapter 6 of this development document, which discusses raw wastewater characterization, describes the relatively small amount of volatile organic compounds currently found in untreated landfill wastewaters (see Table 6-11).

In addition, EPA is addressing emissions of volatile organic compounds from industrial wastewater through a Control Techniques Guideline (CTG) under Section 110 of the Clean Air Act. CAA amendments require that State implementation plans for certain ozone nonattainment areas be revised to require the implementation of reasonably available control technology (RACT) for control of volatile organic compound emissions from sources for which EPA has prepared CTGs. In September, 1992, EPA published a draft CTG document entitled "Control of Volatile Organic Compound Emissions from Industrial Wastewater". This document addresses various industries, including the hazardous waste treatment, storage, and disposal facilities (TSDF) industry, and outlines volatile organic compound emissions expected from their wastewater treatment systems and methods for controlling them. For CTG guideline purposes, EPA has included Subtitle C and D landfills with leachate collection systems in the TSDF industry. EPA estimates that nearly all landfills affected by the Landfills effluent guideline will be subject to this CTG for their volatile emissions from their wastewater treatment systems. It was estimated in the CTG draft document that 43 percent of the facilities in the TSDF industry are located in areas of ozone nonattainment. In 1994, the draft CTGs were revised to reflect changes that were made in the wastewater provisions of the Hazardous Organic National Emission Standards for Hazardous Air Pollutants promulgated by the EPA on April 22, 1994 (Federal Register: Volume 59, Number 19). EPA published these changes to the CTGs in a document entitled "Industrial Wastewater Alternative Control Technology".

10.2 Solid and Other Aqueous Waste

Solid and other aqueous waste would be generated by several of the wastewater treatment technologies expected to be implemented to comply with the landfills regulation. The costs for the disposal of these other waste residuals were included in the compliance cost estimates prepared for the regulatory options. Solid wastes generated by a number of the proposed BPT, BCT, BAT, and PSES wastewater treatment technologies include sludge from clarifiers associated with biological treatment and chemical precipitation systems and backwash waters from filtration systems.

In surveying both subcategories of this industry, EPA determined that it is common practice to dispose of the sludges generated by the on-site wastewater treatment systems directly back into the landfills. This practice eliminates the need for, and the costs associated with, off-site disposal. Analysis of sludge data collected as part of this study also indicates that sludges generated by wastewater treatment systems at landfills in the Subtitle D Non-Hazardous subcategory are non-hazardous, allowing them to be disposed of at the landfill sites from which they are generated.

Waste sludge generated by wastewater treatment facilities at landfills in the Subtitle C Hazardous subcategory may or may not be a hazardous waste, depending upon factors such as the characteristics of the waste deposited in the landfill and the design and operation of the wastewater treatment system. If listed hazardous wastes as per 40 CFR 261 Subpart D are disposed of into the landfill, the resultant sludges from the treatment of landfill generated wastewaters will be considered a hazardous waste. Based upon the "derived-from" rule found in 40 CFR 261.3(c)(2), the sludge will have the same RCRA waste code as the waste in the landfill for monofills. For hazardous waste landfills which dispose of more than one type of listed hazardous waste and generate a multi-source leachate, the sludge from treatment of the leachate will have the F039 RCRA waste code. Sludges from a treated leachate at a landfill which handles only characteristic wastes as per 40 CFR 261 Subpart C will need to be analyzed for to determine whether it exhibits any of the characteristics of a hazardous waste as per 40 CFR 261 Subpart C. EPA has developed land disposal restrictions as found in 40 CFR 268. This regulation places restrictions on the land disposal of wastes and specifies treatment standards that must be met before wastes can be land disposed. For purposes of this regulation, EPA has assumed that dried sludges from facilities in the Subtitle C Hazardous subcategory will be returned to the on-site landfill for disposal. Similarly, EPA has assumed dried sludges from Subtitle D non-hazardous facilities will be returned to the on-site landfill for disposal. Listed or characteristically hazardous waste sludges are to meet applicable treatment standards prior to disposal.

The increased amount of sludge created due to this regulation will be negligible in comparison with the daily volumes of waste processed and disposed in a typical landfill, whether non-hazardous or hazardous. As a result, the practice of on-site disposal has a minimal impact on landfill capacity. For example, based on national estimates the Subtitle D Non-Hazardous subcategory processed approximately 5,300 million tons of waste in 1992. The BPT/BCT/BAT/PSES wastewater treatment options will generate approximately 0.0044 million tons per year of waste solids or only 8.3×10^{-5} percent of the volume of waste disposed into the landfill. For the Subtitle C Hazardous subcategory, the BPT/BCT/BAT/PSES option will generate approximately 194 tons per year of solids as compared to the national estimate of 550 million tons of waste processed, which equates to 3.5×10^{-5} percent.

Filtration backwash waters are generally recycled to the beginning of the wastewater treatment system for reprocessing. This practice eliminates the generation of a waste stream needing disposal.

10.3 Energy Requirements

The operation of wastewater treatment equipment results in the consumption of energy. EPA estimates that the attainment of the proposed BPT, BCT, BAT, or PSES standards will increase energy consumption by a very small increment over present industry use. The treatment technologies that are the basis for the proposed limitations and standards are not energy-intensive, and the projected increase in energy consumption is primarily due to the incorporation of components such as power pumps, mixers, blowers, power lighting and controls, and heating devices. The costs associated with these energy costs are included in EPA's estimated operating costs for compliance with the proposed guideline presented in Chapter 9. For example, the BPT/BCT/BAT Option 2 for the Subtitle D Non-Hazardous subcategory is estimated to consume 3,300 megawatt-hour per year (Mwhr/year). This is equivalent to approximately 1,800 barrels per year of No.2 fuel oil, as compared to the 1992 rate of consumption in the United States of 40.6 million barrels per year. The additional energy demand imposed by this regulatory option will represent an insignificant increase in the production or importation of fuel oil. For the Subtitle C Hazardous subcategory, the proposed regulatory option is estimated to consume 37.3 Mwhr/yr or an equivalent 21 barrels per year of No.2 fuel oil.

11.0 DEVELOPMENT OF EFFLUENT LIMITATIONS AND STANDARDS

This chapter presents the proposed effluent limitations guidelines and standards for the landfills point source category. The proposed effluent limitations are based upon the treatment performance of selected wastewater treatment systems at landfill facilities and are presented as monthly and daily maximum concentrations. The following sections discuss the development of the numerical limitations, which include:

- Development of Long Term Averages and Variability Factors
- Best Practicable Control Technology Currently Available (BPT)
- Best Conventional Pollutant Control Technology (BCT)
- Best Available Technology Economically Achievable (BAT)
- New Source Performance Standards (NSPS)
- Pretreatment Standards for Existing Sources (PSES)
- Pretreatment Standards for New Sources (PSNS)

The sections below present a summary of the statistical methodology used in the calculation of effluent limitations. A more detailed explanation can be found in the "Statistical Support Document for Proposed Effluent Limitations Guidelines and Standards for the Landfills Category" (EPA 821-B-97-006).

11.1 Development of Long Term Averages, Variability Factors, and Effluent Limitations

Effluent limitations for each subcategory are based on a combination of long term average effluent values and variability factors that account for variation in treatment performance within a treatment plant over time. The variability factors and long term averages were developed from a database composed of individual daily measurements on treated effluent. EPA collected technology performance data from field sampling efforts and from industry supplied data provided in the Detailed Monitoring Questionnaire. A detailed description of each data source is presented in Chapter 4.

While EPA sampling data typically reflects the daily performance of a system over a 5-day period, industry supplied data (collected through the Detailed Monitoring Questionnaire) reflects up to three years worth of data. The monitoring data obtained through the Detailed Monitoring Questionnaire is unique to each facility in terms of the number of parameters analyzed and monitoring frequency. Several facilities provided information for dozens of pollutants, while others provided data for only a few parameters. Additionally, monitoring may have been performed weekly, monthly, or quarterly. Wherever possible, when calculating effluent limitations, EPA used a combination of industry supplied data and EPA sampling data in order to better account for the variability of leachate over time.

These data were used to develop long term average values and variability factors, by pollutant and technology option, for each subcategory. The proposed limitations were the result of multiplying the long term average value by the appropriate variability factors. The following paragraphs briefly describe how each of these values were determined. The detailed methodology and data is presented in the Statistical Support Document.

11.1.1 Calculation of Long Term Averages

For each pollutant selected for regulation (see Chapter 7), long term average effluent values were calculated for each regulatory option and subcategory. The first step was to select representative facilities from the EPA database for each option. The criteria used in facility selection are explained in Section 11.2. After selecting the facilities that best represent a technology option, EPA reviewed the influent and effluent data supplied for each of the regulated pollutants. Data from facilities that did not supply both influent and effluent data for a given pollutant were not included in the calculation of the of the pollutant's long term average. Facilities which supplied both influent and effluent data, but for which the influent concentrations were considered to be too low to evaluate removals across the treatment system, were also eliminated. In addition, for each of the regulated pollutants, all of the selected facilities were analyzed to determine if the facility was utilizing treatment technologies, apart from those selected as the technology option, that may provide significant removals of that particular pollutant. For example, the data from a facility that employed carbon adsorption (a treatment technology which was not part of a selected technology option) would not be used in the calculation of the limit for a pollutant which may be treated by carbon. However, if an intermediate data point which preceded the carbon adsorption treatment were available for this facility, then EPA did consider the use of that data point to characterize the performance of the treatment system up to that point. In addition to the editing criteria outlined above, observations below the sample-specific detection level were set equal to the detection level for the purposes of calculating a facility-level long term average. Furthermore, the EPA sampling data were also edited according to the criteria outlined in Chapter 4, Section 4.9.

Once the facilities and effluent data points were selected, EPA calculated the average effluent concentration for each regulated pollutant at each facility. For facilities in which EPA had data from both week-long EPA sampling and industry supplied Detailed Monitoring Questionnaires (representing data collected over the course of at least a year), long term averages were calculated separately as long as the dates for the two data sets did not overlap. Therefore, by using both data sets, the long term average accounted for the variability of leachate over a longer period of time.

The long term average of each regulated pollutant was estimated for each facility data set by the expected value of the pollutant's daily concentrations. The expected value was based on fitting a modified delta-lognormal distribution to the daily concentration data. The modified delta-lognormal distribution models the data as a mixture of non-detect observations and measured values that follow a lognormal distribution. This distribution was selected because: (1) the data for many analytes consisted of a mixture of non-detects and measured values that were approximately lognormal; and (2) in cases where there are no non-detects, the distribution is equivalent to the usual two parameter lognormal. This is the same basic distributional model used by EPA in the final rulemakings for the Organic Chemicals, Plastics and Synthetic Fibers (OCPSF; 40 CFR Part 414) and the Pulp and Paper category (40 CFR Part 430) and for the proposed rulemaking for the Centralized Waste Treatment industrial category (proposed 40 CFR Part 437, 60 FR 5464 January 27, 1995). In the Pulp and Paper and the Centralized Waste Treatment studies, the modified delta-lognormal distribution assumes that all non-detects have a value equal to the reported sample-specific detection levels and that the detected values follow a lognormal distribution. This model was used as the basis of estimates of the long term average (mean) at a landfill facility. In the case of the OCPSF rule, the same basic model was used but the reported non-detect values were set equal to the pollutant analytical minimum level. A more detailed discussion of the modified delta-lognormal distribution can be found in the "Statistical Support Document for Proposed Effluent Limitations Guidelines and Standards for the Landfills Category" (EPA 821-B-97-006) (EPA 821-B-97-006).

After the facility level long term averages were developed for each regulated pollutant using the criteria outlined above, data from the selected facilities were combined into subcategory-specific long term averages for each regulated pollutant by finding the median of the facility-level long term averages. This median of the facility-level long term averages for each regulated pollutant was the long term average used in the calculation of the effluent limitation as described later in this section.

11.1.2 Calculation of Variability Factors

EPA calculated variability factors using the same data sets used to derive the long term average values. As with the calculation of the long term averages, a modified delta-lognormal distribution was fitted to daily concentration data. Separate variability factors were calculated for different averaging periods and applied only to the corresponding period. Thus, different variability factors are applied to daily data (single measurements without averaging), and to a monthly average based on four measurements taken once per week ("4-day averages") or 20 measurements taken once each day of the work week throughout a month ("20-day average").

For those facility data sets that had at least four observations for a given regulated pollutant, including two detected values, the modified delta-lognormal model was used to estimate daily and 4-day or 20-day average variability factors. There were several instances where variability factors could not be calculated from the landfills database because fewer than two samples were measured above the detection limit. In these cases, variability factors were transferred from biological treatment systems used in the final rulemaking of the OCPSF guideline (40 CFR Part 414).

As stated above, in calculating the variability factors, EPA assumed a log-normal distribution of the data. In addition, the Agency used:

- The 95th percentile to establish the maximum monthly average.
- The 99th percentile to establish the maximum for any one day.

The daily variability factor is defined as the ratio of the estimated 99th percentile of the distribution of daily values to the estimated mean of the distribution. Similarly, the monthly variability factor is defined as the estimated 95th percentile of the distribution of 4-day or 20-day averages divided by the estimated mean of the monthly averages. A monthly average and daily maximum variability factor was derived for each pollutant and for each regulatory option. For each subcategory, the daily variability factor for each pollutant was defined to be the average of the facility-level daily variability factors; the 4-day average variability factors for each pollutant was defined to be the average of the facility-level 4-day average variability factors; and the 20-day average variability factors for each pollutant was defined to be the average of the facility-level 20-day average variability factors.

11.1.3 Calculation of Effluent Limitations

The median long term averages and the average variability factors were used in the calculation of the effluent limitations. For each subcategory, the daily-maximum limitations were calculated by multiplying the median of the long term average for a given pollutant by the average daily variability factor for that pollutant, and the monthly maximum limitations were calculated by multiplying the median long term average for a given pollutant by the average 4-day or 20-day variability factors for that pollutant. Twenty-day average limitations were chosen for the conventional pollutants BOD_5 and TSS, and four-day average limitations were chosen for other nonconventional and toxic pollutants.

11.2 Best Practicable Control Technology Currently Available (BPT)

EPA proposes BPT effluent limitations for the Subtitle D Non-Hazardous and Subtitle C Hazardous subcategories. The proposed BPT effluent limitations would control identified conventional, toxic, and nonconventional pollutants when discharged from landfill facilities to surface waters of the U.S. Generally, EPA determines BPT effluent levels based on the average of the best existing performance by facilities of various sizes, ages, and unit processes within an industrial category or subcategory. In industrial categories where present practices are uniformly inadequate, however, EPA may determine that BPT requires higher levels of control than any currently in place if the technology to achieve those levels can be practicably applied. BPT may be transferred from a different category or subcategory. BPT normally focuses on end-of-process treatment rather than process changes or internal controls, except when these technologies are common industry practice.

In addition, the Clean Water Act (CWA) Section 304(b)(1)(B) requires a cost reasonableness assessment for BPT limitations. In determining the BPT limits, EPA must consider the total cost of treatment technologies in relation to the effluent reduction benefits achieved. This inquiry does not limit EPA's broad discretion to adopt BPT limitations that are achievable with available technology unless the required additional reductions are "wholly out of proportion to the costs of achieving such marginal level of reduction." A Legislative History of the Water Pollution Control Act Amendments of 1972, p. 170. Moreover, the inquiry does not require the Agency to quantify benefits in monetary terms. See e.g. *American Iron and Steel Institute* v. *EPA*, 526 F. 2d 1027 (3rd Cir., 1975).

In balancing costs against the benefits of effluent reduction, EPA considers the volume and nature of expected discharges after application of BPT, the general environmental effects of pollutants, and the cost and economic impacts of the required level of pollution control. In developing guidelines, the Act does not require or permit consideration of water quality problems attributable to particular point sources, or water quality improvements in particular bodies of water. Therefore, EPA has not considered these factors in developing the proposed limitations. See *Weyerhaeuser Company* v. *Costle*, 590 F. 2d 1011 (D.C. Cir. 1978).

In setting BPT standards based on a treatment technology, EPA does not require the use of that technology to treat landfill wastewater. Rather, in order to establish the proposed limits, EPA has demonstrated that the concentration limits are achievable based on a well-operated system using the proposed technologies. The technologies which may be used to treat wastewater is left entirely to the discretion of the individual landfill operator, as long as the numerical discharge limits are achieved.

11.2.1 BPT Technology Options for the Subtitle D Non-Hazardous Subcategory

In the Agency's engineering assessment of the best practicable control technology currently available for treatment of wastewaters from landfills, EPA first considered three technologies commonly in use by the Landfills industry and other industries as options for BPT. These technology options were chemical precipitation, biological treatment, and multimedia filtration. EPA removed chemical precipitation from further consideration as a BPT treatment option for the following reason. While chemical precipitation is an effective treatment technology for the removal of metals, non-hazardous landfills were typically found to have low concentrations of metals in the untreated wastewaters. Observed metals concentrations were not typically found at levels that would inhibit biological treatment, or that would be effectively removed by a chemical precipitation system.

Based upon data collected by EPA, eleven percent of the direct discharging landfills in the Non-Hazardous subcategory employ some form of chemical precipitation, and only eight percent utilize a combination of chemical precipitation and biological treatment. Several of these facilities were contacted by EPA to ascertain the basis for installing chemical precipitation treatment. Based upon the results of this survey, it was determined that chemical precipitation systems generally are not utilized to remove metals that may cause inhibition to the biological treatment system. EPA found that these systems were installed either to: 1) ensure compliance with limitations in their current NPDES discharge permit for selected nonconventional metals, such as iron, that are a water quality concern, or 2) to anticipate metals concentrations that were expected prior to obtaining site-specific leachate characteristics.

EPA sampling data collected at facilities in the Non-Hazardous subcategory showed relatively low levels (less than 1 mg/l) of pollutant of interest metals in untreated landfill generated wastewaters. Furthermore, Table 11-1 presents several sources of performance data for metals removals in activated sludge systems along with published biological treatment inhibition ranges and raw wastewater characteristics from the non-hazardous facilities in the EPA database. Performance data for metals from biological treatment systems were obtained from the National Risk Management Research Laboratory (NRMRL) Treatability Database (formerly called the Risk Reduction Engineering Laboratory (RREL) Treatability Database), the 50-POTW (publicly owned treatment works) Study, and a sampling program conducted at twelve OCPSF facilities that have biological treatment systems. Metal concentrations as found in the raw wastewater for this subcategory are below, or close to, the published inhibition levels for biological treatment systems. A review of performance data indicates that certain pollutant of interest metals, such as chromium and zinc, are removed by the biological treatment process at relatively high rates.

Based upon an analysis of these data, EPA concluded that pollutant of interest metals observed in the Non-Hazardous subcategory generally are present in landfill generated wastewaters at levels that should not effect the operation and performance of a biological treatment system. Under these circumstances, biological treatment removes certain metals identified as pollutants of interest in the Non-Hazardous subcategory. Therefore, EPA concluded that biological treatment is an adequate BPT control technology for certain pollutant of interest metals in the Non-Hazardous subcategory.

Based upon the above assessment, EPA developed the following BPT regulatory options. These two technology options are discussed in detail in Chapter 8 and cost estimates developed for these options are discussed in Chapter 9.

Non-Hazardous Subcategory Option I: Biological Treatment

EPA first assessed the pollutant removal performance of equalization and biological treatment. EPA selected this as Option I due to its effectiveness in removing the large organic loads commonly associated with leachate. BPT Option I consists of aerated equalization followed by biological treatment, and included chemically assisted secondary clarification and sludge dewatering. Various types of biological treatment such as activated sludge, sequential batch reactors, aerated lagoons, and anaerobic and aerobic biological towers or fixed film reactors were included in the calculation of limits for this option. The costing for Option I was based on the cost of aerated equalization followed by an extended aeration activated sludge system with secondary clarification and sludge dewatering. Figure 11-1 presents a flow diagram of the treatment system costed for Option I. Approximately 30 percent of the direct discharging non-hazardous facilities employed some form of biological treatment, and 13 percent had a combination of equalization and biological treatment.

Non-Hazardous Subcategory Option II: Biological Treatment and Multimedia Filtration

The second technology option considered for BPT treatment of non-hazardous landfill wastewater was equalization prior to biological treatment with secondary clarification followed by multimedia filtration. Approximately ten percent of the direct discharging non-hazardous facilities used the technology described in Option II. Cost estimates for Option II were based on the cost of Option I plus a multimedia filtration system. Figure 11-2 presents a flow diagram of the treatment system costed for this option.

EPA selected Option II, equalization prior to biological treatment with secondary clarification followed by multimedia filtration, as the technology basis for BPT limitations for the Non-Hazardous landfills subcategory. EPA proposes to base the BPT effluent limitations on Option II because of the ability of the biological system to control the organic loadings and because of the filtration system's effectiveness for removal of the TSS that may remain after biological treatment. EPA's decision to base BPT limitations on Option II treatment primarily reflects two factors: the degree of effluent reductions attainable and the total cost of the proposed treatment technologies in relation to the effluent reductions achieved. In assessing BPT, EPA considered the age, size, process, other engineering factors, and non-water quality impacts pertinent to the facilities treating wastes in this subcategory. No basis could be found for identifying different BPT limitations based on age, size, process or other engineering factors. Neither the age nor the size of the landfill facility will directly affect the treatability of the landfill wastewaters. For the non-hazardous landfills, the most pertinent factors for establishing the limitations are costs of treatment and the level of effluent reductions obtainable.

EPA has selected Option II based on the comparison of the two options in terms of total costs of achieving the effluent reductions, pounds of pollutant removals, economic impacts, and general environmental effects of the reduced pollutant discharges. BPT Option II removed significantly more pounds of conventional pollutants than Option I with only a moderate, associated cost increase. It is estimated that BPT Option II will cost $1.8 million (1992 dollars) annually more than BPT Option I for an additional removal of 130,000 pounds of conventional pollutants (TSS).

Finally, EPA also looked at the costs of both options to determine the economic impact that this proposal would have on the Landfills industry. EPA's assessment showed that under either option only three facilities would incur significant economic impacts. For this assessment, EPA defined significant economic impacts in two different ways, depending on the ownership of the facility. For privately-owned facilities, significant economic impacts exist when the ratio of the annualized compliance costs to revenue is greater than five percent. For municipally-owned facilities, significant economic impacts occur when the ratio of compliance costs to median household income are greater than one percent. The economic assessment for this proposal is described in the "Economic and Cost-Effectiveness Analysis for Proposed Effluent Limitations Guidelines and Standards for the Landfills Category" (EPA 821-B-97-005).

11.2.2 BPT Limits for the Subtitle D Non-Hazardous Subcategory

The proposed BPT effluent limitations for the Non-Hazardous subcategory are based upon the average of the best existing wastewater treatment systems. The first criterion used in the selection of the average of the best facilities was effective treatment of BOD_5. In selecting BPT facilities, EPA identified facilities that employed either Option I or Option II technologies. Even though Option II technologies were selected as the basis for developing the BPT effluent limitations, it was assumed that very little BOD_5 removal would occur over the multimedia filter employed in Option II, and therefore, facilities employing biological treatment only (Option I) could achieve good removal of

BOD_5 and be considered BPT. However, in determining the BPT effluent limitations for TSS, the data from the best performers using BPT Option II technology were used because of the multimedia filtration system's effectiveness in removing suspended solids.

There were 45 municipal facilities (see Table 11-2) in the EPA database in the Non-Hazardous subcategory that utilized some form of biological treatment considered for BPT. Even though the Non-Hazardous subcategory is comprised of both Subtitle D municipal solid waste landfills and non-municipal solid waste landfills, only municipal solid waste facilities were considered for selection as BPT for the Non-Hazardous subcategory because the wastewaters at these landfills tend to contain a wider array of pollutants than those found at Subtitle D non-municipal facilities. The pollutants found at the non-municipal facilities tended to be a subset of the pollutants found at the municipal facilities. In fact, nine out of the ten pollutants of interest for non-municipal facilities were also pollutants of interest for the municipal facilities (see Chapter 7). The only pollutant of interest present at Subtitle D non-municipal landfills but not at municipal solid waste landfills was MCPA. The remainder of the pollutants of interest present at non-municipal facilities were all found at concentrations similar to, or less than, the concentrations typically found at municipal facilities. Therefore, EPA determined that a treatment system that can adequately control pollutant discharges from a municipal solid waste landfill should also be able to control discharges at Subtitle D non-municipal landfills.

In addition to the 45 non-hazardous municipal facilities identified as potential BPT, EPA also evaluated one hazardous facility (16041) in the EPA database. This facility used biological treatment in the form of a sequential batch reactor (SBR) to treat its landfill generated wastewater. Leachate from both non-hazardous and hazardous landfills was commingled prior to treatment by the SBR at this facility. In determining whether it was reasonable to include a facility from the Hazardous subcategory as a potential BPT facility in the Non-Hazardous subcategory, EPA analyzed two different factors. First, since the facility accepted leachate from both hazardous and non-hazardous landfills, the waste stream was found to contain almost all of the pollutants of interest for the Non-Hazardous subcategory at similar concentrations to those found in the non-hazardous landfill raw wastewater database (see Table 11-3). At this facility, only one of the 33 pollutants of interest for the Non-Hazardous subcategory was not detected in the influent concentration (1,4-dioxane) and four others (barium, disulfoton, hexavalent chromium, and n,n-dimethylformamide) were not included in the analytical effort. Therefore, the Agency determined that the raw wastewater concentrations for the non-hazardous pollutants of interest from this hazardous facility were similar to those concentrations found at the non-hazardous facilities. Second, the facility achieved good BOD_5 removal using biological treatment equivalent to BPT Option I. Therefore, a treatment system that can adequately control pollutant discharges from a hazardous landfill should also be able to control discharges at non-hazardous landfills.

Based on the assessment above, there were 46 in-scope landfill facilities in the EPA database that employed various forms of biological treatment considered for BPT for the Non-Hazardous subcategory. These 46 landfill facilities selected as potential BPT candidates were evaluated to determine the performance across the various types of biological treatment systems. In order to determine the best performers for biological treatment a number of criteria were established. The first criterion used in the selection of the best facilities was effective treatment of BOD_5. Under this criterion, there were several reasons why a facility might be eliminated from the selection of BPT facilities.

Of the 46 facilities treating their wastewaters with some form of biological treatment, only 25 facilities provided BOD_5 effluent data. These data were used to evaluate treatment performance across the various biological systems. Table 11-4 lists those facilities that did not supply BOD_5 effluent data and therefore were eliminated from further consideration as BPT facilities. Table 11-5 lists the candidate BPT facilities that did provide BOD_5 effluent data along with the treatment in place at the facility, the average daily flow, and the BOD_5 and TSS influent and effluent concentrations.

Because BPT is based on the effectiveness of biological treatment, facilities that used additional forms of treatment for BOD_5 (other than biological treatment) were eliminated. EPA, therefore, removed two sites (16099, 16125) using carbon treatment in addition to biological treatment from the list of candidate BPT facilities. EPA eliminated another facility from consideration (16117) because it used two separate treatment trains in treating its wastewater, one with biological treatment and the other with chemical precipitation, before commingling the streams at the effluent sample point. After the elimination of these three facilities, 22 potential BPT facilities remained in the EPA non-hazardous landfill database.

To ensure that the facilities were operating effective biological treatment systems, EPA first evaluated influent concentrations of BOD_5 entering the treatment system. Three facilities (16077, 16093, 16097) had average influent BOD_5 concentrations below 55 mg/l, and were not considered for BPT because the influent concentration was considered to be too low to evaluate removals across the treatment system. Seven other facilities (16048, 16052, 16065, 16161, 16164, 16171, 16176) did not supply BOD_5 influent data and were eliminated from the BPT list. Two facilities (16127, 16129) also were dropped because raw wastewater streams consisted primarily of storm water or groundwater which were considered dilution flows.

The next requirement for BPT selection in the Non-Hazardous landfill subcategory was that the biological treatment system at the facility had to achieve a BOD_5 effluent concentration less than 50 mg/l. Facilities not able to maintain an effluent concentration below 50 mg/l were not considered to be operating their biological system effectively. Three of the remaining 10 facilities (16088, 16165, 16170) did not achieve a BOD_5 effluent concentration of less than 50 mg/l, thus leaving seven facilities in the database. The site identification numbers for the seven facilities selected as BPT were 16041, 16058, 16118, 16120, 16122, 16132, and 16253.

The seven facilities that met all of the BPT criteria employed various types of biological treatment systems including activated sludge, a sequential batch reactor, aerobic and anaerobic biological towers or fixed film, and aerated ponds or lagoons. Most of the facilities employed equalization tanks in addition to the biological treatment while several facilities also included chemical precipitation and neutralization in their treatment systems. The biological systems were followed by a clarification or sedimentation stage. All seven facilities employing well-operated biological treatment systems were used to calculate the effluent limitations for BOD_5. The average BOD_5 influent concentrations to these seven treatment systems ranged from 150 mg/l to 7,600 mg/l, and as mentioned above, all of the average effluent concentrations for these seven facilities were below 50 mg/l.

EPA used the data from the seven facilities identified as having good biological treatment systems to calculate the limits for additional pollutant parameters, including alpha terpineol, ammonia, benzoic acid, p-cresol, phenol, toluene, and zinc. The methodology used in selecting the pollutants to regulate is discussed in Chapter 7. Because one facility employed air stripping (16120), EPA did not use its data for determining the proposed limit for ammonia or toluene. Many of the facilities selected as BPT did not provide data for all the pollutants identified for regulation by EPA. In these cases, EPA based the limits on the BPT facilities for which data was available.

While the BOD_5 edits discussed above ensure good biological treatment and a basic level of TSS removal, treatment facilities meeting this level may not necessarily be operated for optimal control of TSS. To ensure that the TSS database for setting limitations reflects proper control, additional editing criteria for TSS were established.

Two criteria were used for editing TSS performance data. The primary factor in addition to achieving the BOD_5 criteria cited above was that the facility had to employ technology sufficient to ensure adequate control of TSS, that is, a sand or multimedia filtration system. Three of the seven well-operated biological systems (16120, 16122, 16253) used a sand or multimedia filtration system as a polishing step for additional control of suspended solids prior to discharge.

The second factor EPA considered was whether the treatment system achieved an effluent TSS concentration less than or equal to 100 mg/l. Treatment facilities meeting these criteria were included among the average best existing performers for TSS. One of the three facilities (16122) had additional treatment for TSS prior to the filter and was therefore eliminated from consideration in the determination of the TSS limits. The remaining two facilities (16120 and 16253) had TSS effluent concentrations well below 100 mg/l, and thus EPA concluded that they should be included among the average best existing performers for TSS. All of the estimated costs were based on a facility installing aerated equalization tanks followed by an activated sludge biological system with clarification and a multimedia filter and included a sludge dewatering system.

Tables 11-6 and 11-7 present the national estimates of the pollutant of interest reductions for both the BPT and BAT options for municipal solid waste Subtitle D landfills and non-municipal Subtitle D landfills. Table 11-8 and Table 11-9 summarize the estimated amount of pollutants discharged annually from direct discharging municipal landfills and direct discharging non-municipal landfills, respectively, before and after the implementation of BPT for the Non-Hazardous subcategory. EPA's proposed BPT limitations for the Non-Hazardous subcategory are presented in Table 11-10.

EPA estimates that the implementation of the proposed BPT effluent limitations will require a capital cost of $18.8 million and annual operating cost of $5.7 million resulting in a total annualized cost of $7.9 million (post-tax) for the Subtitle D Non-Hazardous subcategory (1992 dollars).

11.2.3 BPT Technology Options for the Subtitle C Hazardous Subcategory

EPA's survey of the hazardous landfills industry identified no in-scope respondents who discharge directly to surface water. All of the hazardous landfills responding to EPA's survey are either indirect, zero or alternative dischargers. Consequently, EPA could not evaluate any treatment systems in-place at direct discharging hazardous landfills for establishing BPT effluent limitations. Therefore, to develop effluent limitations based on treatment technologies in use in the Landfills industry, EPA relied on information and data from treatment technologies in use at hazardous landfill facilities discharging indirectly and at non-hazardous landfills discharging directly, a method referred to as "technology transfer". While EPA has not identified any hazardous landfills discharging directly to surface waters, the Agency is proposing to establish BPT effluent limitations for direct discharges from hazardous landfills because there may be direct discharging facilities that were not included in EPA's survey of the industry. Also, facilities that are currently zero or alternative dischargers or are currently discharging to a POTW might be granted permits to discharge wastewater directly to surface water in the future.

EPA considered three potential technology options for establishing BPT effluent limitations for the Hazardous subcategory. These technology options were chemical precipitation, biological treatment, and zero or alternative discharge. EPA evaluated chemical precipitation as a treatment technology because of metals concentrations typically found in hazardous landfill leachate and the efficient metals removals achieved through chemical precipitation. EPA also evaluated biological treatment as an appropriate technology because of its ability to remove organic loads present in the leachate. Finally, EPA considered a zero or alternative discharge option as a potential BPT requirement because a significant segment of the industry is currently not discharging wastewaters. The zero or alternative discharge, or alternative disposal option, would require facilities to dispose of their wastewater in a manner that would not result in wastewater discharge directly to a surface water or indirectly to a POTW.

Currently, EPA estimates that 141 hazardous landfill facilities in the United States are zero or alternative dischargers. Methods of achieving zero or alternative discharge currently in use by hazardous landfills are deep well injection, solidification, and contract hauling of wastewater to a Centralized Waste Treatment (CWT) facility or to an off-site landfill wastewater treatment facility. Thirty seven facilities are estimated to underground inject landfill wastewaters on site, 103 facilities send their wastewater to a CWT facility or off-site landfill treatment system, and one facility solidifies wastewater.

EPA analyzed the zero or alternative discharge facilities in the Hazardous subcategory to determine if it was a viable option for direct discharging hazardous landfills. First, the Agency examined underground injection as an alternative disposal option. Underground injection is a demonstrated alternative disposal option in the Landfills industry and was found to be in use at facilities with both large and small wastewater flows. However, this is not considered a viable option because it is prohibited in many geographic regions of the country where landfills may be located. The second widely used disposal option involves contract hauling landfill wastewater to a CWT facility. EPA's survey demonstrated that only landfills with relatively low flows (under 500 gpd) contract haul their wastewater to a CWT facility. The costs of contract hauling are directly proportional to the volume and distance over which the wastewater must be transported, generally making it excessively costly to send large wastewater flows to a CWT facility, particularly if it is not located nearby. Since only one of the 141 zero discharging hazardous facilities solidified their wastewater, EPA did not consider solidification a demonstrated alternative disposal option, especially for facilities with large flows.

EPA evaluated the cost of all hazardous landfills achieving zero or alternative discharge status and determined that the costs were wholly disproportionate to the benefits potentially achieved by this option. To calculate costs for this option, EPA assumed that all facilities currently discharging to a POTW would have to contract haul wastewater approximately 500 miles to a CWT facility. EPA based cost estimates on a $0.35 per gallon disposal cost at a CWT facility, and $3.00 per loaded mile for transport. EPA estimated the total cost to the industry at approximately $30 million dollars.

Based on the characteristics of hazardous landfill leachate and on an evaluation of appropriate technology options, the Agency selected aerated equalization, chemical precipitation and biological treatment followed by secondary clarification as BPT technology for the Hazardous subcategory.

Hazardous Subcategory Option I: Chemical Precipitation and Biological Treatment

EPA selected this as an option based on the effectiveness of biological treatment systems in removing the large organic loads commonly associated with leachate. Metals in the raw wastewater will be removed prior to the biological treatment system using chemical precipitation. BPT Option I for the Hazardous subcategory consists of aerated equalization followed by chemical precipitation and then biological treatment. Cost estimates for this option were based on the cost of aerated equalization followed by a hydroxide precipitation system (consisting of a chemical feed system, flocculation tank and sedimentation), then an extended aeration activated sludge system with secondary clarification and sludge dewatering. Figure 11-3 presents a flow diagram of the treatment system for this option.

EPA relied on data from two facilities employing variations of this technology to calculate the proposed BPT limits for toxic pollutants. One facility employed a chemical precipitation unit followed by an activated sludge system with secondary clarification. The second facility used a sequential batch reactor which was able to achieve good metals removals. Both of these systems were indirect dischargers, as stated above. In the case of BPT regulation for conventional pollutants and ammonia, EPA concluded that establishing limits based on indirect discharging treatment systems was not appropriate because indirect discharging treatment systems are generally not operated for optimal control of conventional pollutants because they are amenable to treatment in a POTW. Therefore, in establishing limits for BOD_5, TSS, and ammonia, EPA established BPT limitations equal to those established for BPT in the Non-Hazardous landfills subcategory.

11.2.4 BPT Limits for the Subtitle C Hazardous Subcategory

The proposed BPT effluent limitations for the Hazardous subcategory are based upon the average of the best existing landfills. Based on the characteristics of hazardous landfill leachate and on an evaluation of appropriate technology options, the Agency selected aerated equalization, chemical precipitation, and biological treatment followed by secondary clarification as BPT technology for the Hazardous subcategory. As previously mentioned, there were no direct discharging hazardous facilities in the EPA database, and therefore, the Agency could not select any treatment systems in place at direct discharging landfills for establishing BPT effluent limitations. Consequently, EPA relied on information and data from treatment technologies in use at hazardous indirect discharging facilities and at non-hazardous direct discharging facilities. Apart from the 141 hazardous, zero or alternative discharge facilities estimated to be in the U.S. based on the responses to the Detailed Questionnaire, EPA identified only three other hazardous respondents to the Detailed Questionnaire all of which discharged indirectly to POTWs.

The leachate from one of the three indirect discharging facilities was very dilute and required only minimal treatment prior to discharge. This facility was determined not to be one of the best performers in the industry. The two remaining facilities both had extensive treatment systems in place and were selected as the best performers for the subcategory. The treatment at one facility consisted of equalization and a chemical precipitation unit followed by an activated sludge system with secondary clarification; the other facility utilized equalization tanks and a sequential batch reactor. Data from these two hazardous facilities selected as BPT were used in the calculation of the effluent limitations for the nonconventional and toxic pollutant parameters including: alpha- terpineol, aniline, arsenic, benzene, benzoic acid, chromium, naphthalene, p-cresol, phenol, pyridine, toluene, and zinc. The methodology used in selecting the pollutants to regulate is described in Chapter 7. As stated above, for BPT regulation of BOD_5, TSS, and ammonia, EPA concluded that establishing limits based on indirect discharging treatment systems was not appropriate because indirect discharging treatment systems are generally not operated to control conventional pollutants because they are amenable to treatment in a POTW. Therefore, in establishing limits for conventional pollutants and ammonia, EPA established BPT limitations equal to those established for non-hazardous landfills. EPA's proposed BPT limitations for the Hazardous subcategory are presented in Table 11-11.

Since there are no direct discharging hazardous landfills in the EPA database, pollutant reductions as a result of the regulation and the average facility costs for implementation of the regulation could not be estimated.

11.3 Best Conventional Pollutant Control Technology (BCT)

BCT limitations control the discharge of conventional pollutants from direct dischargers. Conventional pollutants include BOD, TSS, oil and grease, and pH. BCT is not an additional limitation, but rather replaces BAT for the control of conventional pollutants. To develop BCT limitations, EPA conducts a cost reasonableness evaluation, which consists of a two-part cost test: 1) the POTW test, and 2) the industry cost-effectiveness test.

In the POTW test, EPA calculates the cost per pound of conventional pollutants removed by industrial dischargers in upgrading from BPT to a BCT candidate technology and then compares this to the cost per pound of conventional pollutants removed in upgrading POTWs from secondary to tertiary treatment. The upgrade cost to industry, which is represented in dollars per pound of conventional pollutants removed, must be less than the POTW benchmark of $0.25 per pound (in

1976 dollars). In the industry cost-effectiveness test, the ratio of the incremental BPT to BCT cost, divided by the BPT cost for the industry, must be less that 1.29 (i.e. the cost increase must be less than 29 percent).

EPA is proposing to establish effluent limitations guidelines and standards equivalent to the BPT guidelines for the conventional pollutants covered under BPT for both subcategories. In developing BCT limits, EPA considered whether there are technologies that achieve greater removals of conventional pollutants than proposed for BPT, and whether those technologies are cost-reasonable according to the BCT Cost Test. In each subcategory, EPA identified no technologies that can achieve greater removals of conventional pollutants than those proposed for BPT that are also cost-reasonable under the BCT Cost Test, and accordingly EPA proposes BCT effluent limitations equal to the proposed BPT effluent limitations guidelines and standards.

11.4 Best Available Technology Economically Achievable (BAT)

The factors considered in establishing a BAT level of control include: the age of process equipment and facilities, the processes employed, process changes, the engineering aspects of applying various types of control techniques to the costs of applying the control technology, non-water quality environmental impacts such as energy requirements, air pollution and solid waste generation, and such other factors as the Administrator deems appropriate (Section 304(b)(2)(B) of the Act). In general, the BAT technology level represents the best existing economically achievable performance among facilities with shared characteristics. BAT may include process changes or internal plant controls which are not common in the industry. BAT may also be transferred from a different subcategory or industrial category.

EPA is proposing BAT effluent limitations for both landfill subcategories based upon the same technologies evaluated and proposed for BPT. The proposed BAT effluent limitations would control identified toxic and nonconventional pollutants discharged from facilities. EPA did not identify any additional technologies beyond BPT that could provide additional toxic pollutant removals and that are economically achievable.

11.4.1 BAT Limits for the Subtitle D Non-Hazardous Subcategory

EPA evaluated reverse osmosis technology as a potential option for establishing BAT effluent limits more stringent than BPT for the control of toxic pollutants for the Non-Hazardous subcategory. Reverse osmosis was selected for evaluation because of its effective control of a wide variety of toxic pollutants in addition to controlling conventional and nonconventional parameters.

EPA evaluated BAT treatment options as an increment to the baseline treatment technology used to develop BPT limits. Therefore, the BAT Option III consisted of BPT Option II (biological treatment followed by multimedia filtration) followed by a single stage reverse osmosis unit. Figure 11-4 presents a flow diagram of the treatment system costed for BAT Option III.

EPA is proposing limits based on a BAT technology that is equivalent to the BPT technology. After an assessment of costs and pollutant reductions associated with reverse osmosis, EPA concluded that it should not propose limits based on more advanced treatment technology than the BPT technology. EPA concluded that a biological system followed by multimedia filtration would remove the majority of toxic pollutants, leaving the single-stage reverse osmosis to treat the very low levels of pollutants that remained. In the Agency's analysis, BPT Option II removed 470,000 pounds of toxics per year whereas BAT Option III removed 500,000 pounds of toxics per year. The small incremental removal of pounds of toxics achieved by BAT Option III was not justified by the large cost for the reverse osmosis treatment system. According to EPA's costing analysis, the BAT Option III, consisting of BPT Option II plus reverse osmosis, was estimated to cost the Landfills industry $109.7 million in capital costs (1992 dollars) and $31.5 million in annualized costs (1992 dollars). By contrast, the selected option, BPT Option II, had capital costs of $18.8 million (1992 dollars) and annualized costs of $6.9 million (post-tax, 1992 dollars). It should be noted that reverse osmosis was much more effective than the proposed BPT Option II at removing the often high quantities of dissolved metals such as iron, manganese and aluminum. However, these parameters were not included in the calculation of pound-equivalent reductions due to their use as treatment chemicals.

Table 11-12 compares the long term averages achieved by BPT Option II, consisting of equalization, biological treatment, and multimedia filtration, to the long term averages achieved by the reverse osmosis treatment system. For the long term average comparison, the effluent concentrations are from the reverse osmosis treatment system sampled by EPA and described in Section 8.2.1.5, including the flow diagram in Figure 8-30. As is demonstrated by Table 11-12, the effluent concentrations achieved by BPT Option II are reduced to very low levels and are similar to the effluent concentrations achieved by the reverse osmosis system. Tables 11-6 and 11-7 present the national estimates of the pollutant of interest reductions for the BAT options for both municipal solid waste Subtitle D landfills and non-municipal Subtitle D landfills.

11.4.2 BAT Limits for the Subtitle C Hazardous Subcategory

As stated in the BPT analysis, EPA's survey of the hazardous Landfills industry identified no in-scope respondents that were classified as direct dischargers. All of the hazardous landfills in the EPA survey were indirect or zero or alternative dischargers. Therefore, the Agency based BPT limitations for the Hazardous subcategory on treatment systems in-place at non-hazardous BPT facilities and at hazardous indirect facilities. Likewise for BAT for the Hazardous subcategory, EPA evaluated the same three technology options that were evaluated for BPT in the Hazardous subcategory. These technology options, which were all demonstrated technologies among the hazardous indirect dischargers, were chemical precipitation, biological treatment with secondary clarification, and zero or alternative discharge.

For the same reasons identified in the analysis of the zero or alternative discharge option for BPT (Section 11.2.3), EPA determined that the costs were wholly disproportionate to the benefits potentially achieved by this option. Therefore, EPA is proposing BAT effluent limitations for the Hazardous landfill subcategory based upon the same treatment technology selected for BPT: equalization prior to chemical precipitation followed by biological treatment with secondary clarification.

11.5 New Source Performance Standards (NSPS)

New Source Performance Standards under Section 306 of the Clean Water Act represent the greatest degree of effluent reduction achievable through the application of the best available demonstrated control technology for all pollutants (i.e. conventional, nonconventional, and toxic pollutants). NSPS are applicable to new industrial direct discharging facilities, for which construction has commenced after the publication of proposed regulations. Congress envisioned that new treatment systems could meet tighter controls than existing sources because of the opportunity to incorporate the most efficient processes and treatment systems into plant design. Therefore, Congress directed EPA, in establishing NSPS, to consider the best demonstrated process changes, in-plant controls, operating methods, and end-of-pipe treatment technologies that reduce pollution to the maximum extent feasible.

EPA proposes New Source Performance Standards (NSPS) that would control the same conventional, toxic, and nonconventional pollutants proposed for control by the BPT effluent limitations for both subcategories. The conventional treatment technologies used to control pollutants at existing facilities are fully applicable to new facilities. Furthermore, EPA has not identified any other technologies or combinations of technologies that are demonstrated for new sources that are different from those used to establish BPT/BCT/BAT for existing sources. Therefore, EPA proposes NSPS limitations that are identical to those proposed in both subcategories for BPT/BCT/BAT.

11.6 Pretreatment Standards for Existing Sources (PSES)

Pretreatment standards are designed to prevent the discharge of toxic pollutants that pass through, interfere with, or are otherwise incompatible with the operation of POTWs, as specified in Section 307(b) of the Clean Water Act. PSES are technology-based and analogous to BAT limitations for direct dischargers.

After a thorough analysis of indirect discharging landfills in the EPA database, EPA proposes not to establish PSES for the Non-Hazardous subcategory. However, EPA proposes to establish PSES for the Hazardous subcategory based on equalization followed by chemical precipitation and biological treatment technology.

11.6.1 PSES Limits for the Subtitle D Non-Hazardous Subcategory

EPA is not proposing to establish pretreatment standards for existing sources for the Non-Hazardous subcategory. The Agency's decision not to establish PSES for this subcategory was based on several factors. EPA evaluated the effect of landfill leachate on receiving POTWs by assessing pass-through, biological inhibition levels, and contamination of POTW biosolids.

EPA conducted the pass-through analysis on the pollutants proposed to be regulated under BAT for landfills in the Non-Hazardous subcategory. Only one regulated pollutant, ammonia, was considered to "pass-through" a POTW in the Non-Hazardous subcategory. However, upon further evaluation, the Agency concluded that it would not propose pretreatment standards for ammonia. The pass-through analysis is discussed in detail in Chapter 7.

The Agency considered a number of factors in addition to the pass-through analysis to determine the need for ammonia pretreatment standards. In part, additional analysis was required because of the unique nature of ammonia in POTWs and receiving streams. First, the pass-through analysis is based on the performance of well-operated POTWs with secondary treatment in place, which generally achieve 60 percent removal of ammonia. However, in the case of ammonia, many POTWs have installed additional treatment specifically for the control of ammonia and are typically achieving removals in excess of 95 percent, which is much higher than the 60 percent removal used in this analysis. Second, ammonia is often a water quality issue, meaning that potential adverse water quality impacts may be dependent upon such receiving stream characteristics as pH and temperature. Consequently, many POTWs discharging to susceptible water bodies have strict ammonia effluent standards, and the pretreatment standards for ammonia established by local ordinances on landfill discharges should reflect the ability of the POTW to treat ammonia.

EPA has also considered establishing pretreatment standards for ammonia, with a stipulation to allow a POTW to waive those standards if the POTW has appropriate control of ammonia and can demonstrate that ammonia does not pass through the POTW. However, based on current discharges of ammonia to POTWs and current local limits established by POTWs, EPA has concluded not to establish pretreatment standards for ammonia. The rationale is further discussed below.

To determine the need for ammonia pretreatment standards for the Landfills industry, EPA considered several factors including "typical" ammonia concentrations of raw leachate, "typical" ammonia concentrations at the headworks of a POTW, the ammonia concentrations currently being discharged to POTWs, national estimates of ammonia loads discharged to POTWs and to receiving streams, as well as the economic impacts, environmental benefits, and cost-effectiveness of establishing pretreatment standards for ammonia.

To evaluate ammonia wastewater concentrations, EPA focused primarily on the means, medians, and 90th percentile of the data collected. For raw wastewater, EPA found that the median concentration of ammonia in raw landfill leachate from non-hazardous landfills was 82 mg/l, and the average concentration was 240 mg/l. Additionally, there were several notable outliers which contained high levels of ammonia in raw leachate due to site specific characteristics of the landfill. Table 11-13 lists the summary statistics of ammonia concentrations in raw landfill wastewater, as well as current discharge concentrations for direct and indirect landfills. Table 11-13 also summarizes typical ammonia concentrations found at the headworks to a POTW, and a summary of pretreatment limits set by local ordinances imposed on landfill wastewater discharges to POTWs.

In terms of current treatment performance for landfills discharging to POTWs, 99 percent of the landfill facilities are currently discharging wastewater which contains less than 90 mg/l of ammonia. Of the indirect landfills that provided data, one facility was discharging 1018 mg/l of ammonia to a 114 million gallon per day (mgd) POTW, which currently has ammonia control (nitrification) in place. In general, POTWs with nitrification achieve over 95 percent removal of ammonia. The remainder of the landfills discharged an average concentration of 37 mg/l of ammonia to POTWs, with one half of the facilities discharging less than 32 mg/l. In comparison, typical ammonia concentrations in raw domestic sewage range from 1 mg/l to 67 mg/l. Therefore, with the exception of the outlier noted above, the average concentration of ammonia in leachate discharged to POTWs was within the range of wastewater typically accepted at a the headworks to a POTW; it should be noted that the upper ranges of leachate concentrations were higher than the upper ranges found in domestic sewage.

Additionally, EPA evaluated wastewater flows and loads of ammonia associated with landfill indirect dischargers. EPA estimated that the industry discharges 3.2 million pounds per year of ammonia to POTWs, which results in 1.3 million pounds per year being discharged to receiving streams, assuming that the POTWs have secondary treatment but do not have additional treatment for ammonia control. Also, over 65 percent of the landfills discharge less than 10 pounds per day to the POTW (3500 pounds/year), which results in discharging less than 4 pounds per day (1400 pounds/year) to receiving streams, again assuming secondary treatment only. EPA analyzed impacts of ammonia discharges from landfills on receiving streams, and potential environmental benefits achieved through establishing pretreatment standards for ammonia. EPA concluded that ammonia removals achieved by national pretreatment standards would have little impact on water quality improvements (for more information see the Environmental Assessment for the Proposed Effluent Limitations Guidelines and Standards for the Landfills Category, EPA 821-B-97-007).

EPA did evaluate a number of options for PSES. EPA's economic assessment of these options showed that they generally achieved removals at a very high cost. For the control of ammonia there are two technology options available in the Landfills industry. The first available option is biological treatment. EPA evaluated PSES Option I equivalent to BAT Option I, which was equalization followed by biological treatment. This option had a total annualized cost of $28.2 million (1992 dollars) and had an average cost-effectiveness of $1,072/ lb-equivalent (1981 dollars). This option was not considered cost-effective, thus further supporting the Agency's position not to establish PSES for the Non-Hazardous subcategory. The second technology option available for the control of ammonia is ammonia stripping with appropriate air pollution controls. However, this is not considered the best option because it is not demonstrated in the industry, the costs are significantly higher than biological treatment evaluated as PSES Option I, and there are no additional pollutant removals achieved by this option. Table 11-14 and Table 11-15 show the pollutant of interest removals for PSES Option I for the municipal solid waste Subtitle D landfills and non-municipal Subtitle D landfills, respectively.

In summary, EPA concludes that landfills typically discharge wastewater to POTWs containing ammonia concentrations comparable to that of raw domestic sewage, that there are minimal benefits to be achieved through establishing national pretreatment standards for ammonia, that POTWs have the ability to establish local limits where necessary, and that the costs of pretreatment were disproportionate to the benefits.

11.6.2 PSES Limits for the Subtitle C Hazardous Subcategory

EPA proposes to establish pretreatment standards for existing sources for the Hazardous subcategory based on the same technologies as proposed for BAT for six of the thirteen toxic and nonconventional pollutants regulated under BAT for this subcategory. These standards would apply to existing facilities in the Hazardous subcategory that introduce pollutants to POTWs. The pretreatment standards would prevent the pass-through of pollutants and help control sludge contamination. According to EPA's database, all existing indirect dischargers already meet this baseline standard, and therefore, no incremental costs, benefits, or economic impacts were developed.

EPA conducted a pass-through analysis on the toxic and nonconventional pollutants proposed to be regulated under BAT for hazardous landfills. The pass-through analysis was not performed for the regulated conventional pollutants, namely BOD_5 and TSS. Conventional pollutants are amenable to treatment by a POTW and are not regulated under PSES or PSNS. Of the thirteen nonconventional and toxic pollutants regulated under BAT for the Hazardous subcategory, seven were determined to pass through. However, EPA proposes pretreatment standards for only the following six pollutants: ammonia as nitrogen, benzoic acid, toluene, alpha-terpineol, p-cresol, and aniline. Table 7-3, in Chapter 7, illustrates the results of the pass-through analysis for the Hazardous subcategory. The proposed pretreatment limitations for the Hazardous subcategory are listed in Table 11-16.

Although phenol appeared to pass through, EPA does not propose to set pretreatment standards for phenol. This decision was largely based on the rationale used in the OCPSF guideline and explained in the "Supplement to the Development Document for Effluent Limitations and Guidelines and New Source Performance Standards for the Organic Chemicals, Plastics, and Synthetic Fibers Point Source Category" (EPA 821-R-93-007). In the Supplemental Development Document, the decision not to set pretreatment standards for phenol was based on the fact that phenol is highly biodegradable and is treated by POTWs to the same degree as the OCPSF direct dischargers. Furthermore, the apparent difference in performance between OCPSF direct dischargers and POTWs was caused by the difference in influent concentrations. Both the POTW and OCPSF systems treated phenol to non-detect values (10 parts per billion (ppb)). However, the OCPSF database contained significantly higher influent concentrations than the POTWs. As a result, the performance across the OCPSF direct dischargers showed higher removals than the performance at the POTWs.

Similarly, in EPA's landfills database, raw wastewater concentrations of phenol at the two BAT facilities (16041 and 16087) in the Hazardous subcategory were much higher than the influent concentrations at the POTWs used in the determination of the POTW percent removal. The average influent concentrations for phenol for the two hazardous BAT facilities ranged from 1,553 ppb to 65,417 ppb, and the average effluent concentrations were 10 ppb and 30 ppb corresponding to an average percent removal of 99.5 percent. For POTW performance, a total of eight POTWs that passed the POTW editing criteria developed for the landfills regulation were used in the analysis for POTW percent removal of phenol. The average influent concentration for phenol at these eight POTWs was 387 ppb, and six of the eight effluent values were below the analytical minimum level and therefore assigned values of 10 ppb. Thus, the average percent removal for the POTWs was 95.25 percent, and the pollutant was determined to pass through. In this case, as was the case in the OCPSF Supplemental Development Document, the pass-through determination may be an artifact of the differing influent concentrations and does not necessarily reflect a real difference in removals.

Therefore, EPA concluded that phenol is treated to essentially the same level by direct dischargers and POTWs and, therefore, does not pass through.

11.7 Pretreatment Standards for New Sources (PSNS)

Section 307 of the Clean Water Act requires EPA to promulgate both pretreatment standards for new sources and new source performance standards. New indirect discharging facilities, like new direct discharging facilities, have the opportunity to incorporate the best available demonstrated technologies including: process changes, in-facility controls, and end-of-pipe treatment technologies.

EPA proposes to establish pretreatment standards for new sources equivalent to the PSES standards for both subcategories. In developing PSNS limits, EPA considered whether there are technologies that achieve greater removals than proposed for PSES, and whether those technologies are cost-effective. In the Hazardous subcategory, EPA identified no technology that can achieve greater removals than PSES; therefore, EPA has set PSNS limitations based on the same technology as PSES: equalization and chemical precipitation followed by biological treatment with clarification. In the Non-Hazardous subcategory, EPA is not establishing PSNS limitations for the same rationale as for not establishing PSES limits.

Table 11-1: Removal of Pollutant of Interest Metals in the Non-Hazardous Subcategory (ug/l)

Non-Hazardous Pollutant of Interest Metals	CAS #	Landfills Raw Wastewater Data		NRMRL Treatability Data (1)		Published Inhibition Levels (2)	50-POTW Study (3)			OCPSF 12 Plant Sampling Data (4)	
				Activated Sludge						Biological Treatment Systems	
		Subtitle D Municipal Median Concentration	Subtitle D Non-Municipal Median Concentration	Median Influent Concentration	Percent Removal		Maximun Influent Concentration	Mean Influent Concentration	Median Percent Removal	Median Influent Concentration	Percent Removal
Barium	7440393	483	822	145	70.0	NV	NV	NV	NV	NV	NV
Chromium	7440473	28	NA	44	45.0	1,000-100,000	2,380	173	82	440	68.5
Strontium	7440246	1,671	4,615	1,724	13.0	NV	NV	NV	NV	NV	NV
Titanium	7440326	63.8	11.8	55	34.0	NV	NV	NV	NV	NV	NV
Zinc	7440666	140	93	372	56.0	80-5,000	9,250	723	79	322	58.5

NA - Not applicable.
NV - Not available.
(1) Source: EPA National Risk Management Research Laboratory (NRMRL) Treatability Database.
(2) Source: EPA Guidence Manual on the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program.
(3) Source: EPA Fate of Priority Pollutants in Publicaly Owned Treatment Works.
(4) Source: EPA Organic Chemicals, Plastics and Synthetic Fibers Database.

Table 11-2: List of Subtitle D Municipal Solid Waste Facilities Employing Biological Treatment Considered for BPT in the Non-Hazardous Subcategory

16001	16056	16065	16085	16102	16121	16129	16159	16170
16047	16058	16077	16088	16117	16122	16132	16161	16171
16048	16059	16078	16093	16118	16123	16154	16164	16174
16049	16060	16079	16097	16119	16125	16155	16165	16176
16052	16063	16083	16099	16120	16127	16158	16166	16253

Table 11-3: Comparison of Raw Wastewater Mean Concentrations of Non-Hazardous Pollutants of Interest for Municipal Solid Waste Landfills and Hazardous Facility 16041

Cas No.	Pollutant	Mean concentration of Pollutants of Interest for All Municipal Landfills in EPA Database	Mean Concentration of Pollutants of Interest for Hazardous Facility 16041
C-002	Biochemical Oxygen Demand	1,149,485	877,875
C-004	Chemical Oxygen Demand	2,036,330	2,033,750
C-005	Nitrate/Nitrite	5,844	1,770
C-009	Total Suspended Solids	764,360	191,375
C-010	Total Dissolved Solids	4,195,518	12,275,000
C-012	Total Organic Carbon	661,481	562,250
C-020	Total Phenols	153,024	3,195
106445	P-Cresol	246	218
108101	4-Methyl 2-Pentanone	3,789	2,175
108883	Toluene	156	1,468
108952	Phenol	287	1,553
120365	Dichloroprop	10	2
123911	1,4-Dioxane	118	10
142621	Hexanoic Acid	13,148	1,632
18540299	Chromium (Hexavalent)	621	Not analyzed
20324338	Tripropyleneglycol Methyl Ether	568	1,750
298044	Disulfoton	9	Not analyzed
3268879	OCDD	0	6
35822469	1234678-HpCDD	0	1
65850	Benzoic Acid	8,423	5,294
67641	2-Propanone	2,407	4,398
68122	N,N-Dimethylformamide	214	Not analyzed
7440213	Silicon	30,913	5,518
7440246	Strontium	1,569	2,846
7440326	Titanium	66	65
7440393	Barium	720	No analyzed
7440428	Boron	3,500	8,839
7440473	Chromium	47	87
7440666	Zinc	1,530	253
75092	Methylene Chloride	309	49
7664417	Ammonia Nitrogen	238,165	382,250
78933	2-Butanone	5,874	6,398
95487	O-Cresol	298	10
98555	Alpha-Terpineol	334	691

Table 11-4: Candidate BPT Facilities for the Non-Hazardous Subcategory Without BOD_5 Effluent Data

16001	16056	16063	16083	16119	16154	16159
16047	16059	16078	16085	16121	16155	16166
16049	16060	16079	16102	16123	16158	16174

Table 11-5: Landfill Facilities Considered for BPT in the Non-Hazardous Subcategory which Supplied BOD5 Effluent Data

Facility QID	Baseline Flow (mgd)	BOD5 (ug/l) Influent	BOD5 (ug/l) Effluent	TSS (ug/l) Influent	TSS (ug/l) Effluent	Treatment in Place
16041	0.058917	910469	47000	329831	35730	Sequencing batch reactor (SBR)
16048	5.0E-06	NV	73000	NV	NV	Aerobic (oxidation pond)
16052	0.0546	NV	37000	NV	20000	Aerobic-anaerobic (lagoon)
16058	0.003	153000	24100	NV	188150	Aerated lagoon
16065	0.008	NV	35000	NV	100000	Aerobic pond
16077	0.00816	53750	10100	48500	19100	Aerated lagoon
16088	0.03621	3799333	209119	2542500	182304	Equalization, sand filter, carbon adsorption, aerobic
16093	0.081575	23524	8299	NV	NV	Activated sludge, secondary clarifier, disinfection, multimedia filtration
16097	0.019	23292	14306	35592	14104	Activated sludge, secondary clarifier
16099	0.01533	NV	11540	NV	37129	Equalization, chemical precipitation, flocculation, coalescing, anaerobic, activated sludge with PACT, nitrification, secondary clarifier
16117	0.04	179571	4786	47600	6875	Equalization, chemical precipitation, primary clarifier, aerated fixed film, secondary clarifier, denitrification
16118	0.0288	1990351	48100	NV	NV	Equalization, chemical precipitation, primary clarifier, anaerobic, aerobic, secondary clarifier
16120	0.042775	789804	4330	1221000	13748	Settling, aeration, chemical precip, primary clarifier, air stripper, neutralization, activated sludge, secondary clarifier, multimedia filtration, disinfection
16122	0.0255	1007111	41100	266733	5440	Equalization, chemical precipitation, primary clarifier, anaerobic, aerobic, secondary clarifier, aerobic equalization, multimedia filtration
16125	0.014193	1672500	56900	210765	12717	Aeration, chemical precipitation, primary clarifier, SBR, secondary clarifier, carbon adsorption, multimedia filtration
16127	0.003627	NV	39808	NV	17981	Unstirred tank, aeration
16129	0.00469	213655	1835	43848	2651	Neutralization (lime), chemical precipitation, primary clarifier, activated sludge, secondary clarifier, sand filter, air stripping
16132	0.03	7609318	15700	244333	47000	Aerated pond
16161	0.053	NV	171000	NV	68000	Aeration, aerobic, settling (aerated pond)
16164	0.01	NV	487000	NV	46000	Aeration, chemical precipitation, primary clarifier, neutralization, equalization, aerobic, secondary clarifier
16165	0.030218	1812000	974000	94000	115000	Aerobic, settling (aerated pond)
16170	0.0048	68636	63000	44125	20500	Equalization, stabilization pond
16171	0.024	327200	213000	150000	122000	Equalization, activated sludge, settling
16176	0.037272	NV	112000	NV	88000	Aeration, activated sludge, settling
16253	0.01776	327000	6420	150000	26400	Equalization, chemical precipitation, primary clarifier, anaerobic, activated sludge, secondary clarifier, nitrification, multimedia filtration

NV: Not Available

Table 11-6: National Estimates of Pollutant of Interest Reductions for BPT/BAT Options for Municipal Solid Waste Landfills - Direct Dischargers

		National Estimates			
Pollutant of Interest CAS Number	Pollutant of Interest	Current Discharge Loads (pounds/yr)	BPT/BAT Option I Loads (pounds/yr)	BPT/BAT Option II Loads (pounds/yr)	BAT Option III- RO Loads (pounds/yr)
C-020	Total Phenols	825	167	111	NA
C-012	Total Organic Carbon	808,588	308,537	147,311	NA
C-010	Total Dissolved Solids	14,052,754	13,932,764	13,116,881	NA
C-009	Total Suspended Solids	357,144	130,724	72,603	NA
C-005	Nitrate/Nitrite	109,647	108,992	109,647	NA
C-004	Chemical Oxygen Demand	2,523,010	1,301,591	1,291,556	NA
C-002	Biochemical Oxygen Demand	452,923	100,689	100,689	NA
7664417	Ammonia Nitrogen	204,481	29,159	3,199	55
18540299	Chromium (Hexavalent)	179	56	89	52
7440393	Barium	1,368	1,136	663	655
7440473	Chromium	116	95	97	50
7440246	Strontium	3,578	547	912	547
7440326	Titanium	130	20	60	20
7440666	Zinc	936	197	193	98
123911	1,4-Dioxane	56	56	55	55
78933	2-Butanone	3,023	107	105	54
67641	2-Propanone	1,741	142	118	54
108101	4-Methyl-2-Pentanone	238	98	53	53
98555	Alpha-terpineol	259	55	55	55
65850	Benzoic Acid	6,698	272	191	54
142621	Hexanoic Acid	9,762	55	55	55
75092	Methylene Chloride	389	40	40	40
68122	N,N-Dimethylformamide	71	55	55	55
95487	O-Cresol	64	54	54	54
106445	P-Cresol	159	49	49	49
108952	Phenol	310	57	55	55
108883	Toluene	202	36	36	36
20324338	Tripropyleneglycol Methyl Ether	864	55	55	55
120365	Dichlorprop	17	17	17	17
298044	Disulfoton	23	11	11	11
35822469	1,2,3,4,6,7,8-HPCDD	0.00	0.00	0.00	0.00
3268879	OCDD	0.01	0.00	0.00	0.00

Table 11- 7: National Estimates of Pollutant of Interest Reductions for BPT/BAT Options for Non-Municipal Solid Waste Landfills - Direct Dischargers

		National Estimates		
Pollutant of Interest CAS Number	Pollutant of Interest	Current Discharge Loads (pounds/yr)	BPT/BAT Option I Loads (pounds/yr)	BPT /BAT Option II Loads (pounds/yr)
C-002	BOD	144,314	51,898	51,898
C-004	COD	2,340,246	726,056	718,197
C-009	TSS	55,085	50,479	24,168
C-005	Nitrate/Nitrite	2,463	2,463	2,463
C-020	Total Phenols	518	105	54
C-012	TOC	500,644	173,798	68,636
C-010	TDS	10,221,640	10,221,640	6,914,849
7664417	Ammonia as Nitrogen	167,097	14,219	1,428
7440246	Strontium	9,554	242	403
94746	MCPA	904	280	280

Table 11-8: Annual Pollutant Discharge Before and After the Implementation of BPT for Subtitle D Municipal Solid Waste Landfill Facilities in the Non-Hazardous Subcategory

Pollutant Group	Current Annual Pollutant Discharge (pounds)	Annual Pollutant Discharge After Implementation of BPT (pounds)	Annual Amount of Pollutants Removed by BPT (pounds)
Conventional Pollutants	810,000	677,400	132,600
Nonconventional Pollutants	17,700,000	3,030,000	14,670,000
Metal Pollutants	6,300	4,300	2,000
Organic Pollutants	23,800	22,900	900
Pesticides	40	12	28
Dioxins/ Furans	0.0	0.0	0.0

Table 11-9: Annual Pollutant Discharge Before and After The Implementation of BPT for Subtitle D Non-Municipal Landfill Facilities in the Non-Hazardous Subcategory

Pollutant Group	Current Annual Pollutant Discharge (pounds)	Annual Pollutant Discharge After Implementation of BPT (pounds)	Annual Amount of Pollutants Removed by BPT (pounds)
Conventional Pollutants	204,000	158,000	46,000
Nonconventional Pollutants	13,500,000	5,600,000	7,900,000
Metal Pollutants	11,900	10,800	1,100
Organic Pollutants	208	134	74
Pesticides	1,500	770	730
Dioxins/ Furans	0.0	0.0	0.0

Table 11-10: BPT Limitations for the Non-Hazardous Subcategory

Pollutant or Pollutant Property	Maximum for 1 day (mg/l)	Monthly Average Shall Not Exceed (mg/l)
BOD_5	160	40
TSS	89	27
Ammonia	5.9	2.5
Alpha Terpineol	0.059	0.029
Benzoic Acid	0.23	0.13
P-Cresol	0.046	0.026
Phenol	0.045	0.026
Toluene	0.080	0.026
Zinc	0.20	0.11
pH	([1])	([1])

([1]) pH shall be in the range 6.0 - 9.0 pH units.

Table 11-11: BPT Limitations for the Hazardous Subcategory

Pollutant or Pollutant Property	Maximum for 1 day (mg/l)	Monthly Average Shall Not Exceed (mg/l)
BOD_5	160	40
TSS	89	27
Ammonia	5.9	2.5
Alpha Terpineol	0.042	0.019
Aniline	0.024	0.015
Benzene	0.14	0.036
Benzoic Acid	0.12	0.073
Naphthalene	0.059	0.022
P-Cresol	0.024	0.015
Phenol	0.048	0.029
Pyridine	0.072	0.025
Toluene	0.080	0.026
Arsenic	1.0	0.52
Chromium	0.86	0.40
Zinc	0.37	0.21
pH	([1])	([1])

([1]) pH shall be in the range 6.0 - 9.0 pH units.

Table 11-12: Comparison of Long Term Averages for Nonconventional and Toxic Pollutants Proposed to be Regulated Under BPT and BAT

Pollutant	BPT Option II: Equalization + Biological + Multimedia Filter	Reverse Osmosis single stage effluent	Reverse Osmosis second stage effluent
Ammonia	1.4	13	0.59
Zinc	0.68	0.010 ND	0.011
Alpha Terpineol	0.018	0.010 ND	0.010 ND
Benzoic Acid	0.091	0.079	0.010 ND
P-Cresol	0.018	0.233	0.022
Phenol	0.018	0.183	0.029
Toluene	0.010 ND	0.114	0.016

ND: Non-detect

Table 11-13: Comparison of Ammonia Concentrations in Wastewaters

	Raw Leachate (mg/l) Non-hazardous landfills [1]	Current Discharge to Stream (mg/l) Direct Discharging Landfills [1]	Current Discharge to POTW (mg/l) Indirect Discharging Landfills [1]	Existing Pretreatment Standards established by POTWs [1] (mg/l)	Typical Domestic Sewage Concentration (mg/l)
Median	82	13	82	100 [2] 50 [3]	14 [4]
Average	240	19	76	260 [2] 400 [3]	15 [4]
Range	1 - 2,900	ND - 100	1 - 1,000	7 - 1,000 [2] 5 - 1,500 [3]	1 - 67 [4]

ND: Non-detect
(1) data collected through EPA sampling and Waste Treatment Industry: Landfills Questionnaire.
(2) monthly average.
(3) daily maximum .
(4) data from "50-POTW Study".

Table 11-14: National Estimates of Pollutant of Interest Reductions for PSES/PSNS Options for Municipal Solid Waste Landfills - Indirect Dischargers

Pollutant of Interest CAS Numbers	Pollutant of Interest	National Estimates	
		Current Discharge Loads (pounds/yr)	PSES/PSNS Option I Loads (pounds/yr)
C-004	CHEMICAL OXYGEN DEMAND	38,760,137	12,955,244
C-020	TOTAL PHENOLS	24,753	1,959
C-012	TOTAL ORGANIC CARBON	13,862,541	3,154,103
C-010	TOTAL DISSOLVED SOLIDS	113,527,543	111,388,250
C-005	NITRATE/NITRITE	48,539	48,539
7664417	AMMONIA NITROGEN	3,061,931	246,762
18540299	CHROMIUM (HEXAVALENT)	2,595	464
7440393	BARIUM	18,108	17,985
7440473	CHROMIUM	1,204	880
7440246	STRONTIUM	60,712	4,196
7440326	TITANIUM	2,286	197
7440666	ZINC	5,942	1,889
123911	1,4-DIOXANE	449	449
78933	2-BUTANONE	62,943	1,165
67641	2-PROPANONE	35,771	1,534
108101	4-METHYL-2-PENTANONE	3,628	1,048
98555	ALPHA-TERPINEOL	4,464	420
65850	BENZOIC ACID	138,815	2,098
142621	HEXANOIC ACID	206,848	420
75092	METHYLENE CHLORIDE	3,741	402
68122	N,N-DIMETHYLFORMAMIDE	446	420
95487	O-CRESOL	597	419
106445	P-CRESOL	2,720	410
108952	PHENOL	4,343	440
108883	TOLUENE	6,237	406
20324338	TRIPROPYLENEGLYCOL METHYL ETHER	7,906	420
298044	DISULFOTON	238	84
120365	DICHLORPROP	228	228
35822469	1,2,3,4,6,7,8-HPCDD	0	0
3268879	OCDD	0	0

Table 11-15: National Estimates of Pollutant of Interest Reductions for PSES/PSNS Option I for Non-municipal Solid Waste Landfills - Indirect Dischargers

		National Estimates	
Pollutant of Interest CAS Number	Pollutant of Interest	Current Discharge Loads (pounds/year)	PSES/PSNS Option I Loads (pounds/year)
C-004	COD	1,937,002	611,146
C-020	Total Phenols	407	88
C-012	TOC	413,238	144,913
C-010	TDS	8,135,113	8,135,113
C-005	Nitrate/Nitrite	2,250	2,250
7664417	Ammonia as Nitrogen	140,371	11,903
7440246	Strontium	7,443	202
94746	MCPA	714	230

Table 11-16: PSES and PSNS Limitations for the Hazardous Subcategory

Pollutant or Pollutant Property	Maximum for 1 day (mg/l)	Monthly Average Shall Not Exceed (mg/l)
Ammonia	5.9	2.5
Alpha Terpineol	0.042	0.019
Aniline	0.024	0.015
Benzoic Acid	0.12	0.073
P-Cresol	0.024	0.015
Toluene	0.080	0.026
pH	([1])	([1])

([1]) pH shall be in the range 6.0 - 9.0 pH units.

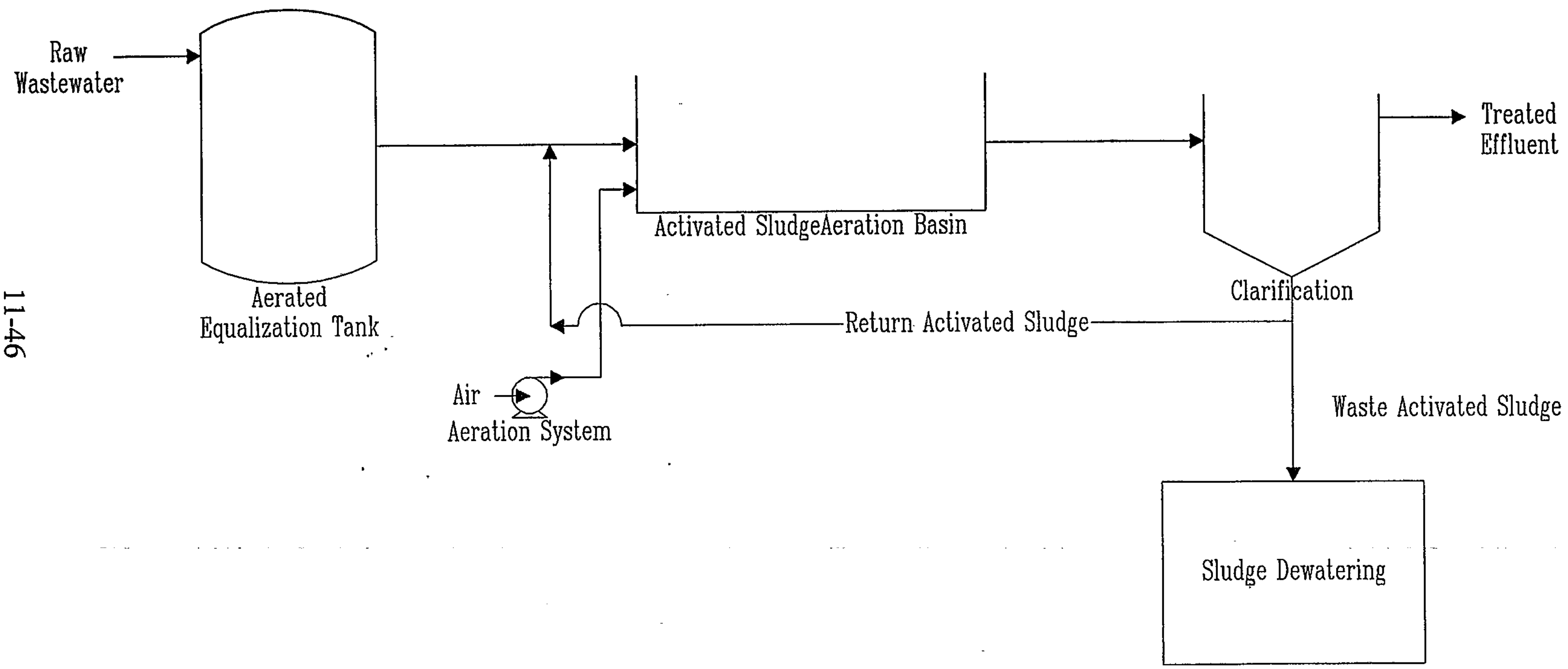


Figure 11-1. BPT/BCT/BAT/PSES/PSNS Non-Hazardous Subcategory Option I Flow Diagram

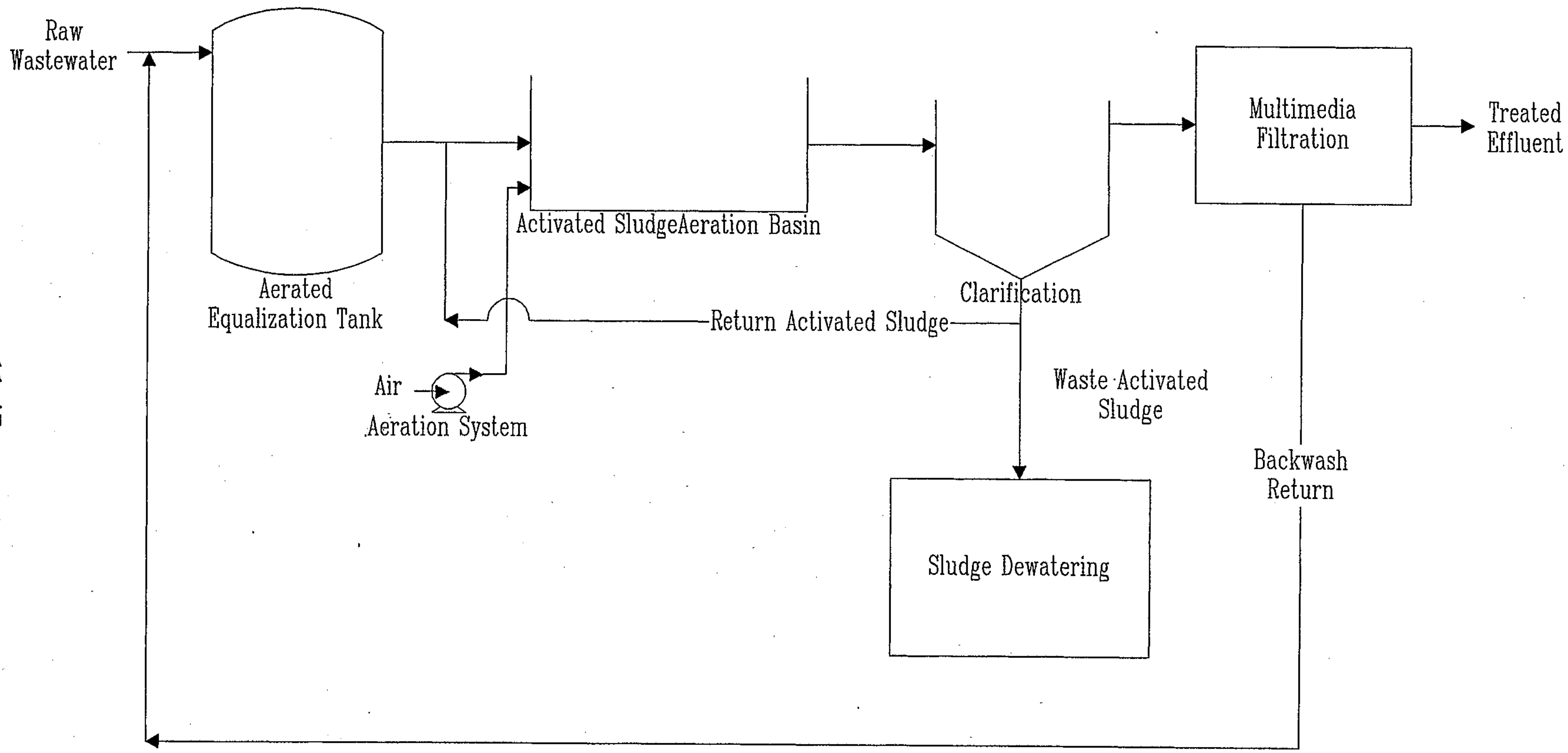


Figure 11-2. BPT/BCT/BAT Non-Hazardous Subcategory Option II & NSPS Flow Diagram

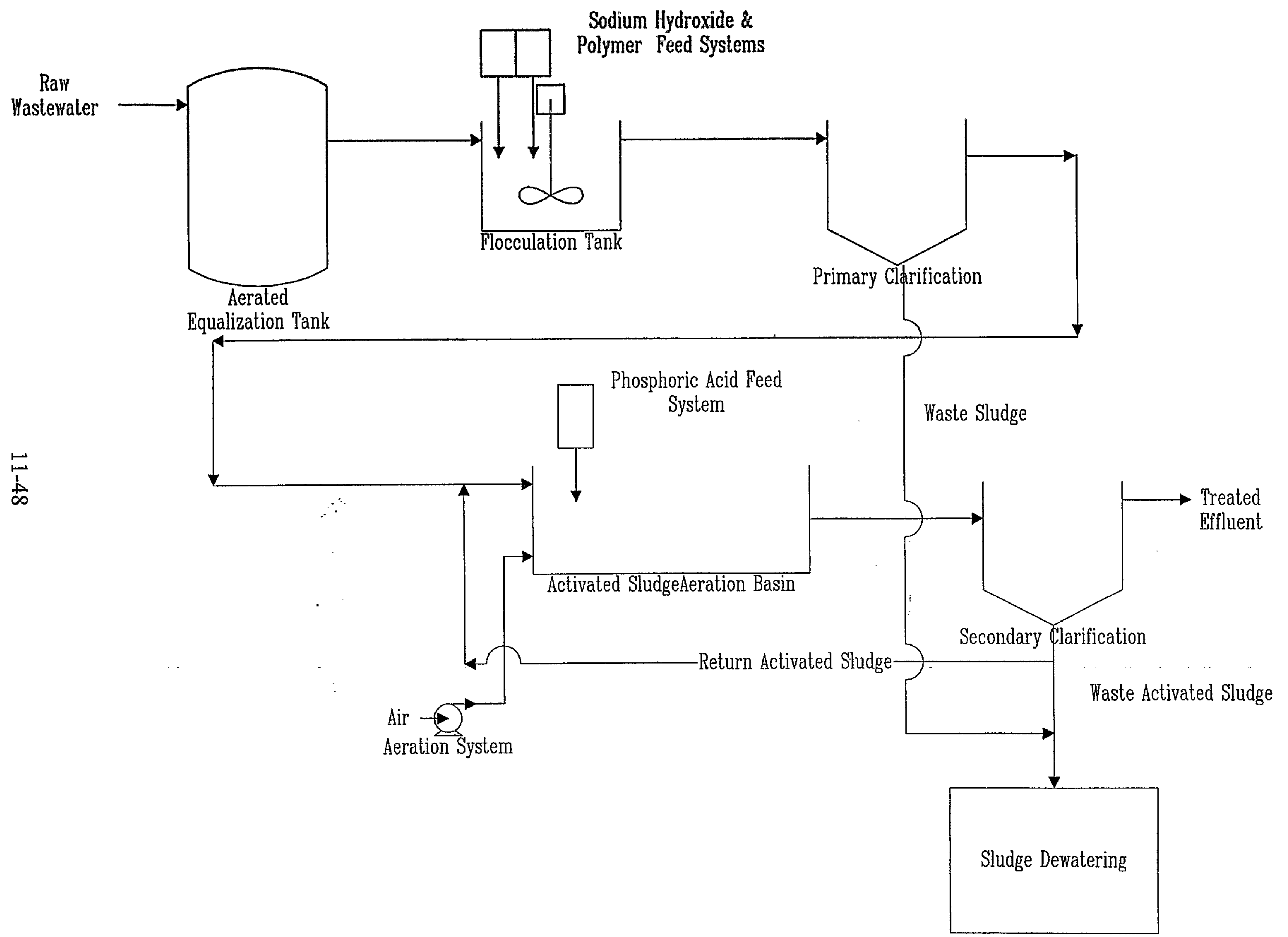


Figure 11-3. BPT/BCT/BAT/PSES Hazardous Subcategory Option I & NSPS/PSNS Flow Diagram

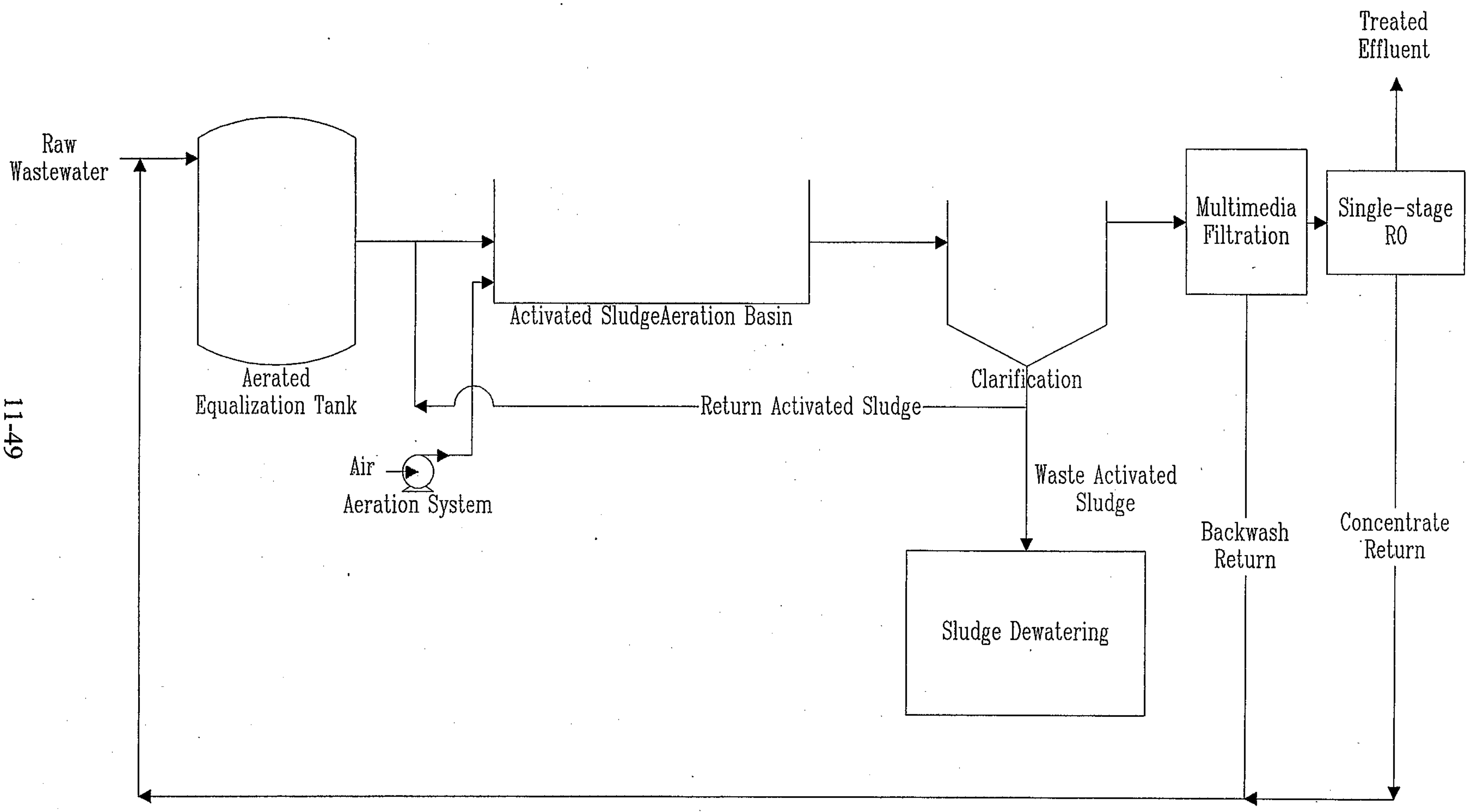


Figure 11-4. BAT Hazardous Subcategory Option III Flow Diagram

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APPENDIX A:

SECTION 308 SURVEY FOR LANDFILLS - INDUSTRY POPULATION ANALYSIS

Appendix A: Section 308 Survey for Landfills-Industry Population Analysis

The list of landfills needed to define the landfill population in the United States was developed from various sources: state environmental and solid waste departments, and other state contacts; the National Survey of Hazardous Waste Treatment Storage, Disposal, and Recycling Facilities respondent list; Environmental Ltd.'s 1991 Directory of Industrial and Hazardous Waste Management Firms; the Resource Conservation and Recovery Act (RCRA) 1992 list of Municipal Solid Waste Landfills; and the Resource Conservation and Recovery Information System (RCRIS) National Oversight Database.

The information provided by state environmental departments was requested during early stages of the rulemaking process for Centralized Waste Treatment and represented 1987-88 data for both active and inactive landfills. This information was incomplete to some extent. For 18 of the 50 states only limited or no information was available. Hence, these states were contacted during the data gathering effort for the development of effluent guidelines and standards for Landfills and Incinerators to obtain updated lists of landfills and wastewater collection information.

The duplication of landfill entries among various sources was eliminated as far as possible by cross checking using computer programs. However, some duplication in Subtitle D landfills is inevitable as some of the various identifiers were unclear.

Landfill population was divided into two categories: Subtitle C (hazardous waste) and Subtitle D (non-hazardous waste). In total, mailing addresses were compiled for 595 Subtitle C landfills and 9,882 Subtitle D landfills. In addition, 448 Subtitle D landfills were identified for which addresses were inadequate for delivery. Thus the population of Subtitle D amounted to 10,330. Table 1 provides a list of the number of landfills with deliverable mailing addresses in each state by category.

Selection of the landfills to survey

From the identified landfill population of 10,925 Subtitle C and D facilities, screener surveys were mailed to 4996. Facilities receiving the screener survey included all of the 595 Subtitle C landfills and a sample of the 9,882 Subtitle D facilities with mailable addresses.

TABLE 1. COUNT OF LANDFILLS WITH MAILABLE ENTRIES IN EACH STATE

State	Subtitle-D	Subtitle-C	Total
Alabama	238	38	276
Alaska	201	1	202
Arizona	90	2	92
Arkansas	134	3	137
California	630	16	646
Colorado	216	12	228
Connecticut	125	22	147
Delaware	8	14	22
Florida	91	9	100
Georgia	277	17	294
Hawaii	15	1	16
Idaho	112	6	118
Illinois	182	14	196
Indiana	101	29	130
Iowa	118	13	131
Kansas	118	8	126
Kentucky	121	33	154
Louisiana	73	17	90

State	Subtitle-D	Subtitle-C	Total
Maine	291	2	293
Maryland	50	5	55
Massachu-setts	722	1	723
Michigan	762	9	771
Minnesota	257	4	261
Mississippi	97	3	100
Missouri	128	7	135
Montana	257	1	258
Nebraska	41	8	49
Nevada	127	3	130
New Hapmshire	58	0	58
New Jersey	467	8	475
New Mexico	121	7	128
New York	565	10	575
North Carolina	244	39	283
North Dakota	85	1	86
Ohio	119	24	143
Oklahoma	189	7	196
Oregon	231	10	241
Pennsyl-vania	41	22	63
Rhode Island	12	0	12
South Carolina	127	9	136

State	Subtitle-D	Subtitle-C	Total
South Dakota	193	0	193
Tennessee	112	9	121
Texas	601	70	671
Utah	92	7	99
Vermont	73	0	73
Virginia	440	8	448
Washington	72	9	81
West Virginia	57	5	62
Wisconsin	183	3	186
Wyoming	218	45	263
Puerto Rico	0	3	3
Guam	0	1	1
Total	9882	595	10477

The remaining 4401 screener surveys were sent to Subtitle D landfills. A statistical approach was taken to sample the 9882 deliverable Subtitle D facilities. For sampling purposes, the 9882 Subtitle D landfills were stratified into three categories:

1) landfills with known wastewater collection
2) landfills from states with fewer than 100 landfills and
3) landfills from states with more than 100 landfills.

All landfills with known wastewater collection were included in the landfill survey sample. The population included 134 landfills with known wastewater collection (1.35%).

Landfills in states with fewer than 100 landfills were stratified from the landfills in states with more than 100 landfills. This was simply a sampling technique for random sampling and was done to ensure the inclusion of a representative number of facilities from each stratum.

There were 16 states with under 100 landfills each (after exclusion of known wastewater collectors), which accounted for 892 landfills. A screener survey was mailed to each of these 892 landfills. The remaining 24 states, with over 100 landfills each, accounted for 8856 landfills. A random sample of 3375 was taken from this strata, and a screener survey was mailed to each of these randomly selected landfills. Table 2 summarizes the stratification.

Screener surveys were distributed by both Federal Express and U.S. certified mail: 1916 surveys were sent via Federal Express, which resulted in 94% receipt confirmation; 3080 surveys were sent via U.S. certified mail, which resulted in 92% receipt confirmation. Twenty three additional screener surveys were mailed because of change of ownership, or different mailing address, even though the physical location of the landfill remained same. A summary of analysis on these additional surveys is presented in Table 3. Thus, a total of 5020 landfill screener surveys were distributed.

TABLE 2. SUMMARY OF STRATIFICATION

Strata #	Population	# in frame	# in sample
1	Subtitle C	595	595
2	Subtitle D -known wastewater generators	134	134
3	Subtitle D - states with ≤ 100 landfills	892	892
4	Subtitle D - states with >100 landfills	8856	3375
	Total	10477	4996

A completed screener survey was received from 3628 landfills excluding the late arrivals. This includes response from a pre-test screener survey. The status of remaining screener surveys is:

- 353 surveys were deemed non-deliverables due to incorrect/non-traceable addresses and were returned to the sender
- 1008 landfills were presumed to be non-respondents
- 4 landfills were found to be out-of-business
- 26 landfills were declared ineligible to participate in the survey for reasons discovered during the mid-point remainder calls
- 1 respondent refused to respond to the survey.

For statistical analysis purposes, screener surveys in each of the above categories were traced back to the respective strata. Table 4 presents a breakdown of these remaining screener surveys by strata.

TABLE 3. SUMMARY OF ADDITIONAL SCREENER SURVEY ANALYSIS

Screener ID	Original ID	Stratum	Reason for re-assignment
15100	13235	4	screener sent to former owner or incorrect address
15101	14044	4	screener sent to former owner or incorrect address
15102	13876	4	screener sent to former owner or incorrect address
15103	11594	4	screener sent to former owner or incorrect address
15104	14117	4	screener sent to former owner or incorrect address
15105	13953	4	screener sent to former owner or incorrect address
15106	13264	4	screener sent to former owner or incorrect address
15107	10985	4	additional screener resp. was obtained for a new landfill
15108	14449	4	additional screener resp. was obtained for a new landfill
15109	12167	1	additional screener resp. was obtained for a new landfill
15110	12883	4	additional screener resp. was obtained for a new landfill
15111			response transferred from pre-test screener survey
15112	14112	4	screener sent to former owner or incorrect address
15113	11319	3	screener sent to former owner or incorrect address
15114	12327	4	screener sent to former owner or incorrect address
15116	11528	4	screener sent to former owner or incorrect address
15117	13389	3	screener sent to former owner or incorrect address
15118	13995	4	screener sent to former owner or incorrect address
15119	14779	4	screener sent to former owner or incorrect address
15120	11422	4	screener sent to former owner or incorrect address
15121	13976	4	screener sent to former owner or incorrect address
15122	12422	1	screener sent to former owner or incorrect address
15123	11299	4	screener sent to former owner or incorrect address
15124	10851	4	screener sent to former owner or incorrect address

Among the 3628 survey responses received, a total of 3581 surveys were sent to data entry; 44 were declared ineligible upon reviewing their response, and were not processed any further; 3 remained incomplete because of unsuccessful attempts to contact the respondents to complete the review process. A total of 859 respondents were found collecting some type of wastewater (landfills collecting only storm water were not included) generated from their landfill operations, and were considered as in scope population from which a sample of facilities will be selected to receive the detailed Section 308 landfill questionnaire. The rest of the surveys sent to data entry were considered out of scope. For statistical analysis purposes, screener surveys not sent to data entry, the out of scope surveys, and the in scope surveys were traced back to the respective strata, and a count of these in each strata is presented in Table 4.

A response bias query was conducted on about 5.65% (57 landfills) of the 1008 presumed non-respondents. Each of these 57 randomly-selected landfills was called to discern the reasons that the screener survey was not received. The result of this effort is as follows:

- 25 facility contacts said that they over looked/misplaced/forgotten the survey (1 in stratum 2; 1 in stratum 3; and 23 in stratum 4)

- 19 facility contacts said that they did not recall receiving any survey (2 in stratum 1; 3 in stratum 3; and 14 in stratum 4)

- 7 facility contacts said that they did not feel it was applicable to them (1 in stratum 1; 2 in stratum 3; and 4 in stratum 4)

- 3 facility contacts said that they forgot and would complete the survey and return (2 in stratum 3; and 1 in stratum 4)

- 2 facility contacts said that they received duplicate surveys, and this was checked and found correct (these 2 are in stratum 4)

- 1 facility contact said that they are under bankruptcy proceedings (this is in stratum 1).

A total of 39 landfill screener survey responses were received past the deadline. since these were received after the close of the screener survey database, they were not considered for any further analyses. Among these 39 late arrivals, only four landfills collected wastewater generated from landfill operations (landfill leachate and contaminated groundwater), and none of these four landfills have any on-site treatment. Additional information on these four landfills is: two were municipal, non-commercial, and discharged untreated wastewater to a Publicly Owned Treatment Works (POTW); one was government, commercial, and discharged untreated wastewater to a POTW; one was private and sent their wastewaters for off-site disposal.

Questionnaire distribution

A total of 859 landfill operators reported that they collect one or more type of wastewater generated from the landfill operations (landfills collecting only storm water were not included). These landfills were considered as the sample frame to receive the Section 308 questionnaire for landfills. Facilities with treatment were targeted most heavily, while some facilities without treatment but collect wastewater were randomly selected to receive only Section A of the questionnaire. The facilities selected fall into any of the following eight categories:

1. Commercial private, municipal, or government facilities which have wastewater treatment and are direct or indirect dischargers. A census was conducted of this part of the industry.

2. Commercial private, municipal, or government facilities which have wastewater treatment and are zero dischargers (do not discharge to surface water or to a POTW). Approximately 25% of these were randomly chosen to receive the questionnaire.

3. Non-commercial private facilities with wastewater treatment. Approximately 40% of these were randomly chosen to receive the questionnaire.

4. Facilities with no wastewater treatment. Approximately 10% of these were randomly chosen to receive only Section A of the questionnaire.

5. Commercial facilities who accept PCB wastes. Only one facility was in this category, and was chosen.

6. Municipal hazardous waste landfills. There were two facilities in this category, and a census was conducted of this part of the industry.

7. Small business with no wastewater treatment. A census was conducted of this part of the industry.

8. Pre-test facility which was not in the screener population. Only one facility was in this category, and was chosen based on knowledge of the industry and professional judgement.

For statistical analysis purposes, the facilities in each of the aforementioned categories were traced back through their screener surveys to the respective strata, and a count of these in each strata is presented in Table 5.

Section 308 Questionnaires were sent to a total of 252 mailing addresses that were considered in scope from their screener responses. The questionnaire response was received from 248 landfills. The remaining four landfills were presumed to be non-respondents. The questionnaire responses received included four responses from pre-test questionnaires. Thus a total of 248 responses were available for further review.

Among the survey responses obtained, 22 were declared out of scope upon reviewing their response and were not processed any further; 226 were reviewed for completeness and technical accuracy and were entered into the landfill questionnaire database. For statistical analysis purposes, the 252 questionnaires that were sent, including the 226 questionnaires reviewed and placed in the database, were traced back to the original screener population strata, and a count of these in each strata is presented in Table 4.

TABLE 4. COUNT OF SCREENER SURVEYS IN EACH CATEGORY BY STRATA[1]

Category	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Total
Non-respondents	69	15	170	755	1009
Ineligible[2]	79	9	45	294	427
Incomplete	2	0	1	0	3
In scope	141	91	222	405	859
Out of scope	305	20	456	1941	2722
Quest. recipients	51	35	77	88	252[3]
Quest. in database	46	32	71	76	226[3]
Quest. out of scope	4	3	4	11	22
Quest. non-response	1	0	2	1	4

[1]For each of the category presented below, a list of Survey ID numbers and their respective strata # is presented in Appendix A.

[2]This includes all non-deliverables, out-of-business, and duplicate addresses.

[3]An additional one is the pre-test questionnaire, which is not part of any stratum.

TABLE 5. QUESTIONNAIRE SELECTION BY CATEGORY

Category	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Total
Pri/com/muni/govt./with treat/D-I discharge	12	27	51	38	128
Pri/non-com/with treatment	30	2	3	7	42
Pri/com/muni/govt./with treat/Zero discharge	1	0	7	0	8
No treatment	5	6	14	38	63
PCB facilities with treatment	0	0	1	0	1
Municipal/hazardous	2	0	0	0	2
Small business/no treatment	1	0	1	5	7
Pre-test not in Screener population[4]	-	-	-	-	1
Totals	51	35	77	88	252

[4]This is a pre-test questionnaire and is not in any stratum because, it was not in the screener database.

TABLE 6. IN SCOPE SCREENERS NOT SELECTED FOR QUESTIONNAIRE BY CATEGORY

Category	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Total
Pri/com/muni/govt./with treat/D-I discharge	0	0	0	0	0
Pri/non-com/with treatment	31	0	6	27	64
Pri/com/muni/govt./with treat/Zero discharge	7	2	9	7	25
No treatment	52	54	130	283	519
PCB facilities with treatment	0	0	0	0	0
Municipal/hazardous	0	0	0	0	0
Small business/no treatment	0	0	0	0	0
Totals	90	56	145	317	608

APPENDIX B:

DEFINITIONS, ACRONYMS, AND ABBREVIATIONS

Appendix B: Definitions, Acronyms, and Abbreviations

ADMINISTRATOR: The Administrator of the U.S. Environmental Protection Agency.

AGENCY: The U.S. Environmental Protection Agency.

AVERAGE MASTER FILE: A method of calculating the average raw wastewater concentration for each pollutant of interest in a subcategory. The Average Master File was calculated using all available data collected in the Landfills industry study.

BASELINE FLOW: Estimated wastewater discharge flow rate for a selected facility in 1992 based on their Detailed Questionnaire response.

BAT: The best available technology economically achievable, applicable to effluent limitations to be achieved by July 1, 1984, for industrial discharges to surface waters, as defined by Sec. 304(b)(2)(B) of the CWA.

BCT: The best conventional pollutant control technology, applicable to discharges of conventional pollutants from existing industrial point sources, as defined by Sec. 304(b)(4) of the CWA.

BOD_5: Biochemical oxygen demand - Five Day. A measure of the biochemical decomposition of organic matter in a water sample. It is determined by measuring the dissolved oxygen consumed by microorganisms to oxidize the organic contaminants in a water sample under standard laboratory conditions of five days and 70 degrees Celsius. BOD_5 is not related to the oxygen requirements in chemical combustion.

BPT: The best practicable control technology currently available, applicable to effluent limitations to be achieved by July 1, 1977, for industrial discharges to surface waters, as defined by Sec. 304(b)(1) of the CWA.

CAPDET:
Computer-Assisted Procedure for the Design and Evaluation of Wastewater Treatment Systems. Developed by the U.S. Army Corp. of Engineers, CAPDET is intended to provide planning level cost estimates to analyze alternate design technologies for wastewater treatment systems.

CAPTIVE: Used to describe a facility that only accepts wastes generated on site and/or by the landfill owner/operator at the facility.

CELL:
An area of a landfill that is separated from other areas by an impervious structure. Each cell has a separate leachate collection system or would require a separate leachate collection system if one were installed. Individual leachate collection systems that are combined at the surface are considered separate systems by this definition.

CLEAN WATER ACT (CWA): The Federal Water Pollution Control Act Amendments of 1972 (33 U.S.C. Section 1251 et seq.), as amended by the Clean Water Act of 1977 (Pub. L. 95-217), and the Water Quality Act of 1987 (Pub. L. 100-4).

CLEAN WATER ACT (CWA) SECTION 308 QUESTIONNAIRE:
A questionnaire sent to facilities under the authority of Section 308 of the CWA, which requests information to be used in the development of national effluent guidelines and standards.

CLOSED: A facility or portion thereof that is currently not receiving or accepting wastes and has undergone final closure.

COMMERCIAL FACILITY: A facility that treats, disposes, or recycles/recovers the wastes of other facilities not under the same ownership as this facility. Commercial operations are usually made available for a fee or other remuneration. Commercial waste treatment, disposal, or recycling/recovery does not have to be the primary activity at a facility for an operation or unit to be considered "commercial".

CONTAMINATED GROUNDWATER: Water below the land surface in the zone of saturation which has been contaminated by landfill leachate. Contaminated groundwater occurs at landfills without liners or at facilities that have released contaminants from a liner system. Groundwater may also become contaminated if the water table rises to a point where it infiltrates the landfill or the leachate collection system.

CONTAMINATED STORM WATER: Storm water which comes in direct contact with the waste or waste handling and treatment areas. Storm water which does not come into contact with the wastes is not subject to the proposed limitations and standards.

CONVENTIONAL POLLUTANTS: Constituents of wastewater as determined by Sec. 304(a)(4) of the CWA, including pollutants classified as biochemical oxygen demand, total suspended solids, oil and grease, fecal coliform, and pH.

DEEP WELL INJECTION: Disposal of wastewater into a deep well such that a porous, permeable formation of a larger area and thickness is available at sufficient depth to ensure continued, permanent storage.

DETAILED MONITORING QUESTIONNAIRE (DMQ): Questionnaires sent to collect monitoring data from 27 selected landfill facilities based on responses to the Section 308 Questionnaire.

DIRECT DISCHARGER: A facility that discharges or may discharge treated or untreated wastewaters into waters of the United States.

DRAINED FREE LIQUIDS: Aqueous wastes drained from waste containers (e.g., drums, etc.) prior to landfilling. Landfills which accept containerized waste may generate this type of wastewater.

EFFLUENT LIMITATION: Any restriction, including schedules of compliance, established by a State or the Administrator on quantities, rates, and concentrations of chemical, physical, biological, and other constituents which are discharged from point sources into navigable waters, the waters of the contiguous zone, or the ocean. (CWA Sections 301(b) and 304(b).)

EPA: The U.S. Environmental Protection Agency.

EXISTING SOURCE: Any facility from which there is or may be a discharge of pollutants, the construction of which is commenced before the publication of the proposed regulations prescribing a standard of performance under Sec. 306 of the CWA.

FACILITY: All contiguous property owned, operated, leased or under the control of the same person or entity.

GAS CONDENSATE: A liquid which has condensed in the landfill gas collection system during the extraction of gas from within the landfill. Gases such as methane and carbon dioxide are generated due to microbial activity within the landfill, and must be removed to avoid hazardous conditions.

GROUNDWATER: The body of water that is retained in the saturated zone which tends to move by hydraulic gradient to lower levels.

HAZARDOUS SUBCATEGORY: For the purposes of this guideline, Hazardous Subcategory refers to all landfills regulated under Subtitle C of RCRA.

HAZARDOUS WASTE: Any waste, including wastewater, defined as hazardous under RCRA, TSCA, or any State law.

INACTIVE: A facility or portion thereof that is currently not treating, disposing, or recycling/recovering wastes.

INDIRECT DISCHARGER: A facility that discharges or may discharge wastewaters into a publicly-owned treatment works (POTW).

INTRA-COMPANY: A facility that treats, disposes, or recycles/recovers wastes generated by off-site facilities under the same corporate ownership. The facility may also treat on-site generated wastes. If any waste from other facilities not under the same corporate ownership is accepted for a fee, the facility is considered commercial.

LANDFILL: An area of land or an excavation in which wastes are placed for permanent disposal, that is not a land application or land treatment unit, surface impoundment, underground injection well, waste pile, salt dome formation, a salt bed formation, an underground mine or a cave.

LANDFILL GENERATED WASTEWATERS: Wastewater generated by landfill activities and collected for treatment, discharge or reuse, include: leachate, contaminated groundwater, storm water runoff, landfill gas condensate, truck/equipment washwater, drained free liquids, floor washings, and recovering pumping wells.

LEACHATE: Leachate is a liquid that has passed through or emerged from solid waste and contains soluble, suspended, or miscible materials removed from such waste. Leachate is typically collected from a liner system above which waste is placed for disposal. Leachate may also be collected through the use of slurry walls, trenches or other containment systems.

LEACHATE COLLECTION SYSTEM: The purpose of a leachate collection system is to collect leachate for treatment or alternative disposal and to reduce the depths of leachate buildup or level of saturation over the low permeability liner.

LINER: The liner is a low permeability material or combination of materials placed at the base of a landfill to reduce the discharge to the underlying or surrounding hydrogeologic environment. The liner is designed as a barrier to intercept leachate and to direct it to a leachate collection .

LONG-TERM AVERAGE (LTA): For purposes of the effluent guidelines, average pollutant levels achieved over a period of time by a facility, subcategory, or technology option. LTAs were used in developing the limitations and standards in the proposed landfill regulation.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT: A permit to discharge wastewater into waters of the United States issued under the National Pollutant Discharge Elimination system, authorized by Section 402 of the CWA.

NEW SOURCE: As defined in 40 CFR 122.2, 122.29, and 403.3 (k), a new source is any building, structure, facility, or installation from which there is or may be a discharge of pollutants, the construction of which commenced (1) for purposes of compliance with New Source Performance Standards (NSPS), after the promulgation of such standards being proposed today under CWA section 306; or (2) for the purposes of compliance with Pretreatment Standards for New Sources (PSNS), after the publication of proposed standards under CWA section 307 (c), if such standards are thereafter promulgated in accordance with that section.

NON-CONVENTIONAL POLLUTANTS: Pollutants that are neither conventional pollutants nor priority pollutants listed at 40 CFR Part 401.

NON-HAZARDOUS SUBCATEGORY: For the purposes of this report, Non-Hazardous Subcategory refers to all landfills regulated under Subtitle D of RCRA.

NON-WATER QUALITY ENVIRONMENTAL IMPACT: Deleterious aspects of control and treatment technologies applicable to point source category wastes, including, but not limited to air pollution, noise, radiation, sludge and solid waste generation, and energy usage.

NSPS: New Source Performance Standards, applicable to new sources of direct dischargers whose construction is begun after the publication of the proposed effluent regulations under CWA section 306.

OCPSF: Organic chemicals, plastics, and synthetic fibers manufacturing point source category. (40 CFR Part 414).

OFF-SITE: Outside the boundaries of a facility.

ON-SITE: The same or geographically contiguous property, which may be divided by a public or private right-of-way, provided the entrance and exit between the properties is at a crossroads intersection, and access is by crossing as opposed to going along the right-of-way. Non-contiguous properties owned by the same company or locality but connected by a right-of-way, which it controls, and to which the public does not have access, is also considered on-site property.

PASS THROUGH: A pollutant is determined to "pass through" a POTW when the average percentage removed by an efficiently operated POTW is less than the percentage removed by the industry's direct dischargers that are using the BAT technology.

POINT SOURCE: Any discernable, confined, and discrete conveyance from which pollutants are or may be discharged.

POLLUTANTS OF INTEREST: Pollutants commonly found in landfill generated wastewaters. For the purposes of this report, a pollutant of interest is a pollutant that is detected three or more times above a treatable level at a landfill, and must be present at more than one facility.

PRIORITY POLLUTANT: One hundred twenty-six compounds that are a subset of the 65 toxic pollutants and classes of pollutants outlined in Section 307 of the CWA. The priority pollutants are specified in the NRDC settlement agreement (Natural Resources Defense Council et al v. Train, 8 E.R.C. 2120 [D.D.C. 1976], modified 12 E.R.C. 1833 [D.D.C. 1979]).

PSES: Pretreatment standards for existing sources of indirect discharges, under Sec. 307(b) of the CWA.

PSNS: Pretreatment standards for new sources of indirect discharges, applicable to new sources whose construction has begun after the publication of proposed standards under CWA section 307 (c), if such standards are thereafter promulgated in accordance with that section.

PUBLICLY OWNED TREATMENT WORKS (POTW): Any device or system, owned by a state or municipality, used in the treatment (including recycling and reclamation) of municipal sewage or industrial wastes of a liquid nature that is owned by a state or municipality. This includes sewers, pipes, or other conveyances only if they convey wastewater to a POTW providing treatment (40 CFR 122.2).

RCRA: The Resource Conservation and Recovery Act of 1976 (RCRA) (42 U.S.C. Section 6901 et seq.), which regulates the generation, treatment, storage, disposal, or recycling of solid and hazardous wastes.

SUBTITLE C LANDFILL: A landfill permitted to accept hazardous wastes under Sections 3001 and 3019 of RCRA and the regulations promulgated pursuant to these sections, including 40 CFR Parts 260 through 272.

SUBTITLE D LANDFILL: A landfill permitted to accept only non-hazardous wastes under Sections 4001 through 4010 of RCRA and the regulations promulgated pursuant to these sections, including 40 CFR Parts 257 and 258.

SURFACE IMPOUNDMENT: A natural topographic depression, man-made excavation, or diked area formed primarily of earthen materials (although it may be lined with man-made materials), used to temporarily or permanently treat, store, or dispose of waste, usually in the liquid form. Surface impoundments do not include areas constructed to hold containers of wastes. Other common names for surface impoundments include ponds, pits, lagoons, finishing ponds, settling ponds, surge ponds, seepage ponds, and clarification ponds.

TOXIC POLLUTANTS: Pollutants declared "toxic" under Section 307(a)(1) of the Clean Water Act.

TRUCK/EQUIPMENT WASHWATER: Wastewater generated during either truck or equipment washes at the landfill. During routine maintenance or repair operations, trucks and/or equipment used within the landfill (e.g., loaders, compactors, or dump trucks) are washed and the resultant washwaters are collected for treatment.

VARIABILITY FACTOR: The daily variability factor is the ratio of the estimated 99th percentile of the distribution of daily values divided by the expected value, median or mean, of the distribution of the daily data. The monthly variability factor is the estimated 95th percentile of the distribution of the monthly averages of the data divided by the expected value of the monthly averages.

ZERO DISCHARGE: No discharge of pollutants to waters of the United States or to a POTW. Also included in this definition are alternative discharge or disposal of pollutants by way of evaporation, deep-well injection, off-site transfer, and land application

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