United States
Environmental Protection
Agency

Office of
Water Enforcement and Permits
Washington, DC 20460

September, 1987

Water

EPA

Guidance Manual for Conducting RCRA Facility Assessments at Publicly Owned Treatment Works

GUIDANCE ON THE CONDUCT OF RCRA FACILITY ASSESSMENT AT POTWs

October 1987

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DISCLAIMER

This guidance is intended to assist Regional and State personnel in exercising their discretion in implementing RCRA Facility Assessment requirements at POTWs. EPA will not in all cases undertake actions that comport with the guidance set forth herein. This document is not a regulation (i.e., it does not establish a standard of conduct which has the force of law) and should not be used as such. Regional and State personnel must exercise their discretion in using this document as well as other relevant information in applying the RCRA Facility Assessment requirements to POTWs.

ACKNOWLEDGEMENT

This document was prepared under the direction of EPA Headquarters, Office of Water Enforcement and Permits (OWEP), by Science Applications International Corporation (SAIC), EPA Contract Number 68-01-7043, Work Assignment Number P1-23. In preparing certain portions of this document (especially Chapter 2), OWEP and SAIC relied extensively on guidance previously prepared by the Office of Solid Waste. Special appreciation is extended to the following individuals for their participation in the document's preparation: Paul Connor, Attorney-Advisor and EPA Work Assignment Manager; James Taft, Environmental Engineer; and Frank Sweeney and Robert Linett of SAIC.

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1. INTRODUCTION

This document provides guidance for the conduct of RCRA Facility Assessments (RFA), the initial phase of corrective action under the Resource Conservation and Recovery Act (RCRA), at POTW facilities. This introductory chapter provides an overview of RCRA permit-by-rule provisions and corrective action programs, discusses the purpose and scope of the guidance document, and summarizes the organization of the document.

1.1 OVERVIEW OF RCRA PERMIT-BY-RULE PROVISIONS AND CORRECTIVE ACTION PROGRAM

1.1.1 Overview of RCRA Permit-by-Rule Provisions

The goal of the RCRA program is to require "cradle-to-grave" management of hazardous wastes. Management requirements are initially triggered by a determination that a waste is hazardous as defined in RCRA hazardous waste identification and listing regulations (40 CFR Part 261). Any party handling a hazardous waste must provide notification to EPA and obtain an EPA identification number. The generation, transportation, treatment, storage, or disposal of the wastes is subject to waste tracking requirements (i.e., manifesting requirements) and numerous other management requirements under RCRA.

Any party which treats, stores or disposes of a hazardous waste (typically referred to as treatment, storage and disposal facilities (TSDF)), is subject to extensive RCRA regulations pertaining to the management of these wastes. Where a hazardous waste is transported offsite from a generator's property, the transporter is also regulated by the hazardous waste management system, and must comply with manifesting requirements to ensure delivery of the hazardous waste to an approved TSDF.

Most hazardous wastes which are received by a Publicly Owned Treatment Works (POTW) for treatment are exempt from RCRA requirements under the Domestic Sewage Exclusion (DSE). As defined at 40 CFR §261.4(a), the DSE operates to exclude "any mixture of domestic sewage and other wastes that pass through a sewer system to a publicly owned treatment works for treatment" from being defined as a solid waste, and therefore cannot be a hazardous waste under RCRA. Based on Congressional intent that the DSE apply to wastes which are controlled under the construction grants and pretreatment program pursuant to the Clean Water Act, the DSE exempts industrial discharges that mix with domestic wastes in the sewer system from most RCRA requirements. Accordingly, if a POTW accepts industrial wastes that are mixed with domestic wastes in the sewer system prior to reaching the POTW property boundary, the industrial wastes will not be regulated as a hazardous waste under RCRA.

Note, however, that the domestic sewage exemption does not apply until after the waste enters the sewer system and mixes with domestic sewage prior to reaching the POTW property boundary. Thus, the generator of such waste is subject to RCRA generator requirements (40 CFR Part 262), and any treatment or storage of such waste by the generator prior to the waste entering the sewer system would require the generator to have a RCRA permit (unless otherwise exempt). Likewise, transportation of such waste prior to the waste entering the sewer system would subject the transporter to RCRA transportation requirements (40 CFR Part 263), including manifest requirements.

One of the generator requirements is §262.20 which requires generators of hazardous waste to transport waste only to a "designated facility," which is defined as a facility with a RCRA permit or interim status. (RCRA interim status is a statutorily recognized grandfather clause for facilities existing at the time RCRA first applied to their operations. POTWs receiving a hazardous waste influent do not have interim status). In addition, transporters are required to transport hazardous waste only to designated facilities, or another designated transporter of the waste to a designated facility.

The dumping of hazardous waste down a manhole outside of the POTW facility is thus a violation of RCRA hazardous waste generator and transporter requirements: the generator and transporter could both be liable. Even if the POTW is covered by a RCRA permit by rule, hazardous waste cannot be trucked to and dumped down a manhole outside of the POTW property boundary;

the manhole is not part of the permitted facility. Likewise, collection systems or pumping stations outside of the POTW property boundary cannot be used by POTWs for the receipt of trucked hazardous waste.

On the other hand, POTWs which accept any hazardous wastes by truck, rail or dedicated pipeline at the POTW facility are considered TSDFs under RCRA. Since these POTWs are already subject to environmental controls, including permitting requirements, under the CWA NPDES and pretreatment programs, these facilities are not required to obtain full-fledged RCRA permits, but are instead eligible for a RCRA permit by rule provided certain requirements are satisfied.* These requirements are specified in 40 CFR 270.60(c), and are discussed below. With the exception of the new corrective action provisions, these permit-by-rule requirements have dual purposes: (1) to "close the loop" of the waste tracking system by requiring a POTW to comply with manifesting and reporting requirements; and (2) to ensure that wastes delivered to a POTW by truck, rail, or dedicated pipeline are controlled under the CWA.

Under 40 CFR 270.60(c) of the RCRA regulations, a POTW accepting hazardous waste by truck, rail, or dedicated pipeline may receive a RCRA permit by rule if the facility:

- Has a NPDES permit, and
- Complies with the conditions of the NPDES permit.

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*Note, however, that RCRA also applies to POTWs which treat, store or dispose of hazardous waste sludge generated onsite. Since the current status of these facilities present some regulatory complexities, State and Federal water management programs should coordinate implementation of RCRA requirements for such treatment works with their respective enforcement and solid waste counterparts. In the case of EPA, specifically, Regions should coordinate with the Office of Water Enforcement and Permits and the Office of Solid Waste.

- Complies with the following regulations:
  - 40 CFR 264.11, identification number;
  - 40 CFR 264.71, use of manifest system;
  - 40 CFR 264.72, manifest discrepancies;
  - 40 CFR 264.73(a) and (b)(1), operating record;
  - 40 CFR 264.75, biennial report;
  - 40 CFR 264.76, unmanifested waste report; and
  - For NPDES permits issued after November 8, 1984, 40 CFR 264.101, corrective action.
- Accepts only hazardous waste which meets Federal, State, and local pretreatment requirements which would apply if the waste were discharged to the POTW through a sewer, pipeline or similar conveyance. (Emphasis added).

The corrective action requirement highlighted above was added to the permit-by-rule provisions as part of the Codification Rule amending the RCRA regulations in response to the 1984 Hazardous and Solid Waste Amendments (HSWA) to RCRA (50 FR 28752, July 15, 1985).

Under permit-by-rule provisions, EPA will require compliance with corrective action requirements by POTWs which:

- Have an NPDES permit;
- Have received hazardous waste by truck, rail or dedicated pipe and are currently treating, storing or disposing of hazardous waste;* and
- Have been covered by a permit-by-rule prior to November 8, 1984 and the POTW's NPDES permit has been reissued since such date or are being covered for the first time by the permit-by-rule after November 8, 1984.

*Note that if a POTW received hazardous waste by truck, rail, or pipe at any time, it may be difficult for the POTW to show that it no longer treats, stores, or disposes of hazardous waste.

Corrective action requirements will be implemented through the issuance of mini-RCRA permits, referred to as RCRA Individual Determination of Explicit Requirements ("RIDER") permits, to POTWs in conjunction with the NPDES permitting process.

1.1.2 Overview of RCRA Corrective Action Program

The primary objective of the RCRA corrective action program is to identify and clean up releases of hazardous waste or hazardous constituents that threaten human health or the environment. The 1984 HSWA established broad new authorities in the RCRA program to assist EPA in accomplishing these objectives. These new authorities include:

- Section 3004(u) - Corrective Action for Continuing Releases:

  Requires that any permit issued after November 8, 1984, require corrective action for all releases of hazardous waste or hazardous constituents from solid waste management units at the facility. The provision also requires that owner/operators demonstrate financial assurance for any required corrective action, and allows schedules of compliance to be used in permits where the corrective action cannot be completed prior to permit issuance.

- Section 3008(h) - Interim Status Corrective Action Orders:

  Provides authority to issue enforcement orders to compel corrective action or other response measures at interim status facilities, and to take civil action against facilities for appropriate relief.

- Section 3004(v) - Corrective Action Beyond the Facility Boundary:

  Directs EPA to issue regulations requiring corrective action beyond the facility boundary where necessary to protect human health and the environment, unless the owner/operator can demonstrate that he is unable to obtain the necessary permission, despite his best efforts.

Other significant RCRA authorities which may be utilized to address corrective action include Section 3008(a), the Section 7003 enforcement authority, the Section 3013 information-gathering authority, and the Section 3007 inspection authority. Moreover, CERCLA authorities may be invoked where appropriate.

These new corrective action authorities contained in the 1984 HSWA amendments change the focus of the RCRA corrective action program from detecting and correcting releases from regulated units to cleaning up problems resulting from a broad range of waste management practices at RCRA facilities. Prior to passage of HSWA, EPA authority under RCRA to require corrective action for releases of hazardous constituents was limited to ground-water releases from units covered by RCRA permits. The HSWA program extends RCRA authority to all solid waste management units at RCRA facilities and all environmental media, and encourages the use of other legal authorities to help achieve corrective action objectives at these facilities.

Because RCRA permit-by-rule facilities are treated as RCRA permitted facilities for the purposes of corrective action, Sections 3004(u) and (v) will typically be the corrective action provisions most relevant to the conduct of corrective action at POTW permit-by-rule facilities. The Section 3008(h) authority will apply only in those rare cases where a POTW has interim status under RCRA. This distinction is significant since the corrective action authorities differ somewhat in scope. For example, the Section 3004(u) corrective action authority is restricted to releases from solid waste management units (SWMUs) at a facility, while the Section 3008(h) authority applies more broadly to any releases associated with hazardous waste management activity at a facility. Section 3004(u) corrective action is imposed through permit conditions, while Section 3008(h) imposes corrective action through enforcement orders.

The RCRA corrective action program consists of three phases:

- RCRA Facility Assessment (RFA) - to identify releases or potential releases requiring further investigation;

- RCRA Facility Investigation (RFI) - to fully characterize the nature and extent of releases; and

- Corrective Measures (CM) - to determine the need for and extent of remedial measures. This step includes the selection and implementation of appropriate remedies for all problems identified.

This guidance document addresses only the first phase of this process and outlines procedures and criteria for the conduct of RFAs by EPA, State, and POTW personnel at POTW permit-by-rule facilities.

1.1.3 Overview of the RFA

The RCRA Facility Assessment is a three-stage process for:

- Identifying and gathering information on releases at RCRA facilities;
- Evaluating solid waste management units (SWMUs)* for releases to all media and evaluating regulated units for releases to media other than ground water; and
- Making preliminary determinations regarding releases of concern and the need for further actions at the facility.

During the RFA, investigators will gather information on SWMUs and other areas of concern at RCRA facilities. They will evaluate this information to determine whether there are releases that warrant further investigation or other action at these facilities. Upon completion of the RFA, Agency personnel should have sufficient information to determine the need to proceed to the second phase (RFI) of the process.

All three steps of the RFA require the collection and analysis of data to support initial release determinations:

- Preliminary review (PR) - focuses primarily on evaluating existing information, such as inspection reports, permit applications, historical monitoring data, and interviews with State personnel who are familiar with the facility;
- Visual site inspection (VSI) - entails a site inspection for the collection of visual information to obtain additional evidence of release; and
- Sampling visit (SV) - fills data gaps that remain upon completion of the PR and VSI.

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*See page 1-8 for definition of SWMU.

The RFA should include the investigation of releases to all environmental media, including air, surface water, sediments, ground water, soils, and subsurface gas. The RFA may address releases that are subject to permitting requirements under the NPDES program and other environmental programs. Where permitted discharges or contamination resulting from permitted discharges are problematical, investigators should refer the case to the original permitting authorities. If necessary, EPA may exercise its RCRA corrective action authorities to remedy the environmental problem. The RFA also addresses releases from SWMUs to media other than the one covered by the unit's discharge permit. For example, EPA may use its corrective action authorities to control the release of volatile organic compounds (VOCs) from NPDES-permitted wastewater treatment units where there is cause for concern. EPA and State investigators should use the full complement of RCRA and CWA authorities to secure appropriate action. Alternatively, Agency investigators may wish to use other authorities such as CERCLA or State authorities, and should consult with EPA or State offices responsible for administering these programs.

The HSWA Section 3004(u) provision focuses on addressing releases from SWMUs at RCRA facilities. For the purposes of conducting corrective action at POTWs, the facility is defined as: The portion of the POTW which is designed to provide treatment, storage, or disposal of municipal or industrial waste and contiguous property owned or operated by the municipality. The definition includes sewers, pipes, and other conveyances which transport wastewater to the POTW plant only to the extent these conveyances are located upon or under the property described above. The definition excludes contiguous property in which the legal rights of the municipality are restricted to the transportation of waste on or through the property (e.g., easements).

By this definition, a facility will include property containing traditional wastewater and sludge treatment units (e.g., headworks, wastewater treatment tanks and basins, sludge processing units, sludge incinerators, etc.), as well as any adjacent areas of the municipal property used for treatment, storage, or disposal of any solid or hazardous waste. Accordingly, a facility may include units, such as adjacent municipal landfills or municipal refuse incinerators, which handle wastes other than wastewaters or sewage sludges. On the other hand, the facility definition operates to exclude POTW operations, particularly those involving sewage sludge use or disposal (e.g., landfilling, land application, incineration, etc.) which occur at noncontiguous, offsite properties owned or operated by the municipality. An offsite, noncontiguous operation is a separate facility, and may even be a RCRA TSDF if the waste managed at the site is hazardous.

The definition also precludes consideration of possible releases of hazardous wastes or constituents occurring outside the property boundaries. As a result, releases from POTW collection systems (e.g., exfiltration, volatilization, combined sewer overflows/bypasses) outside the contiguous property of the POTW should not be evaluated in the conduct of RFA at the POTW. Under HSWA Section 3004(v), however, EPA may, under certain conditions, require corrective action for a release within the facility but which extends beyond a facility boundary where necessary to protect human health and the environment.

Solid waste management unit (SWMU) is defined to include any discernible waste management unit at a RCRA facility from which hazardous waste or constituents might migrate, regardless of whether the unit was intended for the management of solid or hazardous waste. The SWMU definition includes:

- Containers, tanks, surface impoundments, waste piles, land treatment units, landfills, incinerators, and underground injection wells, including those units defined as "regulated units" under RCRA;
- Recycling units, wastewater treatment units, and other units which EPA has generally exempted from standards applicable to hazardous waste management units; and
- Areas contaminated by "routine and systematic discharges" from process areas.

The definition does not include one-time accidental spills from production areas or units in which wastes have not been managed (e.g., product storage areas). One-time spills containing hazardous materials which are not cleaned up may be subject to RCRA Sections 3008(a) or 7003, or CERCLA enforcement authorities. The scope of the SWMU definition should be considered in evaluating areas of the POTW facility (e.g., chemical handling operations) which resemble production areas at a typical RCRA facility.

In accordance with the SWMU definition, conduct of RFA at a POTW should focus on plant units used to manage hazardous or solid waste. These units may include:

- Any waste management units downstream from the point of discharge to the treatment plant of wastes (e.g., hazardous wastes, septage wastes, landfill leachate, etc.) delivered to the POTW by truck, rail, or dedicated pipeline. Wastes delivered to a POTW treatment plant by truck, rail, or dedicated pipeline are not covered by the DSE, and should therefore be considered solid wastes.

- Any waste management units which generate or handle a treatment residual (e.g., grit, primary sludge, waste activated sludge, etc.) which is regulated as a solid waste under RCRA.

- Any waste management units which handle other materials (e.g., municipal refuse, spent solvents, etc.) regulated as solid wastes under RCRA.

In effect, the definition applies to all waste management units at a POTW facility except those which handle only wastewaters which are exempt under the DSE. As a result, the SWMU definition will encompass most units typically found at POTWs including sedimentation tanks, aeration tanks, wastewater treatment ponds, trickling filters, aeration basins, sludge holding basins and other units used for the treatment, storage or disposal of wastewaters or sludges.

Once a release of hazardous wastes or constituents is identified at a SWMU, corrective action will apply to the waste or constituent regardless of its origin within the POTW. A release from a POTW SWMU may result from the presence of materials and substances contributed in DSE wastes, non-DSE solid wastes (e.g., truck, rail, or dedicated pipeline wastes, sewage sludge, etc.), or some combination of these two waste types. Moreover, complete mixture of wastes in POTW waste management units will often make it difficult or impossible to determine whether hazardous wastes or constituents contributing to a release are derived from DSE or non-DSE wastes. Accordingly, in order to assess wastes and constituents managed at and potentially released from POTW units, the RFA investigator should fully characterize wastes and constituents contained in both DSE and non-DSE wastes discharged to a POTW. The investigator should also characterize wastes discharged in the past to the POTW, including DSE and non-DSE wastes discharged prior to enactment of the 1984 HSWA corrective action amendments.

EPA purposely designed the RFA to be limited in scope. This guidance establishes a framework to assist EPA investigators in making preliminary release determinations that are largely based on existing information and best professional judgment. The framework emphasizes the need to focus data collection and analysis efforts (i.e., sampling data) on those data that are required to support specific permit or enforcement order conditions.

The Agency recognizes that sampling needs will differ on a case-by-case basis. The extent of sampling will depend on the amount and quality of information gathered in the PR and VSI, the investigator's professional judgment regarding the amount of information necessary to support an initial release determination, and the degree of owner/operator cooperation.

1.2 PURPOSE AND SCOPE OF THE GUIDANCE DOCUMENT

The EPA Office of Solid Waste (OSW) has prepared guidance for the performance of RFA at RCRA facilities, (NTIS #PB 87-107 769, OSW Publication #530-SW-86-053, October, 1986). In contrast to the OSW guidance, however, this guidance applies only to the conduct of RFA at POTWs that must obtain a RCRA permit by rule. Prepared by the EPA Office of Water (OW) in consultation with EPA/OSW, this document is intended to supplement existing RCRA guidance in providing specific guidance for the conduct of RFA at POTWs subject to RCRA permit-by-rule facilities. This guidance adapts basic RCRA procedures and methodologies for use in the assessment of hazardous releases from POTWs receiving hazardous wastes by truck, rail, or dedicated pipeline. This document is also intended to provide EPA and State water program officials and POTW operators with essential background information on RCRA authorities and procedures, especially those pertaining to corrective action.

The guidance document will highlight technical areas in which conduct of RFA at POTWs can be expected to differ markedly from the conduct of RFA at traditional RCRA TSDFs. Distinctive aspects of POTW RFA relate to the following considerations:

- Relative similarity of waste management units and treatment system configurations across POTWs compared with traditional RCRA TSDFs;
- Potential diversity and variability over time of wastes and constituents received by POTWs, and limitations in POTW knowledge concerning types of wastes and constituents entering the plant; and
- Lack of traditional RCRA data sources (e.g., Part B permit applications, ground-water monitoring data, etc.) for use in the conduct of RFA at POTWs.

These technical concerns are given special consideration in this document. In other technical areas where POTW characteristics resemble those of traditional RCRA TSDFs for purposes of the RFA, this guidance document relies heavily on guidance contained in the EPA/OSW RFA guidance document.

To provide maximum usefulness to the investigator, this document contains most of the information and guidance necessary to support conduct of a POTW RFA. Still, in certain technical areas involving detail and complexity (e.g., ground-water monitoring), the investigator will be referred to other guidance documents prepared by the EPA hazardous waste and water programs. Also, the investigator should be familiar with the companion EPA/OSW guidance document for the conduct of RFA at RCRA interim status and permitted facilities.

1.3 ORGANIZATION OF THE GUIDANCE DOCUMENT

This document contains six chapters. The second chapter details the RFA process as it applies to POTW facilities. The third chapter provides an overview of wastes and waste management units typically found at POTWs. The last three chapters outline procedures for the assessment of releases to specific environmental media, including releases to ground water, soil and subsurface gas (Chapter 4), releases to surface water and sediments (Chapter 5), and releases to air (Chapter 6).

2. CONDUCT OF THE RCRA FACILITY ASSESSMENT

This chapter provides a methodology for conducting RCRA Facility Assessments (RFAs) at POTWs. Section 2.1 outlines the overall technical approach for performance of the RFA. Sections 2.2 to 2.4 provide detailed guidance for each of the three RFA stages, which are:

- Preliminary Review (PR);
- Visual Site Inspection (VSI); and
- Sampling Visit (SV).

The general RFA procedures outlined below are supplemented by information in Chapter 3, which describes how the RFA may be adapted to consider wastes and waste management units typically found at POTWs. Chapters 4, 5, and 6 explain how the RFA may be adapted to consider technical factors relating to specific environmental media.

2.1 TECHNICAL APPROACH FOR THE RCRA FACILITY ASSESSMENT

All three RFA steps require the investigator to examine data on the POTW as a whole and on specific units at the facility. Types of facility data can generally be divided into five categories:

- Unit characteristics;
- Waste characteristics;
- Pollutant migration pathways;
- Evidence of release; and
- Exposure potential.

Figure 2-1 provides a matrix of these categories, and identifies types of factors an investigator should consider within each category. In conducting an RFA, the investigator will utilize best professional judgment to evaluate these factors and their related significance in determining the likelihood of a release at the facility.

FIGURE 2-1. MAJOR FACTORS TO CONSIDER IN CONDUCTING RFAs

Unit Characteristics	Waste Characteristics	Migration Pathways	Evidence of Release	Exposure Potential
Type of unit	Type of waste placed in the unit	Topographic characteristics	Prior inspection reports	Proximity to affected population
Design features	Migration and dispersal characteristics of the waste	Geologic setting	Citizen complaints	Proximity to sensitive environments
Operating practices (past and present)	Toxicological characteristics	Hydrogeologic setting	Monitoring data	Likelihood of migration to potential receptors
Period of operation	Physical and chemical characteristics	Hydrologic setting	Visual evidence e.g., discolored soil, seepage, discolored surface water or runoff.	
Age of unit		Atmospheric conditions	Other physical evidence, e.g., fish kills, worker illness, odors	
Location of unit			RFA sampling data	
General physical conditions				
Method used to close the unit				

Figure 2-2 outlines the types of information in each category that an investigator should obtain and evaluate during the RFA. During the preliminary review, the investigator should examine documents and other written materials to obtain information on the characteristics of wastes managed at the POTW facility as a whole and in specific SWMUs, the design and operating features of the SWMUs, facility location and setting, evidence of past and ongoing releases, and potential environmental receptors. This information will assist the investigator in identifying migration pathways and environmental media which represent significant concerns for the RFA. The investigator should supplement this information with evidence gathered during the visual site inspection and sampling data collected during the sampling visit.

Evaluation of technical factors within each category should reflect concerns relating to specific environmental media. For example, in evaluating unit characteristics at a facility, the investigator should recognize that inground units are more likely to cause ground-water releases than above ground units, and that open wastewater treatment tanks are more likely to cause air releases than closed landfills. Similarly, in reviewing waste characteristics, an investigator should recognize that certain wastes tend to volatilize and be released to air, while other wastes are soluble in water and tend to migrate to surface or ground water. The environmental media that should receive the greatest attention will also depend on facility location and setting. For example, ground-water releases will generally not be a significant concern at facilities located on relatively impermeable, thick soils. Types of evidence and potential receptors will also vary by medium.

The RFA is completed when the investigator has sufficient information to make a preliminary determination regarding the presence of releases or potential releases at the POTW facility and the need for further investigation. Sometimes, it will be possible to make this determination after completing the first two RFA stages (i.e., PR and VSI). In these instances, a SV will not be necessary. In other cases, even when the SV is completed, the investigator may need to collect additional information, conduct follow-up inspections, or perform additional sampling before making a determination.

FIGURE 2-2. TYPES OF INFORMATION EVALUATED DURING THE RFA

RFA STEP	UNIT CHARACTERISTICS	WASTE CHARACTERISTICS	MIGRATION PATHWAYS	EVIDENCE OF RELEASE	EXPOSURE POTENTIAL
PRELIMINARY REVIEW	Evaluate information on design, liners, age, construction, location, method of closure.	Review historical information on types, volumes, characteristics of wastes handled.	Review site hydrogeology, surface water runoff pathways, prevailing winds, locations of rivers, etc.	Review historical sampling data, reports of release, citizen complaints, etc.	Locate drinking water wells, uses of nearby surface water, potential for subsurface gas migration, etc.
VISUAL SITE INSPECTION	Review general unit conditions. Look for evidence of unit failure, problematic operating practices, subsidence and/or ponding at closed units.	Review waste management practices.	Observe erosion indicating runoff, likely pathways of release to each medium from units, etc.	Obtain visual evidence of releases, e.g., seeps, dead vegetation, discolored soils and sediments, etc.	Collect visual evidence on potential receptors, e.g., humans and sensitive environments.
SAMPLING VISIT	May observe additional evidence.	Characterize waste through sampling and analysis.	Sample pathways for additional evidence of release.	Sample pathways/ wastes for specific constituents.	Sample for hazardous constituents in wells, concentrations of volatile organics in air.

In general, when the RFA is completed, the investigator should have performed the following:

- Identified all SWMUs;
- Identified all potential releases of concern;
- Determined which areas of the facility require further investigation and collected sufficient information to focus these investigations;
- Screened out releases not requiring further investigation;
- Referred permitted releases to other authorities, as appropriate; and
- Determined which releases require interim corrective measures.

Upon completion of the RFA, the investigator should prepare a report that describes these six activities and summarizes the findings of the RFA.

2.2 CONDUCTING THE PRELIMINARY REVIEW

2.2.1 Purpose and Scope of the Preliminary Review

This section of the chapter describes procedures for conducting a preliminary review (PR), the first RFA stage. The PR serves three primary purposes:

- To identify SWMUs at the facility;
- To collect and evaluate existing information on the facility in order to identify and characterize potential releases from the SWMUs; and
- To focus the activities to be conducted in the second and third stages of the RFA, the visual site inspection (VSI) and the sampling visit (SV).

After careful evaluation of existing information, the investigator should structure subsequent RFA information collection, inspection and sampling activities to focus on closing data gaps that may hinder or preclude accurate determinations on the presence of releases or potential releases from SWMUs at the facility.

During the PR, the investigator should review existing documents on the entire POTW facility and interview individuals to identify SWMUs that may have released or be releasing hazardous wastes or constituents. The PR should not be limited to those portions of the facilities used to manage hazardous waste delivered to the POTW by truck, rail or dedicated pipeline. Rather, in keeping with the scope of RCRA Section 3004(u) corrective action, the investigator should gather information relating to all known SWMUs and other waste management areas. At large, complex POTWs with many SWMUs, it may be more practical to characterize groups of similarly designed SWMUs or those in the same area rather than individual units. The investigator should also consider information on releases that may be beyond the scope of RCRA corrective action authorities. Some releases may be subject to investigation and remediation under statutory authorities other than RCRA. Any release of hazardous constituents, as defined in RCRA, is subject to these requirements.

The scope of the PR includes investigating release potential to all environmental media, including:

- Ground water, soils, and subsurface gas;
- Surface water and sediments; and
- Air.

The PR should also collect and evaluate information on releases that are permitted or subject to permitting requirements under NPDES or other environmental programs. As a result, a PR conducted at a POTW should include hazardous wastes or constituents released through a NPDES-permitted outfall or as emissions from sewage sludge incinerators. In addition, the PR should consider information on releases to environmental media other than the medium for which the release is permitted. For example, the PR should evaluate the potential for releases of hazardous wastes and constituents to air from plant headworks, primary clarifiers, secondary wastewater treatment units and other SWMUs.

2.2.2 Gathering Information

In the first stage of the PR, the investigator will gather information and documents providing evidence of the potential for releases from SWMUs and the POTW facility. The success of the PR will depend to a great extent on the investigator's ability to collect all relevant information. Data gathering for the PR should typically entail:

- Collection of written information and documents;
- Interviews with individuals familiar with the facility; and
- Requests for additional information from the facility owner/operator.

Each of these steps is discussed below.

Collecting Written Information and Documents on the POTW Facility

Because POTWs have been controlled under the CWA, traditional RCRA data sources, such as Part A permit applications, Part B permit applications, RCRA inspection reports and RCRA exposure information reports, will not be available. Similarly, because CERCLA authorities have rarely been applied to POTWs, data sources such as CERCLA preliminary assessment/site investigation reports, CERCLA remedial investigation/feasibility study reports, hazard ranking system documentation and CERCLA Section 103(c) notifications, will probably contribute little useful information to the RFA. Instead, the investigator will have to rely extensively on data sources relating to the NPDES, pretreatment, construction grants and other water programs administered under the CWA. In addition, the investigator may use facility records and other site-specific materials to assess unit characteristics, waste characteristics, and the environmental setting.

The following six types of data sources may provide useful information for conducting PR for a POTW:

- NPDES program records;
- Pretreatment program records (e.g., manifests);
- RCRA program records;
- Facility design, construction and operating records;
- Records pertaining to land disposal of sludges, ash and effluent; and
- Site-specific materials for assessing the environmental setting of the facility.

NPDES program records. NPDES program records may contain significant information on the potential for releases of hazardous wastes and constituents to surface waters and sediment. Possible NPDES data sources include:

- NPDES permits;
- Permit applications - including Form 2C testing data (may not be available if the POTW completed a Standard Form A for domestic wastewater discharges), general facility information (e.g., topographic maps, wastewater flow diagram);
- Permit records - including draft permits, statements of basis for permit conditions, fact sheets;
- Discharge monitoring reports (DMRs) - containing self-monitoring data for permit parameters;
- Noncompliance reports - including written reports of upsets, bypasses and certain effluent limit violations;
- Inspection reports - including reports from compliance evaluation inspections, compliance sampling inspections, performance audit inspections, compliance biomonitoring inspections, toxics sampling inspections, diagnostic inspections, reconnaissance inspections and legal support inspections; and
- Enforcement documents - including administrative orders, consent decrees.

These documents should be available either in EPA Regional or State water office files or in POTW records.

Pretreatment program records. Pretreatment program records may contain useful data on the types of hazardous wastes and constituents discharged to the POTW by industries. In particular, pretreatment data sources may provide information on hazardous constituents contained in DSE wastes treated at the POTW. Possible pretreatment data sources include:

- POTW pretreatment program submissions;
- Industrial waste surveys - including a list of significant industrial dischargers to POTW system;
- POTW influent/effluent/sludge sampling data - identifying hazardous constituents, especially CWA priority pollutants, present in POTW influent, effluent, and sludge wastestreams;

- Pretreatment audit reports and pretreatment compliance inspections;
- Annual POTW pretreatment reports - summarizing POTW pretreatment activities for a given year;
- Industrial baseline monitoring reports;
- Industrial discharge permits - containing legal conditions for industrial discharges to POTW;
- Industrial self-monitoring reports - containing industrial monitoring data for regulated parameters; and
- Industrial inspection reports and compliance monitoring data - containing data from inspections and monitoring visits conducted by POTWs at industries.

These documents should be contained in POTW records and may also be available from EPA Regional or State water office files.

RCRA program records. As discussed above, most of the data sources typically available for RCRA treatment, storage, and disposal facilities (e.g., Part B permit applications, RCRA inspection reports, RCRA exposure information reports) will not be available for POTW facilities. Still, where a POTW has received hazardous wastes by truck, rail, or dedicated pipeline, and is therefore regulated as a permit-by-rule facility, certain RCRA data sources should be available. These records may include hazardous waste notification forms, manifest records, operating records and biennial reports. At a minimum, these data sources should provide information on types and quantities of non-DSE hazardous wastes managed at the POTW facility. Once the waste type has been identified, the investigator may refer to hazardous waste identification regulations [40 CFR Part 261] or RCRA listing documents for additional information on waste characteristics and constituents. RCRA program records may be obtained from EPA Regional or State hazardous waste files or POTW records.

Facility design, construction, and operating records. Facility design, construction, and operating records provide essential information on unit characteristics and environmental setting of the POTW facility. For example, foundation testing and site preparation records may contain useful information about the geologic and hydrogeologic setting. Facility data sources may include:

- "As built" engineering drawings;

- Construction grants facility plans and applications;

- Site maps and surveys;

- Foundation testing/site preparation records, including boring logs, soil tests, measurements on depth to water table, etc.;

- Plant operations and maintenance (O & M) manuals;

- Equipment supply manuals;

- Daily operating logs;

- Annual and monthly operating records;

- Reports describing emergency conditions at POTW (e.g., spills, upsets, bypasses, explosions); and

- Records of citizen complaints, (e.g., odors, fish kills, ground-water contamination).

Facility records will provide technical data necessary to determine whether POTW unit characteristics and the environmental setting contribute significantly to the potential for a release to any environmental medium.

Records on land disposal of effluent, sludges, or ash. Some POTWs operate onsite land disposal units (i.e., landfills, underground injection, application, waste piles or surface impoundments) for the management of effluent, sludges, or ash residuals. The investigator should collect and review records pertaining to the operation of any of these units. Possible data sources include:

- Effluent, sludge, and ash sampling data, including EP toxicity testing data for solid waste residuals;

- Permits for land disposal, such as Subtitle D land disposal permits, NPDES permits for spray irrigation operations, or UIC permits for underground injection of effluent; and

- Engineering records related to the design, construction, or operation of POTW land disposal units.

These records can generally be obtained from either State solid waste or water program files or POTW records.

Site-specific materials for assessment of a facility's environmental setting. In those instances where site-specific environmental information is lacking, the data necessary to assess the environmental setting of a POTW will have to be assembled from a variety of non-POTW data sources. Examples of these data sources include:

- Topographic, surface geologic, hydrogeologic, hydrologic, and other maps maintained by the U.S. Geological Survey and State geological agencies;
- Soil survey maps maintained by the U.S. Department of Agriculture;
- Maps and surveys maintained by other Federal/State agencies;
- Aerial photographs;
- State/local well permit offices;
- Local public health agencies;
- Local well drillers;
- Local airports/weather bureaus;
- Colleges/universities;
- Environmental organizations; and
- Facility records for nearby RCRA TSD facilities or CERCLA sites

Technical data collected from these and other sources will be used for the assessment of potential migration pathways and environmental receptors of any releases from the POTW facility.

Interviewing Individuals Familiar With the Facility

POTW operators and employees will have the most information about a facility and should be consulted during the visual site inspection. As part of the PR, the investigator should interview personnel from EPA Regional and State environmental program offices who are familiar with the POTW. Because POTWs have historically been regulated primarily under the CWA, staff from Federal and State NPDES, pretreatment, and construction grants offices are likely to have information on the POTW. When POTWs operate units such as landfills or incinerators that are controlled under other environmental programs, officials from the corresponding program offices should also be consulted. Early contact with these program officials can help to ensure that all relevant information is considered during the PR. Where possible, the investigator should also contact local colleges and universities and public interest groups that may be familiar with the POTW facility.

Requesting Additional Information From the Facility Owner/Operator

In situations where the investigator does not find sufficient information to complete the PR, it may be necessary to request additional information from the POTW owner/operator. Such requests should be in the form of a letter in which EPA requests additional information from the facility to comply with RCRA corrective action requirements. Where necessary, the investigator should cite EPA information-gathering authorities under RCRA Section 3013 or CWA Section 308, as well as RCRA corrective action provisions (i.e., RCRA Sections 3004(u) and (v)), to obtain this information. These letters should be as specific as possible to ensure that the requested data are submitted in a timely manner.

2.2.3 Evaluating PR Information

The investigator should evaluate all information collected during the PR to determine the release potential of the POTW facility. Evaluation of available information involves three basic steps:

- Characterizing hazardous wastes and constituents managed at the POTW facility;
- Identifying SWMUs at the facility; and
- Evaluating the potential for releases from the SWMUs.

Each step is discussed below.

Characterizing Hazardous Wastes and Constituents Managed at the POTW

Characterization of hazardous wastes and constituents managed at a POTW may be more difficult than at a typical RCRA TSD facilities. Because POTWs may serve a large, diverse and changing industrial community, wastes and constituents entering the treatment plant may vary over time. Also, because wastes managed at a POTW originate offsite and are mixed with other wastes in a POTW collection system, a POTW may have limited information on types of wastes and constituents entering the treatment plant. In spite of these difficulties, it is essential for the investigator to identify to the greatest extent possible the types of hazardous wastes and constituents that may be present at the POTW.

Since corrective action requirements apply to releases of RCRA hazardous wastes or constituents contained in either DSE or non-DSE wastes, the investigator should gather information on both waste types. To assess DSE wastes, the investigator should use pretreatment data sources to characterize the industrial community served by the POTW and identify specific wastes and hazardous constituents discharged by industries to the POTW collection system. Also, influent, effluent, and sludge toxics sampling data collected for NPDES and pretreatment programs should be carefully reviewed. RCRA program data sources, such as hazardous waste notifications, manifesting records or operating records, should be reviewed if available to identify hazardous wastes delivered to the POTW facility by truck, rail, or dedicated pipeline. The investigator should also characterize wastes discharged in the past to the POTW facilities, including wastes discharged prior to enactment of the 1984 RCRA corrective action amendments. Chapter 3 of this document provides more detailed guidance on the types of wastes and constituents managed at POTWs.

Identifying SWMUs at the POTW

In this step, the investigator should identify all SWMUs at the POTW and mark these units on a facility map. The map should designate all known SWMUs, any waste management areas which may meet the definition of a SWMU (see Chapter 1 for the definition of a SWMU), and other potential releases of concern that may be beyond the scope of RCRA corrective action authorities. The facility map will be a useful document throughout the RFA, particularly during the VSI and SV stages of the RFA. Besides showing facility layout and possible SWMUs, the map will often contain information on relevant migration pathways and potential exposure points. Additional SWMUs may be added to the map as they are identified in subsequent stages of the RFA.

Most data necessary to identify SWMUs at a POTW facility should be readily accessible from facility design, construction and operating records. Generally, as a result of the extensive documentation for these public facilities and frequent use of offsite disposal for treatment residuals, an investigator will confront fewer of the difficulties associated with the identification of abandoned waste management units at RCRA TSD facilities. Also, while RCRA TSD facilities often use numerous independent treatment and disposal systems for the management of residuals, POTW plants typically employ a single connected wastewater and sludge treatment system. Accordingly, an investigator performing a PR for a POTW facility may not have to resort to more unusual data sources such as aerial photographs to identify and characterize historical waste management practices at the POTW. On the other hand, a PR will be more complicated where a POTW operates or has operated onsite land disposal units for wastewater treatment residuals or offsite waste materials such as municipal refuse. In these cases, an investigator should exercise special caution in identifying unit and waste characteristics for these waste management practices.

Evaluating the POTW Facility's Release Potential

During this phase of the PR, the investigator should determine the likelihood of releases from each SWMU at the POTW. The investigator's ability to draw conclusions on the likelihood of release will depend on the extent of available information on unit characteristics, waste characteristics, pollutant migration pathways, and evidence of releases. Information on exposure potential is not needed to determine the likelihood of releases, but is important in determining the need for interim corrective measures because of immediate exposure risks. Types of information which should be considered in these five categories are described below.

Unit characteristics. The design and operating characteristics of a SWMU will determine, to a significant extent, its potential for release to one or more environmental media. As a result, the investigator should carefully evaluate the physical characteristics of each SWMU or group of SWMUs to determine how they affect the potential for releases. Major technical factors which should be considered in the evaluation of unit characteristics include type of unit, design features, operating practices, period of operation, age of unit, location of unit, general physical condition, and unit closure method.

Chapter 3 provides an overview of waste management units commonly found at POTW facilities and their potential for releases to the environment. Also, the media-specific chapters (Chapters 4, 5, and 6) of this guidance document discuss how design and operating characteristics of various types of SWMUs affect their potential for release to each environmental medium. For example, in evaluating a POTW facility for possible ground-water impacts, unlined surface impoundments such as aerobic or facultative wastewater lagoons can be assumed to have a high potential for releasing constituents to ground water. Similarly, open wastewater treatment tanks and impoundments, especially units with aeration processes, will exhibit a high potential for air releases.

Waste characteristics. The investigator should identify wastes or constituents entering the POTW and determine the probable fate of these wastes and constituents within various POTW treatment units. Chapter 3 provides a methodology for the identification of likely constituents in POTW wastestreams based on a review of the industrial community served by the POTW. Chapter 3 also contains a brief discussion on the fate of many hazardous constituents within a typical POTW facility.

In evaluating the release potential for POTW SWMUs, the investigator should identify wastes and constituents present in the POTW and in the specific SWMU in order to correlate constituents present in the environment with those present in the contaminant source. The investigator can usually deduce that a release has occurred if the POTW facility and/or a specific unit contain a constituent observed in a pollutant migration pathway. Information gathered on facility waste generation processes may also be useful in identifying constituents other than RCRA listed constituents. For example, refuse that decomposes rapidly may produce methane when placed in landfills.

The evaluation of POTW wastes should consider the type of waste treated in the unit, migration and dispersion characteristics of the waste, and toxicological, physical, and chemical characteristics. The release potential for specific wastes and constituents will vary depending on unit type. For example, volatile organic compounds are more likely to be released from wastewater treatment tanks, such as activated sludge treatment basins, while toxic metals will tend to concentrate in POTW sludges and may be released to surface waters from sludge lagoons and waste piles. Chapters 4, 5, and 6 discuss the ways in which constituent properties affect the likelihood of releases to a specific environmental medium.

Pollutant migration pathways. The investigator should evaluate existing information concerning the likely pollutant migration pathways associated with each SWMU. Major factors to be considered in this evaluation are hydrologic setting, geologic setting, hydrogeologic setting, atmospheric conditions, and topographic characteristics. This information will be critical when the investigator attempts to demonstrate that constituents observed in the environment originated at a specific SWMU.

Different types of SWMUs will exhibit varying potential for the release of constituents to specific migration pathways. As a result, the investigator should identify the pollutant migration pathways that are most likely to be affected and gather information necessary to assess the characteristics of these pathways. Chapters 4, 5, and 6 provide information to assist the investigator in evaluating the physical characteristics of each migration pathway of interest. This part of the analysis also plays a critical role in evaluating the need for interim measures at the facility by identifying potential exposure points along the various migration pathways.

Evidence of release. The investigator should examine available information to identify any evidence that hazardous wastes or constituents have been released at the POTW facility. The investigator may have access to direct and indirect documentary evidence of releases. Direct documentary evidence of a release may include official reports of prior release incidents (e.g., CWA noncompliance reports, CWA enforcement documents), or sampling data that clearly identifies a release. In other cases, it may be necessary to use indirect evidence to draw connections between a constituent identified in a unit, the likelihood that this constituent could have been released from the unit, and existing sampling data showing the presence of the constituent in the migration pathway. While this connection may not establish unequivocally that the constituent identified in the environment originated in the suspected unit, this evidence will usually be sufficient to trigger further study. In all cases, the investigator should use best professional judgment to assess the strength of any information source providing evidence of a release.

Exposure potential. The investigator should evaluate available information on the location, number, and characteristics of receptors potentially affected by past and continuing releases at the POTW facility. These receptors may include human populations, animal populations, and sensitive environments. The exposure evaluation should consider proximity to affected population, proximity to sensitive environments, and likelihood of migration to potential receptors. Chapters 4, 5, and 6 provide information on the types of receptors which are likely to be affected by releases to the various environmental media.

2.2.4 Completing the PR

The ability to determine the presence and significance of a release will increase with the quantity and quality of information evaluated during the RFA. By the PR's end, the investigator will usually have identified potential releases at the facility, and will have performed a preliminary evaluation concerning the likelihood that releases have occurred at specific SWMUs or groups of SWMUs. Before proceeding with the next phase of the RFA, the VSI, the investigator should achieve the following three objectives:

- Identify significant data gaps;
- Focus activities to be performed during VSI and SV; and
- Document the PR.

Each objective is described briefly below.

Identifying Significant Data Gaps

Depending on the quality of information gathered and reviewed during the PR, the investigator may achieve significant progress in identifying potential releases from SWMUs at the facility. In many cases, however, the investigator will still lack important information on waste characteristics, unit characteristics or other aspects of the facility or environmental setting. Problems associated with data gaps may be particularly severe since the extensive data normally contained in records for fully-regulated RCRA TSD facilities are not available for POTW facilities. Accordingly, basic information must be assembled from a variety of non-RCRA data sources. In cases where an investigator determines that important information is missing and cannot reasonably be gathered as part of VSI or SV activities, the investigator should formally request additional information from the POTW owner/operator.

Focusing Activities to be Performed During the VSI and SV

One of the PR's primary purposes is to provide the investigator with an understanding of waste management activities at the facility, thereby enabling the investigator to focus subsequent activities conducted during the VSI and SV. Because all facilities will undergo a PR and VSI, emphasis should be placed on the quality of information gathered in these two stages. If the conclusions drawn from the PR and VSI are not based on sufficient information, it is likely that facility owners/operators or the public will challenge permit conditions or enforcement orders intended to compel further action at the facility.

The investigator should evaluate the information gathered in the PR on each SWMU and potential release, and determine whether: (1) it is likely that the unit has a release; (2) it is unlikely that the unit has a release; (3) there is insufficient evidence at this stage to assess the likelihood of a release; or (4) a release could threaten human health or the environment. While it is premature to draw conclusions regarding specific units at the completion of the PR, it will often be possible to screen units from further consideration at the completion of the second RFA stage, the VSI. As a result, where the investigator identifies units during the PR that are not likely to have releases of concern, the investigator should inspect these units carefully in the VSI before determining that the units need no further investigation or action.

During the PR, the investigator may also make preliminary recommendations on the need to collect samples. It will often be possible to identify units or locations where sampling data can assist in making release determinations. Sampling recommendations should be checked for appropriateness during the VSI. In general, the VSI and SV should provide additional information necessary to fill data gaps identified during the PR.

Documenting the PR

At the PR's completion, the investigator should prepare a report that documents information sources, identifies SWMUs, and presents preliminary evaluations of the likelihood of release at each location. This information will be used throughout the VSI and SV, and will provide a foundation for preparation of the final report summarizing the findings of the entire RFA process.

2.3 CONDUCTING THE VISUAL SITE INSPECTION (VSI)

2.3.1 Purpose, Scope, and Work Product of the VSI

The visual site inspection is the second step of the three-step RFA process for identifying releases at RCRA facilities under the corrective action program. Major purposes of the VSI include:

- Visually inspecting the entire facility for evidence that releases of hazardous wastes or constituents from POTW SWMUs have occurred, and identifying additional areas of concern;
- Ensuring that all POTW SWMUs have been identified;
- Filling data gaps identified in the PR; and
- Formulating initial recommendations concerning the need for a sampling visit, interim measures, a remedial facility investigation (RFI), or no further action at a facility.

By the end of the VSI, the investigator also will have determined appropriate locations for environmental sampling to be performed during a subsequent sampling visit. In some rare cases, it will be possible to complete the RFA after the VSI is concluded, where all POTW SWMUs can either be screened from or recommended for further investigation in an RFI without the conduct of additional sampling during an SV.

The VSI will include the entire POTW facility and may need to extend beyond the property boundary in cases where an investigator needs to determine whether a release from a POTW SWMU has migrated offsite. For off-site property, permission to conduct any walk through inspection should be obtained beforehand. As discussed previously, however, corrective action at POTW facilities will not apply to releases from POTW collection systems offsite. The VSI will generally be limited to collection of visual evidence of potential releases (i.e., photographic documentation), although it may be appropriate in some cases to conduct air monitoring using portable direct read instruments.

2.3.2 Planning the VSI

The VSI should not require a great deal of time to plan and execute. In general, the site inspection activities can be completed in one day, although some large POTW facilities that may require more time. The PR provides much of the information needed to prepare for the VSI. In conducting the VSI, the investigator should use the facility map prepared during the PR, identifying SWMUs and potential releases at the facility.

The VSI will usually be the investigator's first visit to the facility during the corrective action process. Therefore, the investigator should develop a site safety plan that outlines the need for personal safety devices (e.g., respirators, protective clothing). The content of the safety plan will vary by site, depending on the site's complexity and the investigator's planned activities. All personnel who will go on-site should participate in a safety course that meets OSHA requirements prior to conducting a VSI.

Following a review of materials collected during the PR, the investigator should contact the owner/operator to schedule a date for the VSI. The investigator should arrange to meet with facility representatives before conducting field activities. This meeting will provide the investigator with an opportunity to explain the various steps of the corrective action process to the owner/operator, and answer any of the owner/operator's questions about the RFA process or the corrective action program. During this meeting, the investigator should discuss the proposed safety plan with the POTW owner/operator and incorporate his/her recommendations in the safety plan prior to conducting the VSI.

Logbook

The logbook is perhaps the most important document produced from an RFA. It provides a basis for integrating VSI and SV results into the RFA report, and documents inspection and sampling activities in support of any future legal proceedings under RCRA, CWA, or CERCLA. A new logbook should be developed for each site and for each visit to the site. Logbooks should be bound and pages numbered sequentially, and entries should be chronological and preceded by a notation for time of the entry. A logbook should be maintained with indelible ink.

The following types of entries should be made in the logbook:

- Identities of all personnel onsite during each phase of a VSI or SV;
- Descriptions of instruments used during the field work, including instrument identification numbers;
- Description of film used;
- Description of the weather and changes in the weather;
- Observations relating to SWMUs and their potential for release;
- Results of field measurements, instrument readings, and well measurements;
- Factual descriptions of site structures and features, including wells and well construction, units, containment structures, buildings, roads, topographic, and geomorphic features;
- Signs of contamination such as oily discharges, discolored surfaces dead or stressed vegetation;
- Sketches of facility layout, SWMU location structural features, points of contamination, and release paths;

- Facility map showing points and direction of photographs, SWMUs, release paths, locations of visual evidence of releases, and potential receptors; and

- Other relevant items.

Photography

Investigators should use regular 35mm cameras for taking photographs. Filters should not be used since they tend to discolor images and may unfairly bias photographic results by altering the appearance of physical evidence such as leachate seeps or lagoons. The investigator should identify and record in the logbook the exact type of camera (i.e., including identification number), film, and lens used. Photographs taken with unusual lenses (e.g., wide-angle) can be challenged and may not be admissible in court. Photographs should be taken to document the facility conditions, and procedures used in inspection activities. Types of pictures may include:

- Representative picture(s) of entire facility;

- Posted signs identifying ownership of facility;

- Evidence of releases--leachate seeps, pools, discolored water, or strained soils;

- Individual SWMUs, including photographs from different angles and direction;

- Visual evidence of poor facility maintenance that may contribute to the likelihood of a release;

- Adjacent land use; and

- Areas accessible to unauthorized persons.

2.3.3 Conducting Field Activities During the VSI

Once arrangements for the VSI have been made, the investigator should proceed with field activities. The owner/operator or his designated representative should accompany the investigator while field activities are conducted at the facility.

During the VSI, the investigator should:

- Walk through the entire facility;
- Identify all SWMUs and other areas of concern on a facility map;
- Document all observations in a field logbook;
- Take photographs of all SWMUs, potential releases, receptors, and other locations of interest; and
- Monitor for vapor emissions as necessary to protect the investigator's safety.

Conduct of the VSI will enable the investigator to inspect the entire POTW facility for potential releases not previously identified and to gain further insight into facility waste management practices.

During the VSI, the investigator will focus primarily on identifying and characterizing POTW SWMUs. The RCRA Section 3004(u) corrective action authority requires that the need for corrective action be determined for all SWMUs. Where the investigator identifies spills or other releases which may not be regulated under RCRA Section 3004(u) corrective action (e.g., releases beyond the facility boundary, accidental product spills) the investigator should nonetheless inspect, document, and photograph these releases. It may be necessary, in some cases, to use other statutory authorities in addressing these releases (e.g., RCRA 7003).

Visual Evidence of Unit Characteristics

The VSI should provide substantial information on unit characteristics at a POTW. Observations concerning the integrity, location, and design of a unit can provide information indicating the likelihood that a release has occurred. For example, above-ground wastewater and sludge tanks can be inspected for the integrity of seams and for the presence of adequate secondary containment. Wastewater and sludge impoundments should be inspected for the adequacy of berms, overtopping controls, and devices to control volatile emissions. Sludge and ash landfills should be inspected for the presence of runoff controls, erosion around the unit, and potential for the release of particulate constituents. In general, it will not be possible during the VSI to assess most POTW units for ground-water releases. If possible, the investigator should inspect containment (e.g., liners) for visible indications of deterioration. Where units have a high potential for release to groundwater and contain highly mobile wastes, sampling likely will be needed to rule out a release.

Visual Evidence of Waste Characteristics

Generally, it will not be possible to obtain a great deal of information during the VSI on POTW waste characteristics. In cases where the types of waste handled in a unit are not known, it will seldom be possible to determine their characteristics through visual observation. Waste characteristics will be investigated primarily during the preliminary review (PR) and sampling visit (SV) phases of the RFA. Still, the investigator may use the VSI as an opportunity to inspect additional onsite POTW records regarding types of wastes and constituents that are managed at the POTW facility, and to confirm data collected during the PR.

Visual Evidence of Pollutant Migration Pathways

The VSI should provide substantial information on potential pollutant migration pathways at the POTW facility. Facility characteristics that can facilitate the movement of releases from the immediate area around a unit, but have not been identified previously on the facility map, will often be apparent during the VSI. For example, erosion gullies at the base of landfills or surface impoundments will provide direct pathways for surface water and soil releases from these units. The investigator should locate all potential migration pathways of concern on the facility map. These locations will be important areas for sampling should it be necessary to conduct a SV or RFI at the POTW. In addition, photographs of these pathways should be correlated with facility map locations whenever possible.

Visual Evidence of Releases

The investigator should inspect the entire facility and, if possible and permission can be obtained, areas beyond facility boundaries for visual evidence of releases. While it will not always be possible to determine conclusively that a release has occurred based on visual evidence, such evidence can provide a strong indication of a release. Visual evidence coupled with information indicating that a unit contained hazardous constituents, will often be sufficient to compel further investigation under a RFI. The investigator should look for obvious signs of release, such as discolored soils, dead vegetation or animals, or unusual odors.

Visual Evidence of Exposure Potential

The VSI should provide information on exposure potential at the facility. In most cases, the PR will already have identified whether there are nearby residences or drinking water wells, but the location of previously identified receptors should be confirmed during the VSI. At a minimum, the VSI should identify any additional receptors, especially those near or in migration paths.

2.3.4 Determining the Need for Further Action During the RFA

The results of the VSI should be incorporated into the draft RFA report, which is begun on completion of the PR. The results of the PR and the VSI together should provide sufficient evidence to make a determination of the need for one of the following steps:

- Sampling visit;
- Interim measures*;
- Further investigation in an RFI; and
- No further action.

The investigator should document the results of the VSI concisely and thoroughly in the draft RFA report. Together with information obtained during the PR, the report must support decisions regarding the need for additional action at the facility. The RFA report will be the primary legal document supporting the Agency's initial corrective action activities at a POTW. The report may be closely scrutinized and/or challenged. Incomplete, contradictory, or confusing information in the RFA report may jeopardize the Agency's position.

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*See page 2-27 below for discussion of interim measures.

The RFA report will include recommendations for further action. Information and evaluations presented in the report must be defensible and must support recommendations. The following sections discuss each of the possible recommendations that can be made after completing the first two stages of the RFA.

Recommending a Sampling Visit (SV)

On completion of the VSI, the investigator should have collected information on each potential release and completed a preliminary evaluation concerning the likelihood of releases from each SWMU and from the facility. The investigator should also have identified important data gaps that may interfere with his/her ability to make an enforceable determination of release or release potential. To fill these gaps, the investigator may recommend collecting environmental samples from the facility to support his/her recommendations for further action under the RCRA corrective action process.

The need for sampling at specific units will depend on several important factors, including the complexity of the unit and its environmental setting, the quantity and quality of information gathered during the PR and VSI, preliminary recommendations for further action at the facility, the facility compliance record, and the cooperativeness of the owner/operator. The investigator must consider these factors, using his/her best professional judgment, to determine when a sampling visit is appropriate.

The preliminary recommendations for further action at a facility play an important role in determining the need for sampling. If the investigator believes a release may have occurred, samples collected in the SV can support a decision to require further assessment. On the other hand, if the investigator believes a release is not likely, a preliminary recommendation that the unit does not need further investigation can be made. Sampling can demonstrate that no release has occurred.

There may be situations in which the investigator makes a preliminary recommendation that a unit should be investigated in a RFI without actual sampling data that demonstrates a release has occurred. For example, most determinations on ground-water releases will have to be made with little or no ground-water monitoring data since few POTW facilities have installed ground-water monitoring wells. In these situations, the investigator may have to rely on an assessment of waste characteristics, unit characteristics, migration pathways, and soil sampling data to make these determinations. Where possible, samples should be taken at these units during the sampling visit to demonstrate that a release has occurred.

Environmental sampling is especially important when the investigator believes the POTW owner/operator will be unlikely to cooperate in conducting a RFI at the facility. When the owner/operator's cooperativeness is questionable, the investigator should sample to support recommendations for further steps in the corrective action process in case these recommendations are contested in an administrative hearing. Even the most cooperative owner/operator may ultimately challenge permit conditions that are not supported by strong evidence.

Recommending Interim Measures

The investigator can recommend that interim measures be implemented at any time during the RFA, although he/she may not have sufficient information prior to the VSI to make this recommendation. Interim measures should be recommended whenever there is a significant risk of immediate exposure resulting from releases at the facility. Interim measures are applicable to POTW facilities conducting corrective action under RCRA Section 3004(u) or 3004(v) authorities, and may be implemented through permit conditions contained in RCRA RIDER permits issued to POTW permit-by-rule facilities*, or through other appropriate enforcement authorities.

Recommending A Remedial Facility Investigation (RFI)

Releases identified during the RFA will be fully characterized during the remedial facility investigation (RFI) phase of the RCRA corrective action process. The RFI likely will be conducted by the POTW owner/operator and may

*Details on planning and implementing interim measures can be found in the RCRA (3008(h)) Corrective Action Orders Interim Measures Guidance (Draft).

be resource-intensive. Thus, recommendations for RFIs at facilities should be supported by the evidence collected during all stages of the RFA. In most situations, the investigator should collect samples at units to support recommendations for a RFI.

There may be cases, however, where the investigator will recommend a RFI for particular units without collecting additional samples. This situation is most likely to occur at facilities where an investigator has been able to obtain and evaluate evidence of releases during the PR and VSI. In these cases, existing evidence of release must be sufficient in the absence of supplemental sampling to support the requirement for a RFI.

Recommending No Further Action

The RFA also serves to screen from consideration units that do not threaten human health or the environment with releases of hazardous wastes or constituents. In some cases, the investigator may choose to make this type of determination after conducting the PR and VSI, rather than taking additional samples in a SV. A decision to take no further action after the VSI should be made knowing that the public may contest EPA's decision. In these situations, it will be useful to collect additional sampling information in a SV.

2.4 CONDUCTING THE SAMPLING VISIT

2.4.1 Purpose and Scope

The sampling visit is the final stage of the RFA process. The SV has two primary purposes:

- Fill data gaps identified in the PR and VSI by collecting new sampling data.
- Make a final determination on the presence of releases or potential releases requiring further investigation.

At the conclusion of the SV, the investigator will have completed the first phase of the RCRA corrective action process.

EPA intends to limit the collection and evaluation of new sampling data in making preliminary release determinations, and rely as much as possible upon existing information sources identified in the PR and VSI. Under this approach, EPA will defer major new data gathering efforts to the RCRA Facility Investigation (RFI) phase of the corrective action process. As a result, the investigator should use information sources developed in the PR and VSI to identify sampling activities which are essential in making final release determination for SWMUs or groups of SWMUs at the POTW facility.

The extent of sampling needed at a POTW will vary considerably depending on the quality of information gathered in the PR and VSI. Other factors to consider include the degree of owner/operator cooperation and type of regulatory action necessary to require further action at the facility. While EPA policy encourages the EPA Regions and States to minimize the amount of sampling conducted during the SV, a lack of information on possible environmental contamination at some POTWs may necessitate more extensive SVs at POTW facilities than would be conducted at some RCRA TSDFs. EPA Regions may choose to rely on facility owner/operators to develop a sampling plan and conduct sampling activities. The Regions should be prepared to exercise oversight of owner/operator sampling activities.

2.4.2 Developing a Sampling Plan

Because the need for additional sampling will vary on a case-by-case basis, the investigator must rely on best professional judgment in determining when a SV is appropriate. The investigator may choose to sample in the following cases:

- To collect additional information to support a preliminary determination that a unit has not released and does not require any further action;
- To collect additional information to support a preliminary determination that a unit has released and should conduct a RFI, implement interim measures, or take some other further action; and
- To collect additional information for determining whether a facility has had a release of hazardous waste or constituents.

In some cases, information gathered in the PR and VSI may provide sufficient evidence to indicate that a RFI is necessary, or that no further action is necessary. In other cases, the information gathered in the PR and VSI will not be sufficient to enable the investigator to determine conclusively that there has been a release. For example, a facility may have a surface impoundment that contains sewage sludges known to be contaminated with heavy metals. Information collected during the PR and VSI may not clearly indicate whether the impoundment has released constituents to ground water, or whether any remaining contaminated soil can potentially leach contaminants to ground water. In this situation, it may be necessary to sample the soils around the closed unit or sample the ground water from existing wells located downgradient from the unit to identify a release.

The scope of sampling activities conducted during the SV will also depend on the extent to which the investigator can obtain meaningful results from wastestream and environmental sampling. The ability to obtain meaningful sampling results will relate, in turn, to a number of technical factors including accessibility to appropriate sampling locations, likelihood of environmental contamination from off-site sources, and type of sampling equipment required. For example, because few, if any, POTWs have already installed ground-water monitoring wells, the investigator will probably have to rely on technical evaluation documents and other written information, and soil sampling results to make determinations on the possibility of ground-water releases. Similarly, an assessment of releases to surface waters and sediments may be hindered by the relative inaccessibility of appropriate sampling locations in POTW receiving waters and by the presence of possible contamination from non-POTW sources discharging to the receiving waters. In these cases, the investigator may have to make final release determinations based entirely on data collected in the PR and VSI.

The sampling plan will be the primary document directing the collection of additional data in the SV. This plan should be developed to support the collection of evidence necessary to make a release determination for individual SWMUs, or groups of SWMUs. The procedure may involve the collection of direct evidence (e.g., air samples from a surface impoundment) or indirect evidence (e.g., soil samples at a point downgradient from the SWMU) of a release. In many cases, the investigator may collect samples from the waste source and from an environmental medium, and based upon knowledge of the pollutant migration pathway, evaluate the likelihood that the constituent originated in the SWMU.

The sampling plan may be developed by EPA, a contractor, and/or the owner/operator. In all cases, EPA should review the sampling plan carefully before initiating activities to ensure that the plan can achieve the stated objectives.

Determining the Extent and Locations of Sampling

The extent of sampling required in the SV will vary by site. When the investigator has reason to believe that an owner/operator is likely to contest EPA's determination that a SWMU should be investigated in a RFI, the investigator should be sure to gather sufficient sampling information to support his/her judgment on the likelihood of releases. The Agency also will need ample data when defending its actions in a public hearing.

In general, it is sufficient to determine that a constituent identified in a SWMU has been released to one environmental medium. It may be necessary to take samples at several different points around a unit to ensure that all potential migration pathways have been sampled. One positive sample confirming that the constituent of concern is present in a well-defined migration pathway will usually be sufficient to indicate the need for a RFI.

The location and number of samples necessary to identify a release will vary by unit type and migration pathway. For example, samples from a single ground-water monitoring well may not be sufficient to identify a release from a closed landfill because of the complexities of the ground-water pathway. However, one measurement using a direct-read instrument above or adjacent to a wastewater treatment unit may suffice in identifying an air release. Each of the media-specific chapters in this document contains specific guidance on determining the extent and location of sampling.

Choosing Sampling Methods and Parameters

The sampling plan should specify methods and parameters for each sampling location at the facility. The plan should also specify the number of samples to be taken at each sampling point. Generally, an investigator may choose sampling techniques and parameters to provide either screening level measurements (e.g., a general scan with an hNU photoionizer indicating the presence of volatile organic compounds) or precise, quantitative measurements for specific organic or inorganic compounds. As stated previously, sampling for specific compounds will generally provide the most useful results from the SV and aid in developing defensible recommendations. Sampling for indicator parameters such as total organic halogens (TOX), conductivity, or pH may be useful where the investigator cannot identify wastes that may have been released to a medium. However, indicator parameters offer limited information and will generally not provide sufficient evidence of release. Chapters 4, 5, and 6 describe sampling strategies for each environmental medium and provide guidance on the selection of appropriate sampling methods and parameters.

Preparing the Sampling Plan

While there is no established format for the sampling plan, it should present clear and logical steps for meeting the sampling objectives at each SWMU or group of SWMUs. Depending on facility characteristics, it may be more appropriate to organize the discussion in the plan by sampling location or by sampling method. The sampling plan should contain information on each of the following factors:

- Field activities - The plan should discuss the sequence and schedule for conducting the field activities.

- Sampling locations/rationale - As precisely as possible, the sampling plan should identify the location of each sample to be taken on a site map. A description of the objectives for each sampling activity should be included in the plan, along with a discussion of how the sampling activities will result in data that will achieve the objectives. The plan should describe specific sampling methods, number and locations of samples and parameters.

- Analytical requirements - The sampling plan should explain the technique and level of detection used to analyze each sample.

- Sample handling - Sample preservation and other handling practices should be described. These can usually be described in an appendix to the sampling plan, or where appropriate, a specific document may be referenced.

- Quality assurance samples - The plan should identify the number and type of quality assurance samples (blanks, duplicates, or spikes) to be taken. Specific QA/QC guidelines are discussed later in this chapter.

- Equipment decontamination - The sampling plan should identify reagents and any special procedures associated with equipment decontamination.

Reviewing a Sampling Plan

The investigator should review the sampling plan carefully to ensure that it meets EPA objectives for each unit being sampled. Careful evaluation of the plan will ensure that appropriate sampling methods and locations are used, and that the extent of sampling will be sufficient to support release determinations made for each sampling location. Review of the plan will be especially important in instances where the owner/operator or an EPA contractor has developed the sampling plan.

2.4.3 Preparing for the SV

Once the sampling plan has been completed and reviewed, the investigator may make plans to begin on-site activities. These plans should include:

- Gaining facility access;
- Handling community relations;
- Preparing a safety plan;
- Specifying the QA/QC and chain-of-custody requirements; and
- Specifying EPA oversight of owner/operator sampling activities.

Gaining Facility Access

Prior to conducting field work, the investigator should contact the POTW owner/operator to schedule a time for the SV. The appropriate person (either EPA or a designated contractor) should contact the owner/operator to verify sampling dates and describe the nature of the field activities. If the owner/operator will be responsible for collecting and analyzing the samples, then the owner/operator should be contacted to verify the sampling dates and arrange for the oversight of field activities. Where EPA or a contractor will conduct the sampling, the Agency should coordinate with the POTW owner/operator before the SV, so that he or she can make necessary arrangements. EPA should offer the owner/operator a split of all samples collected. If the owner/operator wishes split samples, then he should provide sample bottles for the splits. After completing all arrangements, a letter or phone call to the owner/operator confirming the sampling dates and scope of field activities should be made.

In some cases, it may be necessary to gain access to adjacent or nearby properties in order to conduct a visual inspection or collect samples. EPA should provide verbal as well as written notification of the dates and nature of the work to owners of these properties, and receive written notice granting access for the proposed activities.

Community Relations

If it is necessary to conduct field activities in or near residential or nonindustrial business areas, the appropriate local officials should be contacted prior to the SV. It is difficult to remain unobtrusive in conducting site inspections, particularly if the investigators are wearing protective clothing. Moreover, the presence of persons collecting samples may cause undue alarm.

Preparing a Safety Plan

Agency personnel should prepare a safety plan for each SV in accordance with appropriate EPA guidance. The safety plan should be tailored to the specific sampling activities. For some SVs, the safety plan will be very simple and require few protective measures. Other sites may require use of higher levels of protection. In developing the safety plan, the POTW owner/operator should be questioned closely about potential hazards at the facility.

For detailed assistance in developing a safety plan, the investigator is referred to EPA's Standard Operating Safety Guide, 1982 (SOSG) which explains how to develop a proper site safety plan. The SOSG was prepared in accordance with EPA and other Federal health and safety guidelines, regulations, and orders. This reference discusses the steps involved in developing a safety plan and describes the contents of each section of the plan. A site-specific safety plan should describe:

- Known hazards and risks;
- Personnel and alternates;
- Levels of protection to be worn;
- Work areas;
- Access control procedures;
- Decontamination procedures;
- Site monitoring program;
- Special training required; and
- Weather-related precautions.

Personnel should participate in an approved safety course before visiting a site, as required by OSHA.

QA/QC and Chain-of-Custody Requirements

All samples, including blanks and spikes, should be maintained under chain-of-custody procedures to ensure the validity of analytical results for any future legal proceedings. These procedures minimize the potential for contaminating, damaging, or losing samples prior to their analysis by tracking the possession of a sample from the time of collection through all transfers of custody to receipt by the laboratory, where internal laboratory chain-of-custody procedures take over. Investigators should review EPA regional protocols for chain-of-custody procedures before the SV.

EPA Oversight of Owner/Operator Sampling Activities

The sampling plan should provide for EPA oversight where the owner/operator conducts the sampling activities. The level of EPA involvement will depend on the extent of sampling, the complexity of the site, and the cooperativeness of the owner/operator. In some cases, EPA may believe that the owner/operator will provide reliable sampling results. In these cases, EPA oversight can be limited to presence at the facility during some portion of the SV. In other cases, it may be necessary to provide EPA oversight at the facility during the entire SV.

2.4.4 Conducting the SV

Once all preliminary activities have been completed, the investigator may begin the site activities. The sampling visit involves gaining access to the site, performing sampling activities, photographing all activities, keeping the SV portion of the logbook, preparing samples for shipment and analysis, and finally decontamination and demobilization.

Preliminary Site Activities

The investigator should meet with the owner/operator prior to entering the facility to conduct sampling. Since the investigator will already have conducted a VSI for the POTW facility, the POTW owner/operator should have some understanding of the corrective action process. During this meeting, the investigator should be prepared to answer questions relating to the sampling plan. In addition, the investigator should offer to provide the owner/operator with duplicate samples. In cases where the owner/operator will perform the sampling, the investigator should arrange for splitting samples and discuss oversight activities at this time.

Sampling Procedures

The investigator should adhere to the sampling plan once sampling activities begin. If it is necessary for any reason to diverge from the sampling plan, changes and the need for modification should be carefully documented. Continuous air monitoring for vapor emissions should be performed to detect any air releases resulting from sampling activities. If the POTW owner/operator is collecting the samples, EPA or State investigators should document precisely the sequence of sampling activities and the procedures and instruments used, and characterize the sample by location, depth, appearance, and other relevant attributes.

The EPA Regional offices have developed standard operating procedures (SOPs) for most SV sampling tasks under the CERCLA PA/SI program. These SOPs are usually applicable to RCRA field activities as well. In instances where the SOPs are not appropriate for a particular field activity, a new SOP should be developed by the investigator. Modifications to existing SOPs should be noted in the field logbook.

Sample Shipment/Sample Analysis

Upon completion of the on-site work, EPA or the POTW owner/operator should deliver all samples to the laboratory for analysis. SOPs covering sample shipment are available in each Regional office or in EPA safety training manuals. Time required for analysis of samples may range from 40 days to 4 months.

Decontamination/Demobilization

Decontamination of persons and equipment should occur not only when all field work is completed, but also each time a person leaves the site for any reason, including rest breaks. Decontamination after sampling activities will usually consist of removal of disposable clothing and decontamination of sample bottles and sampling and field equipment. All materials that will not be reused should be containerized for transport and disposal. Decontamination of persons and equipment will be necessary where significant contact with hazardous materials is likely (e.g., sampling). As a result, in conducting VSI and SV at POTW facilities, the need for decontamination procedures should be assessed on a site-specific basis.

2.4.5 Final RFA Recommendations For Further Action

The final task in the RFA process is to make recommendations concerning the need for further actions at the facility. These recommendations include: (1) taking no further action; (2) conducting a RFI to identify the rate and extent of releases from SWMUs or groups of SWMUs; (3) planning and implementing interim measures at the facility; or (4) referring the further investigation and control of permitted SWMU releases or other unusual releases to other environmental program offices. The RFA is complete only after recommendations have been made for all releases and potential releases investigated. The investigator may determine the likelihood of release for some SWMUs after completing the PR and VSI. In other cases, it will not be possible to make such determinations until sampling results from the SV have been evaluated.

Making RFA Release Determinations

After the laboratory completes its analysis, the investigator should evaluate the validity of analytical results. When EPA conducts the sampling, a preliminary review of the analytical data ensures that all required deliverables are included in the data package, all forms meet contract requirements, and key quality assurance items in the data package are identified. Regional personnel may wish to perform a qualitative data analysis after this preliminary data review, and determine if the data results are valid.

Once the investigator has evaluated the validity of sampling results, sampling data should be added to information collected previously for each SWMU and release location. At this point in the process, the investigator should also have received any additional information requested from the POTW owner/operator, and should take this into consideration.

The investigator must use best professional judgment to determine the likelihood of release to any environmental medium for each SWMU or group of SWMUs. The VSI section has already described how an investigator may make initial release determinations for these units. The investigator should use the same procedures in evaluating additional information collected during the SV.

In some cases, the investigator will have direct evidence of a release. In most cases, however, the investigator will be required to draw conclusions from indirect evidence about the likelihood of release. As stated previously, the strength of these deductions will depend upon the quality of the waste information, the extent to which the pollutant migration pathways have been characterized, and the quality of the environmental sampling results and visual observations.

The level of evidence needed to support a determination will vary on a case-by-case basis, depending upon the cooperativeness of the owner/operator, the EPA objectives at the facility, and the complexity of the facility. In general, it will be sufficient to identify one constituent that is present in both a SWMU and in the migration pathway to support a release determination. The investigator does not need to demonstrate with statistical confidence that the SWMU had a release.

It may often be more difficult to demonstrate that a unit does not have a release. While this conclusion may be intuitively apparent to the investigator, the public may demand stronger supporting evidence. In situations where the public has demonstrated significant concern, it may be necessary to conduct a broader sampling program in attempting to confirm that a unit does not have a release requiring further investigation.

Making Recommendations for Each SWMU or Group of SWMUs

The final step in a RFA entails making recommendations on the need for further investigations. Four recommendations are possible:

- No further action;
- Investigate further in a RFI;
- Plan and implement interim corrective measures; and
- Refer the control of a permitted release to another environmental program office.

No further action. No further investigation will be necessary for SWMUs which have not released hazardous wastes or constituents to the environment. Where an investigator identifies a de minimis release from a SWMU that requires no further action, the investigator should clearly document the evidence and basis of this recommendation.

There are several general situations where it will be possible to determine that a SWMU needs no further action. Some units will have design and operating characteristics that will effectively prevent releases. The investigator should be careful in determining that a unit poses no threat of release if the unit still contains wastes of concern or is located in a vulnerable area. The investigator should always consider the age of the SWMU and its potential for failure in evaluating the need for further action.

In some situations, it may be appropriate to eliminate certain units from further study because they clearly have not released hazardous wastes or constituents into the environment. Examples of such units include above ground and, in some cases, surface level wastewater or sludge treatment tanks. In the case of above ground tanks, a review of unit design and operation, as well as the inspector's direct knowledge of the facility, may provide substantial evidence that the unit has never leaked. It will rarely be possible to make similar determinations for landfills and surface impoundments.

Investigate releases further in a RCRA remedial facility investigation. The investigator should recommend that a SWMU or other release be investigated further in a RFI when he or she identifies a release or potential release from a SWMU to an environmental medium. The investigator should describe each SWMU and the relevant environmental media to be investigated in the RFI. In focusing the RFI, it is important to determine media of concern for each SWMU or group of SWMUs. There may be situations where the facility as a whole poses a problem (i.e., releases have been confirmed over wide areas) and where it is difficult to distinguish among individual SWMUs as sources of contamination. In these cases, it may be more effective to recommend a RFI that requires the owner/operator to investigate routes of release for the entire facility.

Adopt interim measures. Where evidence suggests that immediate action should be taken to protect human health or the environment from releases, the RFA should recommend interim measures at the facility. The investigator should evaluate the severity of the release and the proximity of potential receptors in assessing the need for interim corrective measures. Examples of interim measures include fencing a facility to prevent direct contact with wastes, or stabilizing weak dikes to prevent surface water releases from impoundments. It is important that these units be investigated further in a RFI in order to determine the adequacy of the interim measure and design a permanent remedy.

Refer permitted releases to other program offices. Permitted releases that may threaten human health or the environment should be referred to the Federal or State program office that issued the permit. Since EPA has not developed guidelines on such referrals, they should be addressed on a case-by-case basis. The following four types of releases may be encountered:

- Permitted discharges from units in compliance with their permits - As a matter of policy, EPA will exercise discretionary authority in investigating permitted releases in the RFA. In cases where discharges from units in compliance with permits issued by EPA media programs are cause for concern, EPA will initially refer the case to the original permitting authority and request that they further control the release through their permitting program. If the permitting authority cannot or will not control this permitted discharge in order to meet RCRA standards, EPA should, if necessary, exercise its authority under RCRA Sections 3004(u), 3005(c)(3), 3008(h), or 7003 to control the discharge. This situation should arise only rarely if at all.

- Permitted discharges from units not in compliance with permits - In cases where discharges from units out of compliance with permits issued by EPA media programs are cause for concern, EPA will refer the case to the original permitting authority and request that they bring the discharge into compliance with permit conditions.

- Releases to other media from units with permitted discharges - EPA will use its RCRA corrective action authorities to control releases to media other than the one for which the discharge is permitted. For example, EPA will use §3004(u) to control the release of VOCs from NPDES-permitted wastewater treatment units where there is a potential threat from air releases. These releases will not routinely be referred to the other permitting authority, since this authority would not have permitted a release to the other media.

- Contamination resulting from permitted discharges - When the RFA identifies contamination resulting from permitted discharges requiring further investigation, EPA will work on a case-by-case basis with the Regions and other EPA permit programs to develop a solution to the contamination problem resulting from the discharges. For example, when frequent violations of NPDES permits in the past have resulted in an accumulation of hazardous materials in stream sediments, the RCRA investigator should work with the NPDES authority to develop a solution to the contamination problem.

2.4.6 Final RFA Product

The final RFA report should document the activities undertaken in the PR, VSI, and SV. Many documents will be generated during the SV, such as the sampling plan, safety plan, sampling results, evaluation of the sampling results, release determinations, and recommendations for each unit. All of this information should be compiled into the RFA report for future reference during any subsequent phases of the corrective action program.

3. EVALUATION OF WASTE AND UNIT CHARACTERISTICS AT POTWs

This chapter of the guidance document provides the investigator with an overview of POTW unit and waste characteristics. The first section of this chapter describes types of solid waste management units typically found at POTWs, and identifies potential release points for these units. The second section of this chapter provides a methodology for the characterization of wastes managed at POTW facilities.

3.1 POTW UNIT CHARACTERISTICS

For an investigator to assess potential pollutant release points at POTWs, treatment operations and the units that typically constitute a POTW's system must be understood. This section of the guidance presents typical POTW treatment system configurations and characterizes the impacts of POTW configuration on pollutant releases. Finally, it provides data that can be used to characterize the fates of specific pollutants within POTWs.

3.1.1 Description of Typical POTW Treatment Processes

Although POTWs employ numerous treatment units and processes, the following discussion focuses on those most commonly found at POTWs, as well as those with the potential for significant releases to the environment. Common POTW treatment units and processes include:

- Bar screens;
- Comminutors;
- Grit chambers;
- Primary clarifiers;
- Activated sludge units;
- Secondary clarifiers;
- Lagoons (facultative and aerated);
- Chlorination units;
- Anaerobic digesters;
- Aerobic digesters;
- Sludge drying beds;
- Incinerators;

- Sludge lagoons and waste piles;
- Land application of sludge;
- Landfill disposal of sludge;
- Land application of effluent; and
- Underground injection of effluent.

Each of these treatment units and processes is described below.

Bar Screens

Preliminary treatment of wastewater begins with removal of coarse solids. The usual procedure is to pass the wastewater through racks or bar screens. These screens may be cleaned mechanically or manually. Material retained on the screens may be discharged to comminutors or removed by hauling to landfills. Bar screens are typically located upstream of the POTW's influent pumps and hence are well below ground level. They are generally installed in concrete conduits.

Comminutors

Comminutors grind material retained on the bar screen and return the ground material to wastewater for removal in downstream treatment processes. Coarse material is cut by teeth and shear bars on a revolving drum as the solids are passed through a stationary comb. The small sheared particles pass through the drum slots and are channeled back to the wastewater flow. Comminutors are located adjacent to bar screens, typically well below ground level, in concrete conduits.

Grit Chambers

Grit chambers are basins designed to remove grit, consisting of sand, gravel, cinders, or other heavy solid materials. The chambers are intended to protect moving mechanical equipment from abrasion and accompanying abnormal wear, to reduce formation of heavy deposits in pipelines, channels, and conduits, and to reduce the frequency of digester cleaning required as a result of excessive accumulation of grit in such units. Accumulated grit from grit chambers is most commonly disposed as fill. A grit chamber can consist of either an above-ground or below-ground basin. They are typically made of concrete and can be either aerated or nonaerated.

Primary Clarifiers

In a primary clarifier (sometimes called a sedimentation tank), the wastewater is held in a relatively quiescent state so that solids with a higher specific gravity than the wastewater will settle, and those with a lower specific gravity will tend to rise. The objective of treatment by sedimentation is to remove readily settleable solids and floating material and thus to reduce the suspended solids content. The primary clarifier can be either an above ground or below ground basin usually of concrete.

Activated Sludge

In the activated sludge process, domestic sewage is stabilized biologically in a reactor under aerobic conditions. The resulting biological mass is separated from the liquid in a secondary settling tank. A portion of the settled biological solids is recycled while the remaining mass is removed to prevent overloading the system with biomass. The conventional activated-sludge process consists of an aeration tank, a secondary clarifier, and a sludge recycling line.

Facultative Lagoons

Lagoons in which the stabilization results from a combination of aerobic, anaerobic, and facultative bacteria are known as aerobic-anaerobic lagoons or facultative lagoons. The floor of the lagoon is typically unlined clay. Oxygen is maintained in the upper layer by the presence of algae or by the use of surface aerators. The biological community in the upper layer consists of aerobic bacteria while the microorganisms in the bottom layer are facultative and anaerobic bacteria. A large portion of the solids settle on the bottom of the lagoon. As the solids build up, a portion will undergo anaerobic decomposition, which results in a highly stabilized effluent.

Aerobic Lagoons

Aerobic lagoons are typically unlined earthen basins. The contents of an aerobic lagoon are completely mixed by aeration, and both the incoming solids and biological solids produced from waste conversion do not settle out. In effect, the essential function of this type of lagoon is waste conversion.

Depending on the detention time, the effluent will contain from one-third to one-half the value of incoming BOD in the form of biological solids. Before the effluent is discharged, solids are removed by settling.

Chlorination

The most important use of chlorine, a strong oxidizing agent, is for disinfection, although it has other uses such as odor control and BOD reduction. Chlorine may be applied directly as a gas or in an aqueous solution. The most widely used chlorinators have vacuum-feed devices. The chlorine contact chambers are typically above ground concrete basins.

Anaerobic Sludge Digestion

Anaerobic sludge digestion involves the biological decomposition of sludges in the absence of oxygen. In the digestion process, anaerobic bacteria convert organic matter to methane gas and carbon dioxide. As these gases rise to the surface, the sludge particles and other materials, such as grease, oils, and fats, ultimately form a layer of scum. Through digestion, the sludge becomes more mineralized and thickens because of gravity. The process itself can be a one-stage, two-stage, or high rate digestion process. Anaerobic digesters typically are covered, above ground concrete basins.

Aerobic Sludge Digestion

In the aerobic sludge digestion process, sludge is aerated and biological solids are oxidized to carbon dioxide, water, and nitrates. Aerobic digestion is normally conducted in unheated basins similar to those used in the activated sludge process. For the most part, these basins are above ground and constructed of concrete.

Drying Beds

Sludge drying beds are used to dewater digested sludge. Sludge is placed on the beds in an 8-12 inch layer and allowed to dry. After drying, the sludge is removed and disposed of in a landfill, or pulverized for use as a fertilizer. Open beds are used where adequate isolated space is available. Covered beds with greenhouse type enclosures are used where it is necessary to dewater sludge continuously throughout the year despite adverse weather, and where they cannot be sufficiently isolated. The beds are most commonly flush with ground level and made of concrete.

Incineration

The incineration process converts the sludge into inert ash, which can be easily disposed. With dewatering to approximately 30 percent solids, the process is usually self-sustaining without the need for supplemental fuel, except for initial warm-up and heat control. In the multiple hearth design, heated air and products of combustion pass by finely pulverized sludge that is continually raked to expose fresh surfaces. Products of combustion are released to the atmosphere.

Sludge Lagoons and Waste Piles

The sludge lagoon is essentially a large, unheated shallow digester. Lagoons do not allow recovery of methane gas or the continuous removal of digested sludge. When the lagoon becomes filled with digested sludge, it must be either abandoned, or drained and the digested sludge excavated. The lagoon floor is usually unlined clay.

Land Application of Sludge

Wet digested sludge may be disposed of by spreading over farm land. The humus in the sludge conditions the soil, improving its moisture retentiveness.

Landfill Disposal of Sludge

If a suitable site is convenient, a sanitary landfill can be used for disposal of sludge, grease, and grit whether or not it is stabilized. Disposal in a sanitary landfill method is most suitable if the landfill is also used for disposal of the refuse and other solid wastes.

Land Application of Effluent

Spraying on irrigable land, wooded areas, and hillsides has been used to dispose of POTW wastewater. The amount of wastewater that can be sprayed depends on the climatic conditions, infiltration capacity of the soil, types of crops or grasses grown, and the standards imposed on runoff.

Underground Injection of Effluent

Ground-water recharge is a common method for combining water reuse and effluent disposal. Recharge has been used to replenish ground-water supplies in many areas. In New York, California, Florida, and other coastal areas, treated effluent has been used to replenish ground water and stop saltwater intrusion.

3.1.2 RCRA Terminology as Applied to POTW Treatment Units/Processes

Many POTW treatment units and processes can be evaluated in terms of traditional RCRA hazardous waste treatment, storage, and disposal units. This correspondence between POTW terminology and RCRA terminology is valuable to investigators who may be relatively unfamiliar with key aspects of the RCRA program. The use of traditional RCRA terminology will assist investigators in identifying and understanding pollutant releases at POTWs.

Applicable RCRA terminology for various hazardous waste treatment, storage or disposal units includes:

- Tank - A stationary device designed to contain an accumulation of hazardous waste, which is constructed primarily of nonearthen materials (e.g., wood, concrete, steel, plastic) that provide structural support.

- Surface Impoundment - A facility or part of a facility which is a natural topographic depression, man-made excavation, or diked area formed primarily of earthen materials (although it may be lined with man-made materials), which is designed to hold an accumulation of liquid wastes or wastes containing free liquids, and which is not an injection well. Examples of surface impoundments are holding, storage, settling, and aeration pits, ponds, and lagoons.

- Land Treatment - A facility or part of a facility where hazardous waste is applied to or incorporated into the soil surface. Such facilities are disposal facilities if the waste remains after closure.

- Landfill - A disposal facility or part of a facility where hazardous waste is placed in or on land and which is not a land treatment facility, a surface impoundment, or an injection well.

- Incinerator - Any enclosed device using controlled flame combustion that neither meets the criteria for classification as a boiler or is listed as an industrial furnace.

- Underground Injection - The subsurface emplacement of fluids through a bored, drilled, or driven well, or through a dug well, where the depth of the dug well is greater than the largest surface dimension.

- Waste Pile - Any noncontainerized accumulation of solid, nonflowing hazardous waste that is used for treatment or storage.

Table 3-1 provides a list of RCRA classifications that apply to common POTW units. It should be noted from Table 3-1 that no corresponding RCRA units are provided for bar screens and comminutors. They are difficult to categorize as RCRA units because they are devices rather than containment structures.

Many of the POTW units listed in Table 3-1 are categorized as RCRA tanks or surface impoundments. The distinction between tank and impoundment pertains to the geometry of the individual unit as well as how the unit is situated. If the unit is self-supporting, regardless of its position relative to the ground, the unit is classified as a tank. If the unit is not self-supporting, it is classified as a surface impoundment. It is evident from Table 3-1 that many POTW units can be constructed alternatively as tanks or surface impoundments.

3.1.3 Typical POTW Configurations

As POTWs utilize many different treatment units/processes, POTWs also possess different configurations. Figure 3-1 presents a diagram of the treatment system configuration for a typical POTW. The POTW treatment units and processes shown in Figure 3-1 can include the following:

- Headworks
  - Bar screens
  - Comminutors
  - Grit chambers

- Primary Tanks/Impoundments
  - Primary clarifiers

- Secondary Tanks/Impoundments
  - Activated sludge units
  - Facultative lagoons
  - Aerated lagoons
  - Secondary clarifiers

TABLE 3-1.

POTW UNIT	TRADITIONAL RCRA UNIT
Bar Screen	N/A*
Comminutor	N/A*
Grit Chamber	Tank/Surface Impoundment
Primary Clarifier	Tank/Surface Impoundment
Facultative Lagoon	Tank/Surface Impoundment
Aerated Lagoon	Tank/Surface Impoundment
Activated Sludge	Tank/Surface Impoundment
Secondary Clarifier	Tank/Surface Impoundment
Chlorination Contact Chamber	Tank/Surface Impoundment
Aerobic Digester	Tank/Surface Impoundment
Anaerobic Digester	Tank/Surface Impoundment
Drying Beds	Surface Impoundment/Waste Pile/Tank
Incinerator	Incinerator
Sludge Lagoon	Surface Impoundment/Landfill
Landfill	Landfill
Land Application of Sludge	Land Treatment Unit
Underground Injection of Effluent	Underground Injection Well
Land Application of Effluent	Land Treatment Unit

* N/A = Not applicable.

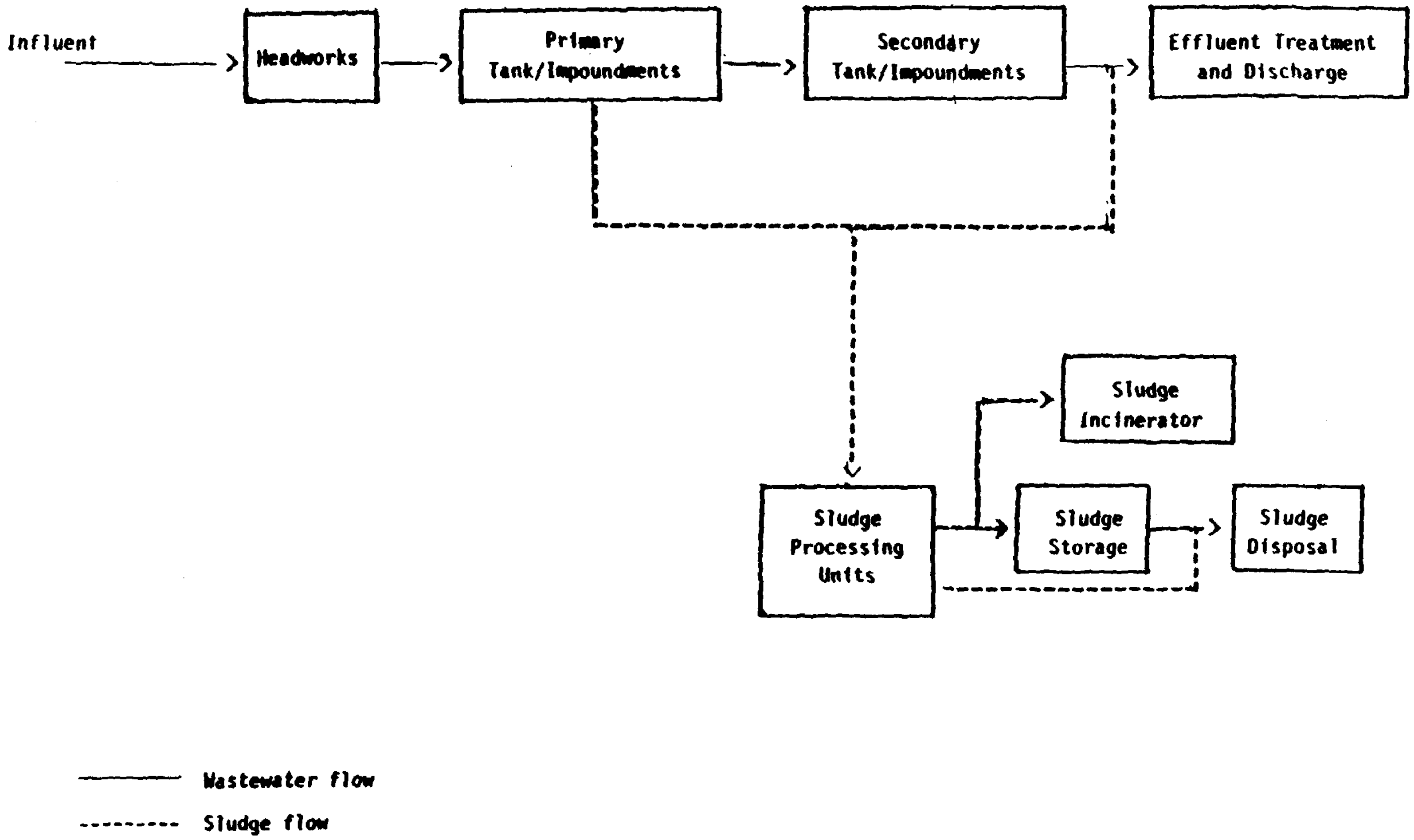


FIGURE 3-1. TYPICAL POTW CONFIGURATIONS

- Effluent Treatment and Discharge
  - Chlorination
  - Land application
  - Underground injection
  - Discharge to receiving waters
- Sludge Processing Units
  - Aerobic digesters
  - Anaerobic digesters
- Sludge Incinerator
  - Incinerators
- Sludge Storage
  - Sludge lagoons
  - Sludge drying beds
- Sludge Disposal (includes ash disposal)
  - Landfill
  - Land application.

POTW treatment system configuration is important in assessing pollutant releases from treatment units and processes, since the constituents in the influent to a particular treatment unit are essentially determined by the removal efficiencies of upstream units. This influence of upstream units on pollutant releases is discussed in more detail in Section 3.2.5.

3.1.4 Pollutant Fate Processes and Release Mechanisms Within POTWs

To identify and assess pollutant releases within POTWs, pollutant fate within POTWs must be understood by the investigator. The principal fates of pollutants in POTWs include:

- Biodegradation,
- Volatilization,
- Adsorption to sludge,
- Chemical reaction,
- Combustion, amd
- Pass through.

Table 3-2 presents a matrix of principal competing fate processes by POTW treatment unit. The table does not, however, consider the influence of the physical and chemical characteristics of specific pollutant fate processes. For instance, volatilization has been designated as a competing fate process in activated sludge units, indicating that aeration will strip volatile organics from wastewaters in activated sludge basins. On the other hand, volatilization of certain semivolatiles in activated sludge basins may well be minimal.

Table 3-2 also indicates that biodegradation is most likely to occur in those POTW units specifically designed for that purpose, including activated sludge units, facultative and aerated lagoons, aerobic and anaerobic digesters, and aerated grit chambers. Volatilization is expected in those POTW units that are aerated, including grit chambers, activated sludge basins, facultative and aerated lagoons, and aerobic digesters. Volatilization will also occur in anaerobic digesters where the gaseous products of sludge digestion (methane and carbon dioxide) can effectively strip volatiles from the sludge. Furthermore, volatilization will occur in units such as sludge drying beds and sludge lagoons, where evaporation is a method of treatment. Finally, volatilization will occur in sludge incinerators, which are specifically designed to convert POTW sludges into gaseous products.

Table 3-2 shows that sludge adsorption is generally confined to POTW sludge treatment operations, such as sludge digestion, drying, and settling operations (primary and secondary clarifiers), and biological treatment units, such as activated sludge units and wastewater lagoons, in which sludges are brought into close contact with wastewaters. Other competing fate processes cited in Table 3-2 are chemical reaction, which occurs in chlorination units, and combustion, which occurs in sludge incinerators.

Pollutants not removed by the fate processes just discussed will typically pass through a POTW unit untreated. POTW treatment units in which pollutant pass through can occur are designated in Table 3-2. Ultimate disposal options, such as landfill and application of sludge, land application of effluent, and underground injection of effluent, by definition possess no pass through potential and thus are not so designated in Table 3-2.

TABLE 3-2. PRINCIPAL COMPETING POLLUTANT FATE PROCESSES

Unit	Biodegradation	Volatilization	Adsorption to Sludge or Ash	Chemical Oxidation	Combustion	Pass Through in Effluent
Bar Screen						*
Comminuter						*
Grit Chamber	*[1]	*[1]				*
Primary Clarifier			*			*
Activated Sludge	*	*	*			*
Facultative Lagoon	*	*[1]	*			*
Aerated Lagoon	*	*	*			*
Secondary Clarifier			*			*
Chlorination						*
Aerobic Digester	*	*	*			
Anaerobic Digester	*	*[2]	*			
Sludge Drying Beds		*[3]	*			
Sludge Lagoon		*[3]	*			
Sludge Incinerator		*	*[4]			
Landfill						
Land Application of Sludge						
Land Application of Effluent		*[3]				
Underground Injection of Effluent						

[1] if aerated
[2] stripping by digester off-gases
[3] through evaporation
[4] adsorption to incinerator ash

Table 3-3 delineates the potential pollutant release mechanisms for each POTW treatment unit and process. These pollutant release mechanisms are defined as follows:

- Stripping/Volatilization - aeration of wastewaters and sludges, which causes volatiles to be stripped and subsequently emitted to the atmosphere; also includes emission of volatiles through evaporation;
- Leaching - wastewaters entering the ground water from the bottom of unlined basins;
- Pass Through and Discharge - untreated pollutants, not removed by POTW treatment units or processes, discharged in the POTW effluent; includes discharges to a receiving stream, land application, or underground injection; and
- Overflow of Treatment Units - open basins within the POTW can overflow onto POTW grounds, if improperly operated, overflows could seep through the soi l to ground water.

As shown in Table 3-3, aerated treatment processes, such as grit chambers, activated sludge basins, and aerobic digesters can emit volatiles through air stripping. Volatiles can also be emitted to the atmosphere through evaporation in sludge incinerators, sludge drying beds, and from land to which effluent has been applied. Pollutants can leach into ground water from unlined basins such as sludge drying beds and lagoons, or from the land following application of POTW sludges or effluent. In addition, pollutants can pass through the POTW untreated and be discharged in effluent following a POTW's final treatment step, usually a secondary clarifier or a chlorination unit. Finally, Table 3-3 designates POTW treatment units and processes that are open and consequently can release pollutants to the land by overflow.

Significant pollutant fate processes within the POTW for a given pollutant will largely determine the location(s) and extent of the pollutant's release from the POTW. Accordingly, nonvolatile, biorefractory organics will likely pass through the POTW and be discharged, whereas nonvolatile, biodegradable organics may be almost entirely broken down in an activated sludge basin and not be significantly released by the POTW. Also, pollutant fate processes operating in upstream treatment units/processes will affect the extent of releases in downstream units. Thus, volatile organics may be

TABLE 3-3. POTENTIAL POLLUTANT RELEASE MECHANISMS

Unit	Stripping/ Volatilization	Leaching	Pass Through and Discharge	Overflow of Treatment Unit
Bar Screen				*
Comminuter				*
Grit Chamber	*[1]			*
Primary Clarifier				*
Activated Sludge	*			*
Facultative Lagoon	*[1]	*		*
Aerated Lagoon	*	*		*
Secondary Clarifier			*	*
Chlorination			*	*
Aerobic Digester	*			*
Anaerobic Digester	*[2]			
Sludge Drying Beds	*	*		
Sludge Lagoon		*		
Sludge Incinerator	*			
Landfill		*		
Land Application of Sludge		*		
Land Application of Effluent	*	*	*	
Underground Injection of Effluent		*	*	

[1] if aerated

[2] stripped by digester off-gases

partially stripped in an aerated grit chamber, thereby reducing volatile emissions from downstream activated sludge units. The impact of the sequence of POTW treatment units/processes on pollutant releases is discussed in more detail in the next section of this report.

3.1.5 Impacts of POTW Treatment System Configuration on Pollutant Releases

As noted above, the POTW's configuration will determine the locations and extent of releases within the POTW. As a result, removal efficiencies of upstream treatment units/processes will affect downstream loadings and the extent of downstream releases. Table 3-4 indicates, by POTW treatment unit/process, the impacts on downstream pollutant loadings caused by the operation of POTW treatment units/processes immediately upstream.

Loadings of volatile and semivolatile organics to primary clarifiers can be reduced by stripping/volatilization occurring in an upstream aerated grit chamber. Stripping/volatilization in an upstream aerated grit chamber and sludge adsorption in an upstream primary clarifier will account for reductions in organics loadings to biological treatment units (i.e., activated sludge, facultative lagoon, aerated lagoon). Stripping/volatilization, biodegradation, and sludge adsorption within biological treatment systems in turn, to reduce pollutant loadings to the secondary clarifier. Metals loadings to the secondary clarifier are reduced by upstream sludge adsorption in the primary clarifier and upstream biological treatment systems.

Pollutant loadings to sludge processing units (aerobic, anaerobic digesters) are determined by the extent of sludge adsorption in the primary and secondary clarifiers. Stripping/volatilization of volatile organics will occur in the digesters, reducing the loadings of these pollutants to additional downstream sludge processing. Similarly, biodegradation of semivolatile organics within digesters will reduce downstream loadings of these pollutants. Finally, it should be noted that biodegradation of organic pollutants, as well as volatilization of organics through evaporation, will occur in sludge drying beds and lagoons. These processes reduce pollutant loadings in dried sludge taken from sludge drying beds/lagoons for landfilling.

TABLE 3-4. IMPACTS OF UPSTREAM UNITS ON DOWNSTREAM POLLUTANT LOADINGS

Treatment Unit/Process	Influent Loadings of Volatile Organics Reduced by:	Influent Loadings of Semivolatile Organics Reduced by:	Influent Loadings of Metals Reduced by:
Headworks			
Bar Screen	No upstream units ——>		
Comminutor	No upstream units ——>		
Grit Chamber	Not affected by upstream units ——>		
Primary Tanks/Impoundments			
Primary Clarifier	Stripping/volatilization in aerated grit chamber	Not affected	Not affected
Secondary Tanks/Impoundments			
Activated Sludge Facultative Lagoon Aerated Lagoon	Stripping/volatilization in aerated grit chamber	Sludge adsorption in primary clarifier	Sludge adsorption in primary clarifier
Secondary Clarifier	Stripping/volatilization in biological treatment	Biodegradation and sludge adsorption in biological treatment	Sludge adsorption in biological treatment
Sludge Processing Units			
Aerobic Digester Anaerobic Digester	Influent loadings are determined by sludge adsorption in primary/secondary clarifier		
Sludge Incineration and Sludge Storage			
Sludge Incinerator Sludge Lagoons Sludge Drying Beds	Stripping/volatilization in aerobic or anaerobic digester	Biodegradation in aerobic or anaerobic digestor	Not affected
Sludge Disposal			
Landfill Landfill Application	Volatilization through evaporation from sludge lagoons/drying beds; also stripping/volatilization in aerobic or anaerobic digestor	Biodegradation in sludge drying beds/lagoons; also in aerobic or anaerobic digestor	Not affected
Effluent Treatment and Discharge			
Chlorination Land Application Underground Injection	Loadings determined by POTW removals affected through volatilization, biodegradation, and/or sludge adsorption		

3.1.6 Fate of Specific Pollutants within POTWs

It has already been noted within this report that specific pollutants have differing fates within POTWs. The EPA Report to Congress on the Discharge of Hazardous Wastes to POTWs provides some data on the fate of priority and nonpriority pollutants. Data on pollutant fate extracted from this report are compiled in Appendix A. The table provides estimates of typical POTW pass through rates (as a percent of POTW influent loading), air emission rates, and sludge partitioning rates for acclimated and unacclimated treatment plants.

3.2 POTW WASTE CHARACTERISTICS

A significant aspect of the RFA involves the characterization of the wastes received by the POTW. Proper waste characterization will assist the investigator in focusing further data collection efforts (i.e., visual site inspections ~~and sampling visits)~~ and in determining the presence of releases or potential releases at the hazardous waste management facility. Waste characterization at POTW facilities represents a significant challenge since POTWs may receive a broad range of hazardous wastes and constituents generated offsite by a diverse set of industrial users. In characterizing wastes managed at a POTW, investigators should be aware that the discharge of hazardous wastes and constituents to a POTW can occur in two ways:

- Wastes containing hazardous constituents can be discharged to a POTW collection system and mixed with domestic sewage (i.e., DSE wastes) prior to arrival at the POTW treatment plant, and
- Hazardous wastes may be discharged directly to a POTW treatment plant by truck, rail, and dedicated pipeline (non-DSE waste).

Consequently, a release from a POTW solid waste management unit (SWMU) may result from the presence of hazardous wastes and constituents contributed by either DSE wastes or non-DSE wastes, or some combination of these wastes. The investigator should attempt to characterize all hazardous wastes and constituents managed by a POTW.

This section provides the RFA investigator with guidance on how to collect the data necessary to characterize hazardous wastes and constituents managed at a POTW. The best data sources will generally consist of data maintained by the POTW. These data sources are discussed in Section 3.2.1 below. Section 3.2.2 discusses "default" data which can be used by the investigator in instances where existing data sources do not provide sufficient information on POTW wastes.

3.2.1 Data Sources for POTW Waste Characterization

There are several data sources available to investigators performing RFAs at POTWs. These data sources should be utilized by investigators to characterize all hazardous wastes and constituents that may be present within POTW treatment units. Accessibility of the data will depend in part, upon the party responsible for conducting the RFA. If State personnel are responsible for performing the RFA, requests to EPA and/or the POTW may be required to obtain the data necessary for proper waste characterization. If EPA personnel ~~will perform the~~ RFA, data requests to the State and POTW may be needed to supplement existing waste characterization data for a POTW. The following section provides descriptions of data sources which will assist an investigator in characterizing the hazardous wastes and constituents managed at a POTW.

RCRA Program Data

Initially, the investigator may utilize records and reports required by the RCRA program to characterize hazardous wastes and constituents managed at a POTW. POTWs which accept hazardous wastes transported by truck, rail, or dedicated pipeline are subject to RCRA permit by rule requirements. As such, a POTW is required to comply with RCRA procedural provisions involving the submission of reports to document known hazardous waste activities. These provisions include the following:

- EPA Identification Number - Facilities that treat, store, or dispose of hazardous wastes are required to file a notification of activity and receive an EPA identification number.
- Manifest System - Permit-by-rule conditions require POTWs to comply with the manifest regulations for TSDFs (40 CFR Part 264.71-264.72). The manifest system is originated by the generator, continued by the transporter, and completed by the POTW. The POTW must return a copy

of the completed manifest to the generator, and retain a copy for its records. The Uniform Hazardous Waste Manifest requires specific information regarding the hazardous waste to be treated including:

- Manifest document number
- Name, address, telephone number, and EPA identification number of the generator
- Name and identification number of each transporter
- Name, address, and EPA identification number of the POTW (including the same information for an alternate TSDF)
- DOT shipping name, hazard class, and waste identification number
- Total quantity of each waste by weight or volume
- Type and number of containers used in transporting the waste
- Certification that the hazardous waste has been properly classified, described, packaged, marked and labeled, and is in proper condition for transportation
- Waste minimization certification stating that the generator has a program in place to reduce the volume and toxicity of the waste.

- Operating Record - Permit-by-rule conditions require a POTW to maintain an operating record regarding hazardous waste practices. This operating record must contain the following information as it becomes available:

  - Description of the type and quantity of each hazardous waste received
  - Method and dates of its treatment, storage, or disposal at the facility, as per Appendix I of the RCRA regulations.

- Biennial Report - A POTW subject to permit-by-rule must submit biennial reports to EPA or appropriate State agency by March 1 of each even-numbered year. This report details POTW treatment, storage, and disposal activities in the previous odd-numbered year. The following information is required:

  - EPA identification number, name, and address of the facility
  - Calendar year covered by the report
  - EPA identification number for each generator from which hazardous waste was received
  - Description and quantity of each hazardous waste received during the year, listed by the EPA identification number of the generator
  - Certification signed by the owner or operator of the facility or his authorized representative
  - Method of treatment, storage, or disposal for each hazardous waste.

- Unmanifested Waste Report - If an unmanifested hazardous waste is accepted by a POTW from an offsite source, the POTW is required to file an unmanifested waste report. This report must contain the following:

- EPA identification number, name, and address of the facility
- Date the waste was received
- EPA identification number, name, and address of the generator and the transporter, if available
- Description and quantity of each unmanifested hazardous waste received
- Method of treatment, storage, and disposal for each waste
- Certification signed by the owner or operator of the POTW or his authorized representative
- Brief explanation of why the waste was unmanifested, if known.

An investigator utilizing these data sources should recognize that these records and reports provide information on hazardous wastes and not hazardous constituents. The investigator will need to refer to 40 CFR Part 261 of RCRA regulations to identify the constituents which provide a basis for regulation of these wastes as hazardous under RCRA. For example, if the investigator determines that a POTW manages an F006 listed hazardous waste (i.e., electroplating wastewater treatment sludge), the investigator should accordingly evaluate the potential for release of cadmium, hexavalent chromium, nickel, and cyanide, which are the hazardous constituents associated with F006.

Generators of hazardous wastes are also required to notify EPA and obtain an EPA identification number. Therefore, if an investigator wishes to identify POTW users with the potential to discharge hazardous wastes and constituents to the POTW under the DSE, a list of RCRA generators located in the POTW service area should be obtained. This generator listing may be quite large depending upon the size of the POTW service area. The investigator may also wish to consider RCRA facilities which treat, store or dispose of hazardous wastes. Hazardous waste treatment, storage, and disposal facilities (TSDFs) are also required to notify EPA of their activities and submit biennial reports which describe hazardous waste activities at the facility. A TSDF listing within the POTW service area may also assist the investigator in identifying industries with the potential to discharge hazardous wastes and constituents to the POTW.

POTW Sampling Data

The investigator should also utilize POTW sampling data to characterize POTW wastes. In particular, influent, effluent and sludge sampling data for the POTW treatment plant will provide the investigator with useful information regarding the presence of hazardous wastes and constituents present at a POTW. Nonetheless, POTW sampling data may be limited in two key respects. First, many POTWs are not required to perform sampling for parameters that are not regulated in their NPDES permit. Thus, in the absence of toxic limits in a POTW NPDES permit, an investigator may not find sampling data for hazardous constituents. Secondly, most sampling performed by POTWs is limited to metals or a subset of EPA priority pollutants. As a result, POTW sampling data for nonpriority hazardous constituents will probably not be available.

NPDES Program Data

Data generated by POTWs for NPDES program reporting requirements may be useful to an investigator attempting to characterize wastes and constituents managed by a POTW. For example, NPDES permit applications submitted by POTWs to EPA or the NPDES delegated State should list the major industrial users of these POTWs. Also, ~~POTWs are required to~~ submit monthly discharge monitoring reports (DMR) to EPA or the NPDES-delegated State. These DMRs contain data regarding POTW compliance with NPDES discharge standards and requirements. Monitoring data for hazardous waste constituents may be available on these DMRs where a POTW is subject to toxic pollutant standards, or is required to monitor for toxic pollutants. However, in most cases, analyses for constituents other than metals are rare. Finally, as part of EPA/delegated State oversight of POTWs, various inspections are performed to determine the compliance status of POTWs with NPDES program requirements. Inspection reports may provide useful information on the presence of specific hazardous constituents at a POTW.

Pretreatment Program Data

Many POTWs have been required by EPA to develop pretreatment programs to control the discharge of industrial wastes to their treatment systems. If an investigator is performing an RFA at a POTW that administers a local pretreatment program, the investigator may find substantial data useful in characterizing POTW wastes. Pretreatment data that may assist in characterizing POTW waste are discussed below.

Industrial Waste Surveys. As part of the pretreatment program development process, POTWs are required to identify and locate all possible industrial users, and identify the volume and character of pollutants discharged by these users. To gather this information, POTWs have typically surveyed all industrial users located within their service area and collected the following information:

- Name of industry;
- Address of facility;
- Standard Industrial Classification (SIC codes);
- Wastewater flow;
- Types and concentrations (or mass) of pollutants contained in discharge (Note: This may not provide information on many hazardous constituents.);
- ~~Major products~~ manufactured or services supplied if pollutant constituents in discharge are not known; and
- Description of existing onsite pretreatment facilities and practices.

A POTW industrial waste survey will provide a list of industrial users located within the POTW service area, and information on the manufacturing processes and waste generation practices of these industrial users. The original completed survey information for each industrial user should be maintained in POTW pretreatment program files.

POTW Industrial User Monitoring. As part of a POTW's implementation of its pretreatment program, the POTW will monitor its industrial users to ensure compliance with applicable pretreatment standards and requirements. This monitoring includes inspection and sampling of industrial users regulated by a POTW. An investigator should review the data generated by these POTW monitoring efforts for information on industry wastes.

A POTW will typically collect information necessary to maintain current operations and waste data on its industrial users and to determine the user's compliance status with pretreatment standards and requirements. POTW inspection information should cover the following areas:

- Manufacturing facility;
- Chemical storage areas;
- Hazardous waste generation;
- Spill prevention and control procedures;
- Pretreatment facilities;
- Industrial user sampling procedures;
- Lab procedures (if applicable); and
- Self-monitoring records.

Findings from industrial user inspections can assist in the identification of actual or potential discharges of hazardous wastes or constituents to a POTW.

Further, each pretreatment POTW is required to sample the wastewaters from its regulated industrial users in order to ensure compliance with discharge standards. An investigator should consider reviewing sampling results to determine if hazardous waste constituents are being discharged by those industries of concern. It should be noted, however, that many POTWs will only analyze for regulated pollutants or for pollutants known or believed to be present in the industrial user's discharge. Also, few POTWs will conduct sampling for nonpriority pollutant parameters.

Industrial User Self-Monitoring. Industries covered by a Federal categorical standard must comply with the baseline monitoring and compliance status reporting requirements found in 40 CFR Part 403.12 of the pretreatment regulations. Information required in a baseline monitoring report, which is submitted only once to the POTW (or Control Authority) includes:

- Identifying information (i.e., name, address, operators and owners);
- List of environmental permits held by the facility;
- Description of operations (including average rate of production and SIC code);
- Flow measurement of all regulated process wastestreams and all nonprocess wastestreams if the combined wastestream formula (40 CFR 403.6) is utilized;
- Measurement of pollutants regulated in process wastestreams;

- Statement of certification of compliance; and
- Compliance schedule (if out of compliance).

Information required in compliance status reports, which are submitted periodically to the POTW, includes:

- Nature and concentration of pollutants in regulated process wastestreams;
- Flow measurement of all regulated process wastestreams, and all nonprocess wastestreams if the combined wastestream formula (40 CFR 403.6) is utilized; and
- Statement of certification of compliance (only needed for the final compliance report).

Beyond self-monitoring requirements contained in Federal Standards, POTWs may require further self-monitoring reports for both categorical and non-categorical industrial users. These local reporting requirements may include:

- Notification of slug loads discharged by an industrial user;
- Notification of in-plant changes which may effect discharged waste quality or quantity; and
- Monitoring requirements for applicable local limits.

3.2.2 Potential Sources and Types of Hazardous Wastes and Constituents Discharged to POTWs

Where adequate waste information is not available in POTW files, an investigator will have to rely upon professional judgment and outside data sources to characterize hazardous wastes and constituents potentially managed at a POTW. This section provides guidance for the investigator in determining types of hazardous wastes and constituents which may be present at a POTW based upon a review of the the types of industrial users served by the POTW.

Profile of Potential Large Quantity Generators

Appendix B provides a list of hazardous constituents potentially discharged by an industrial user in any one of 15 selected industrial categories. Industrial users in these categories have the potential to generate and ultimately discharge to a POTW large quantities of hazardous wastes or constituents. To use Appendix B, the investigator must first identify the types of industries (i.e., organic chemical manufacturers, wood preservers) discharging to the POTW. Section 3.1.1 discussed several sources of data which may be utilized by the investigator to identify types of large quantity generator (LQG) industries discharging to the POTW. Other data sources such as local Chamber of Commerce lists, Dun and Bradstreet and telephone books can also be consulted by the investigator. In many cases, industries are identified and described by their SIC codes. Table 3-5 provides a listing of the 15 selected LQG industries and SIC codes associated with these industry types.

Once the types of LQG industries are determined by an investigator, Appendix B may be used to identify hazardous constituents potentially generated and eventually discharged to a POTW by specific industries. As shown in Appendix B, there are several LQG industries that have the potential to discharge a wide variety of hazardous constituents to a POTW. For example, hazardous waste management facilities have the potential to discharge a broad range of hazardous wastes and constituents. Further, investigators should be aware that some industry types are common to many POTWs (i.e., metal finishing/equipment manufacture), while other industry types may be concentrated in certain geographical areas (i.e., wood preserving in the southeast and northwest).

Profile of Potential Small Quantity Generators

It is estimated that 630,000 facilities in the Nation generate less than 1,000 kilograms per month of hazardous waste. Historically, these small quantity generators (SQGs) have been subject to less stringent RCRA disposal requirements than other generators. However, regulations recently promulgated by EPA have significantly broadened SQG requirements. Recent studies of SQGs by EPA have demonstrated that a significant proportion of all SQGs discharge their hazardous wastes to POTWs. Because industries which qualify as SQGs are common to most POTW service areas, an investigator should always consider possible contributions of hazardous wastes and constituents by SQGs.

TABLE 3-5. APPLICABLE SIC CODES FOR POTENTIAL LARGE QUANTITY GENERATORS OF CONCERN

Industry	Applicable SIC Codes
Electrical and Electronic Components	3612, 3624, 3641, 3671 3672, 3673, 3674, 3677 3679, 3339
Explosives Manufacture	3482, 3483, 2892, 2899
Hazardous Waste Management Facilities	1389, 2992, 3031, 3341 4212, 4953, 5085, 5093
Inorganic Chemicals Manufacture	2812, 2813, 2816, 2819
Iron and Steel Manufacture	3312, 313, 3315, 3316 3317, 321, 3322, 3324 3325, 3462, 3493
Metal Finishing/Equipment Manufacture	all 34 SIC codes all 35 SIC codes all 36 SIC codes all 37 SIC codes all 38 SIC codes all 39 SIC codes
Nonferrous Metals Manufacture	3331, 3332, 3333, 3334 3339, 3341, 3350, 3354 3355, 3356, 3357, 3361 3362, 3369, 3399, 3463 3497
Organic Chemicals Manufacture	2865, 2869
Paint Manufacture	2851
Pesticides Manufacture	2869, 2879
Petroleum Refining	2911
Pharmaceuticals Manufacture	2831, 2833, 2834
Plastics/Rubber Manufacture	2821, 2822, 2823, 2824
Utilities (Steam Electric)	4911, 4931
Wood Preserving	2491

To assist the investigator in evaluating the actual or potential discharge of SQG wastes for a given POTW, Table 3-6 identifies common types of SQGs generating hazardous wastes, predominant types of hazardous wastes generated by these SQGs (i.e., as percent of total waste volume for the industry), and hazardous constituents typically associated with these hazardous wastes. For example, if an investigator determines that several industrial and commercial laundries are present in the POTW service area, then tetrachloroethylene, which is a possible constituent of filtration residues from dry cleaning, may be released from the POTW to the environment.

Profile of Other Wastes Potentially Discharged to a POTW

There are several other types of wastes potentially discharged to a POTW which may be hazardous or contain hazardous constituents. If accepted at a POTW facility, these wastes should be carefully evaluated by the investigator. Descriptions of these waste types are provided below.

Septage Wastes. In considering septage wastes, an investigator should identify their possible sources. Septage wastes derived exclusively from household sources are not considered hazardous wastes and will probably not contain significant quantities of hazardous constituents. Nonetheless, where septage wastes are derived wholly or in part from nonhousehold sources, such as industrial septic tanks, the wastes are regulated as any other solid wastes, and may be deemed hazardous if the septage has been contaminated with listed or characteristic wastes. Septage wastes hauled from nonhousehold sources can also be contaminated with high levels of hazardous constituents.

Leachate, Contaminated Ground Water, and Impoundment Wastes. Facilities that treat, store, or dispose of RCRA regulated hazardous wastes may generate hazardous waste residuals as a result of normal operations or due to unusual situations (e.g., facility closure requirements). Examples of such residuals are leachates, contaminated ground water, and surface impoundment wastes. Where accepted at a POTW facility, these residual wastes should be carefully evaluated for the presence of hazardous wastes or constituents.

TABLE 3-6. SMALL QUANTITY GENERATOR HAZARDOUS WASTE TYPES AND TYPICAL HAZARDOUS WASTE CONSTITUENTS

INDUSTRY	HAZARDOUS WASTE TYPE(S) ACCOUNTING FOR 90% OF WASTE GENERATED	TYPICAL HAZARDOUS WASTE CONSTITUENTS
Construction Industry	Ignitable Wastes (90%)	Naphtha, kerosene, turpentine, gasoline, diesel fuel
Cosmetics Manufacture	Strong Acid or Alkaline Wastes (60%) Ignitable Wastes (30%)	Acetone, ethyl acetate
Fertilizer Manufacture	Strong Acid or Alkaline Wastes (100%)	Ammonia, phosphoric acid, sulfuric acid
Industrial and Commercial Laundries	Filtration Residue from Dry Cleaning (99%)	Tetrachloroethylene, petroleum solve[illegible]
Laboratories and Hospitals	Spent Solvents (50%) Ignitable Wastes (20%) Strong Acid or Alkaline Wastes (15%) Other Reactive Wastes (15%)	Acetone; methyl ethyl ketone; methyl isobutyl ketone; benzene; toluene; methylene chloride; methanol; hydrochloric, sulfuric, nitric, and chromic acids; caustic soda
Miscellaneous Chemical Formulators	Strong Acid or Alkaline Wastes (60%) Spent Solvents (25%) Pesticide Washing and Rinsing Solution (10%)	Solvents (e.g., as listed for "Laboratories"), pesticides, chemical intermediates/feedstocks (e.g., chlorobenzene, nitrobenzene, aniline)
Motor Vehicle Services	Spent Solvents (90%) Strong Acid or Alkaline Wastes (10%)	Gasoline, naphta, tetraethyl lead, sulfuric acid
Printing & Publishing	Photographic Wastes (75%) Strong Acid or Alkaline Wastes (10%) Spent Solvents (10%)	Silver, cyanide, chromium, ketones, alcohols, esters, aromatic hydrocarbons
Service Related Industries	Photographic Wastes (35%) Waste Formaldehyde (35%) Solution or Sludges with Photosilver (20%)	Silver, cyanide, chromium, formaldehyde, phenol, pesticides
Soaps and Detergents Manufacture	Pesticide Washing and Rinsing Solution (50%) Strong Acid or Alkaline Wastes (40%)	Sodium hydroxide, potassium hydroxide, phenol, cresols
Transportation Services	Spent Solvents (100%)	Gasoline, diesel fuel, naphtha (from tank cleaning and hazardous waste hauling operations, almost any RCRA waste is possible)
Wholesale and Retail Trade	Ignitable Paint Wastes (25%) Photographic Wastes (20%) Spent Solvents (20%) Wastewater Wood Preservative (15%) Pesticide Washing and Rinsing Solution (15%)	Cresols, toluene, silver, cyanide, chromium, pesticides, naphtha, turpentine, methyl ethyl ketone, methyl isobutyl ketone, phthalate esters
Wood Furniture Refinishing	Filtration Residue from Dry Cleaning (60%) Spent Solvents (40%)	Tetrachloroethylene, methanol, methylene chloride, methyl ethyl ketone, methyl isobutyl ketone, phthalate esters, turpentine, tol[illegible]

Superfund Waste. Cleanup of Superfund sites by Federal, State, and private parties frequently results in the generation of aqueous wastes such as leachate, contaminated ground water, impoundment wastes, and other wastewaters. Where delivered to a POTW by truck, rail, or dedicated pipeline, some Superfund wastes may be hazardous as defined by RCRA. These wastes may contain hazardous constituents frequently found at CERCLA sites (e.g., trichloroethylene, lead, toluene, benzene, PCBs, and chloroform).

Used Oil. As defined by RCRA statutory provisions, used oil is any oil that has been refined from crude oil, used and, as a result of such use, contaminated by physical or chemical impurities. Used oils include:

- Spent automotive lubricating oils (including car and truck engine oil), transmission fluid, brake fluid, and off-road engine oil.
- Spent industrial oils, including compressor, turbine, and cleaning oils, hydraulic oils, metal working oils, gear oils, electrical oils, refrigerator oils, and railroad drainage.
- Spent industrial process oils.

Under current RCRA provisions, used oils are exempt from RCRA hazardous waste regulations.

In reviewing used oils for possible regulation, EPA has noted the frequent contamination of used oils with metals (e.g., lead, arsenic, cadmium, chromium) and solvents (e.g., trichloroethylene 1,1,1-trichloroethane, tetrachloroethylene), as well as the presence of hazardous constituents (e.g., naphthalene, toluene, phenol) that are naturally occurring in petroleum-derived and synthetic oils.

3.2.3 Physical/Chemical Properties of Selected Hazardous Waste Constituents

Once an investigator has sufficiently characterized the hazardous wastes and/or constituents that are, or have the potential to be, discharged to a POTW, the investigator should begin an initial assessment of the potential for release of these hazardous wastes and/or constituents from the POTW to the environment. In order to undertake this assessment, the physical/chemical properties of the identified hazardous constituents should be considered.

These physical/chemical properties will determine the fate of the hazardous constituent within the POTW, and the fate of the hazardous constituent once released to the environment. Selected physical/chemical properties to be utilized in assessing the fate of selected hazardous waste constituents are included in Appendix C.

Specific use of each of these physical/chemical properties in assessing releases to the environment will be discussed in further detail in other portions of this guidance, including:

- Chapter 4 which discusses physical/chemical properties of constituents to be considered in assessing releases to ground water, soil, and subsurface gas.
- Chapter 5 which discusses physical/chemical properties of constituents to be considered in assessing releases to surface waters and sediments, and
- Chapter 6 which discusses physical/chemical properties of constituents to be considered in assessing releases to air.

4. ASSESSMENT OF RELEASES TO GROUND WATER AND SOIL, AND BY SUBSURFACE GAS

This section contains guidance on identifying and evaluating releases to ground water, soil, and subsurface gas from SWMUs at POTWs. The major difficulty investigators will encounter when evaluating releases of hazardous constituents to soils and ground water at a specific site will be the lack of information on operating units, wastes managed, and hydrogeological conditions. Investigators likely will be required to make assumptions as to a unit's potential for release based on design and operating records. Visual evidence of upkeep and maintenance, and spills outside a unit's containment, will indicate the likelihood of a release. However, sampling results demonstrating hazardous constituents are present outside a unit's containment probably will be required to prove a release has occurred.

A unit's design and construction, and the POTW's operating practices, will control the potential for releases to occur; these are discussed in Section 4.1. The extent of a release will depend on the physical/chemical behavior of specific constituents as they move through the environment; these are discussed in Section 4.2. The migration path released constituents will follow is a function of the release mechanism, the method of transport, and site-specific conditions; these are discussed in Section 4.3. Sampling may be required to confirm releases or to identify hazardous constituents managed at units; sampling procedures are discussed in Section 4.4. Finally, the potential impacts of a release will depend on the receptors along the migration path that would be affected by released constituents; these are discussed in Section 4.5. Releases to subsurface gas are discussed in Section 4.6.

4.1 UNIT CHARACTERISTICS AFFECTING POTENTIAL FOR RELEASES TO GROUND WATER AND/OR SOILS

A unit's design, construction, and operation will control the mechanisms by which a unit may release hazardous constituents to soils and ground waters. Releases occur for the following reasons:

- Design assumptions are not correct, (e.g. surface water control structures at a waste pile were designed using incorrect storm intensity data, or runoff/infiltration percentages, resulting in surface runoff releases).

- Construction is poor (e.g. the concrete base of an impoundment was constructed of below-specification materials, or foundation preparation was not adequate, causing a cracked base resulting in wastewater infiltration to ground water).

- Improper or poor operating practices cause releases (e.g. sludges are placed outside containment areas, or foam overs are not controlled, causing releases to soils and possibly ground waters).

In some cases, units are designed or operated to intermittently release hazardous constituents. Although most units are intended to control or prevent releases, any combination of improper design, construction, or operation may cause releases.

Unit characteristics likely to cause releases are evaluated during the preliminary review and visual site inspections. Design, construction, and operating records may identify actual releases or obvious flaws that would lead to releases. For example, EPA assumes that unlined, including clay- or soil-lined, basins or impoundments will leak. Design records will indicate the type of materials that provide containment at units. Similarly, a sludge pile may be designed and constructed with a concrete pad but without surface runoff controls. Design records and a visual inspection would identify this deficiency. During the PR and VSI, inspectors should focus on identifying:

1. Design characteristics and features that would likely cause a unit to release constituents to soils and/or ground water.

2. Primary release mechanisms and the likelihood of occurrence.

During the VSI, visual evidence of releases and the physical integrity of the unit should be observed. Unit characteristics previously identified should be confirmed. Evidence of actual releases or potential releases will indicate migration paths, which will guide the selection of sampling locations if a sampling visit is needed.

4.1.1 Unit Characteristics Influencing Potential for Soil Contamination Through Surface Runoff

Surface runoff releases occur for two reasons:

- Wastewaters or sludges have breached or overflowed containment, and
- Precipitation has contacted waste, most often sludges, dissolved or entrained constituents, and transported constituents outside containment.

Releases of the first type usually occur at surface impoundments, tanks, and basins. Releases of the second type usually occur at landfills, waste piles, land treatment units, sludge processing units, and container storage areas. Table 4-1 lists surface runoff release mechanisms for units found at POTWs.

The potential for surface runoff releases is a function of the adequacy of a units containment (e.g. tank wall, dike, or berm), and the operational practices that cause or prevent overflows and control runoff. Table 4-2 lists design factors and operational practices that cause surface runoff-type releases. Factors to consider when assessing the potential of specific units for surface runoff releases to occur either by leaks and overflows, or by contaminated runoff, are discussed below.

Leaks/Overflows From Tanks, Basins, and Impoundments

Leaks and overflows are caused by containment that is inadequate to control the volume or type of waste managed at a unit, or by operational practices that exceed the design standards of the units containment. For example, an overflow from an open-topped tank or an impoundment can result if the capacity of the unit is not sufficient to manage peak flows or storm surges (i.e., a design flaw), or if operators do not maintain sufficient freeboard (i.e., an operations error). A leak in a tank wall or impoundment bank can result if wastes managed at the unit are not compatible with the containment (i.e., either an operator error or a design flaw). Design characteristics and operational practices that could combine to cause an overflow or leak must be anticipated when assessing release potential at basins, impoundments, and tanks.

TABLE 4-1. RELEASE MECHANISMS FOR SURFACE RUNOFF RELEASES

Unit type	Release Mechanism
Surface Impoundment	Releases from overtopping
	Seepage through containment
	Containment failure
Landfill	Migration of runoff outside the runoff collection and containment system
	Migration of spills and other releases outside the containment area from loading and unloading operations
	Seepage through dikes to surrounding soils
Waste Pile	Migration of runoff outside the runoff collection and containment system
	Migration of spills and other releases outside the containment area from loading and unloading operations.
Land Treatment Unit	Migration of runoff outside the containment area
Container Storage Area	Migration of runoff outside the containment area
Above-Ground Tank	Releases from overflow
	Leaks through tank shell
	Spills during transfer operations
In-Ground Tank	Releases from overflow
	Spills during transfer operations
Incinerator	Spills or other release error in waste handling/preparation activities
	Spills due to mechanical failure
Injection Wells	Spills from waste handling operations at the well head

TABLE 4-2. CAUSES OF SURFACE RUNOFF TYPE RELEASES

Design and Operating Practices	Applicable SWMUs
Design Practices	
Insufficient cover	Surface impoundments, waste piles, landfills
Inadequate freeboard (runon/runoff control)	Surface impoundments
Presence of liquids or waste exposed to environment	Surface impoundments, waste piles, landfills, land treatment units
Inadequate secondary containment and runon/runoff control	Waste piles, landfills, land treatment units, container storage areas, tanks, waste handling areas
Operating Practices	
Operational failure, faulty piping or other occurrences resulting in leaks and spills	Tanks, container storage areas, waste handling areas
Cracks or structural failure in dike walls or tanks	Surface impoundments, landfills, container storage areas, tanks
Lack of protection from dike wall erosion or tank corrosion	Surface impoundments, landfills, tanks, container storage areas
Repair, installation or replacement of any primary or secondary containment system while the unit contains waste	All SWMUs
Inadequate QA/QC procedures used during operation of SWMU	All SWMUs

Unit containment is not adequate to prevent leaks and overflows if:

- The unit has insufficient capacity to manage possible waste quantities.
- The unit's containment is not compatible with the types of waste managed.
- The unit's containment was not properly constructed and is not well maintained.

Sufficient design capacity can be evaluated by examining design and operation records. Maximum volumes managed by each unit should be readily available in facility records or can be calculated using standard engineering methods. These calculations can be performed either during the PR or the VSI.

Units with inadequate design capacity will have a high potential for overflow unless automatic overtopping control mechanisms such as diversions to emergency surge basins or waste-feed cutoff devices are in-place. Units with adequate design capacity will have a low potential for overflow-type release unless operational practices exceed design conditions. For example, a contaminated surface water control pond designed assuming a two or three-foot freeboard may have inadequate containment capacity if operated with a one-foot freeboard. The combinations of design and operating factors that could result in a release must be evaluated when assessing capacity.

Waste/containment compatibility should not be a problem at most POTWs because of the dilute concentrations likely to be encountered. However, units where concentrated wastes are managed should be examined to determine compatibility. Highly acidic or corrosive wastes may adversely impact clay soils, steel or synthetic tank materials, concrete, or synthetic liners. Available EPA guidance documents should be consulted if highly concentrated wastes are managed at a unit. A high release potential should be assigned those units managing high concentration wastes which may not be compatible with containment materials are managed.

The physical integrity of containment structures should be evaluated as a final step in assuring the adequacy of containment and the likelihood of a leak or overflow. Initially, an investigator should consider age of the units as a preliminary indication of its potential for release. Usually, construction quality control information will not be available to determine that proper procedures were followed. Therefore, the apparent physical condition of the containment will be the only measure of its integrity. Investigators must visually inspect all containment structures such as tank walls, dikes, and berm surfaces to identify obvious inadequacies. Rusting steel tanks, popped seams, dents in tank walls, eroded embankments, cracked concrete walls, etched or crumbling concrete, and overgrown earthen embankments are examples of visual evidence that upkeep and maintenance practices are not adequate to maintain the design integrity of a containment system. Newly repaired containment at units with poor operational histories also may indicate that wastes have breached containment. In general, a high potential for overflows or leaks should be assigned to units where maintenance of containment structures appears poor. A high potential should also be assigned when visual evidence such as rusted tanks, spill stains, discolored soils, and erosion and washouts at potential release points indicate releases have occurred.

In general, those units most likely to leak or overflow at POTWs are tanks, basins, and impoundments that:

- Are constructed of materials which are not compatible with wastes managed.
- Are operated with inadequate freeboard to maintain sufficient capacity and do not have automatic overtopping controls.
- Are located at facilities that manage combined storm and sanitary flows without adequate overtopping controls in-place.

Runoff from Sludge Processing or Diposal Units

Runoff releases from sludge processing or disposal units such as landfills, landfarms, impoundments, incinerators, and piles are caused because containment is not present, is not sufficient to manage the volume of runoff from major storms, or is not well maintained. Waste/containment compatibility is not a factor because concentrations of constituents in runoff will be low.

Units without containment to prevent surface runoff are assumed to have released hazardous constituents to soils and possibly ground water. At units that have runoff containment, releases of contaminated runoff can still be caused by combinations of design characteristics and operational practices. For example, containment will be sufficient to manage the runoff from a waste pile during a 25-year, 24-hour storm (i.e., RCRA Subtitle C regulatory requirement for runoff control for waste piles, land treatment units, and landfills) providing that less than a certain volume of waste is present within containment. Containment will be insufficient if the facility routinely stores greater volumes of waste at the unit, reducing the runoff volume that can be controlled. Factors which can combine to reduce the adequacy of containment must be evaluated when assessing the potential for release of contaminated runoff from sludge processing, use, or disposal units.

A unit's containment is not adequate to control contaminated runoff if:

- The unit has insufficient capacity to manage possible volumes of runoff from a 25-year, 24-hour storm, and
- Containment was not properly constructed or is not well maintained.

In general, units where containment is not sufficient to control the calculated volumes of runoff will likely have releases of contaminated runoff. Even units with adequate design capacity may have a high potential for runoff releases unless mechanisms are in-place to remove runoff and prevent overflow of containment. Similarly, units with adequate design capacities may not have sufficient available volume if waste is placed inside containment and reduces the available volumes.

The physical integrity of any containment structures should be evaluated as a final step in assessing the likelihood of a release of contaminated runoff. Runoff containment structures usually will be earthen berms, ditches or embankments, but sometimes may be asphalt or concrete. Erosion, washouts, cracks, or overgrown vegetation are signs that upkeep and maintenance are not adequate to maintain the integrity of the containment. A high potential for releases of contaminated surface runoff should be attributed to units where upkeep and maintenance are poor, or where visual signs of release are present.

4.1.2 Unit Characteristics Influencing Potential For Ground Water or Soil Contamination Through Subsurface Leachate

Subsurface leachate refers to hazardous constituents dissolved in water that move through the unsaturated zone and enter ground water. These releases occur for two reasons:

- Hazardous constituents previously released by units to soils or surface waters are transported by infiltrating precipitation or surface waters through the unsaturated zone to ground water; this is referred to as an indirect release.
- Wastewaters or contaminated precipitation leak through inadequate or nonexistent bottom containment (i.e., exfiltration) and migrate through the unsaturated zone to ground water; this is referred to as a direct release.

Hazardous constituents in surface soils are assumed to migrate down through the unsaturated zone and to ground water because most constituents are soluble to some extent and most areas have a net downward movement of moisture from land surface through the unsaturated zone to ground water. Indirect releases to soils and possibly ground water through subsurface leachate (#1 above) are assumed to occur whenever there is a release to surface soils. A unit with characteristics that indicate a high potential for releasing constituents to surface soils via surface runoff also will have a high potential for an indirect release to subsurface soils and ground water (see Section 4.2.1).

Hazardous constituents released to surface waters may also migrate to and affect subsurface soils and possibly ground water in areas where surface waters recharge ground waters. Although most surface waters represent ground water discharge areas (i.e., ground-water flows into the surface water body), the reverse occurs naturally in some areas, and in other areas where pumping has lowered the water table. The potential for constituents in surface waters to reach ground water is a function of site-specific hydrogeologic conditions. Therefore, because indirect releases to soils and ground water might occur whenever there is a release to surface waters, the unit characteristics that influence the potential for these indirect releases by infiltrating surface waters are also those that affect the potential for releases to surface waters (see Chapter 5).

Direct releases may occur at impoundments, basins, above and below grade tanks, landfills, landfarms, piles, and any unit from which wastewaters or contaminated runoff may infiltrate. Direct release potential is a function of the adequacy of a unit's containment intended to prevent exfiltration of waste from the unit. Table 4-3 lists mechanisms by which units release hazardous constituents as subsurface leachate. Table 4-4 lists design and operating factors which cause such direct ground-water releases.

The potential for direct releases to occur is evaluated by examining design, construction, and operating records to determine the likelihood of exfiltration, and by visually inspecting the unit to observe evidence of actual spills and degree of upkeep and maintenance. Available records will indicate the type, extent, age, design, and construction method for containment structures. Visual inspection of the unit will confirm unit characteristics, and also will indicate the care taken in operating and maintaining the unit. Because direct releases to ground water and soils will not be observable, data or observations of poor upkeep or spills along with unit characteristics which would increase the potential for a release to occur (e.g., older liners are more likely to leak than new ones) must be used to evaluate the likelihood of a direct release occurring.

The following trends can be used as general guidance when evaluating the potential for direct releases via exfiltration of waste from a unit:

- Unlined basins, impoundments, or sludge management areas are presumed to leak and to have direct release to subsurface soils and ground water.

- Older units require more upkeep and maintenance (e.g., periodic draining to inspect, clean, and replace liners), and more extensive containment (e.g., double liners versus single liners) to prevent direct releases of hazardous constituents to soils and ground water. In general, older units have a greater potential for leaking than younger units.

- Cracks observed on the sides and walls of concrete units are presumed to extend to below the waste/wastewater level and are present on the units bottom; these units are presumed to leak.

- Larger units at locations where extensive foundation preparation work was required because of less than suitable soils will have a higher potential for direct release because of a greater likelihood of differential settling causing a bottom liner failure.

TABLE 4-3. RELEASE MECHANISMS FOR GROUND-WATER RELEASES

Unit Type	Release Mechanism
Surface Impoundment	• Migration of wastes/constituents through liners (if present) and soils • Damage to liners • Overflow events and other spillage outside the impoundment • Seepage through dikes to surface and/or subsurface
Landfill	• Migration of leachate through liners (if present) and soils • Precipitation runoff to surrounding surface and subsurface • Spills and other releases outside the containment area from loading/unloading operations
Land Treatment Unit	• Migration of constituents through the unsaturated zone • Precipitation runoff to surrounding surface and subsurface
Underground Tank*	• Tank shell failure • Leaks from piping and ancillary equipment • Spillage from coupling/uncoupling operations • Overflow
Waste Pile	• Leachate migration through liner (if present) and soils • Precipitation runoff to surface/subsurface
In-ground Tanks	• Overflow • Tank wall failure • Leaks from ancillary equipment • Spillage from coupling/uncoupling operations
Container Storage Unit	• Spills from containers/container failure subsequent migration through liner or base (if any) and soils • Precipitation runoff from storage areas
Above Ground Tank	• Overflow • Shell failure/corrosion • Leaks from ancillary equipment • Coupling/uncoupling operations
Incinerator	• Spillage or other releases from waste handling or preparation activities • Spills due to mechanical failure

*In general, releases from underground storage tanks which store RCRA hazardous wastes are subject to Subtitle C corrective action. Releases from underground storage tanks which contain other "regulated substances" as defined in Subtitle I of RCRA will be subject to a different set of corrective action requirements which have not yet been promulgated.

TABLE 4-4. CAUSES OF DIRECT GROUND-WATER RELEASES*

Design Practices
Inadequate QA/QC procedures used during construction
Insufficient hydrogeologic investigations
Improper foundation preparation prior to liner system installation
Inadequate design of liner, leachate collection and leak detection systems
Operating Practices
Inadequate QA/QC procedures used during operation of SWMU

*Applicable to landfills, surface impoundments and waste piles.

Factors to consider when assessing the potential for direct releases to soils or ground water by subsurface leachate migration at particular types of units are discussed below.

Leaks in Tanks and Basins

POTWs may contain above or below ground tanks or in-ground basins. Tanks may be steel, fiberglass, or concrete. Basins are primarily steel or concrete and are distinguished from tanks by RCRA Subtitle C definitions; tanks are those units which do not depend on surrounding soils to provide structural support. In other words, raised above ground, the unit would support its weight plus that of the material it is designed to contain. The Subtitle C program assumes that tanks, because of the added structural support inherent in their design and construction, are less likely to leak. However, release mechanisms are the same for tanks and basins.

There are two principal causes of steel tank/basin failure:

- Corrosion reduces the thickness of the steel and results in holes or cracks.
- Improper construction or site preparation, open seams, or other flaws result in a breach in the unit wall.

Because subsurface releases cannot be observed, release determinations must be made based on evaluation of design, construction, and operating practices. Operating records will indicate if regular testing of tank integrity or inspection of liners or walls is conducted at the facility. This information will identify units that have had releases, the causes of failures, and the frequency of failure.

Identified releases must be evaluated to determine the potential effects and the need for further study or action. The causes of release and the frequency of failure can be used to identify the potential for additional release at that unit and other units. For example, if a concrete basin released wastewater through cracks that developed in the base because of settling, or if a steel tank corroded because the local soils had a high conductivity, then other concrete basins and steel tanks are susceptible to release for these same reasons. Other facilities in the area, or local and state environmental officials, also can be contacted for information regarding unit failure mechanisms and frequency. As is the case with other units, the data review process should focus on identifying actual releases or combinations of factors which could combine to increase the potential for releases to occur.

In general, the following factors increase the potential for releases from tanks or basins to occur:

- Single-walled steel tanks are more likely to release than are double-walled steel units.
- Unprotected steel units are more likely to release than protected ones.
- The frequency of below ground tank or basin failure increases with age.
- The frequency of underground tank failure increases as conductivity of the surrounding soils increases.
- Steel units in contact with ground water are more likely to release than units above the water table.
- The frequency of leaks from concrete units increases with the size of the unit.
- Poor operating and maintenance procedures increase the potential for failure.

<u>Leachate from Unlined Impoundments, Ponds, and Lagoons</u>

Unlined units are presumed to release constituents to the unsaturated zone and possibly to ground water. Therefore, making a release determination is a matter of identifying the presence and type of a base liner at a unit. Design and construction records will identify materials used and specifications of any bottom liner. A visual inspection will confirm unit construction information, and indicate the level of upkeep and maintenance given the unit. In general, units excavated into native soils that are not prepared will have a higher rate of exfiltration and an increased potential for affecting ground water than will units with compacted clay or soil bases.

Some units may be constructed with engineered features that reduce or eliminate the potential for release. These features act to remove leachate and prevent release, and provide actual evidence a unit is not releasing constituents. These features include:

- Leachate collection systems over a primary soil base.
- Leachate collection systems between a primary and secondary soil base.
- Leachate collection/leak detection systems under soil bases.

The first system acts to remove liquids as they are generated and begin to migrate through the soil liner. These units will be found primarily at landfills or drying/dewatering beds. The second system serves as a detection system warning the operator that a primary base has failed, and acts to remove the liquids as they accumulate and before they can move through the secondary base. The final system acts as does the second system, but the lack of an underliner to reduce the rate of infiltration reduces the effectiveness of the system. The latter two systems are used at landfills and impoundments, ponds and lagoons. In general, the potential for release is negligible at those units where leachate is removed as it is generated, or where leak detection systems provide evidence releases are not occurring. Investigators must determine that these engineered features are properly designed and maintained before assigning a unit a low release potential.

Leachate/Runoff from Sludge and Ash Processing or Disposal Units

Sludge and ash processing, use or disposal units include tanks, piles, lagoons, incinerators, and landfills. Previous discussions on releases from tanks and basins should be referred to when these type units are being evaluated. This section will discuss leachate/runoff releases from sludge/ash piles and landfills.

The potential for release from these units depends on the quantity of leachate generated and the adequacy of containment. Units that generate large quantities of leachate are more likely to have releases through liners than are units generating little leachate. Large quantities of leachate ponded at the base of a unit can create large hydrostatic pressures that will result in a break-out unless containment is specifically designed to handle the pressures. Units where daily cover, run-on diversion structures or caps are in place to divert infiltration will generate less leachate by reducing the quantity of water that will enter the unit and contact wastes. In general, landfills that manage ash exclusively will generate less leachate, and the primary source of leachate will be incident precipitation. Sludge units, and mixed ash and sludge units, will generate larger quantities of leachate because of the increased liquid content of sludges.

The extent of containment at sludge/ash processing units will also affect the potential for releases to occur. Unlined units are presumed to leak unless engineered features that eliminate the potential for release are in place (refer to Section 4.2.2.2). Synthetic liners and concrete bases, if designed and constructed properly and assuming the unit is well operated and maintained, will have a low potential for release. However, the potential for releases to occur, either because of seal splitting or liner rupture, or because of cracks developing in concrete, increases with age. Release potential also increases with unit size, because the potential for improper site preparation or liner or base construction increases.

In assessing a release from sludge processing units, design, construction and operating records will identify waste types handled; containment design, type, and construction; and operating practices. A visual inspection will confirm unit construction and operation information, and will indicate the level of upkeep and maintenance for the unit. Evidence of leachate generation such as ponded liquids within a fill area, or leachate seeps and breakouts along the base and sides of the unit, also will be collected during the VSI. At active units, bases or liners usually will not be visible during the VSI, so design, construction and operating information must be used to estimate the likelihood of liner or base failure.

In general, the following factors increase the potential for releases from sludge/ash processing units:

- Unlined units are presumed to release constituents via infiltration.
- The potential for releasing constituents through the liner increases as the quantity of leachate generated increases; sludge units without precipitation control/diversion structures will generate the largest volumes of leachate.
- The potential for release of leachate increases with unit age and size.
- Units where leak detection systems have confirmed leaks through primary or secondary units will have a higher potential for release then will units where systems have not detected a breakout.
- Poor operating and maintenance procedures increase the potential for liner failure.

Leaks in Sewer Pipes and Other Equipment

Underground pipeline leaks throughout the U.S. have been well documented. However, obtaining information to determine the potential for underground pipes or conduits to leak is difficult. In general, the potential for exfiltration from sewer pipes increases with age. During an RFA, there is little that can be done to evaluate pipeline leaks. However, if ground-water contamination is confirmed at a POTW, than leakage from pipes and other below-ground conduits should be investigated as a potential source.

4.1.3 Data Required to Assess Unit Characteristics Affecting Potential for Releases to Ground Water and Soil

In summary, the design, construction, and operation of a unit controls the potential for the unit to release hazardous constituents to ground water and soil. In assessing the potential for release, investigators should focus on the type, extent, and upkeep of containment features that are intended to prevent release. Unlined units or units without runoff/runon control or containment features are presumed to leak. Units where there is documented or visual evidence of a release also will have a greater potential to release. In other cases, the available unit information must be examined to identify possible release mechanisms and the potential for release.

Unit data that should be evaluated when assessing the potential for releases to ground water or soils include:

- Unit age and size.
- Design and construction records, including foundation/size preparation data.
- Containment design and construction data, including materials, used, extent, and calculations used in designing structures.
- Operational records and SOP manuals
- Maintenance and inspection schedules.
- Maintenance (both scheduled and nonscheduled) records.
- Release reports.
- Sampling results.

Specific unit information and its use in making release determinations depending on the possible release mechanisms and unit type are discussed in Sections 4.2.1 and 4.2.2.

4.2 WASTE CHARACTERISTICS AFFECTING POTENTIAL FOR RELEASE TO GROUND WATER AND SOIL

Waste constituent properties will affect the migration rates of constituents once released, the potential for intermedia (e.g. from soils to ground water) migration to occur, and sometimes, the potential for a release. Waste constituents managed at individual units will be identified during the preliminary review or visual site inspection phases of the RFA.

4.2.1 Waste/Constituent Properties Influencing Movement Through Soil and Ground Water

Constituents migrate in different forms and at different rates in soil and ground water, depending upon their properties. Releases of organic constituents will behave differently than will releases of metals. Therefore, a constituents mobility must be evaluated to determine its potential for dispersion and its tendency for transfer to other media. Also, constituent mobility and persistence will guide selection of sampling locations and parameters. Mobile, persistent constituents will migrate farther and remain in the environment longer than less mobile, easily degradable ones, and may be more likely to impact receptors than less mobile, readily degraded constituents.

Waste or constituent properties affecting release potential or transport through soils and ground water include:

- Waste physical state
- Constituent concentration in wastes or soils
- Solubility
- Octanol/water partition coefficient
- pH
- Persistence.

These properties are discussed below.

Waste Physical State

The physical state of a waste (i.e., whether it is solid, liquid, gas, or some solid-liquid mixture) influences the potential for constituent transport. The physical form of a waste affects the mobility of waste constituents in the environment and their potential to migrate between media. For example, spilled sludge-like, insoluble wastes will not move overland as quickly as liquid wastewater. Therefore, insoluble constituents in sludge are more likely to remain in the immediate vicinity of a unit, rather than percolating downward to ground water or flowing across the land surface to surface water. Constituents in liquid wastes are more likely to migrate to soil or ground water than are constituents in sludges.

Waste Constituent Concentration

The concentration of constituents in a waste usually does not influence the release potential at a unit. However, if there has been a release or there is potential for release based on a unit's physical characteristics (e.g., a possible leaky liner) then a waste with high constituent levels will be of greater concern than a waste containing low concentrations both because of the higher risk associated with exposure to higher concentrations, and because higher concentrations would migrate over larger distances. A waste with high levels of hazardous constituents released to soils will cause high levels of the same constituents to occur in the recipient soils.

Solubility

Water solubility is a chemical property that indicates the constituents affinity for water, and indicates the sorption of chemicals to soils. Highly water-soluble compounds tend to move rapidly through soil because they dissolve and move with water rather than adsorbing to soil particles. Insoluble compounds, therefore, will remain in the soil matrix and thus will accumulate in soils to a much greater extent than soluble compounds. Knowledge of chemical solubility can be very useful in determining the release and migration potentials at a particular site. If a compound is highly soluble, ground water will require further investigation.

Octanol/Water Partition Coefficient

The sorption equilibrium coefficient (K_d) is a quantitative expression of the mobility of organic constituents. K_d depends on the organic content of soils and the constituent-specific soil adsorption coefficient (K_{oc}). During the RFA, the inherent mobility of a constituent as measured by K_{oc} will be more useful because site specific information on soil organic content likely will not be available. However, few K_{oc} values have been developed for hazardous consitituents. Instead, the octanol-water partition coefficient (K_{ow}) can be used to approximate mobility. A large K_{ow} indicates that a constituent is likely to be relatively immobile (i.e., will not migrate far through soils), while a small K_{ow} indicates that a constituent is likely to be mobile.

Most K_{ow} values are expressed in log form. In general, constituents with a log K_{ow} of more than two should be considered relatively immobile, and likely will not migrate far through soils. K_{ow} values are provided in Appendix C.

pH

The pH of a waste may affect contaminant release and migration in two ways:

- It can alter the chemical form of acids and bases, metal salts and other metal complexes, thereby altering their water solubility and soil sorption properties and making them more or less mobile.

- It may alter the soil's chemical or physical makeup, leading to changes in sorptive capacity and permeability.

Therefore, obtaining data on the pH of unit-specific wastes can be very important because of this property's effect on other waste and soil characteristics. For example, a compound's affinity for soil particles may be either increased or decreased, thereby affecting the release and migration potential in local soils. This situation, however, is probably unlikely at most POTWs because the wastes handled are characteristically highly diluted, having relatively neutral pH values between 8.0 and 6.0. Outside this range, investigators should consider the possible effects of high or low pH on constituent mobility.

Persistence

The persistence of a compound in soils is an indirect function of its biodegradability, which is a compound's capability of being broken down into innocuous products by microorganisms. The greater a compound's biodegradability, the less persistent it is in the environment. Appendix C provides data regarding the biodegradation rates for constituents within POTW treatmemt systems. This data can be used as a general indicator of the rates compounds will degrade in the environment; compounds that are not very persistent in the POTW will tend not to be persistent in the environment. As an alternative, the Hazard Ranking System of the National Contingency Plan evaluates the persistence of compounds based on biodegradability, and can be used to evaluate the persistence of compounds. Metals are usually a good indicator of releases to soils because of their relatively low mobility and high persistence.

Relatively persistent compounds that are also insoluble in water will be expected to remain in the soil matrix for a much longer period of time than those compounds that biodegrade relatively rapidly. A release to soils of a waste containing persistent compounds is more likely to result in long term soil contamination than a release involving nonpersistent compounds.

4.2.2 Data Requirements for Assessment of Waste Characteristics

The assessment of waste characteristics for units examined during a POTW RFA requires certain types of data. These data are available from a number of sources, most of which have already been discussed in Chapter 3. The initial sources of information that should be examined are the facility files and records. Facility records will indicate waste constituents managed at the facility and waste analysis data, which will contain some data on waste characteristics (i.e. waste physical state, constituent concentrations, and pH). From the information available in facility files, data gaps can be identified for which other sources of information can then be researched. Chapter 3 should be referred to for sources of data on the other waste characteristics affecting potential release and migration.

4.3 ASSESSMENT OF MIGRATION POTENTIAL OF RELEASE TO GROUND WATER OR SOIL

The rate of constituent movement across land surface, through the unsaturated zone, and in ground water will determine the extent of the areas affected by a release. Water is the primary mechanism transporting constituents through the environment. Therefore, the flow rates and patterns of water at a site must be examined during the RFA evaluation estimating the extent of a release. Soil and hydrogeologic factors which usually can be evaluated during a RFA and which affect the migration potential of releases to ground water and soil are discussed below.

4.3.1 Soil Characteristics

Hazardous constituents in wastewaters and sludges are released to soils either as surface flows (e.g., in spills of wastewaters and sludges, or in sludges spread across land surface) or as infiltration (e.g., in wastewaters exfiltrating from basins, or in contamination precipitation percolating through the unsaturated zone). Assessing the extent of surficial releases is relatively straightforward. Surficial releases will follow drainage patterns, and any areas over which released wastes have moved will be affected. However, the concentrations found in soils will depend on the size of the release and initial concentrations, absorptive capacity of the soils, drainage patterns, distance from the release point, length of time since the release, and amount and type of degradation that has taken place. In general, site drainage patterns (i.e., topography) and size of the release control the extent of surface soils affected by a release.

Assessing the extent of release to subsurface soils is more difficult because the migration paths through the unsaturated zone cannot be directly observed, and because a number of factors influence the migration of hazardous constituents through the subsurface. Water movement through the unsaturated zone is very complicated. Water applied at the land surface or released to near-surface soils, as in the case of a leaking surface impoundment, will move depending on the relative strength of forces which act to pull liquids back towards land surface, bind water to soil particles, or draw water down towards the water table. Evaporation and evapotranspiration remove water from the portion of the unsaturated zone nearest land surface. Capillary forces hold water to soil particles and slow or prevent water movement. Gravity pulls water down through the unsaturated zone towards the water table. These forces act in varying strengths throughout the unsaturated zone, resulting in high variability in moisture content and rate of water movement throughout the zone.

Assessing the exact effects of the various factors influencing the rate of migration through the unsaturated zone is not required during an RFA. Information that can be used to estimate the relative magnitude of these various factors, thereby estimating the relative migration potential of a release through the zone are described below. In general, there is a net downward movement of moisture in the unsaturated zone in all but the most arid areas. Therefore, investigators should assume that releases to the unsaturated zone have a high potential to migrate and enter ground water. The factors discussed below can be used to modify this assessment.

Topography

Topography controls the drainage patterns at a site, and also can be used as a first order approximation of the configuration of the ground-water table. Therefore, topography will control the migration path of a surficial release, and also will indicate the general direction of ground-water flow (i.e., from areas of higher to lower elevations). The migration path of a surficial release will identify the zones of likely surface and subsurface soil contamination.

Published topographic maps showing small scale topography are available from the state or U.S. Geological surveys. In addition, design and construction records should include site-specific, larger scale maps showing topography before and after construction. In using topographic maps, the investigator should note the publication or revision date on the map, and note any changes made to the site since that date. These maps also can be used to identify potential migration paths, ground-water discharge areas (e.g., streams, rivers, lakes, or ponds), other receptors, or other potential sources which might affect sampling results or environmental quality.

Soil Classification and Surficial Geology

Soils at the site should already be classified according to the U.S. Department of Agriculture Soils Classification System (SCS). This system identifies soils based on physical and chemical properties of the soil profile. From a SCS series name, soil scientists can derive information on soil structure, climate, surface slope, and other factors relevant to contaminant transport.

Many surficial geology maps will describe the thickness, depth and texture of subsurface materials, the presence of saturated zones, and possibly other hydrogeologic features. Published surficial geology maps are available from the State and Federal geological surveys. However, soil boring information gathered during foundation testing conducted prior to construction will provide the best information on subsurface conditions at a site. In many instances, engineering test firms will construct subsurface cross sections from these borings, and these cross sections may indicate the depth to water, soil permeability, or other valuable information.

Hydraulic Conductivity

An essential physical property affecting contaminant mobility in soil is the hydraulic conductivity, also called the coefficient of permeability. This property indicates the ease with which liquids will flow through the soil, and is dependent on the porosity of the soil, grain size, degree of consolidation and cementation, and other soil factors, as well as on the viscosity of the liquid. Foundation testing records may indicate the permeability of soil samples collected prior to construction. If grain size distribution tests were conducted on cases, then permeability can be estimated using tables provided in many standard hydrogeology texts or reference books. If available data limited to borehole records and drillers descriptions, an approximate permeability can be determined again using tables in standard references.

Organic Carbon Content

The amount of natural organic material in a soil has a strong effect on retention of organic pollutants. The greater the fraction, by weight, of organic carbon (f_{oc}), the greater the adsorption of organics. Soil f_{oc}'s range from under 1 percent for a clean sand to over 50 percent for a peat soil. In general, the amount of natural organic material can be estimated using soil classification descriptions and standard soil science references.

4.3.2 Hydrogeologic Characteristics

Assessing the extent of releases in ground water requires information on ground-water flow rates and direction. In most cases, detailed hydrogeologic information will not be available at POTWs. Therefore, investigators will have to use available data and make assumptions to estimate the potential for and extent of a release.

Estimating the direction of ground-water flow at POTWs generally is simplified because of nearby surface water bodies such as streams or rivers. Most perennial streams and rivers represent discharge zones for ground water; ground water flows into and provides the base flow for the water body. In these cases, ground water under the POTW is moving towards the water body. However, during storms, the levels in streams and rivers can increase faster than the water table can rise, and water will flow into ground water. Eventually, the river levels will recede and normal ground-water flow conditions will return to normal. These scenarios are illustrated in Figure 4-1.

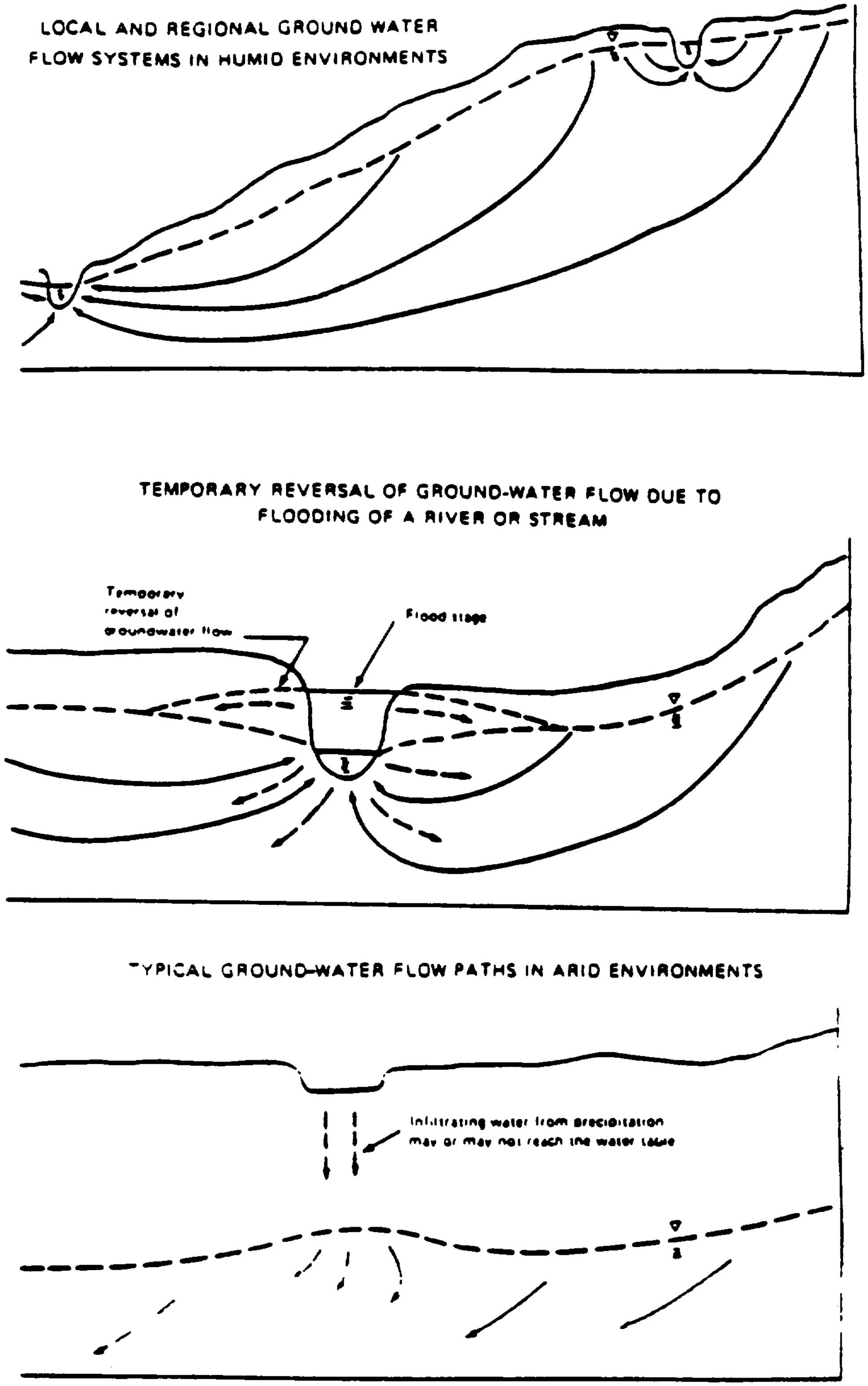

LOCAL AND REGIONAL GROUND WATER
FLOW SYSTEMS IN HUMID ENVIRONMENTS
TEMPORARY REVERSAL OF GROUND-WATER FLOW DUE TO
FLOODING OF A RIVER OR STREAM
Temporary reversal of groundwater flow
Flood stage
TYPICAL GROUND-WATER FLOW PATHS IN ARID ENVIRONMENTS
Infiltrating water from precipitation may or may not reach the water table

FIGURE 4-1

In arid regions, some water bodies may recharge ground water. This scenario also is illustrated on Figure 4-1. In these cases, identifying the direction of ground-water flow will be difficult and may require site-specific data.

Estimating the rate of ground-water flow requires site-specific data that likely will not be available at POTWs. In general, a release to ground water should be assumed to have flowed toward, and entered, nearby surface water bodies. Detailed discussions of ground-water flow theory are available in any hydrogeologic text as a reference. EPA's Guidance Document on Leachate Plume Management (EPA/540/2-85/004, Nov. 1985) contains a brief discussion on methods to assess the extent of a ground-water release. Information useful in assessing the rate and direction of ground-water flow are described below.

Subsurface Stratigraphy

In order to characterize the hydrologic setting of a site, site geology must be analyzed. Geologic site characterization consists of both a characterization of subsurface stratigraphy, which includes soil and unconsolidated sediment cover analysis. Bedrock features include features such as lithology and structure, as well as depositional information, indicating the sequence of events which resulted in the present subsurface configuration. In general, porous materials (e.g., sand, salt, and clay) will be the materials most often found at POTWs. Ground water in these media flow towards nearby discharge areas such as rivers and streams.

Direction of Flow

A thorough understanding of flow direction will require site-specific well data. In unconsolidated materials likely to be found under POTWs, the water table will approximate land surface topography; ground water will flow generally in the direction of decreasing topography and towards discharge areas.

Hydraulic Gradient

The hydraulic gradient is defined as the change in static head per unit distance in a given direction. The hydraulic gradient defines the direction of flow and may be expressed on maps of water level measurements taken around the site. Ground-water velocity is a function of hydraulic gradient. The hydraulic gradient can only be determined from wells located onsite.

Hydraulic Conductivity

A measure of the ability of an aquifer material to allow water to flow is the hydraulic conductivity (K). Hydraulic conductivity is the volume of water that will move per unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow. K has the dimensions of length divided by time (commonly expressed in feet/day or centimeters/second). Table 4-5 lists ranges of values for K for various geologic materials. This table can be used as a relative indicator of the rate of ground-water flow under a site. Water can flow faster through materials with higher hydraulic conductivities.

Depth to Ground Water

The depth to ground water is the distance from land surface to the water table. In general, the deeper the ground water, the longer contaminants will require to move through the unsaturated zone to ground water. Depth to water can be measured by wells located onsite. The potential for ground-water contamination increases as depth to ground water decreases.

4.3.3 Existing Soil and Ground-Water Monitoring Data

Soil and ground-water monitoring data likely will not be available for a POTW. However, other, nearby facilities required to monitor soils and ground water may provide information on soil and ground-water quality, and hydrogeologic conditions. These sources include subtitle C land treatment, storage or disposal facilities; municipal water utilities operating well fields; subtitle D landfills; and CERCLA sites. If soil or ground-water monitoring data is essential in completing an RFA, onsite borings or monitoring wells will be required. EPA's Technical Enforcement Guidance Document describes monitoring well installation and sampling procedures that should be followed.

TABLE 4-5. RANGE OF HYDRAULIC CONDUCTIVITY VALUES FOR VARIOUS GEOLOGIC MEDIA (After Freeze and Cherry, 1979)

Geologic Material	Hydraulic Conductivity cm/sec	gal/day/sq.ft.
Gravel	10^{-1} - 10^{2}	10^{4} - 10^{7}
Sand, well sorted	10^{-4} - 1	10 - 10^{5}
Silty sand	10^{-5} - 10^{-1}	1 - 10^{4}
Silt	10^{-7} - 10^{-3}	10^{-2} - 10^{2}
Clay, unweathered	10^{-10} - 10^{-7}	10^{-5} - 10^{-2}
Glacial till	10^{-10} - 10^{-4}	10^{-5} - 10
Carbonate rocks	10^{-7} - 1	10^{-3} - 10^{5}
Sandstones	10^{-8} - 10^{-4}	10^{-3} - 10
Shales	10^{-11} - 10^{-7}	10^{-6} - 10^{-2}
Crystalline rocks		
Highly fractured	10^{-6} - 1	10^{-1} - 10^{5}
Relative unfractured	10^{-12} - 10^{-8}	10^{-7} - 10^{-3}

1 gal/day/sq.ft. = 1.74×10^{-6} ft/day

1 gal/day/sq.ft. = 4.72×10^{-5} cm/sec

4.3.4 Data Requirements for Assessment of Migration Pathways for Releases to Ground Water or Soil

In general, the best information will be provided by site foundation soil borings, and nearby facilities or sources required to monitor ground-water quality. Local, State, and Federal sources will provide general area information, but probably will not supply necessary site-specific information.

4.4 SAMPLING TECHNIQUES FOR GROUND WATER AND SOIL

The following section discusses assessment of the need for sampling and the selection of sampling parameters, sampling locations, and appropriate sampling procedures for ground water, soil, and wastes.

4.4.1 Assessment of the Need for Sampling

An investigator likely will need sampling data in the following instances:

- Releases are suspected as probable at a unit, but the constituents managed in the unit are not known.
- Releases are suspected as possible, but the presence of constituents in the environment is not confirmed.
- Releases are observed or confirmed, but the constituents released or remaining are not known.

At a POTW, the investigator should assume that hazardous constituents entering the facility are present in all units. However, concentrations of constituents will vary from unit to unit.

Samples from possible migration paths may identify constituents and confirm that releases have occurred. This evidence usually will be sufficient to require a facility to conduct an RFI. These samples can also identify constituents remaining in soils from past releases, and indicate if the release is a potential problem. Finally, media samples will indicate the relative threat posed to other media and receptors. The decision on the need for sampling depends on site-specific conditions and the amount of information an investigator believes is necessary to confirm or deny a release has occurred and may be a possible hazard.

4.4.2 Selection of Sampling Parameters

The selection of sampling parameters will be based on the media to be sampled and the purpose of the sampling. In cases where a waste requires further characterization, an extensive array of parameters may be selected (i.e., Appendix VIII of 40 CFR Part 261). In other situations, a subset of the Appendix VIII parameters may be more appropriate. Analytical parameters selected for ground water and soil sampling will be based on the composition of wastes known to be managed in the unit under investigation, or known or suspected to have been released at the site. Depending upon how much information is available on the waste and/or release characteristics, sample parameters may include nonhazardous constituents which may indicate the presence of hazardous constituents, (i.e., indicator parameters) or specific hazardous constituents. Nonspecific indicator parameters include: pH, total organic carbon (TOC), total organic halogens (TOX), and specific conductance. Specific hazardous constituents may include any chemical constituent, including constituents such as toluene, benzene, or heavy metals.

Indicator parameters are used most often in cases where the composition of the wastes is unknown or sufficient detail on their constituents is unavailable. These types of parameters will simply indicate whether there has probably been a release. Indicator parameter values must be compared to background sample values in order to determine if there is a significant difference between background and the suspected release location. Indicators alone may not be sufficient to characterize a release, since the natural background variability of indicator parameters can be quite high.

Analyses for specific hazardous constituents should be used whenever possible because they are direct confirmation of a release. The selected parameters should be waste-specific subsets of hazardous constituents from 40 CFR Part 261 Appendix VIII. In developing a list of sampling parameters, the following factors should be considered:

- The nature of wastes to identify mobile and persistent constituents.
- The detection limits of parameters.

- The effects of soil and unsaturated zone (if present) characteristics on the mobility, stability, and persistence of the waste constituents.

Selected sampling parameters should be representative of constituents at least as mobile as the most hazardous constituent reasonably expected to be derived from a unit's waste. In addition, the constituents selected should include those persistent in the media being sampled.

4.4.3 Selection of Sampling Locations

The selection of sampling locations will be based on the location and accessibility of water wells at the facility, the location of ground-water seeps/springs, the visible extent of a release (i.e., soil staining; dead vegetation), and potential migration paths. In cases where constituents present in wastes must be identified, samples will be collected from specific waste management units at locations where high concentrations are expected.

Most POTWs do not have ground-water monitoring wells in place, and new wells usually will not be installed during an RFA. Therefore, the locations of well sampling points will depend on where drinking water and other production wells are located at and around the facility. If there has been either a confirmed release or there is reason to suspect there has been a release at a unit that may affect ground water, wells located downgradient from the point of release should be sampled. In addition, samples should be collected from locations upgradient from the suspected release point to obtain background ground-water quality data. The background data can then be used for comparison purposes. If wells are not available for sampling, then ground-water seeps or small springs, if available, can be sampled.

Soil sampling likely will be conducted much more frequently at POTW facilities than ground-water sampling. Location of soil sample collection points will be based on the unit location, the known or suspected extent of the release, the topography at the site, (i.e., where surface runoff drains) and the visible signs of release such as stained soil and lack of vegetation. The number of soil samples taken around a specific unit will depend on the size of the unit, the suspected volume of released substance, and the mobility of the hazardous constituents. The more extensive the release is believed to be, the more points should be sampled.

In addition, background soil samples should always be collected. A background area should be selected based on its similarity to the study area in terms of soil type, drainage, stratigraphic location, and other physical characteristics. Background soil samples should be taken from areas that are not near a suspected source of contamination. Selection and sampling of appropriate background areas is very important because confirmation of a release will be based on the comparison of the study area soil results and the background levels. Most often a single background sample is sufficient for one facility unless there is information available that indicates that background soil quality varies across the facility property. In these cases, multiple background samples may be necessary.

4.4.4 Appropriate Procedures for Ground-Water and Soil Sampling

Ground-water sampling will probably not be conducted at most POTW facilities. Therefore, a detailed discussion on ground-water sampling procedures is not provided here. The investigator is instead referred to procedures that are set forth for ground-water sampling in Test Methods for Evaluating Solid Waste-Physical Chemical Methods (SW-846), and the RCRA Ground-Water Monitoring Technical Guidance Document (OSWER-9950.1). The appropriate methods and techniques for ground-water sample collection, preservation, and handling during a POTW SV are presented in these two documents.

There are two basic types of soil sampling techniques that can be used in collecting soil and waste samples as part of a POTW sampling visit. A grab sample is defined as a single representative sample of a specific location at a given point in time. When a source is known to vary with location or distance from the source, grab samples collected at suitable locations and analyzed separately can indicate the extent of these variations. Composite samples are combinations of more than one sample collected at various sampling locations and/or different points in time. Primarily, analysis of composites yield average values and can, in certain instances, be used as an alternative to analyzing a number of individual grab samples and calculating an average value. It should be noted, however, that compositing can mask problems by diluting isolated concentrations of some hazardous constituents to below detection limits, or to below limits of concern.

Surface samples or shallow subsurface methods will often be used during a RFA. Deep drilling or coring usually will not be required during an RFA. Sampling in the upper soil zone can be accomplished with a variety of simple tools, including shovels, spatulas and soil punches. Contaminants that have moved downwards in the soil profile require tools such as tube samplers and augers. Depending on soil conditions manually operated tools are useful to 20 feet below land surface. Below this, hydraulically or mechanically driven equipment is needed. The RCRA Ground-Water Monitoring Technical Guidance Document (OSWER-9950.1) or the Test Methods for Evaluating Solid Waste-Physical Chemical Methods (SW-846) provide detailed descriptions of soil sampling procedures.

4.5 ASSESSMENT OF POTENTIAL EXPOSURE DUE TO RELEASES TO GROUND WATER OR SOIL

Many hazardous constituents have been identified or listed as hazardous due to their adverse effects in humans, other organisms, and/or the environment. These effects can be acute, chronic, or subchronic, depending on the level of exposure. Many substances also affect reproduction, or are suspected of being carcinogens. Constituents can also enter the food chain through plant uptake or ingestion by organisms. In various concentrations, constituents can kill vegetation and aquatic organisms, or poison a soil so that plants or crops will not grow. The type of effects and the concentration level that causes the effects depend on the specific constituent and the target receptor; similar organisms can have widely different reactions to the same compound.

Determining the risk to the target population of a given set of constituents requires a very complex, specialized study and should not be conducted during an RFA. Instead, an investigator should assume that there will be an adverse impact to any receptor exposed to a hazardous constituent released from a unit. In conducting the RFA, the inspector should focus on identifying the potential receptors along possible release paths, and assume they will be at some risk if exposed to the hazardous constituent. Suggestions for identifying potential receptors and possible effects are provided below.

4.5.1 Potential Effects on Human Health

The primary risk to human health from releases to soils and ground water is posed by ingestion of contaminated drinking water and contaminated crops and organisms. For the RFA, an investigator need only determine the potential for a release to reach drinking water supplies or enter the food chain. This potential depends primarily on the location of possible receptors. A greater potential for adverse effects exists when receptors are located near release points.

Drinking water wells likely will not be located downgradient of units at POTWs located along streams or rivers because, in most cases, the direction of ground-water flow is towards the surface water and the only activities likely to be conducted between units and the river are related to the POTW. However, contaminated ground water is more likely to discharge to and affect surface waters. As a result, investigators should assess the potential impacts of contaminated ground water discharged to surface waters (see Section 5.6).

In assessing the potential for a release to ground water to enter drinking water systems, an investigator first must determine the locations of water supply wells near the POTW. Wells downgradient of the POTW obviously are at risk, with those closest to the units at greatest risk. Wells that are close to the POTW but apparently upgradient (e.g., the POTW is located between the well and a river towards which ground water is flowing) also may be at some risk because:

- During floods or periods of high flow, the level of the river rises and can locally change water table elevations close to the river so that water flows away from the river; wells upgradient of the site may be at risk during these periods (refer to Section 4.5.2).

- Large wells or wellfields can locally alter ground-water flow conditions so that water is flowing from the surface water towards the well.

A third class of wells possibly at risk are those located downstream from a POTW that is releasing constituents to surface water either directly or in contaminated ground water. Many wells alongside rivers draw significant quantities of water from the river. The locations of drinking water wells around the POTWs, including wells upgradient, downgradient, and downstream, should be identified during the PR.

In assessing risk, investigators should assume that the nearest downgradient wells will be affected by a release to ground water, unless sufficient hydrogeological information is available to calculate flow rates and determine flow directions. The assumption that dilution and degradation will reduce the concentrations of released constituents to acceptable levels should not be made during the RFA. Dilution may not be a significant process affecting leachate plumes resulting from a continuous release (e.g., exfiltration from an impoundment) and while degradation may reduce concentrations, even low levels of certain compounds are hazardous. Downgradient wells located within a mile of a POTW that has potentially released hazardous constituents to ground water should be considered at risk. Their presence indicates that a high potential for a release affecting drinking water exists at the site.

Human health can also be affected if constituents enter the food chain. Direct application to farmlands of sludge containing hazardous constituents presents an immediate risk and may trigger an immediate response. Any surface release has the potential for entering the food chain and affecting human health. However, most human exposure routes other than by crop uptake are based on constituents first entering surface water or ground water. The potential for human health impacts caused by contamination of food supplies by constituents in surface waters are discussed in Section 5.6.1.

In general, the following scenarios pose a high potential for human health to be affected by releases to soil and ground water:

- Direct application of sludge to croplands or areas topographically upgradient from croplands.
- Drinking water wells are located within one-mile downgradient of units.
- Drinking water wells are located between POTWs and streams or rivers.
- Drinking water wells are located upgradient of a POTW but topography across the entire area is relatively flat, increasing the possibility of gradient reversal during high surface water flow conditions.

- Large wellfields are located near POTWs (NOTE: the owners of large wells or wellfields will have hydrogeologic test results available which usually will identify the zone from which the well draws water, which will indicate if the well draws water from under the POTW).

- Large wellfields are located alongside rivers and downstream of a POTW suspected of releasing constituents to ground water.

4.5.2 Potential Effects on the Environment

The potential effects of releases to soils or ground waters generally are caused by direct toxicity or accumulation of hazardous materials. High concentrations of constituents can have immediate and lasting effects on plants and animals, while low-levels can accumulate or be concentrated in the environment, or can slowly have an effect on populations. Populations most at risk are those generally recognized as particularly sensitive.

Wetlands generally are regarded as the most sensitive habitat. Contaminants released to soils can migrate in runoff and enter wetlands. Wetlands also can represent a recharge area for ground waters. Constituents entering a wetland, either in surface runoff or ground water, can accumulate in plants and animals that are a food source for birds. Documented losses of large predatory species (e.g., hawks, eagles) are examples of the type of effect an exposure to hazardous constituents can have.

In assessing potential effects of releases, investigators should identify downgradient receptor population areas such as wildlife refuges, sanctuaries, and parks which may be affected by a release.

4.5.3 Data Required for Assessment of Potential Exposures Due to Releases to Ground Water and Soils

The presence of possible receptors along migration paths controls the potential for exposure because of releases to ground water and soils. Migration paths are determined based on a number of factors as discussed in Section 4.3. The locations of the following receptors should be identified during the PR and VSI:

- Public drinking water supply wells.

- Private supply wells, including irrigation wells.
- Wetlands, protected environments, and parks.
- Farmlands.

Public health authorities can provide the locations of major water supply wells. The operators of the wells will be able to provide hydrogeologic data on the wells, indicate the recharge zone for the well, and also indicate the supply area served by the well. Houses and businesses in areas not supplied by municipal or public water supply systems should be assumed to have private wells. Local well drillers will also be able to indicate the area where private wells are located, although they may not be able to provide specific sites. Some counties and states have files (hard copy and computerized) that list the locations of known supply wells. However, these registries usually do not provide data on wells installed prior to the start of the registry, and should not be considered comprehensive.

State resource agencies and environmental protection departments will be able to provide the locations of wetlands, protected areas, and parks. Many of these areas are designated on topographic maps, and these maps also will indicate nondesignated receptor areas such as wetlands. Topographic maps will identify orchards, special farm areas and nondeveloped areas that could be used for farming. However, observations during the VSI will likely suffice in identifying farmlands possibly at risk from a release to soils. In areas of extensive irrigation, investigators should assume that irrigation is provided by ground water.

4.6 ASSESSMENT OF SUBSURFACE GAS RELEASES

Subsurface gas generation and migration from a waste management unit can result in human health and environmental hazards, particularly if gaseous materials, such as methane, go undetected for long periods of time and build up to levels that may result in an explosion and/or fire. The most common gas releases consist of methane and carbon monoxide, which are most often produced through the anaerobic decomposition of organics in landfills. Methane is of particular concern due to its explosive/flammable properties. Other hazardous gases of concern are dependent upon the types of wastes managed, the volatility of the waste constituents, temperature, and possible chemical interactions among wastes.

The potential for a subsurface gas release to occur at a POTW facility depends upon unit design and operation, waste characteristics, gas generation mechanisms, and gas migration barriers. Factors influencing the potential for the release of subsurface gases are discussed in the following subsections.

4.6.1 Unit Design and Operation

Waste management units with a high potential for the release of subsurface gas are those that are partially or entirely below grade, and receive sludges. Units that pose the greatest potential for subsurface gas migration include landfills, sites closed as landfills (e.g., surface impoundments or waste piles with impermeable covers), and underground storage tanks. Landfills and surface impoundments are the two types of units that may release gases at POTWs.

Gas generated in landfills can vent vertically to the atmosphere and/or migrate laterally through permeable soil. Closure of the landfill or periodic covering of cells with impermeable caps will impede the vertical movement of the gases, forcing them to migrate laterally from the unit. Gas migration laterally through the subsurface (e.g., through underground utility lines or sand lenses) may accumulate in structures on or off the site property. Therefore, it is important that the investigator know the type and design of each unit of concern including the presence of liners, the waste constituents placed in the unit and their gas generation potential, and subsurface conditions surrounding the unit prior to initiating a sampling program.

Gas generation and subsequent migration are likely to occur at units closed as landfills. Although units such as surface impoundments and waste piles may be closed as landfills, they generally produce less gas than landfills because they contain small quantities of decomposable and volatile wastes and are located at shallow depths. Closure of units using impermeable covers will increase the potential for lateral gas movement and accumulation in onsite and offsite structures.

4.6.2 Waste Characteristics

In assessing the potential for gas release at a unit, the investigator should determine whether wastes that can generate methane are present. Anaerobic decomposition of organic wastes generates large volumes of methane gas under the proper conditions. When methane is generated at a unit that is below grade and capped, there is high potential that the gas will accumulate under pressure and migrate from the unit, thereby posing a significant risk of explosion. Methane may also be mixed with other volatile hazardous constituents present in the unit depending on existing wastes, and may increase the potential hazard associated with the accumulating gas.

Biological sludges are the primary waste type of concern for methane gas generation. The volume of gas produced in a unit depends on the quantity and types of refuse present. Higher volumes of methane will be generated at units containing larger quantities of refuse. The volume of gas generated also depends upon the age of the unit and how long the waste has been in the unit. Methane generation will increase slowly after waste emplacement to a maximum generation rate which will slowly decline as the waste decomposes. The active lifetime for methane generation from units closed as landfills depends primarily upon the amount of precipitation infiltrating into the waste. Landfills in the arid Southwest will generally produce methane for 20-30 years, while landfills in the humid Southeast may only generate methane for 4-5 years after waste emplacement. Landfills with higher moisture content provide a more suitable environment for bacterial degradation.

The temperature of waste at the time of emplacement can also affect the methane generation rate. Wastes placed in landfills in the winter at temperatures below 10°C may not generate methane for up to 5 years, even in climates with warm summers, due to the insulating properties of the waste. The waste can remain at temperatures low enough to effectively inhibit bacterial decomposition for several years.

The types of wastes disposed in a unit will also affect the rate of methane generation. Rapid decomposable wastes will produce methane at high rates under the proper conditions. These wastes include those that would be found in landfills and surface impoundments of POTWs (i.e., organic sludges from wastewater treatment facilities). The high concentration of readily degradable organic compounds in this type of waste provides an ideal energy source for the anaerobic organisms that produce methane.

4.6.3 Gas Generation Mechanisms

There are three potential gas generation mechanisms: biological decomposition, chemical decomposition, and physical decomposition. The mechanism that will play a role at any particular waste management unit will depend upon the type of unit in question and the types of wastes managed in that unit. With regard to POTW facilities, biological decomposition will probably be most significant because the units in question will generally include landfills and surface impoundments containing organic wastes (e.g., sewage sludges).

Biological decomposition is significant in most landfills and units closed as landfills due to anaerobic microbial degradation of organic wastes such as sewage and treatment plant sludges. Generally, the amount of gas generated in a unit is directly proportional to the amount of organic matter present. Organic wastes such as sewage sludges decompose rapidly resulting in gas generation shortly after burial with high initial yields. Much slower decomposing organic wastes include paper, cardboard, wood, leather, some textiles, and several other organic components. Inorganic and inert materials such as plastics, man-made textiles, glass, ceramics, metals, ash and rock do not contribute to biological gas production. However, these types of wastes are not typically managed at POTW facilities.

Waste characteristics can increase or decrease the rate of biological decomposition. Factors that enhance anaerobic decomposition include: high moisture content, adequate buffer capacity and neutral pH, sufficient nutrients (nitrogen and phosphorus) and moderate temperatures. Characteristics that generally decrease biological decomposition include: the presence of acidic or basic pH, sulfur, soluble metals and other microbial toxicants. The investigator should review the waste characteristic information to estimate the rate of biological decomposition and subsequent gas generation.

Under anaerobic conditions organic wastes are primarily converted by microbial action into carbon dioxide and methane. Trace amounts of hydrogen, ammonia, aromatic hydrocarbons, halogenated organics and hydrogen sulfide are also present. With respect to subsurface migration, the gases of concern are methane (because of its explosive properties) and other volatile organics that may be present in amounts hazardous to human health or the environment.

4.6.4 Gas Migration Barriers

There are two types of gas migration barriers: natural barriers and engineered barriers. Natural barriers include surface water, ground water, and geologic formations. Engineered barriers include walls, onsite structures, and underground structures, caps, and liners.

Natural Barriers

Surface water, ground water, and saturated soils can slow down or prevent subsurface gas migration. Gases encountering these barriers will follow the pathway of least resistance, usually through unsaturated porous soil. Geologic barriers can also slow down or prevent subsurface gas migration. Soil permeability is perhaps the most important natural barrier to gas migration. Gravels and sands allow gas to migrate freely, while clayey gravels and sandy and organic clays impede its movement. The location of natural barriers should be used to establish the location of air monitoring and/or sampling points.

Engineered Barriers

Landfills and units closed as landfills may use caps and liners to prevent moisture infiltration and leachate percolation to ground water. Caps also can contribute to lateral gas movement when upward migration to the surface is restricted. Liners tend to impede lateral migration into the surrounding unsaturated soils. The owner/operator should evaluate cap/liner systems (type, age, location, etc.) to determine if gas migration could occur. Similar to liners, slurry walls are used to border landfill units and can contain lateral gas movement. With respect to underground tanks, caps and liners are not typically used. These tanks are often placed into soils with backfill during installation, followed by paving on the surface. Thus, any escaping gases from a leaking underground tank may migrate laterally along the path of least resistance adjacent to the units.

4.6.5 Assessment of Releases

During a sampling visit at a POTW facility, the investigator should examine available sources of information to identify evidence that subsurface gas has migrated from a unit. Most evidence of subsurface gas releases will usually be limited to reports of explosions at or near a unit. In some cases, there may be sampling information taken from vents placed near the units indicating the presence of methane in a unit. Under most circumstances, the investigator should assume that units generating methane have a high potential for gas migration and possible explosion.

5. ASSESSMENT OF POTW RELEASES TO SURFACE WATERS AND SEDIMENTS

This chapter covers the assessment of releases of hazardous constituents from a POTW to surface waters and sediments. Releases can occur by two pathways: direct discharge to surface waters through an outfall structure (pass through releases) and surface runoff from effluent and sludge management practices. The following sections of this chapter summarize:

- The attributes of treatment units that relate to pass through and surface releases to soils.
- The characteristics of constituents that affect potential for releases.
- Soil and topographic features that determine the potential for surface migration of releases to soils.
- Characteristics of water bodies affecting the fate and effects of released constituents.
- Sampling methods for surface waters and sediments.
- Humans and environmental risks posed by releases to surface waters and sediments.

5.1 APPLICABILITY OF CORRECTIVE ACTION REQUIREMENTS TO RELEASES TO SURFACE WATERS AND SEDIMENTS

EPA will exercise discretionary authorities in investigating releases to surface waters and sediments. Corrective action may apply to the following types of releases:

- NPDES permitted releases - including releases of treated or untreated POTW effluent discharged to surface waters or sediments.
- Nonpermitted offsite releases - including surface runoff of overflows, spills and leaks from POTW units to surface waters or sediments.
- Nonpermitted onsite releases - including releases to soils which pose a threat of release to surface waters and sediments.

Where releases are identified, they will be addressed, to the extent possible, by EPA or State water permitting officials.

5.2 UNIT CHARACTERISTICS AFFECTING POTENTIAL FOR RELEASES TO SURFACE WATERS

There are several potential sources of releases that may migrate to surface waters. These sources are listed in Table 5-1. The major characteristics of various treatment units leading to possible contamination of surface waters are discussed in the following subsections.

5.2.1 Unit Characteristics Influencing Pass Through to Receiving Waters

There are several characteristics of POTWs that can be used to assess whether releases to surface water or sediments have occurred or are occurring. Included in these characteristics are the type and level of treatment at a plant, the scope of constituents regulated by an NPDES permit, the record of compliance with a permit, the history of spills or [illegible]ets at the plant, and possible long term cumulative effects of discharges.

Type and Level of Treatment

The type and level of treatment at a plant strongly influences the possibility of pass through releases to a receiving water body. Primary treatment, which allows little opportunity for biodegradation or volatilization of influent constituents, will eliminate only the larger solids in a wastestream and allow pass through releases of many soluble, biodegradable, or volatile constituents that would normally be removed by other treatment. Insoluble constituents that are less dense than water may also pass through. If records of industrial discharges to the plant indicate the presence of significant loading of these constituents to a primary treatment plan, this fact should be considered when determining what further action is required.

Secondary or tertiary treatment of a POTW will significantly reduce the potential for release of all chemicals to surface waters. However, it should be remembered that even efficient POTWs usually pass through a few percent of many constituents, and large influent loads may still result in significant releases to receiving waters.

In evaluating the potential for release by pass through, the lack of strong aeration in secondary and tertiary units will lead to increases in volatile constituents in the effluent. Normally, 10 percent or less of

TABLE 5-1. RELEASE MECHANISMS FOR SURFACE WATER RELEASES

Unit Type	Release Mechanism
POTW	• Pass through releases at discharge point
Surface Impoundment	• Releases from overtopping
	• Seepage
Landfill	• Migration of runoff outside the unit's runoff collection and containment system
	• Migration of spills and other releases outside the containment area from loading and unloading operations
	• Seepage through dikes to surrounding areas (e.g., soils, pavement, etc.)
Waste Pile	• Migration of runoff outside the unit's runoff collection and containment system
	• Migration of spills and other releases outside the containment area from loading and unloading operations
Land Treatment Unit	• Migration of runoff outside the containment area
Above-ground Tank	• Releases from overflow
	• Leaks through tank shell
	• Spills from coupling/uncoupling operations
In-ground Tank	• Releases from overflow
	• Spills from coupling/uncoupling operations
Incinerator	• Spills or other releases from waste handling/preparation activities
	• Spills due to mechnical failure

*The two remaining solid waste management units; waste transfer stations, and waste recycling operations generally have mechanisms of release similar to tanks.

volatile organic chemicals in the influent will be found in the effluent, but without aeration, this level can increase to 20 or 30 percent, a substantial increase in pass through loadings.

Scope of Parameters Regulated in NPDES Permits

NPDES permits normally cover only a small percentage of the constituents likely to be released by POTWs. The extent to which individual constituents not specifically listed in a permit are released to surface waters and sediments can be estimated by (1) identifying those industries discharging to the POTW by dedicated pipeline, truck, rail or sewers and developing a list of constituents and their loadings from industry data, or (2) developing a list of constituents and their loadings from influent records. Estimation of loadings reductions due to treatment will then produce estimated effluent loadings.

Record of Compliance with NPDES Permit

NPDES monitoring records are used for evaluating the operating performance of the POTW. A comparison of measured effluent loadings with permitted loadings indicates the level of compliance achieved by normal plant operations. Frequent or substantial noncompliance with permit conditions implies poor operating standards that usually result in high levels of releases of constituents both listed and not listed in the permit.

Spills/Upsets at the POTW

A history of spills or upsets at the POTW indicates influent slug loads that are either too large in volume to be handled by the treatment units or have much higher concentrations of toxic materials than normal. In the first case, releases to surface waters by surface runoff or releases to ground water may have occurred. Since the treatment process will have been by-passed for these releases, the level of hazard of the releases will be high. In the second case, the level of treatment will be significantly reduced for the period of the upset, allowing probable releases greater than the permitted level. Occasional small spills or upsets are not usually significant; frequent spills or upsets are a basis for concern.

Pre-NPDES or Nonpermitted Discharges

Historical records of industries sending effluents to the POTW may indicate that industries once discharging to the plant are not now doing so. If the discharges ceased prior to issuance of an NPDES permit, permits and monitoring records will fail to indicate the possibility of significant past releases. It is thus necessary to estimate the POTW effluent loadings based on inputs from such industries to determine if there were significant discharges of constituents that have accumulated in sediments or biota. If significant discharges were probable, further action may be required.

Characteristics of SWMUs Leading to Runoff

Movement by surface runoff will be potentially significant if land application of effluent or sludge is common practice at the POTW. Under both circumstances, special attention should be given to possible releases unless investigation of the land application area indicates that it is not possible for the effluent or runoff from the sludge to enter adjacent waters. Land application areas at a lower topographic level than nearby surface waters, or elevated land between the land application area and surface waters both preclude runoff.

Long Term, Cumulative Effects of Discharges

POTW removal efficiencies are high for many constituents -- between 80 and 95 percent. However, even when 5 to 20 percent of a constituent passes through a POTW to the discharge point, significant accumulation of constituents can occur in sediments and biota over several years of discharge. Constituents with low aqueous solubility and high particle affinity (high K_{ow}) are of particular concern. If constituents with these characteristics appear in the effluent, it is desirable to obtain further information on the ultimate fate of these constituents.

5.2.2 Unit Characteristics Influencing Movement Through Surface Runoff

The major potential source of surface runoff releases will be through direct runoff of land applied effluent, overflow of basins or tanks, runoff from sludge storage, leaks from above ground tanks or basins, or faulty temporary connections between treatment or storage units. Except for runoff from sludge storage facilities, releases near the influent end of the treatment process are likely to have greater adverse effects than releases from the effluent end. Treatment will reduce the level of hazardous constituents as the wastestream passes through the POTW. Emphasis in the RFA should therefore be placed on potential for releases at the influent end and around sludge storage locations.

Rainfall runoff from sludge storage facilities is a major source of nonpass through release to surface waters and is particularly important when above ground uncontained storage is used. While a bed liner may protect ground water, it is not likely to protect surface waters. Stains leading away from sludge storage or drying units give strong indication of releases from these units and is a basis for further investigation.

Major Characteristics of SWMUs Leading to Overflows

The propensity for overflow of tanks and basins is related to the ability of the POTW to regulate flow through the treatment process. Inadequate storage volumes in primary clarifiers combined with a lack of facilities to re-route influents during peak flows will increase the likelihood of a release. Combined sewage and storm water influent will also raise the magnitude of peak flows, increasing the probability of occurrence of overflows.

Evidence of previous overflows and the evaluation of the possibility of overflows is obtained by visual inspection of treatment units and their surroundings. High water levels in the units during periods of low influent volumes may indicate a high potential for overflow. Similarly, water marks on the tanks or basins close to the top of a unit indicate prior near overflow conditions. Scour channels adjacent to tanks, or stains or watermarks on the outside of tanks, basins or the surrounding area are prima facie evidence of previous overflows. Given a high probability of overflow or evidence of actual overflows, it is necessary to estimate the extent and effect of the release.

Characteristics of SWMUs Leading to Leakage or Spills

In contrast to overflows, leaks are not likely to give rise to significant releases of constituents to surface waters. Leaks normally imply small volumes of waste, and often will have greater impact on ground water than on surface water. Nonetheless, above ground tanks or treatment units should be inspected for cracks, particularly cracks associated with stains or water marks on the tank or the ground surrounding the tank. Spills arise through loose or worn fitting between transporting vehicles and storage tanks, if any. In addition, valves used for rerouting waste streams may be worn and cause spillage in certain position.

5.3 WASTE/CONSTITUENT CHARACTERISTICS AFFECTING POTENTIAL FOR RELEASE TO SURFACE WATERS OR SEDIMENTS

Certain characteristics of constituents will increase the probability that a material will reach or be found in surface waters or sediments and thus require assessment in an RFA. One group of chemicals is likely to pass through the treatment process unchanged and be released through discharge. A second group is likely to be released by surface runoff after rainfall or in the event of spills or leaks. A third group will be accumulated within sediments or biota so that substantial concentrations can be attained over time, even with small rates of release.

5.3.1 Waste/Constituent Properties Affecting Pass Through to Receiving Waters

The first group of constituents are those that tend to pass through the POTW in significant quantities. These chemicals may appear at high concentrations in POTW effluent where removal rates due to volatilization, adsorption to sludge and biodegradation within POTW treatment units are limited. Chapter 3 provides a compilation of overall removal rates and principal fate pathways for selected Appendix VIII constituents treated at POTW facilities.

5.3.2 Waste/Constituent Properties Affecting Migration Through Surface Runoff

Compounds that pass through a POTW are also likely to be found in releases through surface runoff. However, since overflows or leaks can occur at any stage of the treatment process, biodegradability is less important in determining the likelihood of release. Similarly, volatility is less important because the short time required for a leak or overflow to reach surface waters will result in little constituent loss through volatilization. High solubility and low particle affinity increase the passage of constituents from the source of a leak or overflow to the receiving waters.

Constituents that normally become part of the sludge stream usually attach readily to particles and are not very soluble in water. Therefore, runoff from sludge units will contain a relatively high proportion of chemicals that would not normally be found in surface runoff.

5.3.3 Waste/Constituent Properties Affecting Accumulation in Sediments and Aquatic Species

Constituents that accumulate in sediments and aquatic biota have very different characteristics from the previous two groups. These constituents have high affinities and low solubility in water, and thus are likely to occur in sludge in much higher concentrations than in effluents. However, even though the effluent load of these constituents is generally only a few percent of the influent load, their behavior in the receiving water will cause their concentrations in sediments and biota to increase over time and thus become a source of environmental concern after several years of discharge.

5.3.4 Data Required on Waste Characteristics for Assessing Potential for Releases to Surface Waters and Sediments

The major characteristics of waste water constituents that determine their propensity for releases to surface waters and their partitioning between surface waters and sediments are solubility, lipophilicity, particle affinity, volatility, biodegradability, and density. Chapter 3 provides a compilation of numerical values for these properties for many hazardous constituents. The nature of each characteristic is described in the following paragraphs.

Solubility

Aqueous solubility of constituents indicates the amount of chemical that will dissolve in a given volume of water. The higher the value, the higher the probability that surface runoff of the constituent will be significant.

Lipophilicity

The tendency of a constituent to dissolve in a lipid-like material more than water. In a mixture of equal amounts of octanol and water, lipophilicity (K_{ow}) is the ratio of the concentration of the constituent in octanol to the concentration of the constituent in water at equilibrium. High values mean that the constituent is much more soluble in octanol than in water, indicating a greater particle affinity and a higher potential for bioaccumulation in aquatic organisms. High octanol/water partition coefficients are also generally associated with low water solubility.

Volatility

The tendency of a chemical to vaporize rather than remain in an aqueous phase. This tendency is measured by the partial pressure of the constituent in air divided by its solubility in water (Henry's law constant). The higher the value, the greater the amount of chemical that will "dissolve" in air -- the greater the volatility. Highly volatile compounds will generally be released to air, not to surface waters or sediments.

Biodegradability

The tendency of a chemical to be "destroyed" or modified by biological action. However, there are no chemical or physical properties of a constituent that can be measured to determine or predict biodegradability. While biodegradability can be measured in laboratory studies, few data are available for the range of compounds normally of concern. Appendix A presents data on POTW removal efficiencies for "acclimated" and "unacclimated" treatment systems. The difference in removal efficiency between these two system types is a measure of the biodegradability of the waste.

Density

The density of a constituent is significant when it has low solubility in water. Density will then determine whether a chemical will tend to float on the water's surface or sink to the bottom. Density is defined as the mass of a specific volume of material divided by the mass of the same volume of water. Values less than 1.0 indicate that the constituent will float on water; values greater than 1.0 indicate that the constituent will sink.

5.4 ASSESSMENT OF MIGRATION POTENTIAL OF RELEASES TO SURFACE WATERS AND SEDIMENTS

Constituents that are released onsite to the ground surface may reach surface waters directly through surface runoff or indirectly through ground water. This section covers only direct releases -- ground-water releases are considered in Chapter 4. However, once constituents reach surface waters, by pass through, surface runoff, or ground water, their fate will be determined by the type of water body. This section summarizes the factors affecting the potential of releases to the ground surface reaching surface waters and their fate in the receiving waters.

5.4.1 Migration Potential of Releases to Soils

If spills or overflow have occurred at the POTW, the migration pathway for the release will need to be determined. As already indicated, large volumes of releases through overflows are more likely to reach receiving waters than small volume leaks or spills. However, several factors will determine the likelihood of larger volumes of releases in affecting surface waters. These include general topography, the presence of containment dikes, soil types, and location of the POTW within a floodplain.

Continuous Downslope Gradient

Spills, leaks or overflow to the ground surface result in migration to one of three receptors -- to surface waters, to ground water or to the atmosphere. A continuous downslope gradient between a potential overflow or leak and receiving waters is the most significant indication that there is a potential for release to surface waters. The steeper the slope of the gradient, the more likely the release. However, if there is a light upslope gradient at any point between the point of release and receiving waters, only larger overflows are likely to reach surface waters.

Containment Structures

The presence and condition of containment dikes or berms will have a large impact on the potential for releases to the ground surface in reaching surface waters. Well designed and well maintained dikes will ensure minimal opportunity for release. Erosion around dikes, evidence of collapse caused by water contact, or large imperfections in the dike surface are evidence of both significant overflow, spillage or leakage as well as probable release to surface waters.

Soil Permeability

The permeability of soils determines the potential for migration to surface waters if a continuous downslope gradient exists. Highly permeable sandy soils will encourage migration to ground water, while relatively impermeable clays or paved surfaces will encourage migration to surface waters. Without a continuous downslope, impermeable soils or paved areas will encourage atmospheric releases of volatile organic compounds, while constituents with low vapor pressures will build up on the ground surface.

Vegetation

The presence of vegetation, particularly grasses and other densely distributed plants, will reduce the flow rate down any downslope gradient by increasing the frictional resistance to water flow. Plants may also accumulate hazardous materials as well as take up some of the water. The reduction in flow increases the probability of releases to ground water and the atmosphere, while water and hazardous material uptake reduces the potential for surface runoff. The absence of vegetation, particularly in natural channels, thus increases the probability of migration to surface waters.

POTW Elevation

The elevation of a POTW above the stage level of a rarely occurring flood will also affect the potential of migration of hazardous materials to surface waters. Obviously, if treatment units are below the flood stage level, there is significant risk of flooding of the entire POTW. With flooding, no other physical factors have any real significance. If flooding is not likely to occur because the POTW is located above the flood stage, the height of the POTW above a flood stage will be related to the depth to the water table. A small depth to water table will indicate that migration to ground water is unlikely because soils will be saturated, and that even if releases do reach ground water, they will also probably end up in surface waters (see Chapter 4).

5.4.2 Migration Potential of Constituents in Surface Waters and Sediments

The nature of the receiving water for pass through and surface runoff releases will determine the fate and potential effects of those releases. Each of the three major receiving water types, including lakes and impoundments, rivers and streams, and estuaries, have unique characteristics that influence the amount of dilution of the release, the distance that hazardous constituents will be carried away from the release point, and the location of any sedimentation of materials from pass through releases.

Lakes and Impoundments

Lakes and impoundments are typically quiescent bodies of water, with low current velocities determined primarily by wind strength and direction. As a result, movement of a discharge plume will depend on the direction and velocity of winds over the previous day or two. Onshore winds will tend to concentrate a plume along the shore, while alongshore or offshore winds will move the plume away from the discharge point, thus effectively diluting it.

Sedimentation of particulates and precipitation of insoluble constituents will generally occur in the immediate vicinity of any outfall structures. Greatest sediment concentrations are likely to be a short distance away from the discharge point in the opposite direction from the prevailing winds.

In deep lakes, temperature stratification (see Figure 5-1) will usually develop in spring or early summer. Discharge above this stratification (i.e., thermocline) may affect the extent of dispersion of settled particles. Lower density particles, mostly organic materials may settle to the thermocline and

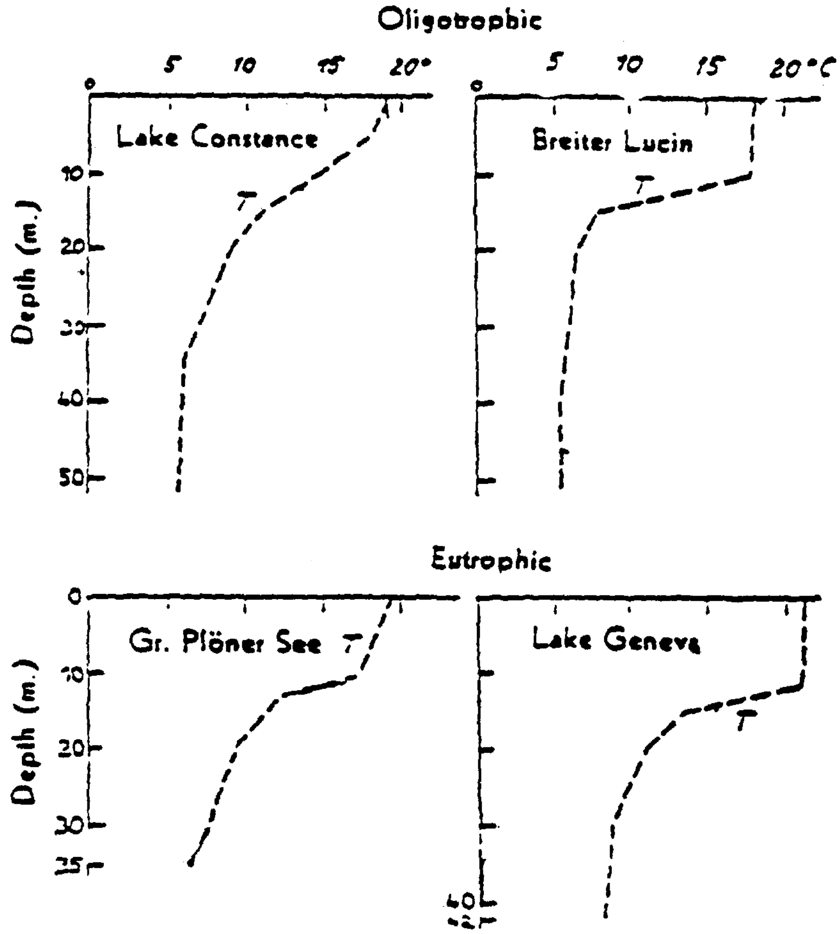


FIGURE 5.1. TYPICAL TEMPERATURE STRATIFICATION IN LAKES. (Source: RI Guidance)

be more dispersed than more dense particles. In addition, the rate of supply of oxygen to waters below the thermocline is very much reduced so that oxygen levels below the thermocline approach low levels, particularly in warmer climates, as summer progresses. Low oxygen levels may cause the remobilization of some heavy metals from the sediments, appreciably raising their concentrations in deeper waters.

Mixing of discharges with lake waters is generally poor unless aided by outfall diffusers. Location of the diffusers in deeper, colder water will cause the generally warmer, less dense effluent water to rise to the surface, increasing mixing and thus effectively diluting the effluent plume.

Rivers and Streams

Rivers and streams are generally characterized by water flowing down a topographic gradient. Since the rate of sedimentation is inversely proportional to the velocity of water flow, the rate of water flow will determine where sediments will accumulate. The steepness of the topographic gradient determines the velocity of water flow. Typically, however, gradients vary considerably in hilly areas, giving rise to sections that are fast flowing and sections that are slow. Coastal rivers and streams tend to be of more uniform gradients and have a more even distribution of current velocities. Such streams or rivers are often characterized by oxbows, which are isolated waters, caused by the sealing off of a previous bend in the river, and meanders where a river curves back and forth on itself, rather than a relatively straight course.

Effluent plumes and surface runoff usually mix well in rivers, although with large rivers, a distinct plume may form along the nearshore bank and perhaps be limited to the surface portion of the river. Surface plumes are typical when the effluent temperature is much higher than the temperature of the river. Within a few miles, plume distinctness usually disappears. However, hazardous constituents in the plume may be carried tens of miles downstream within one or two days, even if the plume cannot be distinguished from the rest of the river.

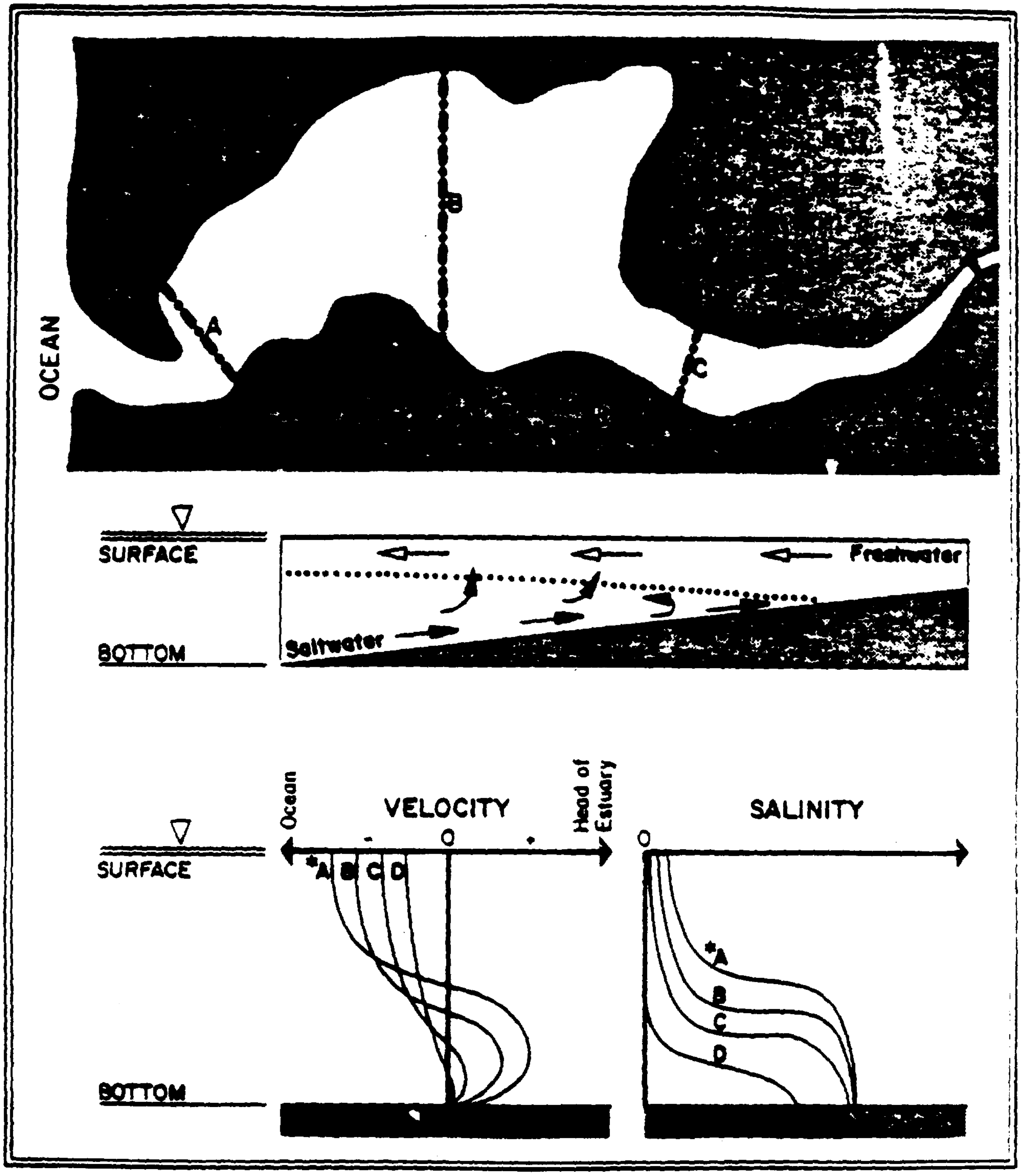
Because of the turbulence in most rivers and streams, sedimentation and precipitation of materials from pass through releases are likely to occur downstream from the discharge in areas where current velocities decrease. Generally, sedimentation will occur in locations where the river suddenly deepens or at the inside edge of a sharp bend. In deep, slow moving rivers, sedimentation will begin immediately, with greatest sediment concentrations several hundred yards downstream. During floods, however, the increased volumes of water flowing through the river channel may be sufficient to scour previously deposited sediments, in some cases relocating these sediments several miles downstream.

Estuaries

Estuaries are similar to rivers in their behavior, with two exceptions: currents may flow both upstream and downstream based on tidal forces, and higher salinity bottom waters may affect the location of deposited materials.

All estuaries have net downstream flow towards the ocean. The magnitude of the net flow is the same as the magnitude of the upstream freshwater input to the estuary. However, depending on the topographic gradient, size of the channel, freshwater flow, the size of the connection with the sea, and the magnitude of local tides, there may be small or large current reversals during a tidal cycle. These current reversals will affect the distribution of discharge plumes and the location of sedimentary particles. This also will affect the choice of sampling locations, especially where "upstream" and "downstream" sampling is desired.

Additionally, a vertical salinity gradient (i.e., halocline, see Figure 5-2) may exist within an estuary. The more saline, dense water will be overlaid by fresher water. The deeper water will tend to have a larger upstream current component than the shallower, fresher components. Direct discharge into the deeper water may cause the plume to have greater movement upstream than anticipated from an examination of surface currents. As well, because of higher salinity, insoluble constituents, particularly metals, will settle out much more rapidly than is the case in fresh waters. Counteracting these effects will be the tendency for the discharge, usually less saline and warmer than the estuary, to rise through the more dense, saline waters, mixing with it. Under certain circumstances, the resulting plume may not reach the



*Letters correspond to cross sections

FIGURE 5.2. TYPICAL SALINITY PROFILES IN A STRATIFIED ESTUARY. (Source: TetraTech, 1982)

surface, but may be transported as part of the mid-depth water. This results in lower net downstream transport than would be expected by examination of surface currents.

Floods are less likely to move deposited sediments in estuaries than in rivers. However, if salinities in bottom waters are the same as those in the surface waters during a flood, it may be assumed that some relocation of sediments has occurred.

5.4.3 Data Required for Assessment of Migration Pathways for Releases to Surface Waters and Sediments

Data for assessing the potential of releases to the ground surface to migrate to surface waters can be obtained from several sources. U.S. Geological Survey topographic maps will indicate general elevations of the POTW above nearby surface waters, and may have sufficient detail to determine natural channels from the POTW. However, plans of the POTW are more likely to be accurate for this purpose. POTW plans will also indicate the presence of any containment structures.

During construction, surveys of the POTW site will have been carried out. These surveys may have included soil types, depths to ground water and vegetation, all of which are useful in predicting the potential for runoff to surface waters. It should be remembered, however, that vegetation maps prior to construction may no longer be appropriate. In addition, the POTW may have been built on fill with materials substantially different from those listed in the survey.

U.S. Geological Survey stream flow records are sometimes useful for estimating volumes of water passing the POTW. If gauging stations are too far away for meaningful use, however, the linear rate of water movement can be determined by vertical gradients on topographic sheets. Pools and slower flowing sections of rivers can usually be identified on these maps.

For navigable lakes and estuaries there are often navigation charts that plot water depths. These charts can be used to estimate water flow by multiplying the cross sectional area of the channel as shown by the chart by the linear flow rate of the estuary. Areas of sediment deposition around tributary mouths can also be identified from these charts. Tributary deltas may be appropriate locations for sampling sediments.

5.5 SAMPLING TECHNIQUES FOR SURFACE WATERS AND SEDIMENTS

5.5.1 Assessing the Need for Additional Sampling

In the previous sections of this Chapter, guidelines have been given on when a RFI will be required. Additional sampling will not normally be required if those guidelines indicate a clear case for initiating RFI. On the other hand, if there is no clear evidence that a RFI is necessary or if the decision is likely to be controversial, additional sampling is advisable.

The purpose of sampling must be clear for the results to be meaningful, however. If access to desirable sampling locations is denied by safety or other reasons, using less desirable locations may yield equivocal results. In this case, sampling will serve no useful purpose. Only with careful selection of sampling parameters and locations will the resulting data assist in determining if a RFI is necessary.

5.5.2 Selection of Sampling Parameters

The great majority of samples to be taken during an RFA will be for chemical analysis. Biological analyses, when required, will usually be limited to species presence-absence comparisons of a rudimentary nature. The following paragraphs outline what constituents should be analyzed and where samples should be taken.

In making the selection of analytes, the investigator may wish to restrict costs by limiting sample analysis to a few indicator constituents most likely to be released. Usually, however, the cost of analyzing a few chemicals is not appreciably different from analyzing several -- the major cost is in sample preparation. Therefore, stringent limitation of parameters to be determined is not always cost effective. On the other hand, inorganic samples (e.g., metals such as lead or copper) require very different sample preparation from organic samples. Care should be taken if both are likely constituents of concern. Each group will have a different likelihood of being found at particular locations. Selection of the most likely parameters will save analytical costs, as long as inorganic and organic analyses are not mixed unless required for a single sample location.

In water samples, emphasis should be placed on soluble constituents, especially those that are nonvolatile and nonbiodegradable. Appreciable loads of these constituents in influent streams will probably be found in effluent streams.

For soil, sediment and biota samples, metals and lipophilic organic compounds are good choices. These are the constituents that are likely to attach to particles and be accumulated by biota. Sizeable influent loads of any of these constituents will maximize the chances of these constituents being found.

Samples of biota should usually be limited to obtaining specimens for chemical analysis (i.e., bioaccumulation in lipid tissues). Any biological analyses requiring taxonomic identification should be left to the RFI. However, the absence of species below discharges or a large reduction in the abundance of plants or animals below a suspected surface runoff or pass through release could indicate deleterious effects and may be sufficient cause for requiring further investigation.

5.5.3 Selection of Sampling Locations

Data on constituent concentrations may be required in one or more of the following: effluent, receiving water, soils, sediments, or biota. The appropriate choice of the sample analyte and location will maximize the utility of information returned for the sampling effort. The discussion that follows outlines locations where each of these media should be sampled.

The effluent can be sampled at any point in the treatment process. Chosen locations should coincide with points of suspected release. If any effluent is sampled, sampling locations should include POTW effluent immediately prior to discharge to the receiving waters. The effluent should be sampled for:

- Hazardous constituents known or suspected to be in the effluent but not covered by an NPDES permit.
- Hazardous constituents that have been discharged at levels in violation of applicable NPDES permit.
- Any soluble, nonbiodegradable, nonvolatile hazardous constituents present in the influent in significant quantities.

Areas where surface runoff enters receiving water are also areas where soils, sediments or plants are likely to have accumulated lipophilic compounds with releases. A comparison of constituent levels in soils or plants in the runoff channel with those in similar materials on nearby higher ground may provide evidence that runoff releases have occurred. A comparison of constituent levels in sediments a few meters downstream from the intersection with those upstream may provide similar evidence. However, allowance must be made in lakes and estuaries for uncertainties about upstream and downstream locations of samples. Often only a transect above and below the point of suspected release will provide adequate "proof" that a release has occurred. However, high concentrations near the intersection may be sufficient to warrant further investigation for lakes and estuaries where upstream-downstream comparisons are often difficult to interpret.

Sampling locations in receiving waters should be at or downstream of a discharge point. For water column samples in particular, it will be necessary to sample in the discharge plume. While one or two samples in the plume will not be adequate for comparing the effluent concentrations and the receiving water concentrations to determine dilution accurately, a rough estimate is useful for assessing potential impacts.

Locations for sampling sediments are downstream of a release point. The distance downstream will depend on the rate of flow of water and the depth of the water course. In deep lakes or impoundments, for example, sediments immediately adjacent to discharges are likely to have elevated levels of constituents. Fast flowing rivers -- 4 or 5 miles an hour or greater -- will keep most sedimentary material in suspension until a deeper, slower flowing section is reached. Because materials will settle or precipitate at the slower flowing section, samples should be taken at these locations. If a slower flowing section is not nearby, samples may be taken on the inside of a sharp bend in the river, also an area of reduced current speed.

When taking sediment samples, it is important to obtain samples of fine-grained material. Coarse material, sand or gravel, is usually well washed and provides few places for the attachment of chemicals with high particle affinity. Silts and clays provide proportionately more sites, and thus are likely to have much higher concentrations of the chemicals of concern. If samples yield only coarser materials, the investigator should attempt to find locations where finer sediments occur. Absence of constituents in these materials provides almost conclusive proof that past releases have not been significant.

When sampling biota for chemical constituents, a similar rationale applies. Animals living in finer sediments are exposed to higher levels of chemicals of concern, and also are more likely to feed primarily on materials in the sediments. These factors combine to increase bioaccumulation in species inhabiting fine sediments. Absence of significant concentrations of chemicals in these animals can be taken as evidence that previous high releases did not occur.

The sampling of biota for taxonomic identification is not usually recommended as part of an RFA. Under certain circumstances, however, the collection of plants and animals above and below a known or suspected release point can provide valuable information. If water depths are shallow, and there are not other obvious differences above and below the point of suspected release, differences in the abundance and kinds of bottom dwelling plants and animals can point to effects not easily documented in any other way.

5.5.4 Sampling Techniques for Surface Waters and Sediments

When sampling is necessary, it will take one of three forms: sampling of waters or effluents, sampling of sediments and biota, and sampling of soils.

Soil sampling is covered in Chapter 4 on ground water. The following paragraphs outline sampling in waters and sediments, each of which requires different techniques.

For all techniques, certain specific information must be recorded: the location of the sample, the date and time the sample was taken, the medium sampled (i.e., water, soil, sediment), the number of the sample container, and by whom the sample was taken. For water bodies, additional information is required on the depth of the sample, and other observations that may influence the interpretation of the data. Weather conditions, estimated rate of stream flow, and location in relation to a thermocline may be useful observations to record, depending on the type of water body.

Determination of sampling locations for later documentation is required. This can be accomplished by one of several methods, each of which is somewhat inaccurate. Triangulation on known landmarks is the easiest, and is carried out by measuring the compass direction from the sampling location to two known landmarks. This allows subsequent plotting of the intersection of the two lines on USGS topographic sheets, appropriate for many lakes, streams and rivers, or nautical charts for estuaries. Nautical charts are generally available from boating stores for most near-sea locations.

Water samples may be taken at the surface or at depth. Water at the surface is usually sampled by means of a sampling beaker dipped into the water, and subsequently emptied into a clean sample bottle. Care must be taken to prevent contamination of samples, especially if some samples are taken in the effluent and others are taken in the receiving water. It is usually good practice to work from the most dilute location to the most concentrated. It is also good practice to clean the sampling beaker between samples. When working with concentrated waste streams, using a beaker holder or wearing disposable plastic gloves will minimize the chances of being exposed to hazardous constituents. Receiving water samples are taken by a Kemmerer sampler, a device that can be lowered into the water to the desired depth and then closed by means of a brass weight (messenger) sliding down the attached wire. Less care need be taken to prevent contamination with the Kemmerer sampler, as it will usually be used only in receiving waters.

Sediment samples for chemical analysis should be taken by a drop core, a hollow tube that is dropped from the surface into the sediments, or pushed into sediments in shallow locations. In fine sediments, 4 or 5 cm of sediment will be sufficient to seal the core, and it can be retrieved. The cored material can be laid out on an impermeable surface, and the top 1 to 2 cm can be cut off and placed in a container for later analysis. Samples should be frozen.

In shallow waters, biota can be sampled with a dip net run through sediments. Large amounts of sediments can be washed out of the net by continuous dipping. Animals remaining can be identified by general type (worms, larvae, clams, etc.) and compared with animals from similar materials at other locations. Large differences are noteworthy, and should be part of the evidence that releases have occurred. If biota are being sampled for chemical analysis, the sample should be placed in a container and immediately refrigerated or frozen.

In deep waters, benthic animals will be sampled most effectively by a Peterson grab. This device is lowered into the water, and after it reaches bottom, it is retrieved. The process of bringing the grab back to the surface closes the jaws, entrapping the sample. On the surface, sediments need to be sieved through geological screens or their equivalent. Fine sediments are washed out, leaving larger sediments and biota. As with the dip net sampler, animals are placed in a container and refrigerated or frozen as soon as possible.

For deep water stations, a boat must be used since sampling from the shoreline will not be meaningful with discharges as little as 20 meters off shore. In rare circumstances, a bridge will be located where samples are appropriate, but this cannot be relied on. If the investigator does not have experience with boats, particularly under the conditions required for sampling, the investigator should not attempt sampling without experienced help.

Details on the use of the various samplers described above should be obtained from Characterization of Hazardous Waste Sites -- A Methods Manual, Volume II, Available Sampling Methods (EPA/600/4-84-076) before attempting their use in the field.

5.6 ASSESSMENT OF POTENTIAL EXPOSURE DUE TO RELEASES TO SURFACE WATERS AND SEDIMENTS

Potential exposures due to releases to surface waters and sediments are based on the transport of constituents of concern once they have reached the surface water body. In streams, rivers and estuaries, the transport logically follows water flow, with the distance traveled being dependent on the physical characteristics of the constituent. Soluble chemicals and those that are less dense than water will tend to travel at the same rate as the water. Insoluble, dense chemicals will tend to travel at much slower rates. In lakes and impoundments, the direction and velocity of transport will be much more variable, and may require a RFI to determine whether potential exposure exists.

5.6.1 Potential Effects on Human Health

The primary risks to human health from releases to surface waters are the contamination of drinking water supplies, the consumption of contaminated fish, and accidental ingestion of surface waters during water-based recreational activity. During an RFA, detailed analysis of these risks will not be possible -- it is only necessary to demonstrate that the potential for a significant risk exists. This potential is determined through an examination of the possibilities of releases reaching sensitive areas, thereby causing human impact.

The location of drinking water intakes in relation to POTW pass through releases is critical. Water can travel several miles in a day, and constituents in the receiving waters can have a long term, low level effect on humans if these constituents pass into drinking waters. The likelihood of significant effects is related to the amount of dilution of constituents in the effluent stream. A small effluent volume in relation to the volume of water passing the discharge structure indicates high dilution. Similarly, the input of additional tributaries below the discharge point will further increase dilution. In lakes and impoundments, additional complications arise in that the direction and velocity of currents are often poorly understood. While effluent plumes may not always be visible more than a few hundred yards from the discharge point, constituents in the water can be elevated over a very large area. Proximity of the water intake to the discharge point will be significant factor in increasing the potential for human health effects.

A second significant source of potential health hazards are created by the consumption of fish or shellfish contaminated with hazardous materials. Shellfish contamination is likely to occur in the immediate vicinity of the outfall, but fish, particularly migratory fish, can attain high concentrations of accumulated materials and pose risks to humans several miles distant. Appreciable accumulations of lipophilic compounds in sediments will increase the possibility of fish and shellfish contamination.

A third, relatively minor source of potential health hazards is exposure during primary contact recreation. Accidental ingestion of hazardous materials while swimming, water skiing or diving is the main exposure pathway, but skin exposure may be significant under unusual circumstances. Both of these potential hazards are likely to be minor, however, since primary contact recreation is generally avoided in areas of obvious pollution.

5.6.2 Potential Effects on the Environment

The potential environmental effects of releases to surface waters are generally caused by direct toxicity or accumulation of hazardous materials. High levels of exposure may lead to immediate and long-lasting changes to various species of plants or animals, and low levels of exposure can lead to a slow change to communities through accumulation. Since in many cases it will be difficult to obtain information on the changes to a particular environment over time, it is best to focus on specific target environments that are recognized as sensitive or unique in the general location of the POTW.

The most sensitive habitat is wetlands. Periodic flooding, or entrapment of waters containing hazardous materials leads to accumulation of constituents in the myriad small plants and animals that serve as a food source for birds, the unique fauna of most marshes and swamplands.

Other environments may be just as sensitive. Habitats of rare or endangered species of aquatic or terrestrial life that are exposed to hazardous materials will pose an additional threat to those species. Similarly, sensitive ecological habitats may be affected by releases to surface waters.

5.6.3 Data Required for Assessment of Potential Exposures Due to Releases to Surface Waters and Sediments

Local public health authorities will be able to provide the location of drinking water intakes. Additional information on problems experienced with contamination of water supplies will be available from the same source. A comparison between likely pass through releases from the POTW and the chemicals posing problems in the water supply may provide strong evidence that the POTW is a source of the constituents of concern.

Bans on fishing and shellfishing may have been placed on waters at or near the POTW. State resource agencies or local public health authorities are generally responsible for imposing these bans. It should be determined whether restrictions on taking fish or shellfish appear to be related to releases from the POTW.

Interviews with people living in the area of the POTW may lead to discovery of human health problems that have not been brought to the attention of public health authorities, or for which they may not have jurisdiction. Illnesses caused by contact with the water or through eating fish are indicators most likely to be related to surface water releases. Any strong indications that problems uncovered may be related to releases warrant further investigation. Similarly, local inhabitants will be aware of spills or major upsets at the POTW that may not be documented.

State resource agencies will be able to provide a variety of information required to assess the environmental effects of surface water releases. In particular, they will generally be aware of local wetlands, endangered species habitats, and bird and wildlife sanctuaries. In addition, any significant changes in populations of birds and fish, or declines in fish catches will probably be available from this source. If records are extensive enough, a case might be developed relating these changes to construction or operation of the POTW, and thus a direct link between releases and environmental effects.

In the absence of information on suspected direct impacts, the investigator may still make a case sufficient to warrant a RFI. If estimates of pass through releases, after dilution in the receiving waters, appear to be of sufficient magnitude to be transported and have an effect on any aspect of human health or the environment, further investigation will be necessary to determine the nature and extent of these effects.

6. ASSESSMENT OF RELEASES TO AIR

This chapter of the guidance document is designed to provide practical information for determining whether a release of hazardous constituents to air has occurred or is occurring at a POTW. Waste, unit, and environmental characteristics that may influence the potential for air releases are described in this section, as are possible information sources. This chapter also describes air sampling techniques and methods for assessing potential human exposures and environmental effects.

6.1 APPLICABILITY OF CORRECTIVE ACTION REQUIREMENTS TO RELEASES TO AIR

EPA will exercise discretionary authorities in investigating releases from POTW units to ambient air. Corrective action may apply to the following types of releases:

- Releases permitted under Clean Air Act (CAA) provisions - including emissions from sewage sludge incinerators regulated under CAA provisions, such as Section 111 New Source Performance Standards (NSPSs), Section 112 National Emission Standards for Hazardous Air Pollutants (NESHAPs), or State Implementation Plans (SIPs) designed to ensure compliance with National Ambient Air Quality Standards (NAAQSs).

- Nonpermitted releases - including volatilization of organic compounds from POTW unit processes or fugitive particulate emissions from POTW sludge handling operations.

Identified releases will be addressed, to the extent possible, by EPA or State air permitting officials.

6.2 UNIT CHARACTERISTICS AFFECTING POTENTIAL FOR RELEASES TO AIR

This section describes some of the POTW processes and practices that may influence the potential for releases to air. The discussion of volatilization concentrates on unit processes where most volatilization is thought to occur. The section on particulates discusses incinerator operation and control technology and sludge management practices.

6.2.1 Unit Characteristics Influencing Volatilization from Wastewater and Sludge Treatment Units

The design and operation of a POTW can significantly influence the volatilization that occurs at the plant. A major consideration is whether POTW unit processes (e.g., headworks, aeration basins) are open to the ambient air, because direct contact with the atmosphere promotes air releases. If processes are open to weather and the POTW receives significant quantities of VOCs in wastewater, some volatilization will certainly occur. To the extent that units are covered, volatilization is probably reduced. In some cases, however, covering unit processes may increase hazardous exposures for POTW workers by concentrating vapors inside buildings or structures.

Volatilization may be increased by natural forces such as temperature and wind. It may also be increased by POTW processes that generate aerosols (e.g., trickling filters) or agitate wastewater (e.g., screens, grit chambers). In both cases, the processes create physical conditions that increase volatilization. Aeration basins are probably the greatest source of volatilization. In aeration basins, air is blown up through the wastewater to support activated sludge treatment. For less volatile compounds, aeration helps achieve biodegradation for chemicals with longer residence times in the POTW. For volatile compounds, however, aeration results in movement of bubbles to the surface of the basin where organics are released to the ambient air.

When visiting the POTW site, the investigator should attempt to identify POTW processes that facilitate volatilization, especially those that involve mixing or moving wastewater. For instance, the influent flow rate may influence the degree of volatilization. Generally, the higher the flow rate of the influent, the greater the degree of volatilization brought about by wastewater turbulence.

The surface area of process units can also influence pollutant behavior. The larger the surface area of ponds, lagoons, or basins, the greater the opportunity for volatilization. Also, organics are more likely to volatilize from shallow basins than from deep basins. Certain sludge processing practices may also result in volatilization of organics. For example, heating sludge prior to incineration facilitates combustion, but may drive off organics that are not tightly bound to the sludge. The investigator should be alert for these situations in conducting the site investigation.

6.2.2 Unit Characteristics Influencing Emissions from Incinerators to Air

Most sewage sludge incinerators are either multiple-hearth or fluidized-bed incinerators. Each type of system reaches and maintains temperatures of 1,300 to 1,800° Fahrenheit to destroy organic constituents in sludge. Organic compounds are not destroyed completely when operating conditions are not optimal, such as during incinerator startup and shutdown. Under these conditions, emissions can contain toxic organics or intermediate products that may be more toxic than the original compounds. Also, material that is not combusted in the incinerator will contain inorganics, including heavy metals.

Emissions of inorganics from sewage sludge incinerators are influenced by the combustion temperature of the incinerator, and for fluidized-bed units, the air flow velocity through the bed. Test data indicate that emissions of some metals increase along with combustion temperature. This is particularly problematic for chromium. At high incineration temperatures, chromium, which is usually present in sewage sludge in its trivalent state, can be oxidized to hexavalent chromium, the more toxic valence state for that metal (Locating and Estimating Air Emissions from Chromium, EPA-450/4-84-007g, July 1984)). In addition, for chemicals with relatively low vapor pressures, such as arsenic and mercury, combustion at normal incinerator temperatures will cause them to volatilize. The challenge for incinerator operators is to operate at a temperature high enough to destroy the organics, but low enough to avoid volatilization of metals.

For fluidized-bed units, the velocity of air blown through the bed is used to control the method by which remaining inorganic sludge material is removed from the incinerator. At lower air velocities, the sludge adheres to the bed materials (usually sand), and they are removed from the bottom of the incinerator. Using higher velocities of air, the inorganic sludge material can be forced out along with exhaust gases. This practice, of course, increases particulate emissions.

A final physical characteristic affecting the potential for environmental release is the emission control technology system used on an incinerator. Typically, incinerators possess particulate control devices that range from wet scrubbers to very efficient electrostatic precipitators. Depending on the control technology used and the actual emissions of an incinerator, particulate emissions can be reduced by from 80 to 95 percent. Unfortunately, particulate control devices will not collect emissions of volatile organics that escape destruction in the incinerator, nor will they trap emissions of metals that have volatilized.

It should be noted that these same characteristics generally apply to co-incineration units that burn sludge and municipal refuse. Combustion temperature and chemical composition of the waste being incinerated are important to both sludge incinerators and co-incineration units in determining the likelihood and magnitude of potential air releases. In addition, the control technologies for both types of incinerators are the same.

6.2.3 Unit Characteristics Influencing Fugitive Particulate Emissions

This section describes conditions at a POTW that may lead to windblown particulate emissions. Particulates may be released because of simple erosion, or they may be emitted from sludge piles and sludge handling machinery operation as discussed below.

Wind Erosion

If dried sludge piles are located in an exposed area some wind erosion will occur. The geographic location of the piles, the meteorology of the surrounding area, (i.e., predominant wind direction and speed), and the presence or absence of manmade or natural obstacles that block the wind can each influence the potential volume of erosion.

Operational Activities

Operational activities associated with handling sludge include the methods by which sludge is moved from a POTW's solids processing facility to the sludge pile, the manner in which the waste is applied to the pile, and the methods used to remove the sludge from the pile for incineration or for off-site disposal. Each of these activities can influence the quantity of fugitive emissions. Emissions will be reduced if dust suppression or particulate control techniques are being used at the POTW.

A major factor that will influence emission rates is the moisture content of the sludge. If sludge is removed from the POTW site and incinerated or trucked to a landfill while moist, few fugitive emissions are likely to occur. Only sludge that is allowed to become relatively dry or that is dried in a POTW process poses a significant risk of fugitive emissions. Many use heat to drive off water before incineration. This may volatilize organic compounds and also increase the likelihood of fugitive windblown emissions.

6.2.4 Data Required for Assessment of Unit Characteristics Affecting Potential for Releases to Air

In gathering information about the POTW, the investigator should be alert for direct or indirect evidence that a release to air has taken place or is still occurring. Potential sources of information include:

- Air monitoring data collected by the POTW or an air pollution control agency, which may have been obtained under the requirements of an air quality permit.
- Visible emissions from the POTW.
- Nearby indications of air emissions, (e.g., evidence of particulate emissions).
- Air monitoring data collected under worker health and safety programs.
- Citizen complaints about releases that may include odors or observable pollutant releases, or complaints about headaches and nausea.

Sources of these data may include the POTW, State and local air pollution agencies, State and local Boards of Health, and Regional EPA offices.

During the site visit, the investigator should examine the area for visible signs of current emissions or evidence of past releases. The investigator should also be alert for unusual odors, particularly chemical smells, that may indicate air releases of volatile compounds. The following sections describe techniques for assessing unit characteristics and their likelihood for air releases.

Volatilization

Assessment of POTW processes that may cause volatilization should begin with a review of plant diagrams. The physical layout and processes of the plant should be carefully noted. One factor to assess is whether units are exposed to the atmosphere or covered. If processes are open, the likelihood of volatilization increases. Other factors that should be assessed include prevailing temperature and wind speed. Data can be checked for accuracy during a site visit.

Those processes that mix or agitate wastewater or sludge should be identified. A priority is to determine whether the POTW has aeration units, since they provide suitable conditions for volatilization. The investigator should also note the influent velocity at the headworks, which also presents favorable conditions for volatilization. If the POTW heats sludge, this practice should be identified since it is likely to drive off volatile organics. Finally, the surface area and depth of water bodies used to treat waste should be determined. Generally, the larger the surface area and more shallow the body of water, the greater the chance for volatilization to occur.

Incineration

The investigator should be careful to examine sludge monitoring data to determine concentrations of arsenic and mercury. These inorganics can be very difficult to control because of their tendency to volatilize during incineration. During the site visit, the investigator should be alert for visible signs of emissions from the incinerator.

A very important information source is the incinerator's air quality operating permit, which should contain information useful in assessing the potential for releases. Depending on the age of the incinerator and local air quality conditions, it may have to comply with Federal NSPS and NESHAPS, and

State or local regulations designed to comply with National Ambient Air Quality Standards. An incinerator's operating permit may contain all of these requirements.

A typical operating permit will provide some or all of the following information: (1) a detailed description of the incinerator, including destruction efficiency, control technology in use, and the technology's control efficiency; (2) regulatory requirements including emission limits for one or more pollutants and monitoring and recordkeeping requirements; and (3) physical operating requirements (e.g., combustion temperature, waste residence time in the incinerator). All of this information can be valuable in assessing the potential for a release.

The source's air quality file may contain summaries of enforcement visits. The relevant air pollution control agency should also have a compliance record for the incinerator. The investigator should examine this information to assess the unit's past performance in controlling emissions.

In some cases, monitoring data for the incinerator may be available. These data are particularly valuable, and can be used to determine whether emissions are occurring from the facility. Finally, for fluidized-bed incinerators, the investigator should determine how the inorganic materials are removed from the unit. If they they are not removed as solid waste, they are removed as air emissions along with exhaust gases.

Fugitive Particulate Emissions

The vulnerability of the POTW to wind erosion can be assessed by determining typical wind speed and direction, the extent to which the POTW is exposed to the wind, and the location and surroundings of the sludge piles. The nearest airport or National Weather Service Station may be able to provide local meteorological information, or the investigator can consult a climatological atlas. Again, the investigator should be alert for signs of visible particulate emissions.

Vehicular traffic within site boundaries should be observed. The volume and duration of traffic should be noted, as well as any reentrainment of dust that may be caused by movement of vehicles. Sludge handling operations within the facility should be observed to determine if these activities may be causing particulate emissions. The sludge itself should be examined to determine whether it is dry enough to release windblown particulates.

6.3 WASTE CHARACTERISTICS AFFECTING POTENTIAL FOR RELEASE TO AIR

The operation of POTWs presents two major opportunities for release of hazardous materials to the air. First, organic compounds can volatilize from POTW unit processes. Second, particulates and volatile metals can be emitted from sewage sludge disposal and management activities. The following sections discuss the characteristics of waste and constituents that affect whether there will be releases to air from volatilization or particulate emissions.

6.3.1 Waste/Constituent Properties Influencing Volatilization to Air

The three main factors influencing volatilization to air are the organic compounds present in wastewater, the concentration of volatile compounds in wastewater, and each compound's physical and chemical characteristics. The higher the concentration of a volatile chemical in wastewater, the greater the potential for an air release. As discussed in Chapter 3 of this guidance document, the POTW may have influent monitoring data that provide concentrations of individual compounds.

A given compound's physical and chemical properties have the greatest influence on a compound's tendency to volatilize. As a result, less volatile compounds that are present in high concentrations in wastewater may present a lower potential for release than compounds with higher volatility that are present in lower concentrations. The most important of these physical and chemical properties are described below.

Water Solubility

A compound's solubility in water is the maximum concentration at which that compound can dissolve in water at a given temperature. This value can be used to estimate the relative quantity of a compound that is dissolved in water and that which is undissolved or immiscible. In general, the higher the water solubility of a given compound, the lower the potential for volatilization to air. Also, compounds with higher solubility are generally more biodegradable in biological treatment systems. Low solubility may be associated with greater environmental persistence. Along with vapor pressure, solubility is used to estimate a compound's Henry's Law Constant (discussed below), a measure commonly used to describe a compound's tendency to volatilize.

Vapor Pressure

Vapor pressure is the pressure exerted by a compound as a vapor in equilibrium with its pure liquid state. In general, compounds with higher vapor pressures are more likely to volatilize than compounds with lower vapor pressures. It should be noted, however, that releases can occur even though the pollutant's vapor pressure is relatively low, particularly if wastewater is aerated.

Henry's Law Constant

The Henry's Law Constant for a given compound represents the equilibrium distribution of that compound between air and water at a constant temperature. Henry's Law Constant is used as a measure of the relative ease in which the compound may volatilize from aqueous solution.

Chemicals with high Henry's Law Constants are most likely to volatilize. In general, when a compound's Henry's Law Constant is less than 10^{-7} atm-m^3/mole, the compound will tend not to volatilize from water. As Henry's Law Constant values increase, the potential for volatilization increases. Compounds with values greater than 10^{-3}, on the other hand, are likely to volatilize from POTW treatment units. Henry's Law Constants for selected compounds are presented in Appendix C.

An important note is the effect of temperature on a compound's tendency to volatilize. In general, the greater the temperature, the higher a compound's vapor pressure. Investigators should consider this association in making plans for conducting site investigations.

6.3.2 Waste/Constituent Properties Influencing Emissions During Sludge Incineration

The waste characteristics discussed below, the concentration of metals and toxic organics in sewage sludge, are important because of their strong influence on the environmental significance of particulate matter emissions. These characteristics do not influence the likelihood of release, but rather the environmental threat or significance of a given release. Another waste characteristic, the particle size distribution of a release, will strongly affect both the dispersion and environmental consequence of a particulate matter release. This will be discussed more fully in Section 6.4 of this chapter.

Waste/constituent properties do not have a major influence on emissions from sludge incinerators. Rather, incinerator design, operation, and emission control systems determine the type and amount of constituents that will be released during incineration; these factors have been discussed in Section 6.2.2. Waste/constituent properties do determine the fate and distribution of constituents once they are released, and these factors are discussed in Section 6.4.

6.3.3 Waste/Constituent Properties Influencing Adsorption to Solids

Octanol/Water Partition Coefficient

The octanol/water partition coefficient measures the tendency of an organic compound to sorb to organic material in sewage sludge. Compounds with high coefficients are more likely to adsorb to solids in sewage sludge and are therefore less likely to volatilize compounds which absorb to sludge, however, are more likely to be release in incinerator emissions or fugitive particulate emissions from other sludge handling practices. Coefficients for selected compounds are presented in Appendix C.

6.3.4 Data Required for Assessment of Waste/Constituent Properties Affecting Potential for Release to Air

The most important data requirement is information on the quantities and chemical composition of the wastes that are received by the POTW. For volatile organic compounds or VOCs, a very important source of information is the data on industrial user discharges maintained by the POTW. These data may have been collected under an industrial user survey, or may have been obtained as a result of compliance monitoring. This information should help identify those organic compounds that are being discharged to the POTW, and their amounts. The POTW may also have influent monitoring data on organic compounds.

Once the investigator has examined the data on discharges to the POTW, the next step is to assess the physical/chemical characteristics of the chemicals discharged to the POTW. Appendix C provides Henry's Law Constants for a number of selected compounds. Using Henry's Law Constant values as a screening tool, the investigator may determine the likelihood of a compound volatilizing from the POTW into the ambient air.

A second major data source is sludge monitoring data. The sludge concentrations of metals and adsorbed organics are crucial in assessing the environmental significance of emissions of particulate matter. Elevated concentrations of toxic metals (e.g., chromium, cadmium, arsenic) in sludge warrant concern about potential human health risks, unless incinerator emissions are very well-controlled.

6.4 ASSESSMENT OF MIGRATION POTENTIAL OF RELEASES TO AIR

As mentioned earlier, environmental factors such as temperature and wind speed can influence the rate of volatilization. The rate at which compounds volatilize generally increases with temperature. Also, as solid wastes become warmer and drier and water evaporates, the likelihood of particulate emissions increases. In wastewater containing organics, the evaporation of water tends to increase the concentration of organics, which makes volatilization more likely. Higher wind speeds across the surface of a body of water tend to induce turbulence and therefore promote releases to the air. Finally, higher wind speed increases particulate matter entrainment.

The investigator is also interested in the pathway that a given release to air might take after leaving the POTW. The factors that influence the dispersion and destination of air releases are local meteorology, terrain, and the characteristics and spacing of nearby buildings and vegetation. The investigator should identify the prevailing wind direction and observe the local geography, (e.g., hills, tall buildings) as well as other factors that are likely to help determine the direction of movement of an air release. Once the investigator has identified the likely pathway, human populations living along that route can be identified, along with candidate sites for collecting upwind and downwind ambient samples. If citizens living in these areas have filed odor complaints or citizen suits about POTW releases, this may indicate that air releases have occurred in the past. The monitoring sites should be chosen where available information suggests that releases will occur.

For particulates, the particle size distribution of the release plays a major role in influencing dispersion. Large particles will not travel as far as smaller particles, and will tend to settle out of the release plume earlier. In addition, the smaller particles tend to be those causing greater risk to human health, because they penetrate the human lung. Larger particles are also less likely to be emitted as fugitive emissions. Particle size information may be available in a sludge incinerator's air quality permit.

6.5 SAMPLING TECHNIQUES

6.5.1 Assessment of the Need for Sampling

An investigator may choose to collect ambient samples after determining that there is a significant potential for air releases from a POTW. In some cases, sampling may not be feasible because of accessibility or problems in obtaining meaningful data. Monitoring data are not necessary to conclude that a release has occurred, but are desirable in those situations where monitoring is feasible.

6.5.2 Selection of Sampling Parameters

The investigator must first determine the pollutant or set of pollutants that appears to be of concern at the POTW. The number of pollutants chosen should be very limited, since it is necessary to demonstrate only that one pollutant is being released from the POTW. The investigator must also attempt to identify the points within the POTW that are most likely to be sources of air emissions. This information will be used to help determine the best sampling points.

6.5.3 Selection of Sampling Locations

After identifying the pollutants of concern and their emission source, the investigator must then determine the best location for collecting ambient samples. If emissions from the aeration basins appear to be most significant, then the location of the aeration basins should be where ambient samples are collected.

Sampling points will be selected based on unit type and location. To determine whether a release is occurring, the investigator should use simple upwind/downwind sampling. Samples should be collected upwind of the source, directly above the source, and downwind of the source. If more data are desired on whether the release is headed offsite, a fourth sampling site downwind of the site perimeter is necessary. Samples should be collected from about three to six feet above the ground.

6.5.4 Appropriate Sampling Procedures for Air

Air sampling techniques that are relevant to conducting RFAs are those that can quickly and economically indicate that VOCs or particulates are being released. If the waste constituent of concern is a VOC, portable organic vapor screening devices can be used to detect most organics in the air at the point where the sample is taken. The instruments do not detect some hydrocarbons, such as pesticides, polynuclear aromatics, and polychlorinated biphenyls. These compounds are typically present at very low concentrations, which inhibits their detection by such instruments.

Portable devices are useful to confirm the presence of gaseous or vapor phase organic compounds. They cannot yield accurate data on the specific compounds that may be present, nor their ambient concentration. They directly measure a total concentration for all organic compounds that register. The two most common screening devices are flame ionization detectors, such as the Century Organic Vapor Analyzer (OVA) 100 series and the AID Model 550, and photoionization detectors, such as the HNU Model PI-101 and the Photovac 10A10. These relatively simple instruments can quickly provide a rough measurement of the organic vapor concentration at a given point down to a few parts per million. If lower detection limits are desired, an onsite gas chromatograph can lower detection limits down to parts per billion.

Investigators should remember that photoionization detectors are typically calibrated only for benzene, and OVAs for methane. As a result, photoionization detectors are very sensitive in picking up low molecular weight aromatics such as benzene and toluene. For other organic compounds or mixtures of compounds, these instruments do not yield accurate measurements of ambient concentrations, but instead provide a general indication of the presence of volatile organics. The readings of these instruments can point to a need for further investigation.

Another disadvantage of these systems is their relative insensitivity. They can detect compounds in the parts per million range, when ambient concentrations in the parts per billion may be of concern for some compounds. Given this fact, these instruments are primarily useful in situations where high VOC concentrations are expected. They can be used to determine if a release is actually occurring at the headworks or aeration basins by sampling directly above them. They may be used to assess the relative release rates from different POTW processes. They may also be used to identify the most advantageous locations for siting more elaborate and expensive monitors. However, because of their high detection limits, these instruments cannot be used to demonstrate that a release is not occurring. The concentration of the constituents being released may simply be below the instrument's detection limit.

An alternative to these portable instruments is the use of detector tubes. These tubes are portable, do not require laboratory analysis, and measure specific compounds. They are small glass tubes that contain a sorbent material that has been treated to change color when a specific organic compound is present in the air. A hand-held pump draws the air sample into the tubes. The length of the color change indicates the concentration of the compound in the air sample, and can be read in parts per million using the scale on the tube.

Detector tubes yield a more accurate measurement of a specific compound, since the calibration problem of the portable instruments does not apply. Unfortunately, tubes are not available for all compounds, and they are relatively bulky since separate tubes must be carried for each of the compounds that may be of concern. In addition, their limit of detection is also in the parts per million range. For situations where one or two compounds are discharged to the plant in high concentrations and volatilization is expected, detector tubes may be the best choice. They also may be the best choice if the investigator needs to determine that a specific compound is being released.

For particulate matter, personal dust monitors are available. Similar to the screening instruments used for organics, they cannot identify specific compounds but can be used to assess whether particulates are being released.

6.6 ASSESSMENT OF POTENTIAL HUMAN HEALTH AND ENVIRONMENTAL EFFECTS DUE TO RELEASES TO AIR

There are two major categories of environmental effects of air releases from a POTW: 1) potential risk to human health, which includes both POTW workers and people living in surrounding neighborhoods; and 2) potential risk to the environment. The following sections contain guidance on assessing the potential effects of air releases.

6.6.1 Potential Effects on Human Health

Persons that may be exposed to an air release includes POTW workers, residents living in neighborhoods near the POTW, and individuals that might be in the vicinity of the POTW during the day (e.g., people working or going to school nearby). If hazardous releases occur, POTW workers are likely to be exposed to the highest concentrations. The investigator should identify the number of workers on the POTW site and their general location at the plant during a typical work day.

The investigator should also identify the location and number of persons living and working in residences and businesses nearest the POTW. The investigator should pay special attention to structures that are located along the migratory pathway that air releases are like to follow, based on predominant wind direction and the presence of natural or artificial wind barriers. Individuals living or working in these areas are most likely to be exposed to an air release. In identifying households or businesses that lie along the release pathway, the investigator should be sure to identify neighborhoods that could be exposed to both particulate emissions from sludge piles, sludge handling, and sewage sludge incineration and volatile emissions from various POTW processes.

Population density and distance from the source are the two factors that have the greatest effect on potential exposures. The highest potential for exposure occurs where a densely populated neighborhood is located immediately adjacent to a POTW. Situations where only a few individuals live very close to a POTW are still important, because concentrations near the POTW can be significant even though the number of people exposed may be relatively small.

The health effects for different potential exposure groups fall into two basic categories. The first includes the acute, threshold health effects on POTW workers and people living or working in the immediate neighborhood. These effects may be caused by brief exposures to toxic substances and are unlikely to affect communities located further away. Chronic health effects from continuous, long-term exposure to lower concentrations of toxic substances are an important concern for the individuals mentioned above and others who live or work in areas within the release pathway.

6.6.2 Potential Effects on the Environment

As mentioned earlier, the same emissions of particulates and VOCs that present risks to human health also threaten the environment. The environmental effects of air releases can include water quality degradation, buildup of pollutant levels in soils, materials damage, and damage to vegetation, including crops and forests. Aesthetic effects of air pollution can include visibility impairment and odor problems.

Surface water and soil contamination resulting from air pollution occurs because of atmospheric deposition. Pollutants are emitted to the ambient air and dispersion takes place. Many of these pollutants are subsequently deposited onto surface water or land. In assessing the potential for such effects, the investigator should identify nearby bodies of surface water that may be sites for atmospheric deposition, as well as land areas where soil contamination would be of concern, such as school playgrounds, garden plots, or pasture areas for livestock. Other sensitive environmental areas, such as wetlands or endangered species habitats, that are near the POTW should also be identified.

Many organic compounds also serve as precursors to the criteria pollutant ozone. Ozone causes damage to trees, crops, and decorative vegetation. The proximity of the POTW to crops, forests, and public parks should be noted. This information will give the investigator an indication of the potential threat to nearby vegetation.

APPENDIX A

PROFILE OF POLLUTANT FATE IN ACCLIMATED SECONDARY POTW*

Pollutant	Total Removal Rate (%)	Air Emissions Rate (%)	Sludge Partition Rate (%)	Biodegradation Rate (%)	Pass Through Rate (%)
Acenaphthylene	95	19	8.55	67.45	5
Acetaldehyde	95	0.47	9.5	85.02	5
Acetone	95	0.47	9.5	85.02	5
Acetonecyanohydrin	90	0	9	81	10
Acetophenone	80	0.4	8	71.6	20
Acetyl Chloride	95	0.47	9.5	85.02	5
Acrolein	95	0.47	9.5	85.02	5
Acrylamide	90	0	9	81	10
Acrylic Acid	90	0	9	81	10
Acrylonitrile	90	0.45	9	80.55	10
Aldicarb	90	0	9	81	10
Aldrin	90	0	33.3	56.7	10
Aniline	95	0	9.5	85.5	5
Anthracene	95	0	52.25	42.75	5
Antimony	60	0	60	0	40
Antu	90	0	9	81	10
Arsenic	50	0	50	0	50
Atrazine	90	0	7.2	82.8	10
Barium	90	0	90	0	10
Benzal Chloride	90	0	7.2	82.8	10
Benzene	95	23.75	1.9	69.35	5
p-Benzoquinone	95	0	7.6	87.4	5
Benzotrichloride	90	18	7.2	64.8	10
Benzyl Chloride	90	22.5	7.2	60.3	10
Bis-2-Chloroethoxy Methane	10	0	1	9	90
Bis-2-Chloroethyl Ether	90	0.45	9	80.55	10
Bis-2-Ethylhexyl Phthalate	90	0	65.7	24.3	10
Bromacil	90	0	9	81	10
Bromomethane	95	85.5	0	9.5	5
N-Butyl Alcohol	95	0	9.5	85.5	5

APPENDIX A

PROFILE OF POLLUTANT FATE IN ACCLIMATED SECONDARY POTW* (Continued)

Pollutant	Total Removal Rate (%)	Air Emissions Rate (%)	Sludge Partition Rate (%)	Biodegradation Rate (%)	Pass Through Rate (%)
Butyl Benzyl Phthalate	95	0	42.75	52.25	5
Cadmium	27	0	27	0	73
Captan	90	0	7.2	82.8	10
Carbofuran	90	0	9	81	10
Carbon Disulfide	95	76	0.95	18.05	5
Carbon Tetrachloride	90	72	11.7	6.3	10
Chlordane	90	9	33.3	47.7	10
Chlorobenzene	90	27	13.5	49.5	10
Chlorobenzilate	90	9	7.2	73.8	10
p-Chloro-m-Cresol	95	0	7.6	87.4	5
Chloroethane	95	76	0.95	18.05	5
Chloroform	90	63	1.8	25.2	10
Chloromethane	95	85.5	0.95	8.55	5
2-Chloronaphthalene	95	0.47	35.15	59.37	5
2-Chlorophenol	95	0	7.6	87.4	5
Chromium	70	0	70	0	30
Cresols	95	0	7.6	87.4	5
Cumene	95	38	3.8	53.2	5
Cyanide	60	0.3	57	2.7	40
Cyclohexane	95	9.5	3.8	81.7	5
Cyclohexanone	85	0	8.5	76.5	15
Diazinon	90	0	7.2	82.8	10
Dibromomethane	85	42.5	12.75	29.75	15
Di-N-Butyl Phthalate	90	0	19.8	70.2	10
1,2-Dichlorobenzene	90	45	31.5	13.5	10
1,3-Dichlorobenzene	90	45	2.7	42.3	10
1,4-Dichlorobenzene	90	45	22.5	22.5	10
Dichlorodifluoromethane	95	90.25	0	4.75	5
1,1-Dichloroethane	90	63	0	27	10
1,2-Dichloroethane	90	45	4.5	40.5	10

APPENDIX A

PROFILE OF POLLUTANT FATE IN ACCLIMATED SECONDARY POTW* (Continued)

Pollutant	Total Removal Rate (%)	Air Emissions Rate (%)	Sludge Partition Rate (%)	Biodegradation Rate (%)	Pass Through Rate (%)
1,1-Dichloroethylene	95	76	0	19	5
2,4-D	90	0	7.2	82.8	10
2,4-DB	90	0	7.2	82.8	10
2,4-Dichlorophenol	95	0	7.6	87.4	5
1,2-Dichloropropane	90	45	0	45	10
Dichloropropanol	90	9	9	72	10
Dichlorvos	90	0	9	81	10
Dicofol	90	45	8.1	36.9	10
Diethyl Phthalate	90	0	0.9	89.1	10
3,3-Dimethoxy Benzidine	80	0	8	72	20
Dimethylamine	95	0.47	9.5	85.02	5
2,4-Dimethyl Phenol	95	0	6	87.4	5
Dimethyl Phthalate	95	0		95	5
2,4-Dinitrophenol	90	0		81	10
Di-N-Octyl Phthalate	90	0	2	82.8	10
Dinoseb	90	0	2	82.8	10
1,4-Dioxane	90	0		81	10
Diphenamid	95	0	6	87.4	5
Diphenyl Amine	90	0	2	82.8	10
Disulfolton	90	0	2	82.8	10
Diuron	95	0	6	87.4	5
Endrin	95	0	15	59.85	5
Epichlorohydrin	87	0	7	78.3	13
Ethyl Acetate	95	0.47	9.5	85.02	5
Ethyl Benzene	95	23.75	5.7	65.55	5
Ethylene Oxide	90	0.45	9	80.55	10
Ethylene Thiourea	85	0	5	76.5	15
Ethyl Ether	95	9.5	5	76	5
Fenthion	80	0	4	73.6	20
Ferbam	90	0	2	82.8	10

APPENDIX A

PROFILE OF POLLUTANT FATE IN ACCLIMATED SECONDARY POTW* (Continued)

Pollutant	Total Removal Rate (%)	Air Emissions Rate (%)	Sludge Partition Rate (%)	Biodegradation Rate (%)	Pass Through Rate (%)
Folex	90	0	2	82.8	10
Formaldehyde	85	0.42	8.5	76.07	15
Formic Acid	90	0.45	9	80.55	10
Furan	90	0.45	12.6	76.95	10
Furfural	90	0.45	9	80.55	10
Hexachloro-1,3-Butadiene	95	0.47	8.55	85.97	5
Hexachloroethane	95	0.47	8.55	85.97	5
Hydrazine	95	0.47	9.5	85.02	5
Isobutanol	95	0	9.5	85.5	5
Lead	70	0	70	0	30
Maleic Hydrazide	90	0	9	81	10
Mercury	50	0.25	47.5	2.25	50
Methanethiol	95	38	9.5	47.5	5
Methanol	100	0.5	10	89.5	0
Methoxychlor	90	54	8.1	27.9	10
MCPA	95	0	7.6	87.4	5
Methyl Ethyl Ketone	95	0.47	9.5	85.02	5
Methyl Isobutyl Ketone	90	0	9	81	10
Methylene Chloride	95	38	13.3	43.7	5
Mevinphos	90	0	9	81	10
Naled	80	0	8	72	20
Napthalam	90	0	9	81	10
Naphthalene	95	0.47	26.6	67.92	5
Nickel	35	0	35	0	65
p-Nitroaniline	90	0	9	81	10
Nitrobenzene	90	0	9	81	10
2-Nitropropane	95	85.5	0.95	8.55	5
N-Nitrosodimethyl Amine	90	0	9	81	10
Oxamyl	90	0	9	81	10
Parathion	0	0	0	0	100

APPENDIX A

PROFILE OF POLLUTANT FATE IN ACCLIMATED SECONDARY POTW* (Continued)

Pollutant	Total Removal Rate (%)	Air Emissions Rate (%)	Sludge Partition Rate (%)	Biodegradation Rate (%)	Pass Through Rate (%)
Parathion Methyl	90	0	7.2	82.8	10
Pentachloroethane	95	57	14.25	23.75	5
Pentachlorophenol	95	0	17.1	77.9	5
Phenol	95	0	14.25	80.75	5
Phenylene Diamine	90	0	9	81	10
Phorate	90	0	7.2	82.8	10
Phosgene	100	0.5	10	89.5	0
Phthalic Anhydride	90	0	9	81	10
2-Picoline	80	0.4	8	71.6	20
PCB	92	9.2	22.08	60.72	8
Pyrethrins	80	0	6.4	73.6	20
Pyridine	15	0.07	1.5	13.42	85
Resorcinol	95	0	9.5	85.5	5
Selenium	50	0	50	0	50
Silver	90	0	90	0	10
Sodium Fluoroacetate	95	0	9.5	85.5	5
Stirofos	85	0	6.8	78.2	15
Styrene	90	22.5	13.5	54	10
Tetrachlorobenzene	90	27	33.3	29.7	10
1,1,1,2-Tetrachloroethane	95	47.5	3.8	43.7	5
1,1,2,2-Tetrachloroethane	90	36	3.6	50.4	10
Tetrachloroethylene	90	45	2.7	42.3	10
Tetrahydrofuran	95	28.5	9.5	57	5
Thiourea	90	0	9	81	10
Thiram	90	0	9	81	10
Toluene	95	23.75	26.6	44.65	5
Toluene Diamine	90	0	9	81	10
Toxaphene	95	57	3.8	34.2	5
Trans-1,2-Dichloroethylene	90	63	27	0	10
Tribromomethane	65	35.75	5.2	24.05	35

APPENDIX A

PROFILE OF POLLUT. T FATE IN ACCLIMATED SECONDARY POTW* (Continued)

Pollutant	Total Removal Rate (%)	Air Emissions Rate (%)	Sludge Partition Rate (%)	Biodegradation Rate (%)	Pass Through Rate (%)
1,2,4-Trichlorobenzene	85	42.5	7.65	34.85	15
1,1,1-Trichloroethane	95	76	0.95	18.05	5
1,1,2-Trichloroethane	80	40	0	40	20
Trichloroethylene	95	66.5	5.7	22.8	5
Trichlorofluoromethane	95	76	0	19	5
2,4,6-Trichlorophenol	95	0	7.6	87.4	5
2,4,5-T	90	0	7.2	82.8	10
1,2,3-Trichloropropane	75	30	6	39	25
1,1,2-TC 1,2,2-TF Ethane	90	63	3.6	23.4	10
Trifluralin	90	0	33.3	56.7	10
Vanadium Pentoxide	25	0	2.5	22.5	75
Vinyl Chloride	95	85.5	1.9	7.6	5
Xylenes	95	23.75	14.25	57	5

*Estimates derived from Report to Congress on the Discharge of Hazardous Wastes to Publicly Owned Treatment Works, U.S. Environmental Protection Agency, February 6, 1986.

APPENDIX A

PROFILE OF POLLUTANT FATE IN UNACCLIMATED SECONDARY POTW*

Pollutant	Total Removal Rate (%)	Air Emissions Rate (%)	Sludge Partition Rate (%)	Biodegradation Rate (%)	Pass Through Rate (%)
Acenaphthylene	90	54	8.1	27.9	10
Acetaldehyde	95	4.75	9.5	80.75	5
Acetone	50	2.5	5	42.5	50
Acetonecyanohydrin	50	0	5	45	50
Acetophenone	50	2.5	5	42.5	50
Acetyl Chloride	50	2.5	5	42.5	50
Acrolein	95	4.75	9.5	80.75	5
Acrylamide	62	0	6.2	55.8	38
Acrylic Acid	85	0	8.5	76.5	15
Acrylonitrile	75	3.75	7.5	63.75	25
Alachlor	50	0	4	46	50
Aldicarb	50	0	5	45	50
Aldrin	90	0	33.3	56.7	10
Aniline	85	0	8.5	76.5	15
Anthracene	90	0	49.5	40.5	10
Antimony	60	0	60	0	40
Antu	50	0	5	45	50
Arsenic	50	0	50	0	50
Atrazine	35	0	2.8	32.2	65
Barium	90	0	90	0	10
Benzal Chloride	55	16.5	4.4	34.1	45
Benzene	90	72	1.8	16.2	10
p-Benzoquinone	50	0	4	46	50
Benzotrichloride	45	13.5	3.6	27.9	55
Benzyl Chloride	90	45	7.2	37.8	10
Bis-2-Chloroethoxy Methane	10	0	1	9	90
Bis-2-Chloroethyl Ether	50	2.5	5	42.5	50
Bis-2-Ethylhexyl Phthalate	90	0	65.7	24.3	10
Bromacil	50	0	5	45	50
Bromomethane	95	90.25	0	4.75	5

APPENDIX A

PROFILE OF POLLUTANT FATE IN UNACCLIMATED SECONDARY POTW* (Continued)

Pollutant	Total Removal Rate (%)	Air Emissions Rate (%)	Sludge Partition Rate (%)	Biodegradation Rate (%)	Pass Through Rate (%)
N-Butyl Alcohol	90	0	9	81	10
Butyl Benzyl Phthalate	90	0	40.5	49.5	10
Cadmium	27	0	27	0	73
Captan	50	0	4	46	50
Carbofuran	50	0	5	45	50
Carbon Disulfide	85	76.5	0.85	7.65	15
Carbon Tetrachloride	85	76.5	8.5	0	15
Chlordane	90	9	33.3	47.7	10
Chlorobenzene	90	45	13.5	31.5	10
Chlorobenzilate	60	6	4.8	49.2	40
p-Chloro-m-Cresol	50	0	4	46	50
Chloroethane	90	81	0.9	8.1	10
Chloroform	80	72	1.6	6.4	20
Chloromethane	90	85.5	0.9	3.6	10
2-Chloronaphthalene	80	4	29.6	46.4	20
2-Chlorophenol	65	0	5.2	59.8	35
Chromium	70	0	70	0	30
Cresols	50	0	4	46	50
Cumene	95	57	3.8	34.2	5
Cyanide	60	3	57	0	40
Cyclohexane	95	85.5	3.8	5.7	5
Cyclohexanone	50	0	5	45	50
Diazinon	60	0	4.8	55.2	40
Dibromomethane	80	64	12	4	20
Di-N-Butyl Phthalate	90	0	19.8	70.2	10
1,2-Dichlorobenzene	87	78.3	8.7	0	13
1,3-Dichlorobenzene	87	78.3	2.61	6.09	13
1,4-Dichlorobenzene	87	78.3	8.7	0	13
Dichlorodifluoromethane	95	90.25	0	4.75	5
1,1-Dichloroethane	80	72	0	8	20

PROFILE OF POLLUTANT FATE IN UNACCLIMATED SECONDARY POTW* (Continued)

Pollutant	Total Removal Rate (%)	Air Emissions Rate (%)	Sludge Partition Rate (%)	Biodegradation Rate (%)	Pass Through Rate (%)
1,2-Dichloroethane	50	45	2.5	2.5	50
1,1-Dichloroethylene	90	81	0	9	10
2,4-D	60	0	4.8	55.2	40
2,4-DB	60	0	4.8	55.2	40
2,4-Dichlorophenol	55	0	4.4	50.6	45
1,2-Dichloropropane	70	63	0	7	30
Dichloropropanol	50	25	5	20	50
Dichlorvos	50	0	5	45	50
Dicofol	90	45	8.1	36.9	10
Diethyl Phthalate	75	0	0.75	74.25	25
3,3-Dimethoxy benzidine	30	0	3	27	70
Dimethylamine	90	4.5	9	76.5	10
2,4-Dimethyl Phenol	85	0	6.8	78.2	15
Dimethyl Phthalate	65	0	0	65	35
2,4-Dinitrophenol	75	0	7.5	67.5	25
Di-N-Octyl Phthalate	90	0	7.2	82.8	10
Dinoseb	40	0	3.2	36.8	60
1,4-Dioxane	50	0	5	45	50
Diphenamid	60	0	4.8	55.2	40
Diphenyl Amine	65	0	5.2	59.8	35
Disulfoton	60	0	4.8	55.2	40
Diuron	50	0	4	46	50
Endrin	90	0	33.3	56.7	10
Epichlorohydrin	59	0	5.9	53.1	51
Ethyl Acetate	90	4.5	9	76.5	10
Ethyl Benzene	90	72	5.4	12.6	10
Ethylene Oxide	50	2.5	5	42.5	50
Ethylene Thiourea	[illegible]	0	6.7	60.3	33
Ethyl Ether	50	20	5	25	50
Fenthion	55	0	4.4	50.6	45

APPENDIX A

PROFILE OF POLLUTANT FATE IN UNACCLIMATED SECONDARY POTW* (Continued)

Pollutant	Total Removal Rate (%)	Air Emissions Rate (%)	Sludge Partition Rate (%)	Biodegradation Rate (%)	Pass Through Rate (%)
Ferbam	55	0	4.4	50.6	45
Folex	60	0	4.8	55.2	40
Formaldehyde	85	4.25	8.5	72.25	15
Formic Acid	90	4.5	9	76.5	10
Furan	70	3.5	9.8	56.7	30
Furfural	60	3	6	51	40
Hexachloro-1,3-Butadiene	90	4.5	8.1	77.4	10
Hexachloroethane	90	4.5	8.1	77.4	10
Hydrazine	85	4.25	8.5	72.25	15
Isobutanol	90	0	9	81	10
Lead	70	0	70	0	30
Maleic Hydrazide	75	0	7.5	67.5	25
Mercury	50	2.5	47.5	0	50
Methanethiol	77	46.2	7.7	23.1	23
Methanol	95	4.75	9.5	80.75	5
Methoxychlor	90	54	8.1	27.9	10
MCPA	50	0	4	46	50
Methyl Ethyl Ketone	50	2.5	5	42.5	50
Methyl Isobutyl Ketone	50	0	5	45	50
Methylene Chloride	87	52.2	12.18	22.62	13
Mevinphos	50	0	5	45	50
Naled	50	0	5	45	50
Napthalam	40	0	4	36	60
Naphthalene	75	3.75	21	50.25	25
Nickel	35	0	35	0	65
p-Nitroaniline	69	0	6.9	62.1	31
Nitrobenzene	25	0	2.5	22.5	75
2-Nitropropane	95	90.25	0.95	3.8	5
N-Nitrosodimethyl Amine	75	0	7.5	67.5	25
Oxamyl	50	0	5	45	50

APPENDIX A

PROFILE OF POLLUTANT FATE IN UNACCLIMATED SECONDARY POTW* (Continued)

Pollutant	Total Removal Rate (%)	Air Emissions Rate (%)	Sludge Partition Rate (%)	Biodegradation Rate (%)	Pass Through Rate (%)
Parathion	55	0	4.4	50.6	45
Parathion Methyl	55	0	4.4	50.6	45
Pentachloroethane	75	45	11.25	18.75	25
Pentachlorophenol	25	0	4.5	20.5	75
Phenol	85	0	12.75	72.25	15
Phenylene Diamine	75	0	7.5	67.5	25
Phorate	60	0	4.8	55.2	40
Phosgene	100	5	10	85	0
Phthalic Anhydride	90	0	9	81	10
2-Picoline	15	0.75	1.5	12.75	85
PCB	92	9.2	22.08	60.72	8
Pyrethrins	60	0	4.8	55.2	40
Pyridine	15	0.75	1.5	12.75	85
Resorcinol	75	0	7.5	67.5	25
Selenium	50	0	50	0	50
Silver	90	0	90	0	10
Sodium Fluoroacetate	50	0	5	45	50
Stirofos	60	0	4.8	55.2	40
Styrene	90	72	13.5	4.5	10
Tetrachlorobenzene	90	27	33.3	29.7	10
1,1,1,2-Tetrachloroethane	90	63	3.6	23.4	10
1,1,2,2-Tetrachloroethane	25	15	1	9	75
Tetrachloroethylene	85	68	2.55	14.45	15
Tetrahydrofuran	75	52.5	7.5	15	25
Thiourea	75	0	7.5	67.5	25
Thiram	75	0	7.5	67.5	25
Toluene	90	72	18	0	10
Toluene Diamine	75	0	7.5	67.5	25
Toxaphene	90	72	3.6	14.4	10
Trans-1,2-Dichloroethylene	80	72	8	0	20

APPENDIX A

PROFILE OF POLLUTANT FATE IN UNACCLIMATED SECONDARY POTW* (Continued)

Pollutant	Total Removal Rate (%)	Air Emissions Rate (%)	Sludge Partition Rate (%)	Biodegradation Rate (%)	Pass Through Rate (%)
Tribromomethane	35	21	2.8	11.2	65
1,2,4-Trichlorobenzene	85	51	7.65	26.35	15
1,1,1-Trichloroethane	90	81	0.9	8.1	10
1,1,2-Trichloroethane	25	20	0	5	75
Trichloroethylene	87	69.6	5.22	12.18	13
Trichlorofluoromethane	90	81	0	9	10
2,4,6-Trichlorophenol	55	0	4.4	50.6	45
2,4,5-T	50	0	4	46	50
1,2,3-Trichloropropane	25	17.5	2	5.5	75
1,1,2-TC 1,2,2-TF Ethane	85	68	3.4	13.6	15
Trifluralin	90	0	33.3	56.7	10
Vanadium Pentoxide	25	0	2.5	22.5	75
Vinyl Chloride	95	90.25	1.9	2.85	5
Xylenes	87	69.6	13.05	4.35	13

*Estimates derived from Report to Congress on the Discharge of Hazardous Wastes to Publicy Owned Treatment Works, U.S. Environmental Protection Agency, February 6, 1986.

APPENDIX B

HAZARDOUS WASTE CONSTITUENTS POTENTIALLY GENERATED AND DISCHARGED BY SELECTED INDUSTRIES

	Electrical and Electronic Components	Explosives Manufacture	Hazardous Waste Management Facilities	Inorganic Chemicals Manufacture	Iron and Steel Manufacture	Metal Finishing/ Equipment Manufacture	Nonferrous Metals Manufacture	Organic Chemicals Manufacture
Acenaphthylene			X		X	X	X	X
Acetaldehyde			X					X
Acetone	X		X			X		X
Acetonecyanohydrin			X					X
Acetophenone			X					X
Acetyl Chloride			X					X
Acrolein			X					X
Acrylamide			X					X
Acrylic Acid			X					X
Acrylonitrile			X					X
Alachlor			X					
Aldicarb			X					
Aldrin			X					
Aniline			X					X
Anthracene		X	X		X	X	X	X
Antimony	X	X	X	X	X	X		
Antu			X					
Arsenic	X		X	X	X	X		
Atrazine			X					
Barium		X	X	X	X	X		
Benzal Chloride			X					X
Benzene	X		X		X	X	X	X
p-Benzoquinone			X					X
Benzotrichloride			X					X
Benzyl Chloride	X		X			X		X
Bis-2-Chloroethoxy Methane			X					X
Bis-2-Chloroethyl Ether			X					X
Bis-2-Ethylhexyl Phthalate			X			X		X
Bromacil			X					

APPENDIX B

HAZARDOUS WASTE CONSTITUENTS POTENTIALLY GENERATED AND DISCHARGED BY SELECTED INDUSTRIES (Continued)

	Electrical and Electronic Components	Explosives Manufacture	Hazardous Waste Management Facilities	Inorganic Chemicals Manufacture	Iron and Steel Manufacture	Metal Finishing/ Equipment Manufacture	Nonferrous Metals Manufacture	Organic Chemicals Manufacture
Bromomethane			X					X
N-Butyl Alcohol	X		X			X		X
Butyl Benzyl Phthalate			X			X		X
Cadmium	X		X	X	X	X	X	
Captan			X					
Carbofuran			X					
Carbon Disulfide			X					X
Carbon Tetrachloride	X		X			X		X
Chlordane			X					
Chlorobenzene	X		X			X		X
Chlorobenzilate			X					
p-Chloro-m-Cresol			X					X
Chloroethane			X					X
Chloroform	X		X			X		X
Chloromethane	X		X			X		X
2-Chloronaphthalene			X					X
2-Chlorophenol			X					X
Chromium	X		X	X	X	X	X	
Cresols			X		X	X	X	X
Cumene			X		X	X	X	X
Cyanide			X	X	X	X	X	X
Cyclohexane	X		X		X	X	X	X
Cyclohexanone	X		X			X		X
Diazinon			X					
Dibromomethane			X					X
Di-N-Butyl Phthalate			X			X		X
1,2-Dichlorobenzene	X		X			X		X
1,3-Dichlorobenzene			X					X
1,4-Dichlorobenzene			X					X

APPENDIX B

HAZARDOUS WASTE CONSTITUENTS POTENTIALLY GENERATED AND DISCHARGED BY SELECTED INDUSTRIES (Continued)

	Electrical and Electronic Components	Explosives Manufacture	Hazardous Waste Management Facilities	Inorganic Chemicals Manufacture	Iron and Steel Manufacture	Metal Finishing/ Equipment Manufacture	Nonferrous Metals Manufacture	Organic Chemicals Manufacture
Dichlorodifluoromethane			X					X
1,1-Dichloroethane			X					X
1,2-Dichloroethane	X		X			X		X
1,1-Dichloroethylene			X					X
2,4-D			X					
2,4-DB			X					
2,4-Dichlorophenol			X					X
1,2-Dichloropropane			X					X
Dichloropropanol			X					X
Dichlorvos			X					
Dicofol			X					
Diethyl Phthalate			X			X		X
3,3-Dimethoxy benzidine			X					X
Dimethylamine			X					X
2,4-Dimethyl Phenol			X		X	X	X	
Dimethyl Phthalate			X			X		X
2,4-Dinitrophenol			X		X	X	X	X
Di-N-Octyl Phthalate			X			X		X
Dinoseb			X					
1,4-Dioxane			X					X
Diphenamid			X					
Diphenyl Amine			X					X
Disulfoton			X					
Diuron			X					
Endrin			X					
Epichlorohydrin			X					X
Ethyl Acetate	X		X			X		X
Ethyl Benzene	X		X		X	X	X	X
Ethylene Oxide			X					X

APPENDIX B

HAZARDOUS WASTE CONSTITUENTS POTENTIALLY GENERATED AND DISCHARGED BY SELECTED INDUSTRIES (Continued)

	Electrical and Electronic Components	Explosives Manufacture	Hazardous Waste Management Facilities	Inorganic Chemicals Manufacture	Iron and Steel Manufacture	Metal Finishing/ Equipment Manufacture	Nonferrous Metals Manufacture	Organic Chemicals Manufacture
Ethylene Thiourea			X					X
Ethyl Ether	X		X			X		X
Fenthion			X					
Ferbam			X					
Folex			X					
Formaldehyde			X					X
Formic Acid			X					X
Furan			X					X
Furfural			X					X
Hexachloro-1,3-Butadiene			X					X
Hexachloroethane			X					X
Hydrazine			X					X
Isobutanol	X		X			X		X
Lead	X	X	X	X	X	X	X	
Maleic Hydrazide			X					X
Mercury			X	X	X		X	
Methanethiol			X		X		X	X
Methanol	X		X			X		X
Methoxychlor			X					
MCPA			X					
Methyl Ethyl Ketone	X		X			X		X
Methyl Isobutyl Ketone	X		X			X		X
Methylene Chloride	X		X			X		X
Mevinphos			X					
Naled			X					
Napthalam			X					
Naphthalene	X	X	X		X	X	X	X
Nickel	X		X	X	X	X	X	
p-Nitroaniline			X					X

APPENDIX B

HAZARDOUS WASTE CONSTITUENTS POTENTIALLY GENERATED AND DISCHARGED BY SELECTED INDUSTRIES (Continued)

	Electrical and Electronic Components	Explosives Manufacture	Hazardous Waste Management Facilities	Inorganic Chemicals Manufacture	Iron and Steel Manufacture	Metal Finishing/ Equipment Manufacture	Nonferrous Metals Manufacture	Organic Chemicals Manufacture
Nitrobenzene			X					X
2-Nitropropane			X					X
N-Nitrosodimethyl Amine			X			X		X
Oxamyl			X					
Parathion			X					
Parathion Methyl			X					
Pentachloroethane			X					X
Pentachlorophenol			X					X
Phenol	X	X	X		X	X	X	X
Phenylene Diamine			X					X
Phorate			X					
Phosgene			X					X
Phthalic Anhydride			X					X
2-Picoline			X					X
PCB	X		X		X	X	X	X
Pyrethrins			X					
Pyridine			X					X
Resorcinol			X					X
Selenium	X		X	X	X		X	
Silver			X	X		X	X	
Sodium Fluoroacetate			X					
Stirofos			X					
Styrene			X		X	X	X	X
Tetrachlorobenzene			X					X
1,1,1,2-Tetrachloroethane			X					X
1,1,2,2-Tetrachloroethane			X					X
Tetrachloroethylene	X		X			X		X
Tetrahydrofuran	X		X			X		X
Thiourea			X					X

APPENDIX B

HAZARDOUS WASTE CONSTITUENTS POTENTIALLY GENERATED AND DISCHARGED BY SELECTED INDUSTRIES (Continued)

	Electrical and Electronic Components	Explosives Manufacture	Hazardous Waste Management Facilities	Inorganic Chemicals Manufacture	Iron and Steel Manufacture	Metal Finishing/ Equipment Manufacture	Nonferrous Metals Manufacture	Organic Chemicals Manufacture
Thiram			X					
Toluene	X	X	X		X	X	X	X
Toluene Diamine			X					X
Toxaphene			X					
Trans-1,2-Dichloroethylene			X					X
Tribromomethane			X					X
1,2,4-Trichlorobenzene	X		X			X		X
1,1,1-Trichloroethane	X		X			X		X
1,1,2-Trichloroethane	X		X			X		X
Trichloroethylene	X		X			X		X
Trichlorofluoromethane			X					X
2,4,6-Trichlorophenol			X					X
2,4,5-T			X					X
1,2,3-Trichloropropane			X					X
1,1,2-TC 1,2,2-TF Ethane	X		X			X		X
Trifluralin			X					
Vanadium Pentoxide			X	X				
Vinyl Chloride			X					X
Xylenes	X		X		X	X	X	X

APPENDIX B

HAZARDOUS WASTE CONSTITUENTS POTENTIALLY GENERATED AND DISCHARGED BY SELECTED INDUSTRIES

	Paint Manufacture	Pesticides Manufacture	Petroleum Refining	Pharmaceuticals Manufacture	Plastics/ Rubber Manufacture	Utilities (Steam Electric)	Wood Preserving
Acenaphthylene	X		X				X
Acetaldehyde		X		X	X		
Acetone	X	X		X	X		
Acetonecyanohydrin							
Acetophenone				X	X		
Acetyl Chloride							
Acrolein		X			X		
Acrylamide							
Acrylic Acid		X			X		
Acrylonitrile			X		X		
Alachlor		X					
Aldicarb		X					
Aldrin		X					
Aniline		X	X	X	X		
Anthracene	X		X				X
Antimony	X		X				
Antu		X					
Arsenic	X	X		X			X
Atrazine		X					
Barium	X	X	X		X		
Benzal Chloride							
Benzene	X	X	X	X	X		X
p-Benzoquinone							
Benzotrichloride							
Benzyl Chloride	X			X			
Bis-2-Chloroethoxy Methane							
Bis-2-Chloroethyl Ether							
Bis-2-Ethylhexyl Phthalate	X				X		
Bromacil		X					
Bromomethane							

APPENDIX B

HAZARDOUS WASTE CONSTITUENTS POTENTIALLY GENERATED AND DISCHARGED BY SELECTED INDUSTRIES (Continued)

	Paint Manufacture	Pesticides Manufacture	Petroleum Refining	Pharmaceuticals Manufacture	Plastics/ Rubber Manufacture	Utilities (Steam Electric)	Wood Preserving
N-Butyl Alcohol	X	X		X	X		
Butyl Benzyl Phthalate	X						
Cadmium	X		X		X		
Captan	X	X					
Carbofuran		X					
Carbon Disulfide		X	X				X
Carbon Tetrachloride	X	X		X			
Chlordane		X					
Chlorobenzene	X	X		X	X		
Chlorobenzilate		X					
p-Chloro-m-Cresol				X			
Chloroethane		X					
Chloroform	X	X		X	X		
Chloromethane	X	X		X	X		
2-Chloronaphthalene							
2-Chlorophenol		X		X			
Chromium	X	X	X		X	X	X
Cresols	X	X	X	X			X
Cumene	X	X	X	X	X		X
Cyanide		X	X	X			X
Cyclohexane	X	X	X	X	X		X
Cyclohexanone	X			X	X		
Diazinon		X					
Dibromomethane		X					
Di-N-Butyl Phthalate	X						
1,2-Dichlorobenzene	X	X		X			
1,3-Dichlorobenzene							
1,4-Dichlorobenzene		X					
Dichlorodifluoromethane				X			
1,1-Dichloroethane		X			X		

APPENDIX B

HAZARDOUS WASTE CONSTITUENTS POTENTIALLY GENERATED AND DISCHARGED BY SELECTED INDUSTRIES (Continued)

	Paint Manufacture	Pesticides Manufacture	Petroleum Refining	Pharmaceuticals Manufacture	Plastics/ Rubber Manufacture	Utilities (Steam Electric)	Wood Preserving
1,2-Dichloroethane	X	X		X			
1,1-Dichloroethylene		X					
2,4-D		X					
2,4-DB		X					
2,4-Dichlorophenol		X					X
1,2-Dichloropropane							
Dichloropropanol							
Dichlorvos		X					
Dicofol		X					
Diethyl Phthalate	X						
3,3-Dimethoxy benzidine							
Dimethylamine		X		X			
2,4-Dimethyl Phenol	X		X				X
Dimethyl Phthalate	X						
2,4-Dinitrophenol			X				X
Di-N-Octyl Phthalate	X						
Dinoseb		X					
1,4-Dioxane		X	X		X		
Diphenamid		X					
Diphenyl Amine				X	X		
Disulfoton		X					
Diuron		X					
Endrin		X					
Epichlorohydrin					X		
Ethyl Acetate	X	X		X			
Ethyl Benzene	X	X	X	X	X		X
Ethylene Oxide			X	X			
Ethylene Thiourea							
Ethyl Ether	X	X	X				
Fenthion		X					

APPENDIX B

HAZARDOUS WASTE CONSTITUENTS POTENTIALLY GENERATED AND DISCHARGED BY SELECTED INDUSTRIES (Continued)

	Paint Manufacture	Pesticides Manufacture	Petroleum Refining	Pharmaceuticals Manufacture	Plastics/ Rubber Manufacture	Utilities (Steam Electric)	Wood Preserving
Ferbam		X					
Folex		X					
Formaldehyde		X			X		
Formic Acid		X			X		
Furan		X					
Furfural		X	X		X		
Hexachloro-1,3-Butadiene		X					
Hexachloroethane		X					
Hydrazine		X					
Isobutanol	X			X	X		
Lead	X	X	X		X		
Maleic Hydrazide							
Mercury	X	X	X				
Methanethiol		X	X				X
Methanol	X	X		X	X		
Methoxychlor		X					
MCPA		X					
Methyl Ethyl Ketone	X	X	X	X	X		
Methyl Isobutyl Ketone	X		X	X	X		
Methylene Chloride	X	X		X	X		
Mevinphos		X					
Naled		X					
Napthalam		X					
Naphthalene	X	X	X	X			X
Nickel	X	X	X				
p-Nitroaniline		X	X	X			
Nitrobenzene			X	X			
2-Nitropropane	X			X			
N-Nitrosodimethyl Amine							
Oxamyl		X					

APPENDIX B

HAZARDOUS WASTE CONSTITUENTS POTENTIALLY GENERATED AND DISCHARGED BY SELECTED INDUSTRIES (Continued)

	Paint Manufacture	Pesticides Manufacture	Petroleum Refining	Pharmaceuticals Manufacture	Plastics/ Rubber Manufacture	Utilities (Steam Electric)	Wood Preserving
Parathion		X					
Parathion Methyl		X					
Pentachloroethane		X					
Pentachlorophenol	X	X					X
Phenol	X	X	X	X	X		X
Phenylene Diamine				X			
Phorate		X					
Phosgene		X					
Phthalic Anhydride					X		
2-Picoline			X				
PCB		X					
Pyrethrins		X					
Pyridine		X		X			
Resorcinol				X			
Selenium	X	X	X				
Silver	X	X					
Sodium Fluoroacetate		X					
Stirofos		X					
Styrene	X		X	X			X
Tetrachlorobenzene							
1,1,1,2-Tetrachloroethane					X		
1,1,2,2-Tetrachloroethane					X		
Tetrachloroethylene	X	X			X		
Tetrahydrofuran	X	X	X	X	X		
Thiourea							
Thiram							
Toluene	X	X	X	X	X		X
Toluene Diamine							
Toxaphene		X					
Trans-1,2-Dichloroethylene							

APPENDIX B

HAZARDOUS WASTE CONSTITUENTS POTENTIALLY GENERATED AND DISCHARGED BY SELECTED INDUSTRIES (Continued)

	Paint Manufacture	Pesticides Manufacture	Petroleum Refining	Pharmaceuticals Manufacture	Plastics/ Rubber Manufacture	Utilities (Steam Electric)	Wood Preserving
Tribromomethane					X		
1,2,4-Trichlorobenzene	X						
1,1,1-Trichloroethane	X	X		X			
1,1,2-Trichloroethane	X	X		X	X		
Trichloroethylene	X	X		X			
Trichlorofluoromethane		X		X			
2,4,6-Trichlorophenol		X					X
2,4,5-T		X					X
1,2,3-Trichloropropane							
1,1,2-TC 1,2,2-TF Ethane	X			X			
Trifluralin		X					
Vanadium Pentoxide							
Vinyl Chloride		X					
Xylenes	X	X	X	X	X		X

APPENDIX C

DATA ON PHYSICAL AND CHEMICAL PROPERTIES FOR SELECTED CONSTITUENTS

Constituent	Water Solubility (mg/l)	Henry's Law Constant atm-m^3/mol	Octanol/Water Partition Coefficient (K_{ow})
Acenaphthylene	4.0	1.45×10^{-3}	1.17×10^{4}
Acetaldehyde	-	7.4×10^{-5}	2.7
Acetone	1.0×10^{6}	6.8 x 10-6	.57
Acetonecyanohydrin	-	Low	0.4
Acetophenone	-	Low	38.9
Acetyl Chloride	-	Low	0.67
Acrolein	-	6.79×10^{-5}	0.8
Acrylamide	-	3.0×10^{-10}	1.55
Acrylic Acid	1.0×10^{6}	Low	0.59
Acrylonitrile	7.9×10^{4}	9.2×10^{-5}	1.78
Alachlor	-	Low	210
Aldicarb	-	2.1×10^{-6}	11
Aldrin	0.18	1.6×10^{-5}	4.7×10^{4}
Aniline	-	1.1×10^{-6}	9.5
Anthracene	0.045	8.6×10^{-5}	2.8×10^{4}
Antimony	-	-	-
Antu	-	Low	130
Arsenic	-	-	-
Atrazine	-	2.6×10^{-9}	478
Barium	-	-	-
Benzal Chloride	-	1.7×10^{-4}	645
Benzene	1.78×10^{3}	5.5×10^{-3}	126
p-Benzoquinone	-	5.0×10^{-7}	1.6
Benzotrichloride	-	1.1×10^{-4}	831
Benzyl Chloride	3.3×10^{3}	5.1×10^{-3}	200
Bis-2-Chloroethoxy Methane	8.1×10^{4}	2.7×10^{-7}	18.2
Bis-2-Chloroethyl Ether	1.02×10^{4}	1.3×10^{-5}	29.0
Bis-2-Ethylhexyl Phthalate	0.4	3.0×10^{-7}	5×10^{8}
Bromacil	-	Low	72
Bromomethane	900	1.06×10^{-1}	12.6

APPENDIX C

DATA ON PHYSICAL AND CHEMICAL PROPERTIES FOR SELECTED CONSTITUENTS (Continued)

Constituent	Water Solubility (mg/l)	Henry's Law Constant atm-m^3/mol	Octanol/Water Partition Coefficient (K_{ow})
N-Butyl Alcohol	-	7×10^{-6}	No data (low k_{ow})
Butyl Benzyl Phthalate	2.9	1.0×10^{-6}	6.3×10^{4}
Cadmium	-	-	N/A
Captan	0.5	Low	224
Carbofuran	-	8.3×10^{-9}	40
Carbon Disulfide	3.0×10^{3}	1.2×10^{-2}	No data (low K_{ow}
Carbon Tetrachloride	7.5×10^{2}	2.3×10^{-2}	436
Chlordane	0.056	9.4×10^{-5}	2.1×10^{4}
Chlorobenzene	488	3.5×10^{-3}	690
Chlorobenzilate	22	5.2×10^{-5}	4000
p-Chloro-m-Cresol	3.85×10^{3}	2.5×10^{-6}	1300
Chloroethane	5.74×10^{3}	1.48×10^{-2}	34.7
Chloroform	1.0×10^{4}	2.88×10^{-3}	93
Chloromethane	6.45×10^{3}	3.8×10^{-1}	8.1
2-Chloronaphthalene	-	3.15×10^{-4}	1.3×10^{4}
2-Chlorophenol	2.85×10^{4}	4.7×10^{-6}	148
Chromium	-	-	N/A
Cresols	3.0×10^{4}	2.5×10^{-6}	1360
Cumene	-	1.4×10^{-2}	4500
Cyanide	-	-	-
Cyclohexane	-	0.18	2700
Cyclohexanone	-	2.5×10^{-5}	6.46
Diazinon	-	1.4×10^{-6}	570
Dibromomethane	-	Moderate	Low
Di-N-Butyl Phthalate	-	2.8×10^{-7}	1.58×10^{5}
1,2-Dichlorobenzene	100	3.6×10^{-3}	2400
1,3-Dichlorobenzene	123	2.63×10^{-3}	3600
1,4-Dichlorobenzene	79	2.37×10^{-3}	3600
Dichlorodifluoromethane	280	1.5	145
1,1-Dichloroethane	5.5×10^{3}	4.26×10^{-3}	63

APPENDIX C

DATA ON PHYSICAL AND CHEMICAL PROPERTIES FOR SELECTED CONSTITUENTS (Continued)

Constituent	Water Solubility (mg/l)	Henry's Law Constant atm-m^3/mol	Octanol/Water Partition Coefficient (K_{ow})
1,2-Dichloroethane	8.5×10^3	9.14×10^{-4}	34
1,1-Dichloroethylene	2.3×10^3	1.5×10^{-2}	134
2,4-D	610	2.0×10^{-10}	645
2,4-DB	-	Low	530
2,4-Dichlorophenol	4.6×10^3	2.0×10^3	2000
1,2-Dichloropropane	2.7×10^3	2.8×10^{-3}	87
Dichloropropanol	-	4.0×10^{-4}	0.34
Dichlorvos	-	3.5×10^{-7}	28
Dicofol	-	4.7×10^{-3}	4.5×10^4
Diethyl Phthalate	896	4.75×10^{-5}	1600
3,3-Dimethoxy benzidine	-	1.0×10^{-11}	28.8
Dimethylamine	1.0×10^6	5.9×10^{-8}	0.5
2,4-Dimethyl Phenol	-	1.8×10^{-5}	316
Dimethyl Phthalate	5.0×10^3	2.1×10^{-7}	131
2,4-Dinitrophenol	5.6×10^3	6.45×10^{-10}	34.7
Di-N-Octyl Phthalate	-	3.0×10^{-7}	1.58×10^9
Dinoseb	45	Low	124
1,4-Dioxane	4.3×10^5	7.0×10^{-7}	0.38
Diphenamid	-	Low	210
Diphenyl Amine	58	Low	3160
Disulfoton	-	2.6×10^{-6}	1800
Diuron	-	Low	400
Endrin	0.25	4.0×10^{-7}	3.4×10^4
Epichlorohydrin	6.0×10^4	3.13×10^{-5}	0.42
Ethyl Acetate	-	1.2×10^{-4}	5.37
Ethyl Benzene	152	6.44×10^{-3}	1412
Ethylene Oxide	1.0×10^6	3.63×10^{-5}	0.5
Ethylene Thiourea	2.0×10^3	Low	0.14
Ethyl Ether	-	8.69×10^{-4}	5.88
Fenthion	-	2.0×10^{-7}	480

APPENDIX C

DATA ON PHYSICAL AND CHEMICAL PROPERTIES FOR SELECTED CONSTITUENTS (Continued)

Constituent	Water Solubility (mg/l)	Henry's Law Constant atm-m^3/mol	Octanol/Water Partition Coefficient (K_{ow})
Ferbam	-	Low	300
Folex	-	Low	Moderate
Formaldehyde	4.0×10^5	5.1×10^{-4}	0.13
Formic Acid	1.0×10^7	4.4×10^{-7}	-0.8
Furan	-	5.7×10^{-3}	21.8
Furfural	-	3.6×10^{-6}	7.2
Hexachloro-1,3-Butadiene	0.15	1.03×10^{-2}	6.0×10^4
Hexachloroethane	50	9.85×10^{-3}	4.2×10^4
Hydrazine	3.4×10^8	Low	0.06
Isobutanol	9.5×10^4	1.03×10^{-5}	4.07
Lead	-	-	N/A
Maleic Hydrazide	-	Low	5.0×10^{-4}
Mercury	-	-	N/A
Methanethiol	-	4.0×10^{-3}	4.57
Methanol	-	1.1×10^{-6}	.23
Methoxychlor	-	Moderate	8.0×10^4
MCPA	-	Low	110
Methyl Ethyl Ketone	3.53×10^{-5}	5.8×10^{-5}	-
Methyl Isobutyl Ketone	-	-	-
Methylene Chloride	2.0×10^4	2.03×10^{-3}	18
Mevinphos	-	Low	3.5
Naled	-	Low	24
Napthalam	-	Low	4
Naphthalene	31.7	4.8×10^{-4}	2200
Nickel	-	-	-
p-Nitroaniline	-	1.0×10^{-6}	24.6
Nitrobenzene	1.9×10^3	1.3×10^{-5}	72
2-Nitropropane	-	.12	Low
N-Nitrosodimethyl Amine	-	Low	0.27
Oxamyl	-	2.4×10^{-10}	4

APPENDIX C

DATA ON PHYSICAL AND CHEMICAL PROPERTIES FOR SELECTED CONSTITUENTS (Continued)

Constituent	Water Solubility (mg/l)	Henry's Law Constant atm-m^3/mol	Octanol/Water Partition Coefficient (K_{ow})
Parathion	-	5.8×10^{-7}	141
Parathion Methyl	-	5.6×10^{-8}	110
Pentachloroethane	-	2.17×10^{-3}	4700
Pentachlorophenol	14	2.8×10^{-6}	1.1×10^{5}
Phenol	9.3×10^{4}	4.54×10^{-7}	30
Phenylene Diamine	-	Low	(o-) 25.7 (m-) 12.6
Phorate	-	5.7×10^{-6}	3.2×10^{-3}
Phosgene	-	Hydolyzes	Hydrolyzes
Phthalic Anhydride	-	1.0×10^{-10}	0.48
2-Picoline	-	2.4×10^{-5}	15.85
PCB	0-400	10^{-3}-10^{-5}	10^{4}-10^{7}
Pyrethrins	-	Low	Moderate
Pyridine	1.0×10^{6}	7×10^{-9}	0.02
Resorcinol	-	1.0×10^{-13}	6.3
Selenium	-	-	N/A
Silver	-	-	N/A
Sodium Fluoroacetate	-	Low	Low
Stirofos	-	3.3×10^{-6}	2100
Styrene	280	9.7×10^{-3}	891
Tetrachlorobenzene	6.0	1.0×10^{-4}	4.7×10^{4}
1,1,1,2-Tetrachloroethane	2.9×10^{3}	1.1×10^{-2}	1100
1,1,2,2-Tetrachloroethane	2.9×10^{3}	3.8×10^{-4}	363.08
Tetrachloroethylene	200	1.53×10^{-2}	759
Tetrahydrofuran	-	1.08×10^{-4}	5.4
Thiourea	1.7×10^{6}	Low	.016
Thiram	-	Low	Low
Toluene	534.8	6.7×10^{-3}	620
Toluene Diamine	-	2.3×10^{-9}	0.81
Toxaphene	0.5	4.3×10^{-1}	2000
Trans-1,2-Dichloroethylene	6.3×10^{3}	6.6×10^{-3}	34

APPENDIX C

DATA ON PHYSICAL AND CHEMICAL PROPERTIES FOR SELECTED CONSTITUENTS (Continued)

Constituent	Water Solubility (mg/l)	Henry's Law Constant atm-m^3/mol	Octanol/Water Partition Coefficient (K_{ow})
Tribromomethane	3.0×10^3	5.82×10^{-4}	200
1,2,4-Trichlorobenzene	30	2.3×10^{-3}	1.9×10^4
1,1,1-Trichloroethane	720	3.0×10^{-2}	310
1,1,2-Trichloroethane	4.5×10^3	7.42×10^{-4}	117
Trichloroethylene	1.1×10^3	9.1×10^{-3}	263
Trichlorofluoromethane	1.1×10^3	5.8×10^{-2}	339
2,4,6-Trichlorophenol	800	4.0×10^{-6}	4100
2,4,5-T	-	2.2×10^{-4}	5248
1,2,3-Trichloropropane	-	-	102
1,1,2-TC 1,2,2-TF Ethane	10.0	High	2000
Trifluralin	-	-	-
Vanadium Pentoxide	-	-	-
Vinyl Chloride	2.7×10^3	1.99×10^{-1}	17
Xylenes	1.98×10^2	5.1×10^{-3}	(o-) 1585
			(m-) 589
			(p-) 1412