United States, et al. v. Inmont Corporation, et al., Civ. No. 86-0029-B (D. Maine)

Winthrop Town Landfill Superfund Site, Winthrop, Maine

Amended Consent Decree

Appendix B
1986 Consent Decree
Part 2

Attachment VII

ALTERNATE CONCENTRATION LIMIT GUIDANCE BASED ON §264.94(b) CRITERIA

PART I

INFORMATION REQUIRED IN ACL DEMONSTRATIONS

DRAFT

Office of Solid Waste
Waste Management and Economics Division
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

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CONTENTS

EXECUTIVE SUMMARY

The hazardous waste regulations under the Resource Conservation and Recovery Act (RCRA) require owners and operators of hazardous waste facilities to utilize design features and control measures that prevent the leaking of hazardous waste into ground water. Further, all regulated units (i.e., all surface impoundments, waste piles, land treatment units, and landfills that received hazardous waste after July 26, 1982), are also subject to the ground-water monitoring and corrective action standards of 40 CFR Part 264, Subpart F. The ground-water protection standard (GWPS) under Subpart F (40 CFR 264.92) requires the Regional Administrator to establish in the facility permit, for each hazardous constituent entering the ground water from a regulated unit, a concentration limit beyond which degradation of ground-water quality will not be allowed. The concentration limits determine when corrective action is required.

There are three possible concentration levels that can be used to establish the GWPS:

1. Background levels of the hazardous constituents,
2. Maximum concentration limits listed in Table 1 of Section 264.94(a) of the regulations, or
3. Alternate concentration limits (ACL).

The first two levels are established in the facility permit unless the facility owner or operator applies for an ACL.

To obtain an ACL, a permit applicant must demonstrate that the hazardous constituents detected in the ground water will not pose a substantial present or potential hazard to human health or the environment at the ACL levels. ACLs are granted through the permit process under Parts 264 and 270 and are established in the context of the facility GWPS. This document provides guidance to RCRA facility permit applicants and writers concerning the establishment of alternate concentration limits (ACLs).

The factors that are used to evaluate ACL requests, or demonstrations, are listed in Section 264.94(b) of the regulation. These factors are:

1. Potential adverse effects on ground-water quality considering:

   - The physical and chemical characteristics of the waste in the regulated unit, including its potential for migration,
   - The hydrogeological characteristics of the facility and surrounding land,
   - The quantity of ground water and the direction of ground-water flow,
   - The proximity and withdrawal rates of ground-water users,
   - The current and future uses of ground water in the area,
   - The existing quality of ground water, including other sources of contamination and their cumulative impact on the ground-water quality,
   - The potential for health risks caused by human exposure to waste constituents,
   - The potential for damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents,

- The persistence and permanence of the potential adverse effects, and

2. Potential adverse effects on hydraulically-connected surface water quality, considering:

   - The volume and physical and chemical characteristics of the waste in the regulated unit,
   - The hydrogeological characteristics of the facility and surrounding land,
   - The quantity and quality of ground water and the direction of ground-water flow,
   - The patterns of rainfall in the region,
   - The proximity of the regulated unit to surface waters,
   - The current and future uses of surface waters in the area and any water quality standards established for those surface waters,
   - The existing quality of surface water, including other sources of contamination and the cumulative impact on surface-water quality,
   - The potential for health risks caused by human exposure to waste constituents,
   - The potential for damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents, and
   - The persistence and permanence of the potential adverse effects.

Information on each of these criteria is not required in every ACL demonstration because each demonstration requires different types and amounts of information, depending on the site-specific characteristics. A separate chapter of this document is devoted to each of these criteria. The criteria are briefly discussed, along with the type, quantity, and quality of information that should be provided depending on the site-specific characteristics.

Chapter I is an introduction to the ACL guidance. This chapter discusses the purpose, intent, and organization of the document. It also defines an ACL and describes how ACLs fit into the RCRA permitting process. A major portion of the information required for an ACL demonstration is also required for a RCRA Part B permit application. This chapter points out the overlap between these two informational requirements.

Chapter II discusses the data that the permit applicant must submit on the physical and chemical characteristics of the waste constituents. The permit applicant should already know about the hazardous constituents present in the ground water at the facility by the time an ACL demonstration is submitted. Additional ground-water sample collection is probably not necessary for ACL purposes. The permit applicant should submit the hazardous constituent information in terms of three-dimensional representations of constituent concentrations. The permit applicant needs to submit data on any factors relating to the stability and mobility of the waste constituents in the ground water. These factors may include density, solubility, vapor pressure, viscosity, and octanol-water partitioning coefficient of each constituent for which an ACL is requested.

Chapter III discusses the data needed to describe the hydrogeologic properties of the site. The geologic and hydrologic properties of each of the individual strata beneath a site that are likely to affect ground-water contaminant migration should be submitted in the ACL demonstration. Much of the data should already be available to the permit applicant if other RCRA permitting requirements have been fulfilled. The important geologic attributes of a site include:

1. Soil and rock characteristics,
2. Geologic structure, and
3. Geomorphology and topography.

In ACL demonstrations where soil and other matrix attenuation mechanisms are used to justify that exposure to ground-water contaminants will be minimal or prevented, data on attenuative properties must be discussed. The near-surface stratigraphic units located in the zone of saturation must be characterized for the hydrologic parameters of hydraulic conductivity (vertical and horizontal), specific yield (unconfined aquifer) or specific storage (confined aquifer), and effective porosity.

Chapter IV discusses ground-water quantity and flow direction which are used to assess contaminant transport. The general RCRA permit requirements specify the submittal of ground-water flow information. This data should be adequate for ACL demonstration purposes and the permit applicant probably will not have to collect additional field data. Ground-water quantity can be estimated from hydrologic parameters such as specific yield for unconfined aquifers and specific storage for confined aquifers. The use of Darcy's law for determining ground-water flow quantity is acceptable.

The hydrogeologic portion of the ACL demonstration must include an adequate description of both horizontal and vertical ground-water flow components. The horizontal ground-water flow description should include a flow net based on ground-water elevation measurements taken from monitoring wells or peizometers, screened at the same elevation in the same saturated zone. Facilities should have several nested piezometers for vertical gradient determinations. Facilities that are located in environmental settings that exhibit temporal variation in ground-water flow direction should define the extent to which the flow change occurs.

Chapter V discusses man-made hydraulic barrier systems that may be used to augment natural attenuation. Although man-made barriers are not listed in the Section 264.94(b) criteria, they are discussed in this guidance document because they can be an important factor in assessing exposure to hazardous constituents. Ground-water control structures that can be used to justify ACLs are plume management mechanisms that either steer contaminated ground water away from exposure points or reduce the ground-water transport velocity so that a natural attenuation mechanism can reduce contaminant concentrations to acceptable levels. The engineered ground-water control measures that will be considered include low permeability barriers such as slurry walls. These measures can be used either separately or together to prevent or limit exposure to the contaminated ground water. Design and construction considerations must be evaluated in order to assess the adequacy of all subsurface barrier systems. In cases where ground-water control structures are proposed for preventing or limiting exposure, the applicant must submit a plan detailing a methodology that will demonstrate the effectiveness of the engineered system.

Chapter VI discusses the types of precipitation data that should be submitted in an ACL demonstration. The permit applicant should focus the discussions of precipitation around the site's hydrologic regime. If the applicant's ACL demonstration clearly shows that ground-water discharge to surface waters is unlikely, then the discussion of precipitation events can be limited to effects on infiltration and ground-water recharge. However, if ground-water discharge to surface water is an important element of the ACL demonstration, then precipitation events should be related to ground-water recharge and discharge.

Chapter VII discusses the proximity of surface water and ground-water users and the information that should be submitted on these users. The level of information necessary to satisfy the proximity of users requirement depends on the basis of the ACL. If a downgradient surface water body is the primary focus of a demonstration, then data related to the specific characteristics of the surface water body are necessary. If the permit applicant argues that downgradient surface water bodies are unaffected by the ACL constituents, then general information on the distance of the surface water bodies from the facility is necessary. In order to assess the likelihood of exposure of current ground-water users, every ACL demonstration must discuss the proximity of ground-water users to the facility.

Chapter VIII discusses the factors needed to determine current and future uses of ground water and surface water in the vicinity of the facility. The permit applicant should examine pertinent aspects of both ground-water and surface water uses. Permit applicants must submit information on the types of ground-water uses in the vicinity of the facility, unless they can successfully argue that no exposure to the contaminated ground water will occur. The permit applicant should discuss the ground water in the vicinity of the facility in terms of the three classes discussed in the U.S. EPA Ground-Water Protection Strategy.

Surface water uses should be discussed by the permit applicant if contaminated ground water can migrate to surface waters. Surface water use information is especially critical for ACLs based on surface water dilution.

Chapter IX is concerned with the existing quality of ground water and surface water and other sources of contamination. In order for "benchmark" levels of contamination to be set, the background levels of hazardous constituents in the ground water and surface water must be established. For ACL purposes, background water quality is the quality that would be expected to be found if the facility's regulated unit(s) was not leaking contaminants. Background monitoring wells must yield ground-water samples from the uppermost aquifer representative of the quality of ground water that has not been affected by leakage from a facility's regulated unit. Background surface water quality need only be assessed in cases where surface waters are likely to receive contaminated ground-water discharges.

The permit applicant should also examine the possibility of other sources of contamination if the upgradient waters in the vicinity of the facility are contaminated. This will give the permit applicant information for assessing cumulative impacts associated with any contamination emanating from the facility.

Chapter X discusses the health risk assessment. A health risk assessment should be submitted if human exposure to the ground-water contaminants is not prevented. The purpose of the health risk assessment is to determine acceptable concentrations at a point of exposure for the constituents for which ACLs are requested. There are two major components to a determination of health risks. First, the applicant must perform an exposure assessment characterizing the populations that may be exposed to the contaminants, and the potential pathways to human exposure. Second, the health effects associated with exposure to each contaminant and mixture of contaminants must be examined.

The potential point of exposure to the ground-water contaminants is assumed to be at the facility waste management boundary unless use restrictions have been implemented. If there are ground-water use controls beyond the facility waste management boundary that will prevent use of the affected resource, the potential ground-water exposure point will be at any point downgradient of the waste management boundary. In order to designate the property boundary as the point of exposure, a facility must ensure that there are permanent prohibitions on the use of on-site ground water as a source of drinking water or for any other use that would not be protective of human health or the environment. These restrictions must apply to the owner of the facility, as well as to any successive owners. In order to designate a potential point of exposure beyond the facility property boundary, ground-water use restrictions must be in place off-site to prevent any use of the contaminated ground water. The point of exposure for surface water bodies is assumed to be the water body closest to the facility in the pathway of contaminant migration.

If human exposure can occur, the permit applicant is responsible for providing information on the health effects of the hazardous constituents present in the ground water for which ACLs are requested. The health risk assessment should be based on conservative health assumptions. The applicant should distinguish between ground-water contaminants having threshold (toxic) and non-threshold (carcinogenic) effects. The Agency is currently compiling toxicity information on many of the hazardous constituents and this information should be useful in preparing ACL demonstrations.

Chapter XI discusses data that should be submitted on the potential impacts to the environment. The initial step in assessing possible environmental impacts is to determine the probable exposure pathways for hazardous constituents to reach environmental receptors. For ACL purposes, the receptors of concern include wildlife and vegetation in aquatic and terrestrial environments; agricultural crops, products, and lands; and physical structures. The permit applicant must examine the potential impacts to all of the receptors discussed above if exposure to hazardous constituents is likely to occur. Otherwise, the permit applicant should discuss specific data that support no probable exposure and explain why the potential environmental impact assessment is not needed. If there is a likely pathway for wildlife and vegetation to become exposed to contaminants, then environmental toxicity factors should be examined.

The permit applicant is responsible for surveying the area near the facility and determining the presence of any endangered or threatened species in terrestrial or surface water environments. If any endangered or threatened species are in the area, then the potential impacts of the contaminated ground water on the species, including critical habitat impacts, should be discussed.

Physical structures can also be adversely affected by hazardous constituents in the ground water. The determination of potential impacts to and contamination of physical structures in the area around the facility requires the examination of exposure pathways, waste characteristics, and construction materials and techniques. Physical structures of concern include buildings, buried cables and pipes, railroad beds, roads, parking areas, and machinery.

Chapter XII discusses data needed to determine the persistence of the contaminants in the environment and the permanence of the adverse effects. The applicant should discuss the process by which each ACL constituent will degrade, either from a ground-water perspective, surface water perspective, or a combination of both depending on the site-specific situation. Information on the permanence of the adverse effects resulting from exposure to the ACL constituents will be required only if the ACL demonstration is based on an acceptable level of exposure to receptors. Information on permanence is needed to determine the long-term effects associated with exposure to the ACL constituents.

Chapter XIII discusses institutional controls that can be used to prevent or minimize exposure by controlling access to the contaminated ground water. Institutional ground-water use controls are not specifically listed in the Section 264.94(b) criteria but they can be important factors in assessing exposure to hazardous constituents. However, they are discussed in this document because use controls are frequently implemented in situations concerning ground-water contamination. The permit applicant must submit evidence supporting all use controls that are being proposed as a means of preventing exposure. The use controls must prevent contact with the contaminated ground water as well as encompass the existing and projected areal extent of the ground-water contamination plume. The institutional controls used to prevent exposure to the ACL constituents must contain some type of enforcement provision to guarantee the existence of the use control for as long as the ground-water protection standard is exceeded.

Chapter XIV presents the summary and conclusions of the ACL guidance document. This chapter emphasizes the independent nature of each ACL demonstration and presents the time frame of the ACL process. Information on each of the criteria discussed in this guidance document is not required in every ACL demonstration. Each ACL demonstration must reflect site specific environmental properties and waste characteristics. As part of the ground-water protection Standard, an ACL is in effect during the compliance period. If, at the end of the compliance period, the owner or operator is engaged in a corrective action program, the compliance period is extended until the owner or operator can demonstrate that the GWPS, which may contain ACLs, has not been exceeded for a period of three consecutive years.

Chapter I

Introduction

Hazardous waste facilities permitted under the Resource Conservation and Recovery Act (RCRA) regulations (40 CFR Parts 264 and 270) are required to be designed and operated in a manner that will prevent ground-water contamination. Therefore, the concentration limits for hazardous constituents detected in ground water at RCRA facilities (the "ground-water protection standards") will generally be set at background levels or RCRA adopted maximum concentration limits. These maximum concentration limits are established for 14 hazardous constituents, as set by the National Interim Primary Drinking Water Standards, and are listed in Table 1 of Section 264.94(a) of the regulations. Variances are available from these standards if the permit applicant can demonstrate that the constituents will not pose a substantial present or potential hazard to human health or the environment. In such cases, the applicant may ask for an "alternate concentration limit" (ACL) under Section 264.94 of the regulations. This section of the regulations lists 10 criteria to be applied in ACL demonstrations.

This guidance document serves to elaborate on these 10 criteria and thus provide guidance to permit applicants seeking ACLs and permit writers evaluating ACL demonstrations. The document is divided into 14 chapters which include an introduction, an explanation of each of the 10 criteria in the regulation, a discussion of the use of man-made barriers, a review of the use of institutional ground-water use controls, and a conclusion.

This document is intended to be used by RCRA permit applicants and permit writers. It may also be useful for Record of Decision preparations pursuant to the EPA Superfund program (CERCLA) or for State permit writers. In applying this guidance for Superfund or for State permits, the users must be cognizant of any differences between the requirements of their programs and the RCRA regulations and permitting programs.

Alternate concentration limits are discussed in the RCRA Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities under Subpart F: Ground-water Protection (U.S. EPA 1982a). ACLs are granted through the permit process under Parts 264 and 270. The permit applicant and reviewer should become familiar with the ground-water protection regulations and supporting preamble before proceeding with this guidance. The Subpart F Ground-Water Protection regulations and applicable parts of the preamble to the July 26, 1982, Federal Register are reprinted in Appendix 1 (U.S. EPA 1982b). These documents will give the permit applicant and reviewer a proper perspective on both the requirements and the intent of the ground-water protection regulations.

Alternate concentration limits are established in the context of the facility ground-water protection standards. The standard establishes a limit on the amount of ground-water contamination that can be allowed without endangering public health or the environment. The ground-water protection standard is an essential element in the Agency's strategy to ensure that public health and the environment are not endangered by any contamination of ground-water resulting from the treatment, storage, or disposal of hazardous wastes. As such, the standard will indicate when corrective action will be necessary to control contamination that has emerged from a regulated unit.

The principal elements of the ground-water protection standard are discussed in Section 264.92. For each hazardous constituent entering the ground water from a regulated unit, a concentration limit must be established that will serve as a limit beyond which degradation of ground-water quality will not be allowed. There are three possible concentration levels that can be used to establish the ground-water protection standard:

1. Background levels of the constituents,
2. Maximum concentration limits listed in Table 1 of Section 264.94(a), or
3. Alternate concentration limits as described in this guidance.

Section 264.94 establishes the criteria that must be used to specify concentration limits. The approach used by the regulation is to adopt widely accepted environmental performance standards, when available, as concentration limits. However, because of the lack of currently available standards, specific concentration limits for only a few specific constituents have been included in the regulations. These limits are those standards that were established by the National Interim Primary Drinking Water Regulations. If a constituent is not one of these compounds, then no degradation beyond background water quality becomes the standard. In such cases, the concentration limit should be set at background. However, a specified amount of degradation beyond background levels can be allowed by establishing alternate concentration limits. Alternate concentration limits can be established only after the applicant successfully shows that these concentrations of hazardous constituents will not adversely affect public health or the environment.

The criteria that the applicant must use when preparing requests for ACLs are specified in Section 264.94(b). Essentially, the applicant must be able to demonstrate that as long as the concentration of the hazardous constituent does not exceed the requested alternate concentration limit at the point of compliance, no substantial current or potential hazards to human health or the environment will result.

An ACL demonstration is essentially a risk assessment and risk management process in which a determination of acceptable ground-water contamination is made. Site specific information, such as local hydrogeological characteristics, the facility's waste constituents, and local environmental factors, is needed to assess the potential impact of each hazardous constituent present in the ground water on human health or the environment. There are two approaches that an applicant can take in an ACL demonstration:

1. There will be no exposure to the ground-water contaminants, or

2. The exposure to the ground-water contaminants will be at concentration levels that do not pose a substantial current or potential hazard to human health and the environment.

In the second approach, the ACL demonstration depends upon determining concentration levels of the ground-water contaminants that do not pose a substantial current or potential hazard to human health and the environment at a potential point of exposure. The ACLs for the ground-water contaminants are derived from these acceptable concentrations and are set at the facility's point of compliance.

All Agency published acceptable exposure levels for the protection of human health and the environment can be used as ACLs without going through elaborate exposure pathway analyses or fate and transport modeling. For example, a health based acceptable ground-water exposure concentration for a constituent detected in the ground water can be used as an ACL at the point of compliance. However, the acceptable level used as an ACL may need to be modified to include an assessment of any cumulative effects associated with exposure to the ACL constituent. It is anticipated that the Agency will periodically publish and update a list of acceptable dose levels that can be used by permit applicants in preparing ACL demonstrations.

The type and amount of information needed for an ACL demonstration depends on site-specific characteristics and which approach (either no exposure or acceptable risk) is chosen. Both approaches require information on the physical and chemical characteristics of the waste, flow direction and quantity of the ground water, and hydrogeological characteristics of the site. An ACL demonstration based on the second approach requires additional information. Depending on the basis for the demonstration, one or more of the following must be addressed in greater detail:

1. Current and future uses of ground water and surface water (if applicable),
2. The proximity of the user of the water resources to the facility,
3. The existing ground-water quality,
4. The potential human health risks and environmental damage from exposure to the contaminants, and
5. The permanence of the potential adverse effects resulting from exposure to the contaminants.

For any of the above factors that are not part of the ACL basis, justification is required to explain why they do not need to be addressed. Depending on the site characteristics, either approach may require information on the engineered characteristics of the facility, the rainfall patterns in the area, the existing quality of ground-water and surface water (if applicable), and any current or future institutional ground-water use restrictions.

The ACL demonstration for each constituent must be independent. It may cross reference many sections of the Part B Permit Application and it will cross reference each individual ACL constituent demonstration. Information required from the following sections of the Part B Permit Application portion of the regulations should be included in all ACL demonstrations:

270.14(b) General information requirements for all hazardous waste management facilities.

- (1) General description of the facility.
- (2) Chemical and physical analyses of the hazardous waste, in accordance with Part 264.

(8) Description of the procedures, structures, or equipment used at the facility to prevent contamination of water supplies.

(11) Facility location information:

  (i) Identification of the political jurisdiction (e.g., county or township) in which the facility is located,

  (ii) If the facility is located in an area listed in Appendix VI of Part 264, information must be submitted to demonstrate compliance with the seismic standard under §264.18(a),

  (iii) Identification of whether a facility is located within a 100-year floodplain,

  (iv) Information required if a facility is located in a 100-year floodplain.

(19) A topographic map clearly showing:

  (i) Map scale (at least one inch: 200 feet) and date,

  (ii) 100-year floodplain area,

  (iii) Surface waters including intermittent streams,

  (iv) Surrounding land uses,

  (vi) Orientation of the map,

  (vii) Legal boundaries of the facility,

  (ix) Injection and withdrawal wells both on-site and off-site,

  (x) Buildings; treatment, storage, or disposal operations, or other structures,

  (xi) Barriers for drainage or flood controls, and

  (xii) Location of operational units within the facility site, where hazardous waste is or will be.

270.14(c) Additional information required for the protection of ground water for hazardous waste surface impoundments, piles, land treatment units, and landfills.

(1) A summary of the interim status ground-water monitoring data.

(2) Identification of the uppermost aquifer and aquifers hydraulically interconnected beneath the facility property, including ground-water flow direction and rate, and the basis for such identification.

(3) Additional information to be included on the topographic map:

   (a) Delineation of the waste management area, the property boundary, and the proposed "point of compliance";

   (b) The location of ground-water monitoring wells;

   (c) The hydrogeologic information required under §270.14(c)(2).

(4) A description of any plume of contamination that has entered the ground water that:

   (i) Delineates the extent of the plume on the topographic map, and

   (ii) Identifies the concentration of each Part 261 Appendix VIII constituent throughout the plume, or identifies the maximum concentrations of each Appendix VIII constituent in the plume.

(7) Information needed to establish a compliance monitoring program under §264.99:

   (i) A description of the wastes previously handled at the facility;

   (ii) A characterization of the contaminated ground water, including concentrations of hazardous constituents;

   (iii) A list of hazardous constituents for which compliance monitoring will be undertaken in accordance with §§264.97 and 264.99;

   (iv) Proposed concentration limits for each hazardous constituent, based on the criteria set forth in §264.94(a), including a justification for establishing any ACLs;

(v) Detailed plans and an engineering report describing the proposed ground-water monitoring program to be implemented to meet the requirements of §264.97; and

(vi) A description of the proposed sampling, analysis, and statistical comparison procedures to be utilized in evaluating ground-water monitoring data.

The following sections of the Part B permit application could be used in an ACL demonstration, if they apply to the site-specific characteristics:

270.14(b)(5) General inspection requirements under §264.15(b), if applicable to the ACL demonstration.

(13) A copy of the closure plan and the post-closure plan, if applicable to the ACL demonstration.

(20) Additional information necessary to satisfy other Federal law requirements under §270.3. These laws may include:

(a) The Wild and Scenic Rivers Act (16 USC 1273),

(b) The National Historic Preservation Act of 1966 (16 USC 470),

(c) The Endangered Species Act (16 UC 1531),

(d) The Coastal Zone Management Act (16 USC 1451), or

(e) The Fish and Wildlife Coordination Act (16 USC 661).

270.14(c)(8) Information needed to establish either a corrective action program which meets the requirements of §264.100, if applicable to the ACL demonstration, or a compliance monitoring program which meets the requirements of §264.99 and §270.14(c)(6).

The information presented in the demonstration on proposed concentration limits is only one source that should be reviewed by the permit writer. Independent research by the permit writer is essential in reviewing the applicant's ACL demonstration. The rocks or steeply inclined strata. Ground-water flow direction is difficult to determine from water level data in these types of anisotrophic aquifers.

The factors that make the determination of flow rates and directions unreliable can often be overcome by an expanded effort in water level monitoring. For seasonal variations in water levels, a higher frequency monitoring schedule is necessary. For low horizontal gradients, the effects of short-term changes in water levels can be analyzed by installation of continuous recorders in selected wells. In aquifers having significant vertical gradients, piezometers completed at various depths may be required in order to provide a three-dimensional description of the flow field. For heterogeneous and anisotropic aquifers, more water level monitoring wells and more field tests for hydraulic properties are required.

The hydrogeologic portion of the ACL demonstration must include an adequate description of both horizontal and vertical ground-water flow components. This requirement has very obvious implications from the standpoint of determining where the hazardous constituents may migrate. The horizontal ground-water flow description should include a flow net based on ground-water elevation measurements taken from monitoring wells or peizometers, screened at the same elevation in the same saturated zone. It must be designed to provide reliable results of the ground-water flow direction in the zone of saturation. There may be sites that will require the applicant to monitor for hazardous constituents at more than one ground-water elevation. When this situation occurs, the permit applicant must be especially careful to ensure that the monitoring plan is designed correctly.

Information obtained from analyses of the hydrogeological properties and flow direction will allow the calculation of the interstitial flow velocity. The use of flow nets is described in Appendix 4. Well identifier codes, well depths, screened intervals, ground water elevations, and sampling data should be presented in tabular form. The flow net data should be graphically portrayed on a site map that includes ground-water elevations, isopleths, and flow vectors. As discussed before, the interstitial ground-water velocity can be determined by a simple modification of Darcy's equation (see Appendix 4). All calculations and assumptions should be included in the discussion of flow rates.

Vertical ground-water gradients and flow should also be described. Facilities should have several nested piezometers for vertical gradient determinations. Vertical flow gradient will aid in determining discharge and recharge zones, aquitard characteristics, and whether the monitoring wells are located and screened at the appropriate depths. The permit applicant should refer to Appendices 3 and 4 for further discussion of nested piezometers. The data that should be submitted in tabular form for each well nest includes well identification code, well depth, screened interval, ground-water elevation, and sampling date. All calculations and assumptions should be described in detail.

Facilities that are located in environmental settings that exhibit temporal variation in ground-water flow direction should define the extent to which the flow change occurs. The main causes of ground-water flow variation are:

1. Seasonality of recharge or discharge,
2. Ground-water withdrawals,
3. Underground injection, and
4. Surface water elevation changes.

In cases of seasonal ground-water flow variation, the permit applicant should provide information that describes those temporal changes in ground-water flow direction using records compiled over a period of no less than one year.

The rate of withdrawal of ground water is an important factor that influences ground water and contaminant movement, and exposure to contaminated water. The rate of ground-water withdrawal in the vicinity of the facility should be summarized in tabular form and include well location, depth, type of user, and withdrawal rates. The zone of impact created by any major well or well field withdrawal should be identified on a USGS topographic map. The map should include drawdown isolines out to the 10 centimeter drawdown level. Modeling of drawdown curves should use low recharge assumptions such as drought conditions.

Chapter V

Engineered Characteristics of the Site

While the two previous chapters dealt with natural hydrogeologic characteristics of a facility's site, this chapter discusses man-made hydraulic barrier systems that may be used to alter the natural hydrogeology. Man-made hydraulic barriers are not specifically mentioned in the criteria listed in Section 264.94(b) of the regulation but they can be an important factor in assessing exposure to hazardous constituents (see Section 264.94(b)(viii and ix)). However, they are discussed in this document because man-made barriers to ground-water movement, such as slurry walls, frequently come into consideration as control devices in cases of ground-water contamination. Man-made ground-water control structures must meet one of the following criteria before they will be accepted as the basis for ACLs:

1. Exposure to the ACL constituent will be prevented by the control structure, or
2. Exposure levels to the ACL constituents will be reduced to levels that are protective of human health and the environment by the use of hydraulic barriers.

It must be stressed that a demonstration that claims perpetual containment of contaminated ground water is not acceptable for purposes of justifying ACLs. This is because engineered systems eventually leak and therefore by themselves do not preclude the ACL constituent from "posing a substantial present or potential hazard" as specified by Section 264.94(a) of the regulation.

This is not to say that containment measures (e.g., slurry walls) cannot be used as part of a corrective action measure for a facility. For example, a containment structure could be used in conjunction with withdrawal wells to remove contaminants from the ground water. Such corrective action measures must be initiated and completed within a "reasonable period of time" under Section 264.100. The permit writer may specify the duration of such corrective action measures after considering the need for prompt action at the site and the technical capacity of the owner or operator.

Any owner or operator that uses man-made hydraulic barriers to restrict exposure or augment attenuation must demonstrate that there will be a permanent monitoring system present to ensure that the proposed control technology functions according to the specified performance standards. Appendix 5 contains information on the types of monitoring systems needed to ensure the effectiveness of slurry walls. Similar monitoring systems are required for other types of engineered structures.

The permit applicant has the opportunity to demonstrate that a ground-water control structure will augment natural attenuation of the ACL constituents in the ground water, thereby limiting exposure. Ground-water control structures that can be used to justify ACLs are plume management mechanisms that either steer contaminated ground water away from exposure points or reduce the ground-water transport velocity so that natural attenuation mechanisms can reduce contaminant concentrations to acceptable levels.

Demonstration Objectives

Attenuation of ground-water contaminants occurs naturally through several mechanisms:

1. Dilution of contaminants by mixing with "uncontaminated" ground water,
2. Adsorption of contaminants by the aquifer matrix, or
3. Degradation of contaminants by processes occurring in the ground water.

These processes depend on both spatial and temporal factors. A ground-water control system can act to delay ground-water transport so that natural attenuation is enhanced, aiding adsorption or degradation by increasing the time for processes to occur or by increasing the contact time with the aquifer matrix. Control systems can also act to increase the distance of travel to exposure points or to prevent short-circuits via fractures, sand lenses, or other hydrologic channels. An increase in transport distance can be effective in attenuating contaminants because of greater dilution or increased adsorption. Greater dilution could result from an increase in the volume of ground water and increased adsorption would result from more aquifer matrix coming in contact with the hazardous constituents.

The objective of an ACL demonstration based on man-made control mechanisms is to show that the control system is effective in reducing contaminant concentrations to acceptable levels. Control structures could result in acceptable exposures if they steer ground-water contaminants to major surface water dilution sources where the effects of the contaminants are minimal.

Engineered Ground-Water Controls

The various methods of engineered ground-water control that will be considered include barriers of low permeability such as slurry walls, cutoff walls, and grout curtains. The low permeabilfty barriers can be used to limit exposure to the contaminated ground water. Low permeability barrier systems will be considered in ACL demonstrations only when they are used to steer or manage ground-water plumes.

Slurry walls and cutoff walls are subsurface barriers that can reduce, retard, or redirect the flow of ground water. In general, they consist of an excavated trench that is refilled with either a soil-bentonite mixture, a bentonite-cement mixture, or an asphalt mixture. In most instances, they will be keyed into an impermeable layer or bedrock. There are several design and construction considerations that must be evaluated in order to assess the adequacy of such a system. The permit applicant must submit the results of a thorough hydrogeologic and geotechnical investigation (see Chapters III and IV). The applicant must also submit detailed information regarding:

1. Hazardous constituent compatability;
2. Barrier wall constituent mixture ratios, and method of mixing;
3. Method of excavation;
4. Method of keying the slurry wall into the aquitard or bedrock;
5. Method of determining the effectiveness of the barrier wall;
6. Location;

7. Length, width, and depth;
8. Hydraulic conductivity and sorption capacity; and,
9. Changes in the hydrologic regime.

All information submitted to the agency describing the design considerations should be accompanied by the signature of a professional engineer or qualified geologist or geotechnical engineer attesting to the appropriateness of the barrier wall system to the site geohydrology.

Grout curtains are another method of ground-water control. In general, grouting is accomplished by drilling holes to the desired depth and injecting the grout under pressure into the holes. The grout mixture itself may be one of two types, either suspension grout or chemical grout. For a more detailed description of grout types, see Appendix 5.

As with designing a slurry wall system, hydrogeologic and geotechnical testing must be performed prior to installing a grout curtain. All the information needed for an evaluation of a slurry wall system must be submitted by the permit applicant. In addition, the following information is needed:

1. Detailed drilling information,
2. Grid design,
3. Type of grout used,
4. Grout losses and injection pressure, and
5. Curing time (if applicable).

Ground-water pumping systems that are considered corrective action measures may be used to augment plume management. Again, the permit applicant must submit the detailed hydrogeologic and geotechnical information as described in Chapters III and IV. In addition, the applicant must submit an analysis describing the predicted effect that the ground-water pumping system will have on the natural flow regime. The applicant must consider the effects that the pumping system has on:

1. Production wells in the site vicinity,
2. Injection wells in the site vicinity, and
3. Facility withdrawal and/or injection wells.

A computer modeling analysis should be performed to predict the above effects.

All hydrogeological parameters used for the computer modeling analysis should be field-determined values. Parameter values that are taken from the literature or represent "reasonable" assumptions should not be accepted in lieu of actual facility-specific parameter values except in those rare instances when the literature data is unquestionably applicable to the site.

In cases where ground-water control structures are proposed for limiting exposure, the applicant must submit a plan detailing a methodology that will demonstrate both the effectiveness of the engineered system and the steps that will be taken if the system fails. This plan must include a ground-water monitoring program, a control structure testing plan, a modeling plan assessing effectiveness, and an exposure assessment describing the consequences of system failure. Failure of the system to meet specifications for its effectiveness is a violation of the permit equally as serious as exceeding the ACL at the point of compliance. Such failure will require reevaluation of the ground-water protection standards and possibly corrective action.

Chapter VI

Patterns of Rainfall
(§264.94(b)(2)(iv))

Precipitation is a driving factor for ground-water recharge and ground-water discharge. These processes are basic components of the hydrogeology at a facility. To verify a claim of no exposure or exposure to acceptable levels of contaminants, precipitation data in support of ground-water flow and contaminant transport information must be submitted. This chapter describes the type of precipitation data that should be submitted in support of an ACL demonstration.

The permit applicant should focus the discussion of precipitation around the site's hydrologic regime. If the applicant's ACL demonstration clearly shows that ground-water discharge to surface waters is unlikely, then the discussion of precipitation events can be limited to effects on infiltration and ground-water recharge. However, if ground-water discharge to surface water is an important element of the ACL demonstration, then precipitation events should be related to recharge and discharge of ground water.

Precipitation events are variable and occur with different intensities, volumes, and durations. The geographical distribution of rainfall also varies from one area to another within a region. However, over a long period of time (years), the precipitation data for an area can be represented by events with definite volumes that occur at various frequencies. These frequencies are classified in terms of duration and yearly return periods. For example, a one day/10-year storm event is defined as the amount of rainfall that is expected to occur during a 24-hour period, once every 10 years. The precipitation volume of a storm of specific return period and duration is used to produce an estimate for the volume of precipitation for a given geographical area.

All permit applicants must submit general information on the precipitation characteristics of a site. This includes data on rainfall and snowfall, expressed as its equivalent in rainfall. Monthly precipitation data gathered over a period of at least 12 months should be submitted. Historical data can be used if it is from an area within 15 km of the facility. The regional rainfall data from areas greater than 15 km of the facility should be correlated with available on-site data. The National Oceanographic and Atmospheric Administration or climate data in Ruffner (1980 and 1981) may be a source of this precipitation information if on-site data is unavailable. The monthly mean and range of this data, the specific time period the data comes from, and the location of the rain gauge(s) in relation to the facility should be provided. The permit applicant should discuss the precipitation data in terms of temporal effects on infiltration and seasonal ground-water recharge. These processes should be related to any effects on contaminant transport.

If the facility is located near surface water bodies (see Chapter VII), or if surface water dilution is used as an argument in an ACL demonstration, then more detailed information on precipitation events should be submitted. Otherwise, the permit applicant can proceed to the next chapter. The permit applicant should submit data on specific storm frequency patterns and discuss how these storms relate to flood and infiltration/discharge characteristics of the facility.

The predicted volume of precipitation produced over a 24-hour period by storms of return frequencies of 1, 10, 25, and 100-years should be submitted. The 1-year and 10-year storm frequency information gives insight into ground-water infiltration and discharge patterns. The 25-year and 100-year storm frequency data are useful in assessing discharge during flood conditions.

The 100-year floodplain should be described on a *USGS* topographic map. The floodplain information should be readily available to the applicant since it is required by Section 270.14(b) permitting requirements. Federal Insurance Administration flood maps can be a useful source for this information. If the facility has any special flood prevention devices, they should also be shown on the map. These devices could include any dikes, berms, and special flood retention walls. The effect of these devices on ground-water infiltration and discharge should be discussed. Furthermore, any special site conditions that affect infiltration and discharge should be discussed. These include site topography, solar orientation of the regulated unit, and wind patterns.

The ground-water discharge patterns at the facility should also be delineated on a topographic map. All streams, ditches, culverts, and sewers that receive ground water should be clearly identified. Normal ground-water discharge patterns (1-year storm) and discharge during flood conditions (25 and 100-year storms) should be clearly marked. Snow melt pathways should be identified, if appropriate. Any discharge abatement or collection devices, such as detention basins, swales, and canals, should be described.

Chapter VII

Proximity of Surface Water and Ground-Water Users (§264.94(b)(1)(iv) and (2)(v))

This chapter and the next chapter discuss important factors necessary for assessing probable exposure pathways for the ACL constituents through surface and ground water. This chapter discusses the location of surface water and ground-water users in the vicinity of the facility. The uses of surface and ground water in the vicinity of the facility are discussed in Chapter VIII.

A key factor involved in assessing exposure is the proximity of surface water and ground-water users to the facility. This factor is considered in the evaluation of existing or potential off-site migration of hazardous constituents and in the assessment of the uses of the specific water resources. For ACL demonstrations, "proximity" is liberally defined to include both spatial and temporal concepts. Linear distance may be more appropriate for judging potential surface water exposures, while time of travel is important for ground-water exposures. Proximity should be expressed in terms of both linear distance and time required for ground-water flow and contaminant transport.

The level of information necessary to satisfy the proximity of users requirement depends on the basis of the ACL. If a down-gradient surface water body is the primary focus of a demonstration, then data related to the specific characteristics of the water body are necessary. The permit applicant may use surface water dilution as an argument for acceptable exposure limits for an ACL constituent.

An ACL demonstration based on dilution should be supported by data on specific physical attributes of the surface water body. This includes information necessary to estimate the dilution potential and mixing mechanisms of the water body. If the permit applicant argues that no exposure will take place in downgradient water bodies, then general information on the distance of the water bodies from the facility is necessary, along with time of travel estimates for contaminant migration to the water bodies. Likewise, the same arguments apply to the level of information necessary to assess exposure of ground-water users. This will be discussed further in the following sections.

Surface Water

All ACL demonstrations should include a discussion of the potential effects of the facility on surface waters. The initial evaluation includes assessing the facility's proximity to surface waters and involves:

1. Identifying each surface water body in the vicinity of the facility,
2. Determining the distance from the waste management area boundary to each surface water body,
3. Identifying ground-water discharge pathways to surface waters, and
4. Estimating time of travel of waste constituents to water bodies.

Each water body within five kilometers downgradient (or downstream) of the facility boundary should be identified. The owner or operator of the facility must supply a USGS topographic map identifying each water body. All streams, rivers, ponds, lakes, estuaries, and marine waters should be clearly marked. All ditches, streams, sewers, and runoff pathways that serve as ground-water discharge or infiltration areas should be delineated on the topographic map. A table specifying the name of each water body and the distance from the waste management area to the closest part of each water body should be provided by the owner or operator of the facility.

The travel time of the ACL constituents from the facility to the discharge areas should be discussed by the permit applicant. Ground water and hazardous constituents may move at different rates due to different physical and chemical properties. Therefore, discharge calculations should include estimates of both hydraulic transport and waste transport. The ground-water transport models and methods discussed previously in Chapter IV should be used to estimate the hydraulic and hazardous constituent loading rates. Actual seepage measurements may be necessary to verify model estimates if ground-water discharges are estimated to be a significant portion of the annual hydraulic load to a water body.

A greater level of detail on characteristics of surface water bodies is needed in ACL demonstrations that include dilution in surface waters as an argument or in cases where surface waters are likely to be exposed to ACL contaminants due to their proximity to the facility. In these cases, the physical characteristics of each identified downgradient (or downstream) water body should be included in a table. Important lake and pond characteristics are:

1. Surface area,
2. Mean depth,
3. Volume,
4. Temperature stratification, and
5. Hydraulic residence time.

Information on estuarine and marine areas should include:

1. Surface area,
2. Mean depth, and
3. Tidal periodicity and amplitude.

Pertinent stream and river characteristics are:

1. Mean width;
2. Mean depth;
3. Flow rate, including average flow and lowest flow that would be expected to occur during a continuous 7-day period, once every 10 years (Q7-10); and
4. Lowest recorded flow rate.

This information is necessary to estimate the dilution potential and mixing mechanisms of each type of surface water in the vicinity of the facility. The temporal and spatial variability of flow rates, tidal factors, and hydraulic residence times are also essential factors for establishing dilution potential.

The permit applicant should synthesize this information to support arguments of acceptable surface water exposures or no significant exposures due to dilution in surface waters. The expected amount of dilution and the mixing zones of probable discharge areas should be factored into this discussion. The permit applicant should be aware that certain States have approved surface water dilution models that are used in the NPDES permitting program. If approved models are available, they should be used by the applicant to determine mixing zones and dilution in surface waters.

Ground Water

As a matter of general policy for ACL demonstrations, the potential ground-water exposure point is the waste management boundary of the facility. If there are ground-water use controls beyond the facility waste management boundary, the potential groundwater exposure point will be at any point downgradient of the waste management boundary. In order to designate the property boundary as the point of exposure, a facility must ensure that there are permanent prohibitions on the use of on-site ground water. These restrictions must apply to the owner of the facility, as well as to any successive owners. In order to designate a potential point of exposure beyond the property boundary, ground-water use restrictions must be in place off-site to prevent any use of the contaminated ground water. Ground-water use restrictions are discussed in Chapter XIII.

In order to assess the likelihood of exposure of current ground-water users, every ACL demonstration must discuss the proximity of ground-water users to the facility. This requires determining:

1. The distance of each ground-water user from the facility, and
2. The hydrologic transport time for the contaminants to reach the closest users.

The users of ground water within a five kilometer radius of the facility boundary must be identified. The applicant should delineate each ground-water withdrawal or injection well on a USGS topographic map. The distance of each well from the waste management area should be given in a table. The following uses of each well should be clearly marked:

1. Potable (municipal and residential),
2. Domestic, non-potable,
3. Industrial,
4. Agricultural, and
5. Recharge.

The permit applicant has the opportunity to discuss the likelihood of exposure at the facility's property boundary. Although it is not required in every ACL demonstration, it may be to the permit applicant's advantage to submit information on the projected future users of the ground water. Several factors should be examined:

1. Demography of the surrounding area,
2. Zoning patterns and projected changes in zonings,
3. Projected population growth,
4. Projected ground-water use, and
5. Restrictions on ground-water use.

Each of these factors should be concisely described in a narrative format. The projections in zoning changes, population growth, and ground-water use should include median and maximum estimates. Discussions of ground-water use restrictions should explicitly state the legal nature of any restrictions and the

Chapter VIII

Current and Future Uses of Ground Water and Surface Water in the Area (§264.94(b)(1)(v) and (2)(vi))

Once the location of the surface water and ground-water users has been determined, the nature of the use must be considered. A major objective of an ACL demonstration can be to show that ground-water contamination at a facility will not adversely affect any water use. The supporting arguments for the ACL can center around the fact that the ground-water contamination at the facility is not degrading the designated beneficial uses of the water resources. This requires the permit applicant to review federal, state, and local standards or guidelines that govern the uses of both ground and surface water to ensure that the presence of a contaminant plume is not inconsistent with any published regulations, ordinances, or guidelines. This chapter points out the types of water uses that should be investigated, and the information that should be submitted on those water uses to support an ACL demonstration

An ACL demonstration based on a claim of no degradation of a water resource should discuss the current uses of all water resources near the facility. Information gathered to satisfy data requirements on the proximity of water resource users (see Chapter VII) will be adequate to identify major water resources near the facility. In order to aid the permit reviewer, the water resource use information should be structured around the following general categories:

1. Agricultural - irrigation and animal watering;
2. Industrial - process, cooling, and boiler water;

3. Domestic and municipal - potable and lawn/garden watering;

4. Environmental - ground-water recharge or discharge, fish and wildlife propagation, unique areas; and

5. Recreational - fishing, swimming, boating, and other contact uses.

The permit applicant should examine pertinent aspects of both ground water and surface water uses. Both the current uses and the likely future uses of the water resources should be examined. Permit applicants must submit information on the ground-water uses in the vicinity of the facility, unless they can successfully argue that no exposure to the contaminated ground water will occur. The specific type of ground-water use information is described in the following section.

Ground-Water Uses

The U.S. EPA has developed a Ground-Water Protection Strategy (U.S. EPA, 1984b). An important part of this strategy is to adopt guidelines for consistency in the Agency's ground-water protection efforts. The strategy states that ground water should be protected to its highest beneficial use. Guidelines for classifying ground water should be available in the fall of 1985. Three general classes of ground water are recognized:

Class I: Special ground waters are those that are highly vulnerable to contamination because of the hydrological characteristics of the areas under which they occur, and that are also characterized by either of the following two factors:

a) Irreplaceable--no reasonable alternative source of drinking water is available to substantial populations, or

b) Ecologically vital--the aquifer provides the base flow for a particularly sensitive ecological system that, if polluted, would destroy a unique habitat.

Class II: Current and potential sources of drinking water and waters with other beneficial uses include all other ground waters that are currently used or potentially available for drinking water or other beneficial uses.

Class III: Ground waters not considered potential sources of drinking water and of limited beneficial use are those that are heavily saline, with total dissolved solids (TDS) levels over 10,000 mg/l, or are otherwise contaminated beyond levels that allow cleanup using methods that are reasonably employed in public water system treatment. These ground waters also must not migrate to Class I or II ground waters or have a discharge to surface water that could cause degradation.

The permit applicant should discuss the ground water classification in the vicinity of the facility in terms of these three classes or other appropriate State approved classification schemes. This classification information may be found in State ground-water plans (208 plans) or State ground-water classification documents. The data should be presented in tabular form in order to expedite its review. Certification by the state and/or local government as to the beneficial use of the ground water should be included if the State has classified the ground water. Otherwise, the permit applicant should have its ground-water classification data reviewed by the State. The State's review should be included in the ACL demonstration.

It should be obvious that the ground-water use can be critical in the setting of ACLs at a facility. Facilities that are contaminating, or have the potential to contaminate, Class I or Class II ground waters must incorporate human health factors into their ACL demonstration (see Chapter X). The Agency's Ground-Water Protection Strategy states that the Agency's policy is to not grant ACLs at hazardous waste facilities situated above Class I ground waters. Before this policy can be fully implemented in the ACL process, it will be necessary to define Class I ground waters in regulations and to appropriately amend the ACL regulations. In the interim, this guidance document emphasizes the careful consideration of contaminant impacts on Class I ground waters during the ACL process.

If the ground water is Class III, then health-based concerns may be secondary to environmental-based concerns in the setting of ACLs. More information on ACLs in Class III ground water is presented in Appendix 6. Two situations are envisioned in which ACLs could be proposed based on poor ground-water quality:

1. The existing risk from potential consumption or use of the ground water may be already so great that the increase of the concentration of a specific constituent would pose no additional risk, or
2. The ground water has been declared unfit for use by the State government, and controls are in place to prevent its use (see Chapter XIII).

<u>Surface Water Uses</u>

Surface water uses should be discussed by the permit applicant if contaminated ground water can migrate to surface waters. Surface water use information is especially critical for ACLs based on surface water dilution. The previous chapter on proximity of surface waters should aid in deciding which water bodies are of interest. If no surface water impacts are likely, then the data discussed in this section are not required to be submitted.

The statutory established guidelines, criteria, and/or standards for each water body identified in Chapter VII must be examined. The permit applicant should list in a table the designated use of each water body, a citation of the local, state, or federal regulations governing the use, and the agency responsible for implementing the regulation. The following general use categories should be used by the permit applicant in preparing the table:

1. Drinking water source,
2. Fish and wildlife propagation area,
3. Industrial or agricultural water source,
4. Area of special ecological concern, and
5. Recreational area.

It should be noted that many States have generic restrictions on the discharges of "toxic pollutants in toxic amounts" and of "potential carcinogens" to surface waters.

The surface water use information will aid in determining appropriate ACLs by identifying surface water exposures that can occur. The data gathered to fulfill the requirements of this section will be used to prioritize the likely exposure pathways and to determine whether human health and environment factors should be assessed in further detail (see Chapters X and XI).

Chapter IX

Existing Quality of Ground Water and Surface Water, and Other Sources of Contamination (§264.94(b)(1)(vi) and (2)(vii))

In order for "benchmark" levels of contamination to be set, the background levels of hazardous constituents in the ground water must be determined in every ACL demonstration. If surface water exposure to the ground-water contaminants is part of the ACL demonstration, the background levels of the ground-water contaminants in the surface water must also be determined. If the ground water and surface water sampled for background levels appear to be contaminated, the facility owner or operator should examine the possibility of other sources of contamination in the vicinity of the facility. This chapter discusses the type of background water quality data that should be submitted in an ACL demonstration in order to adequately assess the cumulative impacts associated with any contamination emanating from the facility.

Background Water Quality

For ACL purposes, background water quality is the quality that would be expected to be found if the facility was not leaking contaminants. Careful planning must be used in deciding where representative background water samples should be taken. Under Section 264.99, the regulations specify a procedure for establishing background levels for hazardous constituents for purposes of setting ground-water standards. Essentially, background monitoring wells must yield ground-water samples from the uppermost aquifer that represent the quality of ground water that has not been affected by leakage from a facility's regulated unit. For most sites, this is an upgradient area that can be determined readily from the water level data. The permit applicant is directed to the Draft RCRA Permit Writers' Manual for Ground-Water Protection (U.S. EPA, 1983a) for further guidance on ground-water monitoring and station locations. Background surface water quality must be assessed only in cases where surface waters are likely to receive contaminated ground-water discharges (see Chapter VIII). Background surface water quality should be determined upstream of the facility to ensure that any leakage from the facility is not affecting the monitoring results.

The permit applicant should submit a site map that identifies the location of background sampling stations and monitoring wells, and the direction of both ground-water movement and stream flow. Any flood discharge pathways and directions should also be shown on the site map.

The permit applicant may find historical ground-water monitoring studies and ambient surface water monitoring programs to be useful when assessing background water quality. The USGS, U.S.EPA, State, and local environmental program offices can be good sources of historical data. The background concentrations in both ground water and surface water of Appendix VIII constituents for which ACLs are being proposed should be included in a summary table. Each distinct aquifer and surface water body that is likely to be exposed to contaminants should be listed separately. If additional monitoring studies are necessary for determining background water quality, the EPA Regional Office may assist by reviewing the monitoring work plans. Regardless of the source of the background water quality data, the permit applicant should submit available quality assurance and quality control information on sample collection, sample analysis, well construction, and environmental conditions. Documents from which any data were taken should be available for review if they are requested by the permit writer.

Ground-Water Contamination Sources

The permit applicant should investigate other sources of ground-water contamination if background monitoring wells exhibit contamination. If no contamination is found, the permit applicant can omit the following discussion and proceed to the surface water discussion. The types of upgradient pollution sources and the impacts of the contamination on ground-water use are important and should be considered. Identifying potential pollution sources is necessary in order to assess the cumulative impact of pollution sources on human health and the environment. The following potential pollution sources should be identified within a five kilometer radius of the site:

1. Other RCRA facilities,
2. Superfund sites,
3. Landfills,
4. Industrial areas,

5. Surface impoundments,
6. Chemical storage areas,
7. Deep well injection sites,
8. Agricultural areas,
9. Septic tanks, and
10. Underground storage tanks.

Each potential contamination source should be delineated on a USGS topographic map. The distance of each source from both the facility and the upgradient monitoring wells should be discussed. All pertinent ground-water data on any of the identified sources should also be discussed.

Some areas may have hazardous constituents present in the ground water because of natural processes occurring in the ground water. For example, some metals may be found at fairly high levels in certain ground waters. However, natural sources of synthetic organic compounds (e.g., chlorinated solvents) are not expected. If synthetic organic compounds are found in background samples, then the permit applicant should attempt to to identify the the source of contamination.

The water-use impacts from the contamination should be discussed by the permit applicant if upgradient ground water is impaired by any source of contamination. In Chapter VIII of this guidance, the current and future uses of ground water are discussed in more detail.

Surface Water Contamination Sources

The permit applicant should examine other sources of surface water contamination if the applicant's facility affects surface water resources. Consideration should be given to both point and non-point sources of contamination. Any point sources of pollutant loading to surface waters should be identified on a USGS topographic map. The point sources should include:

1. Discharges from industrial facilities,
2. Discharges from Publicly Owned Treatment Works (POTW), and
3. Past waste discharges.

The permit applicant should submit a table that includes the name of each point source and the water body into which the point source discharges. The discharge rate and NPDES permit number of each point source should also be included in this table. Any waste load allocations, permit discharge conditions, and mixing zones should be discussed. The applicant should focus these discussions around the impact of the facility's discharge on these factors. For example, a lake may have an established waste load of 5 grams of lead/day, of which 4 grams are allocated to a NPDES permitted facility. The discharge of lead from the applicant's facility to the lake is estimated to be 3 grams/day. In this situation, an appropriate ACL for lead may be one that results in a loading rate of one gram/day to the lake, thus requiring some type of corrective action to reduce the lead concentration to the ACL. Copies of available

NPDES permit compliance and permit application monitoring data should be submitted if they contain information on the specific ACL constituents.

Any non-point sources of pollution to surface waters that may affect the ACL decision should also be discussed. The permit applicant should submit information on:

1. Urban storm run-off,
2. Agricultural run-off,
3. Ground-water infiltration, and
4. Other RCRA facilities.

Actual monitoring data may be submitted along with loading model calculations, if they are applicable.

Chapter X

Potential Health Risks
(§264.94(b)(1)(vii) and (2)(viii))

A health risk assessment should be included in an ACL demonstration if human exposure to the ground-water contaminants is not prevented. There are two major components to a determination of health risks. First, an exposure assessment must be performed that characterizes the current and future populations that may be exposed to the contaminants, and the current and potential human exposure pathways. Second, the health effects associated with exposure to each contaminant and mixture of contaminants must be examined. The purpose of the health risk assessment is to determine acceptable concentrations at a point of exposure for the constituents for which ACLs are requested. These acceptable concentrations can be used as a basis to calculate the ACLs at the point of compliance. This chapter describes the information necessary to sufficiently support proposed acceptable concentrations for constituents in an ACL demonstration.

The type of information needed to satisfy the health risk requirement depends on the exposure pathway. If the contaminated ground water is discharging into a downgradient surface water body that is a source of drinking water and a sustained fishery, the health risk information must be based on exposure from the consumption of contaminated water and aquatic organisms. In this case, an ACL demonstration could be based on surface water dilution of the contaminated ground water to an acceptable level.

If the primary exposure pathway is from a ground-water source of drinking water, the health risk information must be based on the consumption of contaminated drinking water. In this case, attenuation mechanisms in the saturated zone may be the basis for the ACL demonstration.

The health risk assessment may be based on the following types of likely exposure pathways:

1. Drinking water exposure from either a ground water or a surface water source,
2. Ingestion of contaminated food (e.g., aquatic organisms or agricultural products),
3. Dermal contact (e.g., recreational use of surface waters, or bathing),
4. Inhalation of volatile organics, or
5. Any combination of the above pathways.

The inhalation exposure pathway usually does not have to be addressed in great detail in an ACL demonstration. It should only be considered in cases where significant quantities of volatile organic compounds are either likely to degas from the contaminated ground water during use or can be expected to penetrate subsurface structures such as basements. The permit applicant should comment on the probability of the occurrence of these two types of exposures. The applicant will have to address inhalation in the health assessment in these situations where the use of ground water or the presence of subsurface structures allows for probable exposures.

When determining potential health risks, certain assumptions are usually made when complete data on specific human effects are lacking. Both the information that is needed to make a reasonable determination of potential health risks and the areas where assumptions may be necessary are discussed in the following sections.

Exposure Assessment

The location of the potential sources of exposure from surface and ground water is discussed in Chapter VII. The potential point of exposure to the ground-water contaminants is assumed to be at the facility waste management boundary unless use restrictions discussed in Chapter XIII have been implemented. The point of exposure for surface water bodies is assumed to be the water body closest to the facility in the pathway of contaminant migration. Once the location of the potential sources of exposure are identified, the applicant should determine whether a characterization of the populations that may be exposed at each point is necessary. In cases where the probability of exposure is not high because of no current off-site contamination or no large population centers, the exposure assessment can be based on standard assumptions (e.g., a 70 kg adult consuming 2 liters of water per day). The permit applicant does not need to assess population characteristics of the site but should follow the Agency's proposed quidelines for exposure assessments (U.S. EPA, 1984c).

However, the permit applicant should specifically characterize the exposed population in three specific situations:

1. Exposure to hazardous constituents is occurring due to the use of contaminated off-site water resources,

2. Exposure to hazardous constituents is highly probable due to off-site migration of contaminants, and

3. Probability of exposure is high due to a large population near the facility.

These situations of likely exposure are defined for ACL purposes to be cases either where hazardous contaminants have moved off-site via either ground-water or surface water pathways, or where the facility is located within a standard metropolitan statistical area (SMSA) as defined by the U. S. Department of Commerce. The following population characteristics should be determined in these cases:

1. Sex and age distributions,
2. Growth rates, and
3. Sensitive subgroups.

Most of this information can be obtained through the Bureau of the Census, U.S. Department of Commerce.

The presence of sensitive groups such as pregnant women, children, or chronically ill individuals within an exposed population directly affects the assumptions used to determine an acceptable concentration for an ACL constituent (U.S. EPA, 1980). The applicant should identify the most sensitive group within the exposed population. This subgroup should form the basis for the exposure assumptions used in deriving the acceptable concentrations for the ground-water contaminants. The U.S. Department of Health and Human Services, National Center for Health Statistics may be a good source of information on sensitive individuals in the region. All of this information should be presented in tabular form to facilitate easy reference.

Health Risk Assessment

Certain assumptions are usually made when determining health risks. Assumptions must be made concerning either intake rates of food, water, and air, or body surface area and weight. Absorption and excretion rates may be assumed to estimate equivalent oral doses based on data from inhalation or dermal exposure studies. The permit applicant should use generally-accepted standard factors in the exposure assessment. Some of the common factors used are listed in Appendix 7.

The permit applicant should identify the compounds that can be grouped together based on similar physical and chemical properties, since health effects data are sometimes listed for broad groupings such as polynuclear aromatic hydrocarbons (PAHs), halomethanes, or polychlorinated biphenyls (PCBs).

The permit applicant may find it advantageous to use groupings of hazardous constituents in order to simplify the development of ACLs. The acceptable exposure level of each hazardous constituent within a group can be based on the toxicity of the most toxic compound within the group. This would result in the acceptable toxic effect level for each constituent being set at the acceptable level for the most toxic compound within the group. This conservative approach to risk assessment could reduce the amount of data needed to quantify potential human health effects. However, it must be emphasized that the grouping of compounds into specific categories can be difficult, and approved methods are not available.

The applicant should perform a comprehensive literature search for health effects data on the contaminants or groups of contaminants found in the ground water for which ACLs are requested. Health effects data are available for compounds with established concentration levels such as Ambient Water Quality Criteria. Site-specific water quality criteria may be available at the State level. Guidance on modifying national criteria is available in the Water Quality Standards Handbook (U.S. EPA, 1983b). Appendix 8 contains a list of health and environmental effects profiles and assessments, available through the U.S. EPA, Environmental Criteria and Assessment Office. The Agency is currently compiling toxicity information on many of the hazardous constituents and this information should be useful in preparing ACL demonstrations.

In order to account for cumulative impacts of the hazardous constituents for which ACLs are requested, an assessment of the existing concentrations of the ACL constituents in the potentially impacted ground water or surface water should be performed. This information is necessary for determining the total concentration of the ACL constituents in the affected water resource, the health effects associated with the concentrations, and the relative contribution of the ACL constituents emanating from the site to the total concentration.

The applicant should distinguish between ground-water contaminants having threshold (toxic) and non-threshold (carcinogenic) effects. Toxicity data should be submitted for the toxic (threshold) contaminants. Draft guidance on the use of ADIs has been proposed by the Agency (U.S. EPA, 1984d). If Agency compiled data on threshold contaminants are not available, then the submitted data should contain dose/response information reflecting the acute, subchronic, chronic, and "no effect" levels for the threshold contaminants. Acceptable concentrations can be derived by applying appropriate exposure assumptions to established acceptable daily intake values or alternate dose levels derived from the literature. The National Academy of Sciences (NAS, 1977) defines and outlines the use of uncertainty factors in determining acceptable dose levels.

Non-threshold compounds, or carcinogens, should be subjected to the same review as the other toxic compounds. Cancer risk models, such as the linear non-threshold model, produce carcinogen potency factors or unit cancer risk (UCR) values. A UCR value represents the largest possible linear slope at low extrapolated doses that is consistent with the dose-response data (U.S. EPA, 1980). The uncertainties and extrapolation techniques that are used to estimate UCRs from cancer risk models should be clearly stated. Unit cancer risk values are used to estimate hazardous constituent concentrations that correspond to statistical lifetime cancer risk values. For example, a contaminant concentration corresponding to a lifetime cancer risk of 10^{-6}, assuming that a 70 kg adult consumes 2 liters of water per day, is estimated by the following formula:

$$\text{Exposure level (mg/l)} = \frac{70 \times 10^{-6}}{2 \times \text{UCR}}$$

Unit cancer risk values have been derived for many compounds by the Carcinogen Assessment Group (CAG, 1984) and are also available from Ambient Water Quality Criteria. Reference citations should accompany each exposure level based on a UCR.

The acceptable concentration of non-threshold compounds, or carcinogens, is determined through the risk management process. In general, the Agency has made decisions to allow concentrations of carcinogens where the individual risk values have been within the range of 10^{-4} to 10^{-8}. In setting ACLs the following factors should be considered in determining an acceptable risk level to any exposed individual within the 10^{-4} to 10^{-8} range:

1. Other environmental health factors borne by the affected population,
2. Level of uncertainty in the data base and models used in the risk analysis,
3. Level of uncertainty involved in predicting exposures including the expected effectiveness and reliability of man-made systems affecting exposure,
4. Current and expected future use of the affected resource, and
5. Impacts upon the environment.

It may be useful to also determine the total population that is currently exposed or likely to be exposed in the future, when weighing the importance of the five factors. As a general matter, a level of 10^{-6}, the middle of the range, should be used as the point of departure when proposing a risk level within the 10^{-4} to 10^{-8} range for a particular facility.

The permit applicant should discuss any other effects associated with the contaminants, including odor and taste effects, mutagenic effects, teratogenic effects, and synergistic or antagonistic effects. At a minimum, an additive approach based on contaminants that produce the same effects by similar mechanisms should be used to estimate health effects from exposure to mixtures of contaminants. The applicant should investigate criteria development for entire classes of compounds. Ambient Water Quality Criteria have been developed for classes of compounds such as polynuclear aromatic hydrocarbons (PAHs) and halomethanes. A reference citation and a summary should be submitted for each study that was used to determine the type of effect for each contaminant.

The permit applicant is responsible for providing information on health effects of the hazardous constituents present in the ground water for which ACLs are requested. Appendix 9 of this document contains a survey sheet on health effect factors that can be used to summarize the toxics information. The applicant should submit available health effects numbers for each ACL constituent. The health risk assessment should be based on conservative health based numbers. If the applicant uses less conservative numbers as a basis for the health risk assessment, the applicant must submit information to justify the use of these numbers. As discussed previously, the acceptable exposure levels for a group of constituents can be based on the toxicity of the most potent constituent within that group, if such a grouping is sufficiently justified. If sufficient toxicity information on any of the compounds has not been submitted, the ground-water protection standard will be set at background levels or at the maximum concentration levels listed in Table 1 of Section 264.94(a) of the regulations.

Chapter XI

Potential Damage to Wildlife, Vegetation, Agriculture, and Physical Structures (§264.94(b)(1)(viii) and (2)(ix))

In addition to risks to human health, environmental risks must be addressed in an ACL demonstration. Unless an ACL demonstration is based on no exposure to hazardous constituents, risks to animals, plants, and structures resulting from exposure to the hazardous constituents must be considered. This environmental risk assessment involves an exposure assessment and an effects assessment similar to the human health risk assessment. This chapter delineates the information needed to perform the assessments of risks other than those to human health.

The initial step in assessing possible environmental impacts is to determine the probable exposure pathways for hazardous constituents to reach environmental receptors. For ACL purposes, the receptors of concern include wildlife and vegetation in aquatic and terrestrial environments; agricultural crops, products, and lands; and physical structures. The exposure assessment involves examining the extent of the hazardous contaminant plume, the potential migration of hazardous constituents, and the location of receptors and environments of concern. The exposure assessment will result in delineation of likely exposure pathways. Information submitted to fulfill requirements discussed in previous chapters should be adequate to determine probable surface water and terrestrial exposure pathways. The permit applicant should examine the data requirements of Chapters VII and VIII, before proceeding with this chapter. The data necessary for assessing the effects of exposure of physical structures and agricultural crops, lands, and products to the hazardous constituents are discussed in subsequent sections of this chapter.

The permit applicant must examine the potential impacts to all the receptors discussed above if exposure to hazardous constituents is likely to occur. Otherwise, the permit applicant should discuss specific data that supports no probable exposure as well as justify why the potential impacts assessment is unnecessary.

Generally, data on chronic toxicity levels of the hazardous constituents are sufficient to characterize potential environmental impacts. However, chronic environmental toxicity data may not be available for many waste constituents likely to be the subjects of ACL requests. In the absence of environmental toxicity data, ACL applicants may be able to argue that a contaminant will have no adverse environmental effects. This argument could be based upon considerations of exposure levels and the toxicities of similar chemical compounds. If environmental receptors are actually being exposed to ACL constituents above chronic toxicity levels, or above background levels if no chronic toxicity levels are established, then field assessments of the impacts can be performed to support the proposed ACLs. The types of field studies that should be carried out are discussed in more detail in the following sections.

Terrestrial Impact Assessment

The quantification of adverse terrestrial environmental effects is difficult. However, examination of several environmental factors will provide an estimate of potential impacts to the environment due to exposure to contaminated ground water.

- Potential impacts to terrestrial wildlife and vegetation can be assessed by examining exposure and environmental toxicity factors. The exposure assessment involves determining whether the contaminated ground water at a facility has the potential to impact any terrestrial environment. The specific data necessary to assess exposure are discussed in Chapters II, III, and IV. If there is a likely pathway for wildlife and vegetation to become exposed to contaminants, then environmental toxicity factors should be examined. It is expected that ACL applicants will not need to address terrestrial environmental impacts in detail, where there are no direct exposure routes between terrestrial systems and ground water. In these cases the permit applicant can omit this section and move on to the endangered species section of this chapter.

The toxicity and bioaccumulation of hazardous constituents by terrestrial flora and fauna should be examined by the permit applicant. Terrestrial species can be exposed to toxicants either directly through assimilation of or contact with contaminated ground water, or indirectly through food web interactions. Toxicants can accumulate in exposed biota and increase to levels that are lethal or have chronic effects. The permit applicant should perform a comprehensive literature search for toxicity and bioaccumulation values for the ACL constituents found in the ground water. The information should be summarized in a table that includes information on the toxicants, the test species, the specific effects, the effect levels, the bioaccumulation potential, and the reference. The permit applicant can base the potential terrestrial toxicity assessment on the most toxic constituent within a group of constituents, if appropriate groupings of constituents exist for a facility. If literature information is sparse or nonexistent, then a more thorough analysis of potential environmental impacts may be necessary. This could be based on consideration of exposure levels and the toxicities of similar chemical compounds. Bioassays could also be used to support the proposed ACLs; however, techniques for performing bioassays on terrestrial ecosystems are not an exact science, and they involve considerable time and expense to carry out. If the permit applicant plans to perform bioassays, then he should consult either U.S. EPA (1983c) or U.S. EPA (1984e) for more discussions on the use of bioassays to characterize chemical waste sites.

If terrestrial environments are presently being exposed to contaminants above chronic toxicity levels, or above background levels for constituents without established chronic toxicity levels, then field studies can be used to support the proposed ACLs. The permit applicant should examine the dominant terrestrial habitats in the vicinity of the facility. Evidence of any stressed vegetation should be documented and can be supported with aerial IR photography, or ground photography and vegetation surveys. Both a topographic map and low level aerial photographs delineating any stressed terrestrial environments should be submitted.

Vegetation survey data on species and abundance information on macrofloral types, usually trees and shrubs, should be collected. However, if the dominant habitat is an alpine or prairie environment, grasses and other plants should be examined. The community floral diversity can be calculated from the species information. Discussions of diversity should include species richness and community structure. This diversity information should be summarized in tabular form. Any differences between the background and affected habitats should be explained. The selection of the background habitat should be carefully planned so as to ensure that it is outside the influence of the facility. Sampling protocols for diversity and productivity studies should be submitted by the applicant, along with the data collected and a complete discussion of results.

Endangered Species Impact Assessment

Endangered and threatened species near the facility should be identified. The facility owner or operator should contact the U.S. Department of the Interior, Fish and Wildlife Service, for a current list of endangered or threatened species in the vicinity of the facility. The permit applicant is responsible for surveying the area and determining the presence of these species in any terrestrial or surface water environment. If any endangered or threatened species are in the area, then the potential impacts of the contaminated ground water on the species, including critical habitat impacts, should be discussed. A table should be submitted that lists the endangered and threatened species.

Aquatic Impact Assessment

The permit applicant should assess potential aquatic environmental effects by examining exposure and aquatic toxicity factors. The exposure assessment for surface waters was discussed in Chapters VII and VIII. Ground-water contaminants, flow direction, discharge areas, and proximity of surface waters are important considerations. The permit applicant should examine potential pathways of contaminant migration to surface waters. If exposure to contaminants is likely, then aquatic toxicity factors should be examined. If no hazardous constituents can reach surface waters, then the permit applicant should provide supporting evidence of this fact. The aquatic impact assessment can be omitted if sufficient evidence is available to support a claim of no surface water exposure.

The aquatic toxicity and bioaccumulation of hazardous constituents found in the ground water should be examined by the permit applicant if migration of the constituents to surface waters is likely. The U.S. EPA has published Water Quality Criteria for 64 toxic contaminants or contaminant groups (U.S. EPA, 1980). These water quality criteria specify concentrations of contaminants which, if they are not exceeded, are expected to normally result in aquatic ecosystems suitable for fish and wildlife propagation and water recreation. A summary of the water quality criteria is provided in Appendix 10. The permit applicant should calculate surface water contaminant concentrations from predicted ground-water discharge volumes and hazardous constituent concentrations.

Conservative assumptions should be used, such as low flow (Q7-10) conditions and small mixing zones (see Chapter VII). The predicted contaminant concentrations should be compared to acute toxicity values within the mixing zone and chronic toxicity values outside of the mixing zone. If compounds for which ACLs are requested do not have U.S. EPA or State approved water quality criteria, the permit applicant should complete a comprehensive literature search for aquatic toxicity data. This data may be available from commercial computer data bases. The aquatic toxicity data should be taken from studies that used test species comparable to the aquatic species present in the water body. The toxic data should be summarized in a table that includes information on the toxicant, test species, specific effects, effect levels and the references. The permit applicant can base the potential aquatic toxicity assessment on the most toxic constituent within a group of constituents, if appropriate groupings of constituents exist for a facility.

Bioaccumulation values should also be summarized from the literature. If aquatic toxicity information for an ACL constituent is missing, a more thorough analysis of potential aquatic impacts is necessary. This could include consideration of exposure levels and toxicities of similar chemical compounds. The analysis could also include field studies and possibly bioassays to justify an ACL. If the permit applicant intends to use bioassay data to support ACLs, the aquatic bioassay protocols and guidelines found in U.S. EPA (1980) and U.S. EPA (1983c) should be followed. All aquatic toxicity and bioaccumulation data collected by the permit applicant should be submitted. Appendix 11 contains a survey form that can be used to summarize environmental effects data.

The permit applicant could also submit available information on aquatic community exposure to support an ACL demonstration. Initially, the applicant could perform a literature search for aquatic community effects information on the ACL constituents. Aquatic effects can include fishery impacts, habitat impacts, and productivity changes. Submitted information could contain data on contaminant concentrations, environmental habitats, aquatic effects, and literature citations.

If aquatic environments are being exposed to contaminants above chronic toxicity levels, or above background levels if no chronic toxicity levels are established, field assessments of impacts may be necessary to support the proposed ACLs. Studies can be performed to verify either environmental impact or no impact to the exposed environment. A habitat assessment can be used to identify affected habitats in exposed surface waters. The exposed surface waters must be identified, along with their specific physical characteristics (see Chapter VII). The habitat assessment of such surface waters involves examining habitat alterations that are the result of ground-water contaminants. A control site in an unaffected area should be used for comparative purposes.

A comprehensive examination involving water and sediment sampling of each nearby water body that is downgradient (down-stream) of the facility and likely to receive contaminated ground-water discharges is also required. Each contaminant for which an ACL is requested should be analyzed in each of these media. The resulting data should be presented in a table that identifies the water body, the media, the specific contaminants and corresponding concentrations, the sampling locations and the date of sampling. The data should be discussed in detail. Affected aquatic environments should be delineated on a USGS topographic map. The site-specific sampling protocol and data should also be submitted.

The U.S. EPA publication, Water Quality Standards Handbook (1983b), contains information on evaluating the habitats and water quality of surface water environments. The types of environmental studies that are needed to evaluate the attainability of water quality standards are discussed. This handbook can be used as guidance by the permit applicant during the assessment of surface-water impacts. Appendix 12 contains two chapters of this handbook that may be useful.

The permit applicant should examine community structure parameters for aquatic environments near the facility. Evidence of floral and faunal impacts can include:

1. Stressed vegetation in surface waters or along shorelines,
2. Sparsely populated communitites,
3. Changes in community diversity, and,
4. Altered community structure.

These determinations may require an ecological survey of habitats in each surface water body that is downgradient from the facility and likely to receive contaminants above chronic toxicity levels, or above background levels for constituents without established chronic toxicity levels. Floral surveys of dominant macrophyte vegetation will require information on the number of species and their abundance. Macrobenthic surveys should be used to obtain abundance information on benthic fauna. Sport and commercial fishery impacts should be assessed. The permit applicant should submit all sampling protocols and data used to examine community structure and diversity. The diversity and species abundance information should be summarized in a table. Any difference in diversity between control and impacted areas should be discussed. Data discussions should include both experimental design and sampling protocols.

Agricultural Impact Assessment

The potential impacts of ground-water contamination on agriculture must be examined by the permit applicant. Exposure pathways, crop impacts, and livestock impacts should be included in the assessment. The exposure assessment is used to determine if there are likely pathways for ground-water contaminants to reach any agricultural lands or products. As part of the exposure assessment, data on the agricultural land uses near the facility should be submitted by the permit applicant. Specific uses such as row crops, rangeland, grazing, tree farming and timber should be depicted on a USGS topographic map. A table that lists acreages of the specific uses should also be submitted.

The potential exposure pathways that the permit applicant should examine include shallow ground water, ground-water irrigation, and surface water irrigation. The shallow ground-water flow direction, aquifer attenuation mechanisms, and ground-water elevation are important characteristics that are used to determine exposure due to direct crop uptake of ground water. These topics were discussed in Chapters III and IV, and must be evaluated by the permit applicant during this exposure assessment. The irrigation wells near the facility should be identified and delineated on a USGS topographic map. Chapter VIII lists specific use information that is necessary for this assessment of the irrigation wells. Surface waters that are used for irrigation and have the potential to be impacted by ground-water contamination must be evaluated (see Chapter VII). The current and projected irrigation withdrawal rates should be determined from each irrigation source.

Agricultural crop impacts should be assessed by the permit applicant if exposure to ACL constituents is likely to occur. The agricultural damage assessment can be omitted if a condition of no exposure is demonstrated. The following potential agricultural impacts should be assessed:

1. Direct crop impacts and reduced productivity, and
2. Bioaccumulation of contaminants.

The permit applicant may be able to estimate the expected crop and productivity impacts resulting from exposure to hazardous contaminants in the ground water by examining the literature. Literature values that exist on crop impacts from exposure to the contaminants should be summarized in a table that includes the contaminant, the crop tested, the effect level, the bioaccumulation potential, and the specific reference. The U.S. Department of Agriculture (USDA) can be a source of crop effects information and testing methods. If literature information does not exist, and crops are likely to be exposed to ACL constituents, the ACL demonstration may be denied and the ground-water standards may be set at background levels. However, the permit applicant has the opportunity to carry out experiments to estimate potential crop impacts. The applicant should be aware that standard experimental protocols do not exist and that all data to support the ACL demonstration must be submitted in a timely fashion. If tests are performed by the permit applicant, all protocols and data should be submitted.

The permit applicant should describe potential livestock impacts that may occur from direct and indirect exposure to contaminants found in the ground water. Direct exposure would include livestock contact through watering. Indirect exposure could include contact during animal grazing and foraging. The applicant should submit any available information on potential livestock impacts of the ACL contaminants. If literature values exist, the information should be summarized in tabular form and include the factors discussed above in the crop impacts section. The USDA may have information on this topic. Permit applicants are not normally expected to carry out experiments on exposed livestock because of the high costs and long-term nature of such experiments. If exposure modeling shows that livestock exposure occurs and sufficient literature information does not exist to support an ACL, then the ground-water protection standard may be set at background levels.

Physical Structure Impact Assessment

Physical structures can be adversely affected by hazardous constituents in the ground water. The situation at Love Canal, N.Y., where toxicants entered basements of homes, is just one example. The determination of potential damage to and contamination of physical structures in the area around the facility requires the examination of exposure pathways, waste characteristics, environmental factors, and construction materials and techniques.

Potential exposure of the physical structures to waste contaminants requires identifying physical structures in the area and exposure pathways. All manmade structures including buildings, buried cables and pipes, railroad beds, roads, parking areas, and machinery near the facility should be identified and delineated on a vicinity map. The possible exposure pathways of the ground-water contaminants to the physical structures should be identified. The permit applicant should refer to Chapter IV to determine what information should be submitted in order to determine contaminant migration pathways. If the exposure assessment determines that physical structures are likely to come in contact with ACL contaminants then the potential effects of the contaminants on the physical structures should be examined. Otherwise, the permit applicant needs only to explain why the assessment is not needed.

The hazardous constituent characteristics of primary concern for the physical structure impact assessment are reactivity, ignitability, and migration potential. Two important categories of reactive chemicals are corrosives and solvents. The groundwater contaminants that fall into either of these two categories should be listed in a table by the permit applicant. The potential effects of these compounds on building materials such as concrete, iron, steel, plastic, wood, asphalt, and limerock should be identified and summarized in a table. The ability of the contaminants to permeate these materials should also be discussed. The permit applicant should submit data on the flammability and ignitability of the ACL constituents which have the potential to permeate subsurface structures. Volatile organic compounds should be given special attention since they have been implicated in sewer-line explosions.

Chapter XII

Persistence and Permanence of Potential Adverse Effects (§264.94(b)(1)(ix) and (2)(x))

Many of the chapters in this guidance document discuss informational needs for ACL demonstrations that are related to the persistence and permanence of the ACL constituents. The general ACL policy will be to assume a worst case approach of no degradation of the ACL constituents unless information on the persistence of the ACL constituents in the environment is submitted. Similarly, if there is a potential for exposure to the ACL constituents resulting in adverse effects, the adverse effects will be considered permanent unless it is generally accepted not to be permanent or information is submitted by the permit applicant to justify it is not permanent. This chapter describes the information that is needed to characterize the persistence of the ACL constituents in the environment and the permanence of their adverse effects, if exposure occurs.

Persistence

Information on the persistence of the contaminants in the environment should be discussed in varying detail, depending on the basis of the ACL demonstration. The applicant should discuss the process by which each ACL constituent will degrade, either from a ground-water perspective, surface water perspective, or a combination of both depending on the site-specific situation. Contaminant degradation in ground water occurs predominantly through chemically mediated processes. If the applicant is claiming attenuation as a means of reducing the contaminant concentrations, the applicant must discuss the types of processes that may occur. These processes can include biodegradation, hydrolysis, oxidation, reduction, or precipitation, all of which were discussed in Chapter II.

If surface water exposure is involved, bioconcentration and biotransformation processes are important. Bioconcentration factors are important for evaluating human intake levels of contaminants from consumption of aquatic organisms and for assessing the permanence of ecological effects. Bioconcentration factors can be derived by experimentation or calculation. The applicant should provide justification for the use of any bioconcentration factors. Biotransformation is primarily carried out by microorganisms in the surrounding media. A lag time or acclimation period usually occurs before the biodegradation process begins. If biotransformation is used in the ACL demonstration, the applicant should determine whether the microbes are acclimated to the contaminant. A discussion of biotransformation and the use of bioconcentration factors can be found in U.S. EPA (1980) and U.S. EPA (1979).

If degradation processes are used in the ACL demonstration, the process rates should be calculated. Whether the mechanism of degradation is biological or chemical, all rates describing the processes should be included in the ACL demonstration. The parameters, coefficients, and assumptions used by the permit applicant to calculate the degradation rates for each contaminant should be submitted in tabular form.

Permanence

Information on the permanence of the adverse effects resulting from exposure to the ACL constituents will be required only if the ACL demonstration is risk based. This information should be included in the demonstration's health risk assessment (Chapter X) and the environmental risk assessment (Chapter XI). Permanence information is necessary in order to give the permit reviewer some idea of the long-term effects associated with exposure to each ACL constituent, as well as a better understanding of which ground-water contaminants are of most concern.

Many environmental systems exhibit a high degree of resiliency. If the damage is limited to individuals within the population and the gene pool is not irreparably depleted, the environmental damage may be reversible. However, if irretrievable habitat change has occurred, then environmental damage may be permanent. The permit applicant should examine the literature on the contaminant's environmental effects to determine the permanence of likely ecological impacts. Many biological evaluations can be performed to examine the resiliency and stability of an environmental system. Some examples include tissue analyses to determine bioaccumulation, diversity and recovery studies to estimate elasticity, and intolerant species analyses to determine the degree of degradation. A detailed explanation of these studies is presented in the *Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analyses* (U.S. EPA, 1983d). The permanence of the adverse effects is related to the contaminant's concentration level at the point of exposure. The acute and chronic effects levels for each contaminant should be determined if the ACL demonstration is based on risk considerations. The effects should be classified as either reversible or irreversible.

Chapter XIII

Institutional Ground-Water Use Restrictions

Exposure to a contaminant is a function of the pollutant pathway, the type of water resource use, and the proximity of receptors to the water resources. This chapter discusses institutional controls that can be used to prevent or minimize exposure by controlling access to the contaminated ground water. Institutional ground-water controls are not specifically mentioned in the criteria listed in Section 264.94(b) of the regulations but they can be important factors in assessing exposure to hazardous constituents (see 264.94(b)(vii and ix)).

The permit applicant must submit evidence supporting all use controls that are being proposed as a means of preventing exposure. The use controls must prevent contact with the contaminated ground water and encompass the existing and projected areal extent of the ground-water contamination plume. The institutional controls used to prevent exposure to the ACL constituents must contain some type of enforcement provision to guarantee the existence of the use control for as long as the ground-water protection standard is exceeded. In addition, the use and projected uses of the affected ground-water resource must be considered.

States' ground-water allocation rules are generally categorized into three types:

1. Absolute ownership, where the landowner essentially owns the ground-water underlying the landowner's property;

2. Reasonable use, where the courts can place reasonable limits on the use and withdrawal of ground water; and

3. Prior appropriation, where states, through common law and statutory schemes, have the authority to allocate ground-water rights and regulate ground-water use (Henderson, et al., 1984).

States that utilize the reasonable use rule or prior appropriation rule may contain ground-water use restrictions that include state enforced:

1. Ground-water extraction controls,
2. New well prohibitions, and
3. Existing well closures.

If the permit applicant uses arguments that depend on state use controls such as these, then the applicant must submit evidence that the State has authority to prevent exposure to the contaminated ground water.

Another institutional option for preventing exposure to contaminated ground water is a deed restriction. If the permit applicant owns the property over a contaminated ground-water plume, then the applicant may use deed restrictions that prevent the use of the water. These must be enforceable covenants running with the land that prevent exposure to the ground water, and must apply to both current and future property owners. However, if in the future the contamination no longer presents a threat to human health and the environment, a termination provision may be allowed in the deed restriction. In order to remove the deed restriction, the petitioner must submit evidence to the U.S. EPA that the use restrictions are no longer necessary. This evidence must include long-term ground-water monitoring data that supports the removal of the restriction. The permit applicant could also use zoning restrictions to prevent the use of the contaminated ground water.

Chapter XIV

Summary and Conclusions

The factors involved in preparing and supporting an ACL demonstration were discussed in the previous chapters. Information on each of the criteria discussed in this guidance document is not required in every ACL demonstration. Every RCRA facility is unique, with different environmental properties and waste characteristics. This necessitates that each ACL demonstration reflect site-specific conditions and that flexibility be integrated in applying the criteria. Much of the information required for an ACL demonstration may be taken from the facility's Part B permit application. This guidance document points out when additional information that satisfies the criteria should be submitted and also when it may not be necessary. However, the burden is always on the permit applicant to justify all arguments used for not submitting information on specific criteria. Appendix 13 contains a list of tables and figures that can be submitted as part of an ACL demonstration. The use of these tables and figures will greatly facilitate the review of the ACL demonstration by the permit writers. Appendix 14 contains a summary outline of the information that can be required to support an ACL demonstration. The permit applicant should be sure to submit all data necessary to fulfill the information requirements outlined in this Appendix.

Permit applicants who anticipate the need for an ACL demonstration should do some advance planning to enable themselves to make the demonstration quickly if ground-water contamination is detected. However, in recognition of the fact that a permit application requesting an ACL will contain more information and analysis than an application based on the other types of concentration limits, the ground-water regulations allow for additional time to submit the data necessary to justify an ACL. Within 90 days after detecting a significant increase in the concentration of hazardous constituents at the compliance point, the permit applicant must indicate whether he intends to seek an ACL variance for any Appendix VIII constituents detected in the ground water. The permit applicant indicates his choice by proposing established concentration limits, or offering background concentration limits, or giving notice that he intends to seek ACLs. The permit applicant has an additional 90 days to submit the actual information to support the proposed ACLs.

Once the data have been submitted by the permit applicant, the permit writer must assess the quality of the submitted information and determine the appropriateness of the potential point of use, the acceptable concentrations of contaminants at the point exposure, and of the ACLs at the point of compliance. In many cases, the permit writer will have to use professional judgement in determining the adequacy of the submitted information.

The Agency will indicate its decision on the merits of the ACL demonstration when it issues the compliance monitoring permit. The permit will contain a ground-water protection standard (GWPS) for each ground-water contaminant. The GWPS will contain either background values or the National Interim Primary Drinking Water Regulation limits listed in Table 1 of Section 264.94(a) (if EPA rejects the ACL demonstration), or it will contain ACLs. The need for corrective action will be averted if the ACL for each hazardous constituent is established at a level higher than its concentration at the facility's compliance point. If any constituent exceeds its ACL, corrective action will be necessary. The ACL then becomes the benchmark for the intensity and duration of the corrective action.

As part of the ground-water protection standard, an ACL is in effect during the compliance period. The compliance period is the number of years equal to the active life of the waste management area, including the closure period. If, at the end of the compliance period, the owner or operator is engaged in a corrective action program, the compliance period is extended until the owner or operator can demonstrate that the GWPS, which may contain ACLs, has not been exceeded for a period of three consecutive years.

Once the ground-water protection standard has been set in the permit, the permittee can only seek ACLs through permit modifications under the procedures outlined in 40 CFR Part 124. Such modifications are always major and the burden of proof to justify the variance is on the applicant. If a facility owner or operator violates the ground-water protection standards, he cannot postpone corrective action in order to argue for ACL changes.

The cost of ground-water corrective actions can be considerable. Therefore, there is a strong incentive for permit applicants to forestall imposition of corrective action requirements by submitting an ACL demonstration. In balancing the risks of setting ACLs as opposed to requiring corrective action, permit writers must consider that unwarranted and unnecessary corrective actions not only constitute inefficient use of resources but also could cause considerable adverse environmental impacts. Actions necessary to remove hazardous constituents could result in ground-water depletion, subsidence, and ecosystem dewatering. It is essential that the preparation of an ACL demonstration be fully supported, and that decisions on the demonstration be made expeditiously.

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ATTACHMENT VIII

QUALITY ASSURANCE PROJECT PLAN

1.0 INTRODUCTION

The purpose of the Quality Assurance Project Plan (QAPP) for monitoring of groundwater, surface water, and sediment is to indicate prime responsibilities and prescribe requirements for assuring that the monitoring program (see Attachment III) is planned and executed in a manner consistent with quality assurance objectives. This QAPP provides guidance and specifications to assure the following:

- Field determinations and analytical results are valid through preventive maintenance, calibration, and analytical protocols.
- Samples are identified and controlled through sample tracking systems and chain-of-custody protocols.
- Records are retained as documentary evidence of the quality of samples, applied processes, equipment, and results.
- Generated data are validated and their use in calculations is documented.
- Calculations and evaluations are accurate, appropriate, and consistent throughout the program.
- Safety is maintained by requiring inclusion of the Health and Safety staff function in the project organization.

The requirements of the QAPP apply to sampling and analysis activities associated with monitoring of wells, surface water, and sediment near the Winthrop Landfill site (Attachments III and V).

The content and format of the QAPP is based on "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans - QAMS-005/80" prepared by the U.S. Environmental Protection Agency (EPA), Office of Research and Development.

2.0 QUALITY ASSURANCE OBJECTIVES

2.1 General

The quality of measurements made during this study will be determined by the following characteristics: accuracy, precision, representativeness, completeness, and comparability. Specific objectives for each characteristic are established to develop sampling protocols, and identify applicable documentation, sample handling procedures, and measurement system procedures. These objectives are established based on site conditions, objective of the project, and knowledge of available measurement systems. The subsequent use of these measurements in calculations and evaluations is also subjected to aspects of the QAPP as described in the following section.

2.2 Representativeness

Measurements will be made so that results are as representative of the media and conditions being measured, as possible. Sampling protocols will be used to assure that samples collected are representative of the media. Sample handling protocols (e.g., storage, transportation) protect the representativeness of the collected sample. Proper documentation will establish that protocols have been followed and sample identification and integrity assured.

2.3 Precision and Accuracy

Precision, the ability to replicate a value, and accuracy, the ability to obtain a true value, will be addressed for all data. Data quality objectives for precision and accuracy are established for each major parameter to be measured at the site. These objectives are based on prior knowledge of the capabilities of the measurement system to be employed, in turn, selected in accordance with the requirements of the project. The precision and accuracy requirements vary, depending on their intended use. For example, a screening tool to identify the general extent of chemical distribution will not require the same precision and accuracy required to define the exact nature and amount of chemicals present at specific locations. Later sections contain information regarding analytical procedures.

2.4 Completeness

The characteristics of completeness is a measure of the amount of valid data obtained compared to the amount that was expected to be obtained under normal conditions. The amount of valid data expected is established based on the measurements required to accomplish project objectives. The extent of completeness is expressed on a relative basis for sample collection activities. Completeness of data handling systems is described in later sections.

2.5 Comparability

The characteristic of comparability reflects both internal consistency of measurements made at the site and expression of results in units consistent with other organizations reporting similar data. Each value reported for a given measurement should be similar to other values within the same data set and within other related data sets. Comparability of data and measuring procedures must also be addressed. This characteristic implies operating within the calibrated range of an instrument and utilizing analytical methodologies which produce comparable results (e.g., data obtained for phenol (4AAP) are not comparable to data obtained for phenol (GC/MS).

Measurements compared to similar measurements which appear as outliers will be re-assessed. Units of measurement will be externally comparably by utilizing the appropriate standard units for each measurement system.

2.6 Quality Assurance Objectives

The quality assurance objectives for the monitoring program are listed below.

- To collect sufficient field, sampler, and trip blank samples and field duplicates to allow an assessment of sample representativeness and sample collection protocol precision
- To analyze sufficient internal duplicates, blanks, reference standards and matrix spike samples to allow an assessment of analytical precision and accuracy. Sufficiency of analytical QC procedures is specified by the referenced methods.
- To produce consistent technically defensible analytical reports

3.0 SAMPLING PROCEDURES

3.1 General

The quality of sample collection techniques is assured by keying the technique used to both the media/matrix to be sampled and the analytes of interest. For example, samples intended for semivolatile organic analysis are collected in glass bottles, samples for volatile organic analysis are collected in Teflon-septum-capped glass vials with"zero" head space to minimize diffusive and evaporative losses, and most samples for inorganic analysis are collected in linear polyethylene bottles. Sample containers will be prepared in a manner consistent with EPA protocol as noted in the following section.

Acquisition of environmental samples also requires specialized collection techniques to preserve their integrity and ensure that a representative portion of the source is collected. Media-specific sample collection techniques are specified in the following sections.

Further, unless the proper sample bottle preparation and sample preservation measures are taken in the field, sample composition can be altered by contamination, degradation, biological transformation, chemical interactions, and other factors during the time between sample collection and analysis. Typical sample bottle preparation protocols are presented in Section 6.2. Steps taken to maintain the in-situ characteristics required for analysis may include refrigeration on samples at 4°C, freezing, pH adjustment, and chemical fixatioh. Samples are preserved according to the protocol established for the specific analytical method selected to obtain the desired data. Table 6-1 provides more specific information.

Water sample containers are generally filled directly from the source, sampler or pump discharge without special considerations. A major exception is the collection of volatile organic analyte (VOA) samples. VOA samples must be collected as specified below. Each sample is taken in duplicate.

- Uncap the sample bottle, taking care not to touch the teflon-faced septa. If the septa is contaminated in any way, it should be replaced.
- If a chlorine residual is present, add three drops of 10 percent sodium thiosulfate to the sample container prior to filling the bottle.
- Pour the sample slowly, minimizing air entrainment, into the sample bottle. Pour sample until the bottle overflows.
- Place the teflon-faced silicon rubber septa on the convex miniscus, teflon side (shiny side) down and screw cap on.
- Invert the bottle, tap lightly, and check for air bubbles.
- If air bubbles are present open the bottle, add sample to eliminate air bubbles, and reseal. Repeat this procedures until the bottle is filled and no air bubbles are detected.

3.2 Preparation of Sample Containers

3.2.1 Semi-volatile (Acid/Base-Neutral) Organic Analytes and Sampler Blank Containers. The procedure for cleaning and one-liter glass bottles is listed below.

- Washing the bottles and teflon-lined caps thoroughly in hot, detergent water.

TABLE 6-1
SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS
CERCLA/RCRA SAMPLES

	Concentration	Container	Sample Size	Preservation	Holding Time
WATER					
Organics GC & GC/MS	VOA	glass	2 x 40 mℓ	Cool to 4°C	14 days
	Extractables Low	amber glass	2 x 80 oz. or 4 x 1 ℓ	Cool to 4°C	14 days
	Medium	wide-mouth glass	4 x 32 oz.	None	14 days
Inorganics	Metals Low	polyethylene	1 ℓ	HNO_3 to pH ≤ 2	6 months (Hg-20 days)
	Medium	wide-mouth glass	16 oz.	None	6 months
	Cyanide Low	polyethylene	1 ℓ	NaOH to pH >12	14 days
	Medium	wide-mouth glass	16 oz.		
Organic/Inorganic	High Hazard	8-oz. wide-mouth glass	6 oz.	None	14 days
COD	--	polyethylene	0.5 ℓ	H_2SO_4 to pH <2	28 days
TOC	--	polyethylene	0.5 ℓ	HCl to pH <2	28 days
Oil & Grease	--	glass	1.0 ℓ	H_2SO_4 to pH <2	28 days
Phenols	--	polyethylene	1.0 ℓ	H_2SO_4 to pH <2	28 days
General Chemistry	--	polyethylene	1.0 ℓ	None	--
SOIL					
Organics GC & GC/MS	VOA	2 x 120 mℓ wide-mouth glass	240 mℓ	None	NA
	Extractables Low/Medium	8 oz. or 2 x 4 oz. wide-mouth glass	6 oz.	None	NA
Inorganics	Low/Medium	8 oz. or 2 x 4 oz. wide-mouth glass	6 oz.	None	NA
Organic/Inorganic	High Hazard	8 oz. wide-mouth glass	6 oz.	None	NA
Dioxin	All	4 oz. wide-mouth glass	4 oz.	None	NA
EP Toxicity	All	250 mℓ polyethylene	200 grams	None	NA
AIR					
Volatile Organics	Low Medium	Charcoal Tube 7 cm long, 6mm OD, 4mm ID	100 ℓ air	Cool to 4°C	NA

- Rinse the bottles and caps thoroughly with hot tap water.
- Rinse the bottles and caps thoroughly with blank water[1].
- Heat bottles at 825°F for 30 minutes.
- Heat teflon-lined caps at 250°F for one hour.
- Allow bottles and caps to cool in a hood located in an area where they are protected from sources of contamination.
- After bottles and teflon-lined caps have cooled, cap the bottles using a pair of surgical gloves.
- For blank water bottles, fill the one-liter bottles with blank water using a bell jar apparatus to protect from atmospheric contamination. Change filters as required on the water system to maintain steady flow.

3.2.2 Volatile Organic Analytes (VOA) Sample Containers. The procedures for cleaning the 40 ml glass vials, caps, and teflon-faced silicon rubber septa is listed below.

- Wash the vials and septa thoroughly with hot detergent water.
- Rinse the above items thoroughly with hot tap water.
- Rinse the above items thoroughly with blank water.
- Place the vials (upright) and septa in an oven at 105°C (225°F) for one hour.
- Remove the vials and septa from oven and cool in a hood located in an area protected from organic and other sources of contamination.
- After the bottles have cooled, place the septa (shiny surface down) and the cap on the bottle and seal screw cap on bottle. Wear surgical gloves while doing this.

---

[1] The "blank water" used is identical to the reagent water (ASTM Type II or better) used to prepare sample blanks and is certified monthly by the ALS and State of Maine Public Health Laboratory.

- DO NOT OPEN the bottles until they are to be filled with sample.

3.2.3 Preparation of Pump Tubing. Adequate lengths of 3/8-inch ID teflon tubing and 3/8-inch ID silicon tubing will be prepared if pump tubing is specified for the sampling episode. The tubing preparation procedures is listed below.

- Prepare solution of hot water and detergent.
- Attach suction and pump tubing to ISCO unit.
- Place end of suction line in detergent solution.
- Pump detergent solution through the system for two minutes.
- Pump clean hot water through the system for two minutes or until clear, whichever is longer.
- Pump blank water through the system for two minutes.

3.3 Groundwater Sampling

Objective: To obtain samples of groundwater suitable for chemical analysis.

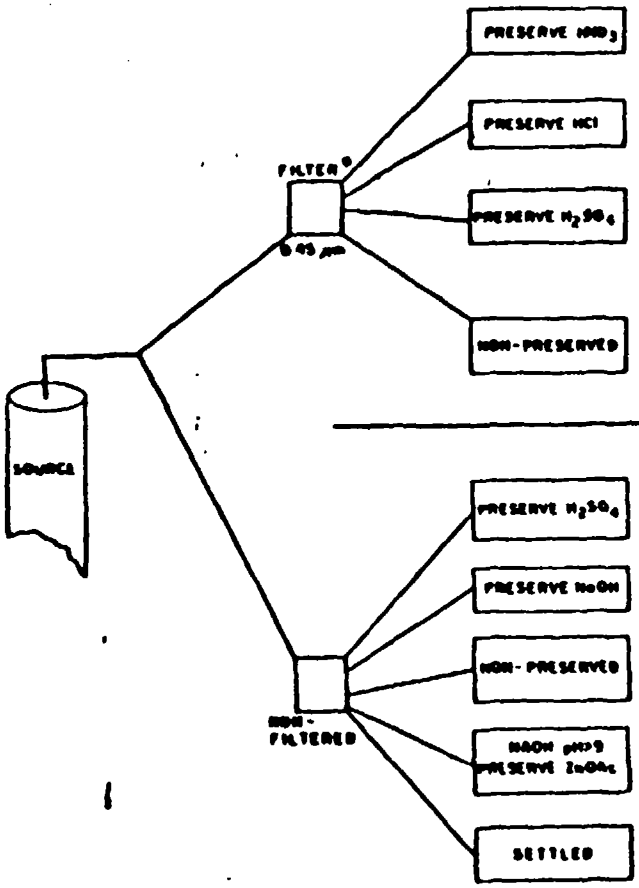
Preprinted labels will be prepared for all groundwater samples. These samples will consist of various containers for each location and will be analyzed for the parameters selected for the project. Filtering of groundwater is normally required prior to filling containers for dissolved inorganics analysis except for drinking water samples and samples requiring total suspended solids (TSS) analysis. An example of a sample-splitting flowchart is shown as Figure 6-1. The pH and specific conductance of each sample will be determined in the field. Glass containers will be used for samples required to be analyzed for organics, and plastic containers will be used for samples requiring all other analysis.

Monitoring wells will be sampled in the following manner:

Monitoring and sampling of groundwater wells will proceed from the upgradient or background wells to the downgradient or contaminated wells as can be best determined.

The well will first be checked for proper identification and location. The height of protective casing will be measured and recorded.

SAMPLE SPLITTING FLOW CHART-GROUNDWATER/SURFACE WATER MONITORING



PARAMETER & MINIMUM VOLUMES REQUIRED

ELEMENTAL PARAMETERS - NO. OF ELEMENTS: 1 – 5 100 ml
6 – 10 125 ml
OVER 10 150 ml
As OR Se - 50 ml ADDITIONAL
Hg - 150 ml ADDITIONAL
Sb - 50 ml ADDITIONAL
HARDNESS (100 ml)

TOC (10 ml)

COD (100 ml)
NITRATE - NITRITE (50 ml)
PHOSPHORUS (TOTAL SOLUBLE) (100 ml)

BORON (10 ml)
CHLORIDE (100 ml)
ORTHOPHOSPHATE (SOLUBLE) (50 ml)
NITRATE (100 ml)
SILICA (50 ml)
CHROMIUM VI (100 ml)
SULFATE (100 ml)

O & G (1000 ml)
(GLASS ONLY)
TKN (1000 ml)
NH$_3$ (1000 ml)
PHENOL (1000 ml)
PHOSPHORUS (TOTAL) (150 ml)

CN (1000 ml)

FLUORIDE (100 ml)
BOD (200 ml)
VOA (2 - 40 ml)
(GLASS W/TEFLON SEPTA ONLY)
VSS (200 ml)
TSS OR TDS (200 ml)
TURBIDITY (40 ml)
SULFITE (100 ml)
ORTHOPHOSPHATE (TOTAL) (100 ml)
TANNIN/LIGNIN (50 ml)
MBAS (400 ml)
ORGANICS, EXTRACTABLE (SVOA) (1000 ml)
(GLASS ONLY)

SULFIDE (200 ml)

ACIDITY (100 ml)
ALKALINITY (100 ml)
pH/Eh, SPECIFIC CONDUCTIVITY (25 ml)
COLOR (50 ml)

NOTES:

1 THE MINIMUM VOLUMES STATED ARE FOR SAMPLING SITES WITH PREVIOUS ANALYSES PERFORMED. FOR NEW SITES OR NEW PARAMETERS, DOUBLE THE MINIMUM VOLUMES REQUIRED

2 DOMESTIC WELL SAMPLES WILL NOT BE FILTERED PRIOR TO ANALYSIS

* FILTRATION IS REQUIRED FOR GROUNDWATER SAMPLES ONLY

FIGURE 6-1

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After unlocking the well and removing any well caps, measure and record the ambient and well-mouth organic vapor levels using the photoionization meter.

If the ambient air quality at breathing level reaches 5 ppm, the sampler shall utilize the appropriate safety equipment as described in the Health and Safety Plan.

Using the electronic water level meter, measure and record the static water level in the well and the depth to the well bottom to the nearest 0.01 foot. Upon removing the water level wire, rinse with reagent grade methanol and then distilled water. Calculate the volume of stagnant water in the well casing. Volume in liters equals 0.154 times the square of the inside diameter of the casing in inches times the depth of water in feet.

Following these measurements, sampling will commence in the sequence listed below.

1. Lower the submersible pump or peristalic pump intake into the well. Pumping should start at the static water level and the pump or pump intake should be gradually lowered to the bottom of the well as the water is removed.

   Connect the instrumentation header to the pump discharge and begin flushing the well. Monitor the in-situ parameters (pH, Eh, temperature, and specific conductivity) and measure the volume of groundwater being pumped. Alternately, in-situ parameters may be monitored in a beaker filled from the pump discharge. Purging of the standing well water is considered complete when one of the following is achieved.

   - o Five well volumes have been purged
   - o In-situ parameters stabilize
   - o Well has been pumped dry

2. Record the in-situ parameters (see Figure 6-2).

3. After purging, lower the pump intake or bailer (as appropriate for the parameters of concern) to the middle of the screened interval or mid-point of the static water level and collect the sample.

4. Volatile organic analyte (VOA) samples are filled directly from the submersible pump discharge tubing or bailer with as little agitation as possible.

FIELD SAMPLE DATA AND QUALITY ASSURANCE RECORD

PROJECT ________________ JOB NO ________

STATION NO/LOCATION ________________ DATE ________

SKETCH ON BACK YES ☐ NO ☐ PHOTOGRAPHS YES ☐ NO ☐ ROLL NO/EXPOSURE NO ________

FIELD DATA

TIME ________ AIR TEMP ________ WEATHER ________________

WELL DEPTH ________ WATER DEPTH ________ SAMPLE DEPTH ________ SAMPLE METHOD ________________

VOL. PURGED ________ SAMPLE TEMP. ________ °C ☐ IN SITU ☐ IN BOTTLE SP. COND. ________ / ________ @ 25° C ☐ IN SITU ☐ IN BOTTLE

pH ________ ☐ IN SITU ☐ IN BOTTLE Eh ________ ☐ IN SITU ☐ IN BOTTLE DISSOLVED O_2 ________ ppm ☐ IN SITU ☐ IN BOTTLE

VOA LEVEL (ppm) AMBIENT ________ SAMPLE LOCATION ________ ________ HEADSPACE ________

BOTTLE ID	LAB ID	VOL	MATERIAL	FILTERED	PRES./VOL.	ANALYSIS REQUESTED

REMARKS/OBSERVATIONS ________________________________

____

FIELD EQUIPMENT QUALITY ASSURANCE CHECKLIST

pH METER BUFFER CHECK pH 4 ________ pH 7 ________ pH 10 ________

SP COND. METER STANDARDS CHECK ________________ Eh PROBE ________________

PUMP TUBING RINSED ________ CHANGED ________ SAMPLER BLANK ________

FILTRATION BLANK WITH PRES. ________ FILTERS ACID WASHED ________________

SAMPLER ________________

FIGURE 6-

Other samples will be placed directly into the appropriate container from the discharge tubing of the pump or bailer.

5. Remove the pump from the well and decontaminate the pump and tubing by flushing one gallon of methanol/water mix through the pump and tubing followed by one gallon of distilled water. Using paper towels and reagent grade methanol, hand wipe the outside of the teflon tubing and pump. Rise with distilled water.

6. Attach appropriate labels to all sample bottles and complete chain-of-custody forms after each well is sampled.

7. Secure the well cap and lock.

3.4 Surface Water Sampling

Objective: Surface water samples are to be collected for analysis to establish the degree of contamination of the surface water for risk assessments and determination of contaminant plume extension.

Sample labels will be prepared prior to initiation of work using the computerized label system. Each sample will require several containers dependent on the intended analysis to be performed. The pH and specific conductance of each sample will be determined in the field at the time the sample is obtained. At the time the sample is obtained, a surface water sample record will be completed. An example sample record is shown as Figure 6-3. Records will include the following information

- A plan of the site
- Sample label numbers
- A description of the sample site
- Width and depth of the stream and its approximate flow rate in cfs
- At least one photographic of the sample site (Note: Orientation of photograph must be shown on sketch map) showing the sampling equipment
- Chain-of-custody documentation

SURFACE WATER AND STREAM SEDIMENT SAMPLE RECORD

SAMPLE STATION ____________ DATE ____________ TIME ST. ____________ END ____________

SITE LOCATED ON : MAP SITE AIR PHOTO

SKETCH MAP OF SAMPLE SITE
(SHOW WHERE SAMPLE TAKEN)

SCALE 1" = ______ FT

PROFILE OF STREAM BED

NOTE: DIMENSION SKETCH

SAMPLES OBTAINED

	SERIAL NOS.	CONTAINER
SURFACE WATER	____________	VOA
	____________	VOA
	____________	1 LITER GLASS
	____________	1 LITER GLASS

VOLATILE ________ ppm
pH ________
SPEC. COND. ________

SEDIMENT	____________	VOA
	____________	VOA
	____________	VOA
	____________	VOA
	____________	1 QT. GLASS

PI VOLATILES ______ ppm

NOTES ________________________________

____

____

____

____

____

____

PHOTOGRAPH ROLL ____________ EXP. ________

REFERENCE: FIELD BOOK, PG. ______
ATTACHMENTS

____
SIGNATURE

FIGURE 6-3

E.C. JORDAN CO.

The sample will be taken in the following manner.

1. The sample will be collected from the surface water body by immersing a clean beaker or water sampler. If a stream is being sampled, the sample will be collected upstream of the sampler with the opening of the sampling device oriented upstream but avoiding floating debris. If a lake is being sampled, the sample will be collected near the bottom of the water column.

2. The appropriate sample containers will be filled directly from the sampling device (see Table 6-1).

3. The following measurements will be made, if possible, by direct immersion of instrument probes into the body of water.

    - Photoionization meter reading
    - Temperature measurement
    - pH measurement
    - Specific conductance measurement
    - Any other site-specific field measurements which are required

    If direct measurement is not possible, these measurements will be made from water remaining in the sampling device or another sample bottle. This information will be recorded on the sample data record, sample labels completed, and chain-of-custody procedures initiated.

3.5 Sediment Sampling

Objective: To obtain samples of the sediment found in streams, ponds or other bodies of water for chemical analysis. Usually sediment samples are taken in conjunction with surface water samples to help define the partitioning of the contaminants between the soil and water.

Approach: Sediment sampling procedures for small streams and drainage ways are very similar to shallow soil sampling procedure; i.e., a trowel or shovel is used. The exact location of each sampling station will be established in the field at the time of sampling. The sample site will be noted on a site plan or aerial photograph and marked in the field with flagging and a four-foot wooden stake. The stake will be labeled with the sample site number.

If both water and sediment samples are to be collected at a given sampling site, the water samples will be collected prior to the sediment sample.

The sediment samples will be collected in the following manner.

- The sampler will select the sample site, locate it on a site map or aerial photograph and set the wooden stake. He will locate the sample site on the site plan using the grid system.
- Where sediments are to be obtained in wetlands, a grab sample will be obtained in the immediate vicinity of any associated surface water sample. Unless otherwise specified, grab or composited samples will be obtained from the surface of the sediment.
- The sampler will photograph the sample site, complete the required records and initiate chain-of-custody procedures.

Sediment samples collected from deeper waters will utilize either a gravity corer or dredge. These sediment sample locations will be marked with buoys. When using a gravity core sampler, the following procedures will be followed.

- Check all sampling equipment for cleanliness. The gravity corer should be decontaminated prior to its use at any site and between sample points on the same site.
- The sediment sample is collected by dropping the corer from a near surface position and allowing it to free-fall through the liquid to the bottom.
- Once the corer has become imbedded in the bottom in an upright position, release the messenger to activate the suction cup at the top of the corer.
- Retrieve the corer with a smooth, continuous lifting motion. Do not bump corer as this may result in some sample loss.
- Discharge the sediment from the corer into a large clean, unused, disposable aluminum foil pan.

- Repeat the above sample collection procedures in adjacent areas until there is sufficient sediment to fill the appropriate sample jar.

- Allow the sediment to settle in the pan, which should only take 2 to 3 minutes (only the heavier materials will be collected), then decant (pour) the water from the surface.

- Remove and discard any foreign materials (stones, pieces of wood or bark, aquatic weeds etc.) using either a pre-cleaned stainless steel spoon or tongs.

- Using the spoon or tongs, homogenize (mix) the sediment and then transfer the sample into the appropriate sample jar.

The decontamination procedures to be used in the field are the same as those followed when initially cleaning the corer prior to its being shipped to the field. These cleaning procedures are listed below.

- Wash thoroughly with distilled water.

- Rinse with deionized water

- Rinse with pesticide-grade acetone

- Rinse with pesticide-grade hexane

- Allow to air dry.

- Place core barrel in plastic bag prior to storing or moving between sample points

Sediment sampling information is recorded on the appropriate form (see Figure 6-3). All sediment sample labels will be prepared prior to initiation of work using a computerized label system.

3.6 Sample Handling and Preservation

All samples will be preserved by packing in ice (4°C) and shipped to ensure sample receipt at the laboratory within 48 hours of collection. In addition, at the direction of EPA Region I, all samples collected for volatile organic compounds (VOC) analysis will be preserved by the addition of 20 mg/L mercuric chloride to limit biodegradation of purgeable aromatics. VOC sample vials will be pre-preserved (see Table 6-1).

Holding time for samples prior to analysis shall not exceed 14 days.

4.0 PROJECT CUSTODY

Sample chain-of-custody will be followed during sample handling activities in both the field and laboratory operations. This program is designed to assure that each sample is accounted for at all times. To maintain this level of sample monitoring, computer-generated sample container labels, and shipping manifests are normally employed. Sample field data sheets, chain-of-custody records, and laboratory receipt sheets must also be completed by the appropriate sampling and laboratory personnel.

The objective of sample custody identification and control is to assure that:

- All samples scheduled for collection, as appropriate for the data required, are uniquely identified
- The correct samples are analyzed [illegible] are traceable to their records
- Important sample characteristics are preserved
- Samples are protected from loss or damage
- A record of sample integrity is established for legal purposes

The advantages of a computer-based chain-of-custody system over field marking systems are:

- All required samples are indicated on pre-prepared labels and shipping manifests
- Once the computer-generated label is affixed to the bottle and covered with clear plastic tape, sample identification is virtually unalterable

The chain-of-custody protocol followed by the sampling crews involves:

- Documenting procedures and amount of reagents or supplies (e.g., filters) which become an integral part of the sample for sample preparation and preservation
- Recording sampling locations and specific sample acquisition measures on the appropriate forms
- Using pre-prepared sample labels to document all information necessary for effective sample tracking

- Completing standard field data record forms to establish sample custody in the field before sample shipment

Pre-prepared labels are developed for each sample to be collected. Each label is numbered to correspond with the appropriate sample(s) to be collected. Examples of pre-prepared labels are shown in Figure 7-1. The field data sheet is used to record the sample location, sampling method, type of sample, date of sample collection, the name of the sampling crew member responsible for the sample, and other relevant information. Examples of field data sheets are presented in Figures 6-2 and 6-3.

The chain-of-custody record is used to:

- Document sample handling procedures including sample location, sample number and number of containers corresponding to each sample number
- Described the sample
- Described the chain-of-custody process

The chain-of-custody description section requires:

- The sample number
- The names of the sampler(s) and the person shipping the samples
- The date and time that the samples were delivered for shipping
- The names of those responsible for receiving the samples at the laboratory

A sample chain-of-custody record is shown in Figure 7-2.

The field data record and the chain-of-custody record are completed in quadruplicate. Two copies accompany the samples to the laboratory, another is kept by the sample crew chief, and the fourth is maintained in the project file. Additional copies can be provided, if needed, for the project.

A sample custodian at the laboratory signs for incoming samples, obtains shipment documents, assigns a unique sample identification number and verifies data entered in sample custody records. Based on the type of sample collected and the analysis required, further procedures for sample handling, storage, and disbursement for analysis are specified.

E C JORDAN CO   P O BOX 7050
PORTLAND ME 04112   207-775-5401
WELL R13-29
VOA 4 DEG C
40 ML GLASS   SHIP TO E C JORDAN

397112   000001

E C JORDAN CO   P O BOX 7050
PORTLAND ME 04112   207-775-5401
WELL R13-29
VOA 4 DEG C
40 ML GLASS   SHIP TO E C JORDAN

397112   000002

E C JORDAN CO   P O BOX 7050
PORTLAND ME 04112   207-775-5401
WELL R13-29
DMF 4 DEG C
40 ML GLASS   SHIP TO BORRISTON LAB

397112   000003

E C JORDAN CO   P O BOX 7050
PORTLAND ME 04112   207-775-5401
WELL R13-29
DMF 4 DEG C
40 ML GLASS   SHIP TO BORRISTON LAB

397112   000004

E C JORDAN CO   P O BOX 7050
PORTLAND ME 04112   207-775-5401
WELL R13-29
SVOA 4 DEG C
1 LITER GLASS   SHIP TO E C JORDAN

397112   000005

FIGURE 7-1
EXAMPLE COMPUTERIZED LABELS

PA ___ OF ___

CHAIN OF CUSTODY RECORD

PROJECT NO.

PROJECT NAME

SAMPLERS (SIGNATURE)

STA. NO	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO OF CONTAINERS	SAMPLE TYPE												REMARKS INDICATE SOIL/WATER/AIR SEDIMENT/SLUDGE

RELINQUISHED BY: (SIGNATURE)	DATE / TIME	RECEIVED BY: (SIGNATURE)	RELINQUISHED BY: (SIGNATURE)	DATE / TIME	RECEIVED BY: (SIGNATURE)
RELINQUISHED BY: (SIGNATURE)	DATE / TIME	RECEIVED BY: (SIGNATURE)	RELINQUISHED BY: (SIGNATURE)	DATE / TIME	RECEIVED BY: (SIGNATURE)
RELINQUISHED BY: (SIGNATURE)	DATE / TIME	RECEIVED FOR DISPOSAL BY: (SIGNATURE)	DATE / TIME	REMARKS	

FIGURE 7-2

The flow of samples and the analytical data through the laboratory is shown in Figure 7-3. Properly identified samples are received in the laboratory by a sample custodian. This person signs the chain-of-custody form after verifying that all samples submitted are listed and the required information is entered on the form. The sample custodian then places the samples in a refrigerator designated for the receipt of new samples. When a request for analysis form (Figure 7-4) is received by the laboratory the sample custodian then places a laboratory identification number on each sample and the samples are moved to another refrigerator designated for storing samples to be analyzed. Since there are several refrigerators designated for storing samples waiting for analysis, the samples are also color coded to identify the refrigerator in which they are stored. On the front of the refrigerator, a laboratory chain-of-custody record (Figure 7-5) is placed for the purpose of keeping track of the samples during analysis. When directed to analyze a specific sample, the analyst will record on the chain-of-custody record the sample number, the date it was removed from the refrigerator and the analyst who removed it. The date when it was returned is also indicated.

Reagent Documentation. Records of all reagent preparations are maintained in writing. Information recorded in the reagent log books includes identification of preparation, date, name of individual, lot number of reagent used, raw weighing and dilution data. Only volumetric glassware and analytical balances are used for reagent preparation. Reagents are placed in appropriate containers, clearly and permanently labeled with the date of preparation, individual and identification of reagent. Reagents are stored at conditions appropriate for each and discarded after standard permissible holding times or if contamination/decomposition is evident.

All aqueous reagents are prepared from water of at least ASTM Type II purity. All reagents and solutions used are of ACS reagent grade quality (minimum). Organic solvents for photometric procedures are Spectral grade. All solvents for organics analysis are either suitable for pesticide residue analysis or Nanograde. All organic standards are of GC standard purity. Mixtures are purchased from reputable suppliers and are of GC standard purity. Isotopic surrogates are certified by the suppliers and are of highest possible enrichment.

SAMPLE PROGRESSION THROUGH LABORATORY

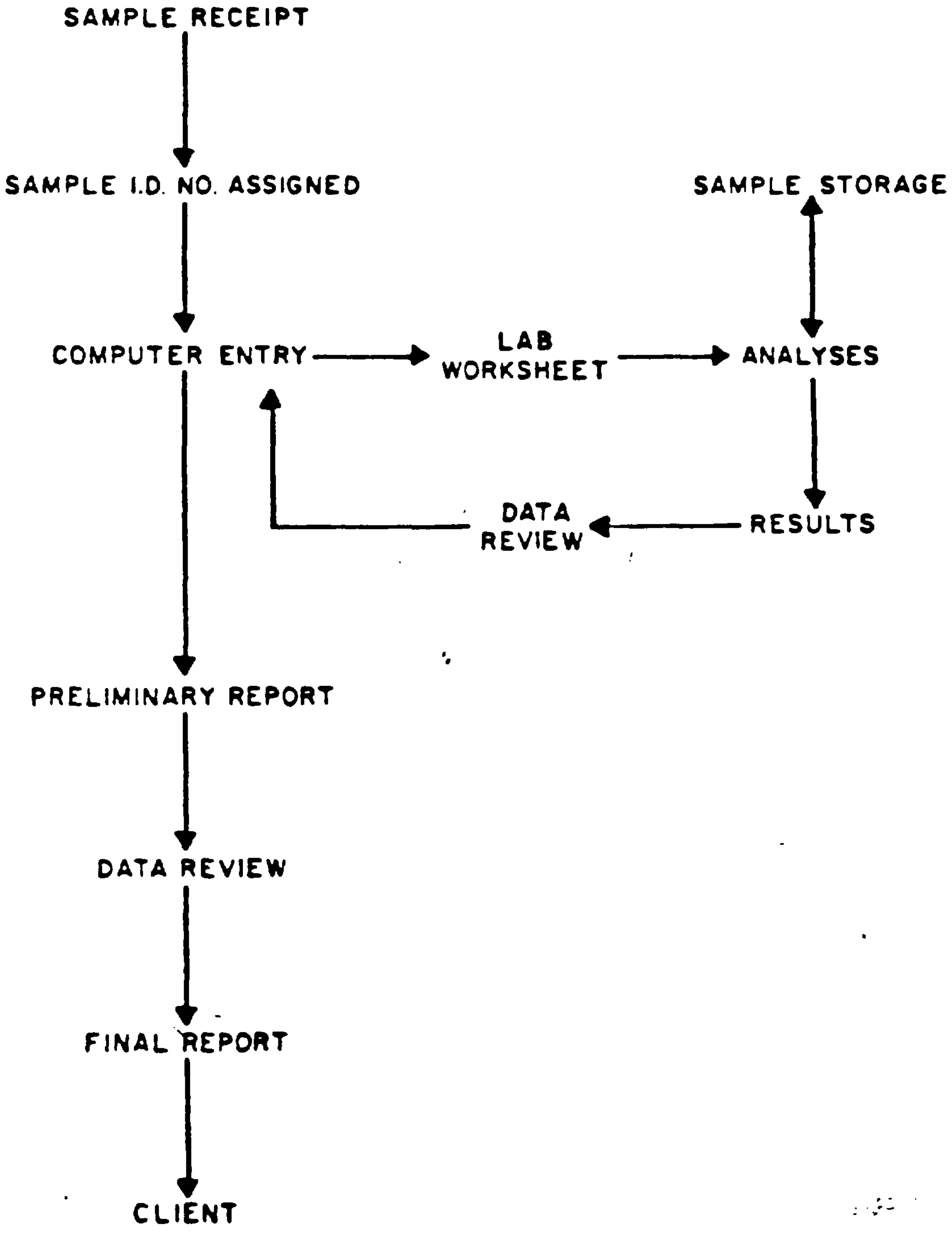


FIGURE 7-3

ANALYSIS REQUEST FORM

E.C. JORDAN CO.
ENVIRONMENTAL LABORATORY SERVICES

CLIENT INFORMATION: NAME ______________________

COMPANY ______________________

MAILING ADDRESS ______________________

____

PURCHASE ORDER/JOB NUMBER ______________________

WHERE TO SEND REPORT: ☐ DIRECTLY TO CLIENT

☐ ECJ - NAME ______________________

ANALYSES REQUESTED BY: ______________________
TECHNICAL PROJECT PROFESSIONAL

APPROVED BY: ______________________
PROJECT MANAGER

SAMPLE IDENTIFICATION	LAB NUMBERS	DATE SAMP'D	SAMP'D BY	ANALYSES REQUIRED

DATE RECEIVED ______________________
LAB LOCATION ______________________
RESULTS DUE ______________________
CLIENT ID.NO. ______________________
☐ SOLID WASTE DATA FILE
☐ DATA DOCUMENTATION REQ'D
☐ ENTERED IN COMPUTER

TYPE OF SAMPLE ______________________
LIST ANY HAZARDS ______________________

☐ SPECIAL PROCEDURE

ADDITIONAL INFORMATION OR SPECIAL PROCEDURES ______________________

FIGURE 7-4

LABORATORY CHAIN OF CUSTODY RECORD

DATE IN	ANALYST	SAMPLE NO.	DATE OUT

5.0 LABORATORY PROCEDURES

The following preprinted sections of this Attachment document procedures to be used in assuring and controlling the quality of laboratory data. These sections are entitled as follows:

8.0	Calibration Procedures and Frequency
9.0	Analytical Procedures
10.0	Data Reduction, Validation, and Reporting
11.0	Internal Quality Control
12.0	Audits
13.0	Preventive Maintenance
14.0	Data Quality Assessment
15.0	Corrective Action
16.0	Reports to Management
17.0	Dimethyl Formamide Analytical Methodology

These preprinted sections describe the procedures used by E.C. Jordan Company (ECJ) and Rhode Island Analytical Laboratories (RIAL), which have been retained by one of the Settling Parties. In the event that ECJ and RIAL are no longer involved in these activities, similar procedures, as approved by U.S. EPA and MEDEP, shall be adopted by the Settling Parties or their consultants to assure the quality of laboratory work.

WDR119/009

8.0 CALIBRATION PROCEDURES AND FREQUENCY

8.1 CALIBRATION PROCEDURES FOR LABORATORY EQUIPMENT

8.1.1 Gas Chromatograph/Mass Spectrometer/Data System (GC/MS/DS)

All GC/MS analyses are performed in accordance with methods established by EPA (40 CFR Part 136, October 26, 1984). Qualitative identification of the priority pollutants is based on relative retention times and the relative abundance ratios of the characteristic ions. Quantitative analysis of priority pollutants detected is performed using internal standardization.

Initial Calibration

Initial calibration was performed for volatile (EPA Method 624) and semivolatile (EPA Method 625) organic analytes in accordance with sections 7 and 8 of the respective methods.

A calibration curve was developed from the analysis of standard mixes of the analytes at three concentration levels. Clean water precision and accuracy data were generated from the analysis of four replicates of laboratory blank water spiked with standard mixes of the priority pollutants.

Continuing (Daily) Quality Control

Volatile Organic Analytes. The following operations are performed on a daily basis:

- The instrument is tuned to manufacturer's specifications with perfluorotributylamine (PFTBA).
- The tune is validated using p-bromofluorobenzene (p-BFB) to verify that it meets EPA criteria. Table 6-1 presents tune verification data.
- A method blank is analyzed.
- A calibration check standard is analyzed and checked against the calibration curve to verify that calibration acceptance criteria are met.
- All samples, blanks, and standards are spiked with internal and surrogate standards.
- 10% of all samples are analyzed in duplicate.
- 5% of all samples are matrix spikes.

Semi-Volatile Organic Analytes. The following operations are performed on a daily basis:

- The instrument is tuned to manufacturer's specifications with PFTBA.

TABLE 8-1

MINIMUM FRAGMENTATION CRITERIA - MS TUNE VERIFIERS (BFB)

MASS	ION ABUNDANCE CRITERIA
50	15 to 40 percent of mass 95
75	30 to 60 percent of mass 95
95	Base peak, 100 percent relative abundance
96	5 to 9 percent of mass 95
173	Less than 2 percent of mass 174
174	Greater than 50% percent of mass 95
175	5 to 9 percent of mass 174
176	Greater than 95 but less than 101 percent of mass 174
177	5 to 9 percent of mass 176

- The tune is validated using decafluorotriphenylphosphine (DFTPP) to verify that it meets EPA criteria. Table 8-2 presents tune verification data.
- A calibration check standard is analyzed and checked against the calibration curve to verify that calibration acceptance criteria are met.
- All samples, blanks and standards are spiked with internal and surrogate standards.
- 10% of all samples are analyzed in duplicate.
- 5% of all samples are matrix spikes.

8.2 CALIBRATION PROCEDURES AND FREQUENCY FOR FIELD INSTRUMENTS

Each piece of equipment will be calibrated prior to each day's use. The procedures described below apply to the specific instrument noted. If other instruments are used, follow the manufacturer's calibration procedures.

8.2.1 Y.S.I. S-C-T Meter (Model No. 33)

Temperature Probe.

1. Using a National Bureau of Standards-approved thermometer, immerse both probes into a beaker of water and note any differences for the field probe.
2. Recalibrate as necessary.

Specific Conductance Meter.

1. Calibrate meter and probe using the calibration control and the red-line on the meter dial (Y.S.I. S-C-T Meter, Model No. 33).
2. Turn the function switch to read conductivity x 10 and then depress the cell test button, noting the deflection. If the needle falls more than 2 percent of the reading, clean the probe and retest.
3. Using at least two buffer solutions, which will most likely bracket the expected values for conductivity, note accuracy of the water and probe and clean probe if necessary.

8.2.2 Specific Ion Meter

pH Probe.

1. Place electrodes and buffer solutions in a water bath at the temperature of the water to be sampled. After temperature equilibrium, measure temperature and adjust the temperature compensation knob for this temperature.

TABLE 8-2

MINIMUM FRAGMENTATION CRITERIA (DFTPP)

MASS	ION ABUNDANCE CRITERIA
51	30 to 60 percent of mass 198
68	Less than 2 percent of mass 69
70	Less than 2 percent of mass 69
127	40 to 60 percent of mass 198
197	Less than 1 percent of mass 198
198	Base peak, 100 percent relative abundance
199	5 to 9 percent of mass 198
275	10 to 30 percent of mass 198
365	Greater than 1 percent of mass 198
441	Present but less than mass 443
442	Greater than 40 percent of mass 198
443	17 to 23 percent of mass 442

2. If using refillable probes, remove electrode cap and check that filling solution is above the filling mark.

3. Immerse the probe in the pH 7 buffer solution and adjust the calibration control to read the appropriate pH. Check the pH buffer solution for correct pH value at the equilibrated temperature.

4. Remove the probe, rinse with distilled water and then immerse in either the pH 4 or pH 10 buffer solution, depending on the expected pH of the sample.

5. If the meter does not register the correct pH for that buffer solution, adjust the calibration knob on the back of the instrument to obtain the pH of the buffer.

6. After rinsing, insert the pH probe into the flow cell and allow the probe to come to equilibrium with the sample water.

7. The pH probe is stored in the ambient air overnight.

Eh Probe.

1. Check that the platinum probe is clean and the platinum bond or tip is unoxidized. If dirty, polish with emery paper.

2. Immerse the standard solution, Zobell solution, and probe in a water bath at the temperature of the water to be sampled. After the temperature has equilibrated, increase the probe and the reference probe, if required, into the Zobell solution. Record the mV reading and the temperature and compare with the expected value (±10-20 mV).

3. Rinse the probe with distilled water or probes and insert into the flow cell. Allow for temperature equilibration and record the sample Eh.

4. At the end of the day, the probes should be stored in water.

8.2.3 Tripar Analyzer

Temperature Calibration.

- Temperature Zero Adjustment - Connect the temperature sensor and select temperature as the display parameter. Remove the rear access cover exposing the sensor calibration potentiometers.

  Prepare an ice water slurry and place the temperature sensor in the solution. Allow the temperature sensor to stabilize for approximately one minute while stirring the sensor in the solution vigorously. Using the adjustment tool provided in the rear cover, adjust the temperature "zero" potentiometer for a reading of 0.00°C on the system display.

- Temperature Span Adjustment - Prepare a test solution to be used for temperature calibration. A beaker of water at room temperature works well as it will not be changing rapidly in temperature. Place the Tripar temperature sensor in the test solution and allow to stabilize for approximately one minute. Using a precision laboratory thermometer, measure the temperature of the test solution. At the Tripar rear panel, adjust the temperature "CAL" potentiometer until the Tripar display reads the value of the calibration solution.

  Best results will be obtained if the temperature "ZERO" and "SPAN" calibration procedures are repeated.

Conductivity Calibration. From time to time, it will be required to calibrate the Tripar conductivity circuit. A simple two-point calibration procedure is utilized by first adjusting the conductivity zero and then the span.

- Conductivity Zero Adjustment - With the conductivity sensor clean, dry, and in air, adjust the conductivity "zero" potentiometer for a reading of 0000 on the Tripar display.

- Conductivity Span Adjustment - Totally immerse the Tripar conductivity sensor in calibration solution of known conductance. Note that the reading displayed on the Tripar is a temperature corrected value to 25°C. Therefore, the value of the standard solution must be calculated to 25°C. Also, the value of the calibration solution should fall in the upper 50 percent of the ranges to be calibrated; i.e., adjustment of the 1000 micromho range should be accomplished with a 500 to 1000 micromho standard. Once the sensor has stabilized in the solution for approximately one minute, adjust the conductivity "CAL" potentiometer at the Tripar rear panel for a reading on the display equal to the temperature corrected value of the standard solution.

  Best results will be obtained if the conductivity zero and span procedures are repeated.

pH Calibration.

- pH Standardization - The pH sensor should be standardized before each use after long storage. First, moisten the electrode body with tap water and carefully remove the plastic storage cap covering the tip of the electrode. Care should be taken not to bend the body of the electrode as this can result in damage to the internal element.

  For first time use after long storage, immerse the lower end of the electrode in tap water for 30 minutes. This hydrates the pH bulb and prepares the ceramic wick for contact with test solutions. If air bubbles are present in the pH bulb, shake the electrode downward to fill the bulb with solution.

  Prepare a small sample of pH 7.00 buffer solution and measure the temperature of the buffer. Rinse the pH electrode with distilled water and immerse the pH bulb in the reference buffer. Set the compensation dial in the Tripar front panel to the temperature of the buffer, allow several minutes for the sensor to reach equilibrium and stir the sensor slightly to dislodge any possible air bubbles from the electrode tip. Using the "Standardize" potentiometer, adjust for a reading of 7.00 on the Tripar display.

- <u>pH Slope Adjustment</u> - Very infrequently, the pH slope adjustment may require re-calibration. This adjustment is available at the Tripar readout rear panel. To accomplish this adjustment, prepare a test solution of pH 4.00 or 10.00. Measure the temperature of the solution and make the appropriate setting at the pH "Compensation" dial. Rinse the pH electrode in distilled water and immerse in the buffer solution. Allow several minutes for the sensor to equilibrate and stir the electrode slightly. Using the pH "Slope" potentiometer available at the rear panel, adjust the Tripar readout module for a reading equal to the value of the buffer solution. For best results, the pH "Standardize" and "Slope" adjustments should be repeated at least once.

  Note that some interference may be seen on the pH reading if the Tripar conductivity sensor is present in the same test solution as the pH sensor.

8.2.4 HNU Photoionization Meter

With the probe attached to the instrument turn the function switch to the battery check position. The needle on the meter should read within or above the green battery area on the scale plate. If the needle is in the lower position of the battery arc, the instrument should be recharged prior to any calibration. If red LED comes "on", the battery should be recharged. Next, turn the function switch to the on position. In this position the UV light source should be on.

To zero the instrument, turn the function switch to the standby position and rotate the zero potentiometer until the meter reads zero. Clockwise rotation of the zero potentiometer produces an upscale deflection while counterclockwise rotation yields a downscale deflection. If the span adjustment setting is changed after zero is set, the zero should be rechecked and adjusted if necessary. Wait 15-20 seconds to ensure that the zero reading is stable. If necessary, readjust the zero.

The instrument is now ready for calibration by switching the function switch to the proper measurment range.

Using non-toxic analyzed gas mixtures available from the manufacturer in pressurized containers, connect the cylinder with the analyzed gas mixture to the end of the probe with a piece of tubing. Open the valve of the pressurized container until a slight flow is indicated and the instrument draws in the volume of sample required for detection. Now adjust the span potentiometer so that the instrument is reading the stated value of the calibration gas.

If the instrument span setting is changed, the instrument should be turned back to the standby position and the electronic zero should be readjusted if necessary. If the instrument does not calibrate, it may be necessary to clean the probe or the lamp connection.

8.2.5 Organic Vapor Analyzer

Set up the Photovac 10A10 in a temperature-stable environment at least eight to ten hours before beginning analyses. Attach AC power cord to Photovac and plug into 110V power outlet. Attach recorder AC power cord to Linear recorder and plug into 110V power outlet. If fully charged, internal battery packs provide 6 to 8 hours operation as a portable instrument.

Connect coaxial cable to "output" jack on Photovac, and plug opposite end into +/- input jacks on records. If positive meter reading on the Photovac gives negative recorder response, reverse polarity of recorder by reversing plug in +/- jacks. Attach gas supply to either "carrier in" port and test for proper flow rate on "vent" and "out" parts with a bubble flow meter. Record actual flow rate. Proper flow rate is 10-15 mℓ/min during analysis; ~5 mℓ/min on standby or overnight. Reduce flow rate for overnight flush by adjusting the air tank pressure regulator. Note: Use only "Zerograde" or better air as carrier. Plastic tubing is preferred for the connection.

Set Photovac attentuation on 100 and range on x1. Start gas flow at 10 mℓ/min. Place "charge" switch in off position and turn detector switch on 30 minutes prior to beginning of analysis. Turn recorder chart drive off, and with the input voltage switch set at 100 mV, turn the recorder power on. Using the "zero" and "attenuation" knobs on the recorder, set so that a zero reading on the Photovac meter gives zero plot on the recorder, and so that 100 reading on Photovac gives full scale reading on recorder. (Turn the "offset" knob on the Photovac to make photovac meter reading change.)

Turn the "offset" knob fully counterclockwise. Meter reading should be 20-50 percent of full scale. If higher, either the air supply is contaminated or the column needs to be flushed. The instrument can still be used in this condition, but the detector can easily be overloaded. Wait until reading is 20-50 percent if possible before analysis. Set the attenuation on the Photovac to the desired setting (e.g., 100 for "unknown" or dirty samples; 10 for low ppm standards or clean samples).

Rotate the offset knob clockwise until meter (and recorder) reads ~10 percent of full scale. Set the column selector switch to the desired column. Use column #1 (10 inches long) for screening unknown samples by injecting a small (~ five-μℓ) amount in port #1 to determine how much sample to inject in column #2 (four feet long) for analytical purposes. Use the results of this initial small injection on column #1 to avoid overloading column #2. If column #2 is overloaded, it may take hours or even days before it is useful again.

Reset the offset (if necessary) to give 10 percent full scale reading. Wait for m ter to stabilize. Set recorder chart speed to 1 cm/-in and turn chart drive on (flip switch up to cm/min setting). Inject sample or standard into proper port in a smooth motion and note on the recorder chart the moment of injection. Note on the chromatogram the sample or standard identification, volume injected, column #, range and attenuation (e.g., 100 x 1), chart speed and date.

Let chromatogram run until all compounds have eluted and the baseline has stabilized before making another injection (~15-20 minutes for column #1, ~30-60 minutes for column #2). Run standard mix every five or six samples to monitor changes in retention times or response. To interpret chromatograms, measure retention times from point of injection (1 cm = 1 min, or appropriate scale). Measure peak height from baseline to estimate quantity of a given compound, relating sample peak retention time and height to that of known standards. Peak height is directly proportional to concentration and to volume injected (e.g., if a 50 μl injection of a 5 ppm standard gives a 5 cm peak with retention time of 114 seconds, a sample with a 3 cm peak at 112 seconds may contain 3 ppm of the same compounds if 50 μl was injected).

Miscellaneous. Use only air-tight syringes with sharp pointed needles to introduce samples into the Photovac. Any bend in the needle will damage the septum and analyzer will not be reliable. Pierce the septum of the sample container and rinse the syringe three or four times by working the plunger back and forth before filling with sample. Remove syringe and quickly adjust volume and make injection with no hesitation. Never remove or loosen caps or valves on sample containers. Once the septum on a sample container is pierced, complete all analyses on that sample as soon as possible, as some loss of contaminants may occur.

Never interrupt the carrier gas (air) supply without first turning the detector off! Change air tanks when pressure reaches ~300 psig, or at the end of the day if analyses are to be performed the following day (detector off while changing).

Typical Standards, Retention Times, Response Factors for the Photovac 10A10. The retention times and response factors below are estimates based on laboratory work under controlled conditions (20°C and a carrier flow of 10-15 ml/min). Actual retention times and response factors must be acquired in the field under identical conditions to those under which samples will be run.

A table like that shown below must be generated prior to analysis of actual samples. Documentation must also include attenuation settings, column identification, head pressure and ambient conditions.

Compound	Mixed Standard Concentration (ppm)	Retention Time (seconds)	Response 50 μl Injection (cm)
methylene chloride	5.0	50	~10
1,1-dichloroethane	10.0	63	4.5
1,2-dichloroethane	20.0	100	4.5
benzene	1.0	110	6.5
toluene	2.0	285	5.8
1,1,2,2-tetrachloroethylene	2.0	340	7.1
chlorobenzene	2.0	435	7.1
xylenes (3 isomers)	10.0	615,665,800	1.0,4.3,1.3

9.0 ANALYTICAL PROCEDURES

9.1 SELECTION OF PARAMETERS

The parameters to be monitored in groundwater, surface water, and sediment were selected based on results obtained during pervious studies of the site. The studies showed volatile organics, dimethyl formamide, tetrahydrofuran, MEK, and MIBK to be present at the site. In addition, semivolatile organics are to be analyzed annually at five monitoring wells.

9.2 ANALYTICAL PROCEDURES

Analyses will be performed by USEPA Methods 624 and 625 except for the determination of dimethyl formamide (DMF). DMF will be analyzed by direct injection to a gas chromatograph utilizing a nitrogen-phosphorus detector and a 1 percent SP-1000 on 60/80 Carbopack B, 1.8 meter by 2 millimeter glass column in accordance with the methodology specified by the Administrative Order by Consent for provision of alternate water supply, 1984.

The DMF analysis, discussed further in Section 17.0, will be performed by Rhode Island Analytical Laboratories, Providence, R.I.

Samples will be collected in both water and soil matrices. Water samples will be analyzed for organic parameters in accordance with USEPA Methods promulgated as 40 CFR 136 on 26 October 1985. Soil samples will be handled such that organic contaminants are exchanged to an aqueous or solvent extractant, and subsequently analyzed by the same methods cited above.

9.2.1 Water Matrices

Table 9-1 presents selected organic analytical method information. Precision, accuracy and method detection limits, as stated by the methods, reflect method performance under ideal sample matrix and laboratory conditions. These performance levels are not expected to be equaled during this project. Actual analytical method performance is provided with the analytical results in the form of duplicate analytical results, blank analytical results, spiked sample results and surrogate compound recoveries. Additional data documentation is not required by the referenced methods.

9.2.2 Solid Matrices

As noted previously, organic analyses of solid matrices will utilize the same methods specified for water matrices. Precision, accuracy and method detection limits, as stated by the methods, reflect method performance under ideal sample matrix and laboratory conditions. These performance levels are not expected to be equaled during this project. Actual analytical method performance is provided with the analytical results in the form of duplicate analytical results, blank analytical results, spiked sample results and surrogate compound recoveries. Additional data documentation is not required by the referenced methods.

TABLE 9-1

ANALYTICAL METHODS

Parameter	USEPA Analytical Method[1] & Nominal Detection Limit[2]	
	Water	Solids
Volatile Organics[3,4]	624 - 10 µg/ℓ	624 - 400 µg/kg
Semivolatile Organics[3,4]	625 - 20 µg/ℓ	625 - 800 µg/kg

---

[1] The ideal precision and accuracy of the referenced methods (if available) is contained in the method.[4] The actual precision and accuracy is dependent upon the matrix interferences encountered and will be determined as the project progresses. It is anticipated that precision and accuracy will be less than that stated by the method.

[2] Nominal detection limits are presented. Actual detection limits are dependent upon the matrix interferences encountered and the compound to be determined.

[3] Solid samples are prepared such that contaminants are exchanged to a liquid phase and the referenced methods utilized.

[4] Organic methods are contained in 40 CFR Part 136 "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act" 26 October 1984. Inorganic methods are contained in "Methods for Chemical Analysis of Water and Wastes," EPA-600/4-79-020, March 1983. Both inorganic and organic methods for solid matrices are contained in "Test Methods for Evaluating Solid Waste" USEPA SW-846, July 1982.

Solid sample preparation for organic analyses will utilize the following protocols:

Volatile - Fraction	One gram of sample is placed in a 40 ml vial filled with water and spiked with surrogates. The vial is agitated for at least 16 hours at 4°C and the water is analyzed by the specified method.
Semi Volatile - Fraction	20 grams of sample are sonicated and sequentially extracted with 3 volumes of a mixture of methylene chloride and acetone. The combined extractant is then analyzed.

These protocols are described in more detail in "Development of Analytical Test Procedures for the Measurement of Organic Priority Pollutants in Sludge and Sediments," Midwest Research Institute, Final Report-EPA Contract No. 68-03-2695, June 26, 1979, and USEPA's National Contract Laboratory Program "Consensus Organics Protocols", respectively.

10. DATA REDUCTION, VALIDATION AND REPORTING

Data reduction is the process of converting measurement system outputs to an expression of the parameter which is consistent with the comparability objective (identified in Section 5 of this QAPP). Calculations made during data reduction are described in the USEPA analytical methods.

Validation of measurements is a systematic process of reviewing a body of data to provide assurance that the data are adequate for their intended use. The process includes the following activities:

- editing,
- screening,
- checking,
- auditing,
- verification,
- certification, and
- review.

Data validation activities will be documented and records kept of any necessary corrective or remedial action.

Laboratory reports of data will be edited by comparing with original calculations. Subsequent data tabulations will be edited by comparing with the laboratory reports. The data will be screened to determine compliance with the quality assurance objectives identified in Section 5.

Field data collection and validation will follow the process illustrated as Figure 10-1. Prior to data collection, determinations are made regarding the data which is required to be gathered in the field and the methodology to be used. Once the data is obtained, it will be reviewed and assessed as to its adequacy. If it is determined that the initial data collection concept did not provide adequate data, the entire process will be repeated.

Calculations performed during data reduction are checked before the laboratory reports the data, as was illustrated in Figure 7-3.

Jordan's Environmental Laboratory routinely participates in and successfully completes performance audits using reference samples provided by USEPA and other regulatory authorities. Results of these audits will assist in validating the data reported. In addition, system audits of laboratory procedures and data management are conducted by the QAC.

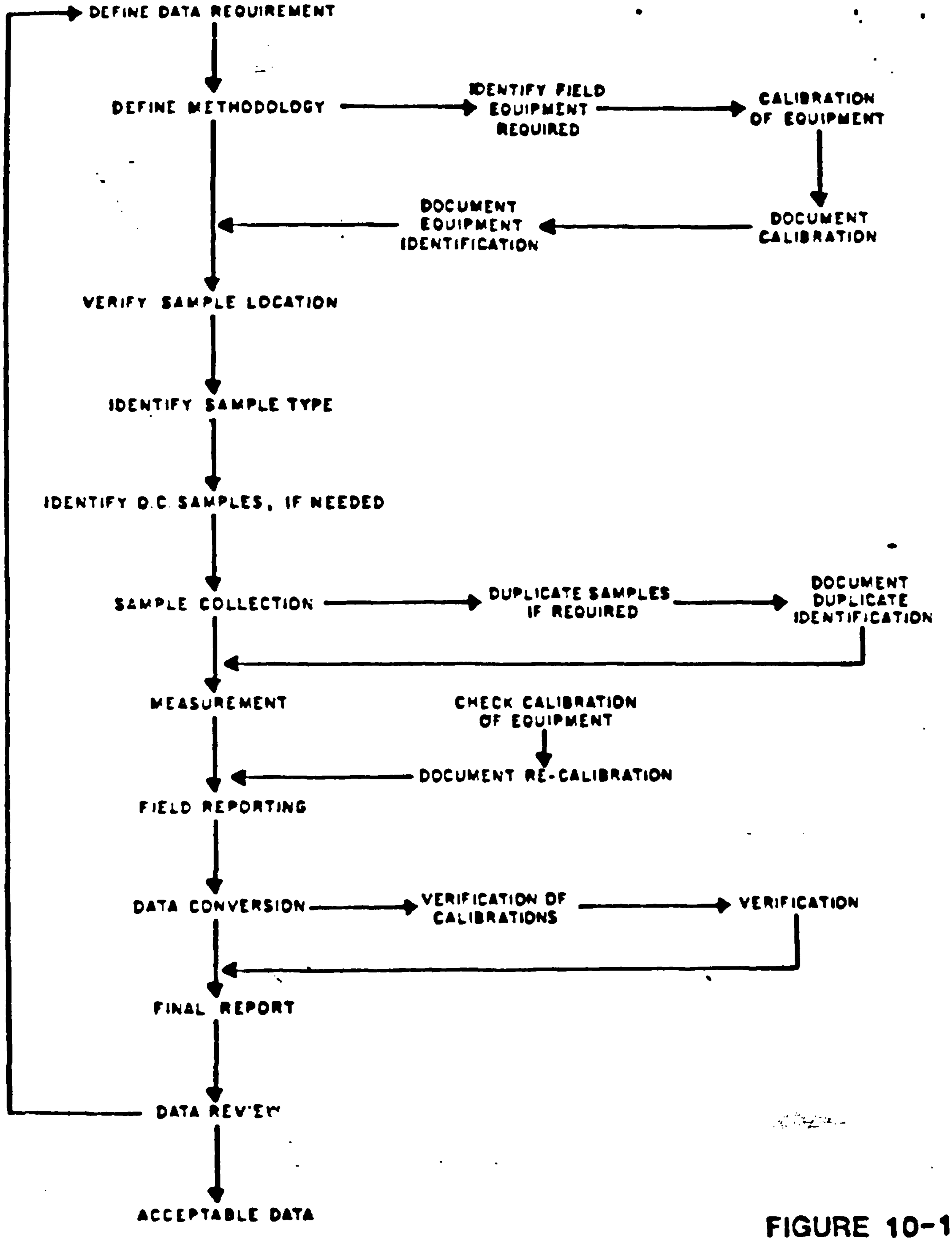
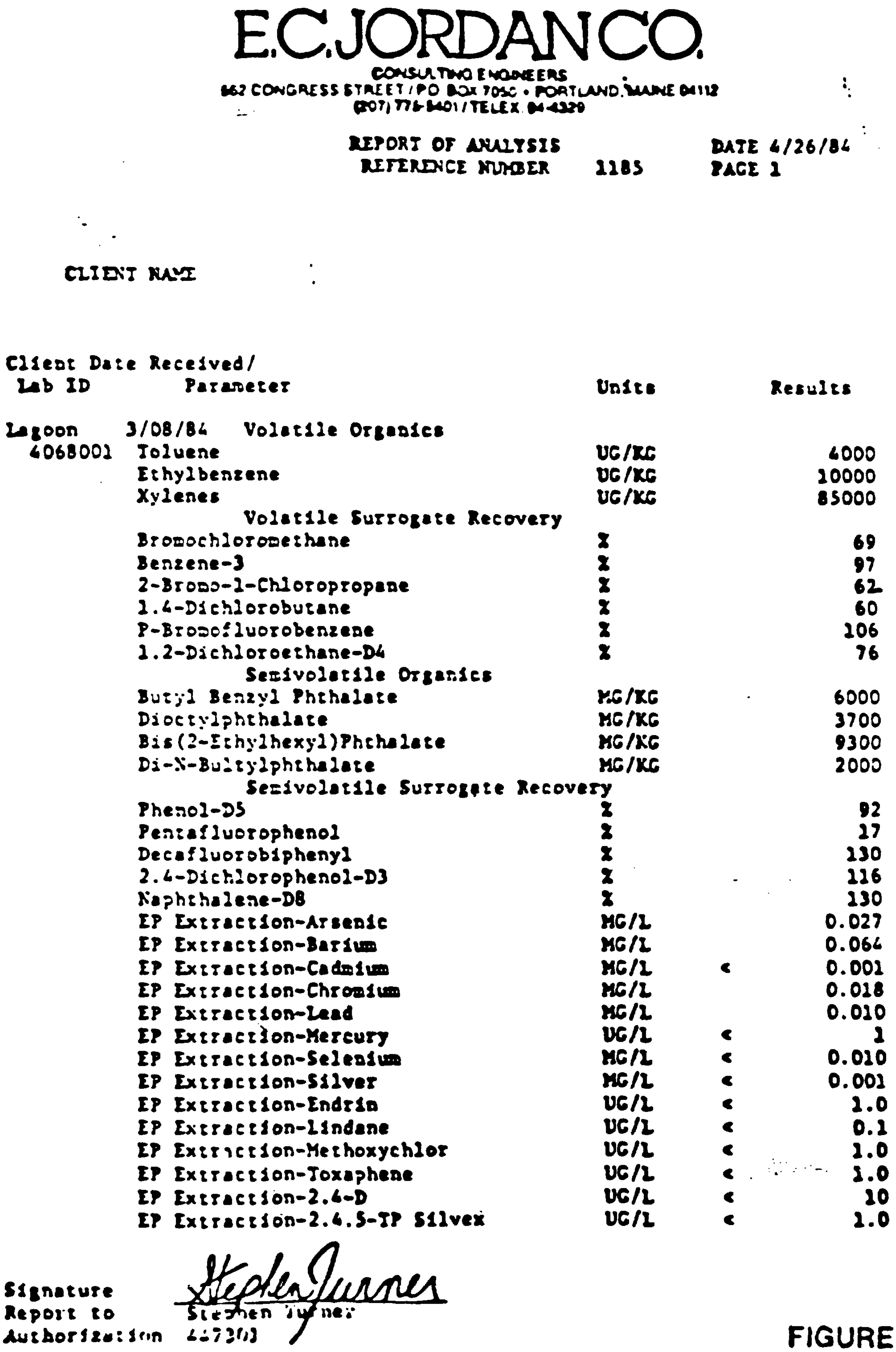


FIGURE 10-1
FIELD DATA COLLECTION AND VALIDATION

E C JORDAN CO

Results reported for each sample are verified to assure proper identification by comparing the original sample collection log sheets (see Section 6) with chain-of-custody forms and laboratory log books. Upon certification by the laboratory manager, the reported values are received and reviewed by the technical staff and the QAC (if deemed necessary).

Analytical data are to be reported from Jordan's laboratory within 30 days of sample receipt in the format illustrated in Figure 10-2. It should be noted that analytical data documentation is limited to that required by the specified methodologies.



E.C.JORDAN CO.
CONSULTING ENGINEERS
562 CONGRESS STREET / PO BOX 7050 • PORTLAND, MAINE 04112
(207) 775-5401 / TELEX 94-4329

REPORT OF ANALYSIS DATE 4/26/84
REFERENCE NUMBER 1185 PAGE 1

CLIENT NAME

Client Lab ID	Date Received/	Parameter	Units		Results
Lagoon	3/08/84	Volatile Organics			
4068001		Toluene	UG/KG		4000
		Ethylbenzene	UG/KG		10000
		Xylenes	UG/KG		85000
		Volatile Surrogate Recovery			
		Bromochloromethane	%		69
		Benzene-3	%		97
		2-Bromo-1-Chloropropane	%		62
		1.4-Dichlorobutane	%		60
		P-Bromofluorobenzene	%		106
		1.2-Dichloroethane-D4	%		76
		Semivolatile Organics			
		Butyl Benzyl Phthalate	MG/KG		6000
		Dioctylphthalate	MG/KG		3700
		Bis(2-Ethylhexyl)Phthalate	MG/KG		9300
		Di-N-Bultylphthalate	MG/KG		2000
		Semivolatile Surrogate Recovery			
		Phenol-D5	%		92
		Pentafluorophenol	%		17
		Decafluorobiphenyl	%		130
		2.4-Dichlorophenol-D3	%		116
		Naphthalene-D8	%		130
		EP Extraction-Arsenic	MG/L		0.027
		EP Extraction-Barium	MG/L		0.064
		EP Extraction-Cadmium	MG/L	<	0.001
		EP Extraction-Chromium	MG/L		0.018
		EP Extraction-Lead	MG/L		0.010
		EP Extraction-Mercury	UG/L	<	1
		EP Extraction-Selenium	MG/L	<	0.010
		EP Extraction-Silver	MG/L	<	0.001
		EP Extraction-Endrin	UG/L	<	1.0
		EP Extraction-Lindane	UG/L	<	0.1
		EP Extraction-Methoxychlor	UG/L	<	1.0
		EP Extraction-Toxaphene	UG/L	<	1.0
		EP Extraction-2.4-D	UG/L	<	10
		EP Extraction-2.4.5-TP Silvex	UG/L	<	1.0

Signature Stephen Turner
Report to Stephen Turner
Authorization 447303

FIGURE 10-2
EXAMPLE ANALYTICAL DATA REPORT

11.0 INTERNAL QUALITY CONTROL

11.1 MEASUREMENT SYSTEMS

Quality control procedures are established for laboratory and field activities. Procedures used in the Jordan laboratory, such as analytical duplicates, blanks, control charts, internal standards, surrogates and reagent checks are described in detail in the specified analytical methods. Jordan also has established quality control procedures for all field activities such as sampler blank collection, duplicate sample collection, and field measurement validation. Field quality control activities include the use of calibration standards and blanks for pH, specific conductance, temperature and photoionization measurements. Special samples to be submitted to the laboratory include:

- trip blanks,
- blind replicates (field duplicate),
- sampler blanks
- filtration blanks

These samples provide a quantitative basis for validating the data reported.

Trip Blanks

Trip blanks are required for assessing volatile organic priority pollutants reported in water samples. The trip blank consists of a VOA sample container filled with reagent water which is shipped to the site with the other VOA sample containers. Two trip blanks are included with each shipment of water samples scheduled for volatile organic analysis. One of the two trip blanks will be analyzed with the other VOA samples. The other may be analyzed if VOA are detected in the first VOA trip blank.

Replicates

Replicates of water and sediment will be submitted for analysis of all parameters specified for those samples according to the following schedule:

Media	Number
groundwater and surface water	10% of samples analyzed or a minimum of 1 per event
sediments	10% of samples analyzed or a minimum of 1 per event

The identity of the replicate samples will not be revealed to the laboratory.

True replicates of sediment samples are not possible because chemicals are typically not uniformly distributed in these materials. A modification of ASTM C702, Method B "Reducing Field Samples of Aggregate to Testing Size" will be used to split sediment samples. Samples for volatile organic analysis, however, must be grab samples to avoid the loss of volatile constituents, which may be expected during sample splitting.

Filtration Blanks

Groundwater samples scheduled for analysis of inorganic parameters are to be filtered. In order to assess filtration apparatus cleaning procedures and potential cross contamination, as well as any contribution to the sample from the fitler itself, a filtration blank will be collected for every 10 to 15 samples filtered. The filtration blank will be prepared by passing reagent water through a freshly cleaned filtration apparatus.

Sampler Blanks

A minimum of one sampler blank for the bailer or sampling pump and tubing assembly is scheduled prior to monitoring well sampling. Volatile or semi-volatile organics present within the pump apparatus or discharge tubing are assessed by collecting a sample of reagent water passed through the sampling apparatus after washing the pump and tubing with the methanol-deionized water solution followed by a rinse with reagent water.

Completeness

Completeness of scheduled sample collection will be controlled in the field by comparing a computer generated label inventory with samples actually collected each day. Daily checking of field data sheets and comparison of transport and chain-of-custody logs will provide further control on documentation and completeness.

Criteria Used in Evaluating Laboratory Assays of Internal Quality Control Samples and Field (Sample) Replicates

Establishment of specific criteria depends on the number of field and quality control samples for each media sampled, the quality of chemical data and how the data will be used in interpreting, evaluating and assessing the site. Chemical assay results of a particular sample may be used for more than one purpose in a remedial investigation and feasibility study. Chemical assay results of quality control samples may be considered differently depending on how the data will be used.

The following general criteria are identified for use by the professional responsible for assessing site conditions:

- Quality of Laboratory Data:
  - acceptable
  - provisional
  - unacceptable

- Method Limitations:
    - detection range
    - accuracy
    - method detection limits (MDL)
    - minimum reportable concentration (MRC)
    - precision

- Sampling/Analysis Scope and Results:
    - number of replicates at one location
    - number of samples on site/media
    - background/downgradient distribution
    - consistency/trends of chemical assay data collected at site
    - agreement with existing site information

- Use of Data:
    - chemical distribution and transport at the site (generally order of magnitude comparisons)
    - compliance with standards, regulations, response objectives
    - presence or absence of chemical
    - treatability
    - disposal method for media containing chemicals

11.2 QUALITY REVIEW OF STUDIES AND REPORTS

The purpose of quality reviews through the course of studies, designs and reports is to ensure that the service, designs and documents produced by each department meet currently accepted professional standards. The level of effort for each project will vary depending on type of project, duration and size. Review of small projects may entail periodic discussions between production staff and discipline managers. Quality control on larger projects may require that a review team be selected for more frequent meetings and discussions. Quality control reviews should be scheduled on a routine basis, but the option of holding a quality control review at any time is always open.

The time required to plan, schedule, and conduct quality control reviews should be considered part of all other design, writing and checking phases of a project.

Each project is divided into phases for quality control reviews. At each phase, the review should include client goals, contractual commitments, technical merit, timing, budget, assignment of appropriate personnel, department coordination, project problem resolution, documentation, and consistency with company policy. Key elements to the success of any quality control review are identification of problem areas, communication to implement solutions, and follow-up.

Quality control during the preparation of studies and reports relies on documentation of data utilized and peer review of conclusions drawn from the assembled data base. The comparability objective established for the project is of particular importance when data are derived from many sources (i.e., the data base is comprised of secondary measurements). Documentation of secondary data typically is accomplished via data verification/tracking checklists with accompanying written criteria describing "acceptable" data to insure consistency in data selection. This allows all data base components to be traced to the primary generator and forces a review of data quality as the data base is developed. All project personnel are responsible for utilization and monitoring of this process; compliance is audited by the QAC. Upon completion of the data base, data interpretation, evaluation, and report preparation commence. Interpretation may require consultation with Jordan's statistician and/or use of computerized statistical routines. Documentation is also prepared for statistical manipulation methodologies. Data evaluations incorporate peer review to provide broad-based insight to data correlations and interactions.

To enhance the professional quality of the company's studies and reports, the discipline manager will also:

- require that reports refer to and are consistent in scope with the project proposal and contract; and
- require that report language and contents be chosen to foster client's understanding of risks and uncertainties by distinguishing fact from opinion and identifying risks and limitations in a clear and informative manner.

12.0 AUDITS

Quality assurance audits are performed to assure and document that quality control measures are being utilized to provide data of acceptable quality and that subsequent calculations, interpretation and other project outputs are checked and validated.

System and performance audits will be conducted by the Quality Assurance Coordinator (QAC). The Laboratory Technical Director will conduct project audits of calculations, interpetations and reports which are based on the measurement system outputs.

12.1 SYSTEMS AUDIT

A system audit will be conducted on all components of measurement systems to determine proper selection and utilization. The systems audit includes evaluation of both field and laboratory procedures.

Organization and Personnel. The project organization is reviewed for compliance with the proposed organization and for clarity of assigned responsibility. Personnel assigned to the project will be reviewed to determine that assigned responsibility, skill and training of the personnel are properly matched. The laboratory director maintains firsthand knowledge of his team's capabilities and will discuss the organization's efficacy with the QAC. Assigned personnel may be interviewed by the QAC during an audit.

Facilities and Equipment. The audit will address whether field tools and analytical instruments are selected and used to meet requirements specified by the project objectives stated in the QAPP. Equipment and facilities provided for personnel health and safety will also be evaluated. Calibration and documentation procedures for instruments used in the field will receive special attention.

Analytical Methodology. Routine external performance evaluations as well as blind internal performance evaluations are conducted. A review of analytical methodology in regard to the data requirements for the project is usually performed; this project, however, has specified analytical methods. An on-site observation of analyst technique, data reduction and record keeping may be performed. Periodic review of precision and accuracy data is essential. Jordan's Analytical Laboratory routinely participates in USEPA performance evaluations.

Sampling and Sample Handling Procedure. An audit of scheduled samples vs samples collected vs samples received for analysis will be performed. Field documentation will be reviewed. If deemed necessary, a site visit will be made to assure that designated control procedures are practiced during sampling activities.

Data Handling. During a system audit, the QAC will review data handling procedures with the TD and Task Leaders. Accuracy, consistency, documentation and appropirate selection of methodologies will be discussed.

12.2 PERFORMANCE AUDIT

Performance is monitored periodically (about 10%) for sampling protocols and continuously for analytical procedures to determine the precision and accuracy of the total measurement system(s).

The precision of sampling is assessed through field duplicates and sampler/ filtration blanks. To determine the accuracy of measurement systems in the laboratory, performance test samples are used to assess precision and accuracy. USEPA has prepared test samples for numerous parameters in many different matrices. The QAC coordinates regulatory authority performance audits and periodically submits blind performance audit samples for analysis. Currently, Jordan participates in (and successfully completes) USEPA WS-series and WP-series performing evaluations. Results of the most recent USEPA performance evaluation are available upon request.

Performance audits for data handling systems will involve review of field data records, calculations and data reduction methods.

12.3 QA AUDIT REPORT

A written report of the QA audit (see Figure 12-1) is prepared to include:

- an assessment of project status in each of the major project areas;
- clear statements of areas requiring improvement or problems to be corrected. Recommendation and assistance will be provided regarding proposed corrective actions or system improvements. If no action is required, the report will state that the QA audit was satisfactorily completed;
- a timetable for any corrective action required; and
- a follow-up to assure that recommendations have been implemented.

The QA Audit Report is submitted to the project manager.

FIGURE 12-1

QUALITY ASSURANCE AUDIT REPORT

Project:____

Contract/Project No.:____________ Quality Assurance Coordinator:__________

Laboratory or System Audited:____________________________

Laboratory/System Director:____________________

Audit Conducted By:__________________________

Date:____

PURPOSE AND OBJECTIVES OF THE PROJECT

BRIEF DESCRIPTION OF THE SAMPLING AND ANALYTICAL REQUIREMENTS

FIGURE 12-1 (Cont.)
RESULTS OF THE QUALITY ASSURANCE AUDIT

Organization and Personnel

Facilities

Analytical Methodology

FIGURE 12-1 (Cont.)
RESULTS OF THE QUALITY ASSURANCE AUDIT

Sampling and Sampling Handling

Quality Control

Data Handling

FIGURE 12-1 (Cont.)

Quality Assurance Deficiencies

Recommended Corrective Actions and Timetable

Signed Dated

Title

Distribution:
- Quality Assurance Coordinator
- Project Manager
- Technical Project Director
- Task Leaders

13.0 PREVENTIVE MAINTENANCE

Preventive maintenance of field equipment proceeds routinely before each sampling event; more extensive maintenance is performed on the basis of hours in use. Preventive maintenance is performed contractually on the laboratory's Hewlett Packard gas chromatograph/mass spectrometer, Perkin-Elmer 603 and 5000 atomic absorption spectrophotometers, Perkin-Elmer Sigma I Gas Chromatograph and analytical balances (Mettler H20, Mettler H28, and Ohaus 1500D).

HEWLETT PACKARD MODEL 5985B GAS CHROMATOGRAPH/MASS SPECTROMETER SYSTEM

This system is under a service agreement with Hewlett Packard which covers all repair parts, extended parts, labor and travel, and three annual preventive maintenance service visits. These visits involve cleaning, adjusting, inspecting, and testing procedures designed to reduce product failure and/or extend useful product life. Between visits, routine operator maintenance and cleaning is performed according to manufacturer's specifications.

PERKIN-ELMER 603 ATOMIC ABSORPTION SPECTROPHOTOMETER

The full service maintenance plan with Perkin-Elmer covering this system includes replacement parts required during both routine maintenance and emergency maintenance visits. Routine operator maintenance and cleaning is performed by an experienced analyst or chemist according to manufacturer's specifications.

METTLER H20, METTLER H28, AND OHAUS 1500D ANALYTICAL BALANCES

Each analytical balance is cleaned, serviced, and calibrated semi-annually by a qualified service representative.

PERKIN-ELMER SIGMA I FID/ECD GAS CHROMATOGRAPH AND PERKIN-ELMER MODEL SIGMA 3-B DUAL FID GAS CHROMATOGRAPH

These systems are under service agreements with Perkin-Elmer which cover all repair parts, extended parts, labor and travel. The visits involve cleaning, adjusting, inspecting, and testing procedures designed to reduce product failure and/or extend useful product life. Between visits, routine operator maintenance and cleaning is performed according to manufacturer's specifications.

PERKIN-ELMER MODEL 5000 ATOMIC ABSORPTION SPECTROPHOTOMETER

This unit carries full service-maintenance warranty. Routine operator maintenance and cleaning is performed by an experienced analyst or chemist according to manufacturer's specifications.

14.0 DATA QUALITY ASSESSMENT

The purpose of data quality assessment is to assure that data generated under the program are accurate and consistent with project objectives. The quality of data will be assessed based on the precision, accuracy, consistency and completeness of the data that are measured or generated.

Data quality assessment will be conducted in three phases:

PHASE 1

Prior to data collection, sampling and analysis procedures will be evaluated in regard to their ability to generate the appropriate technically acceptable information required to achieve project objectives. This QAPP meets this requirement by establishing project objectives defined in terms of parameters, analytical methods, and required sampling protocols.

PHASE 2

During data collection, results will be assessed to assure that the selected procedures are efficient and effective and that the data generated are sufficient and comply with the Administrative Order by Consent. Precision and accuracy of measurement systems will also be evaluated. In general, evaluation of data will be based on performance audits, results of duplicate and spiked sample analyses, and review of completeness objectives.

Documentation may include:

- number of replicate samples collected;
- number of replicate, spike and field blank samples analyzed;
- identification of statistical techniques, if used, to measure central tendency, dispersion, or testing for outliers;
- identification of analytical method; and
- verification of transmitted data by the laboratory technical director.

Completeness is expressed as a percentage of validated data sets obtained versus those intended for collection. The process of evaluating completeness compares:

- number of data sets desired (project objective) with
- samples collected, and with
- samples analyzed, and with

- validated data sets obtained.

The percentage obtained is then compared with the percentage completeness required to fulfill project goals.

PHASE 3

Following completion of data collection activities, an assessment of the adequacy of the data base will be undertaken. Recommendations for improved quality control will be developed, if appropriate.

Each phase of the assessment will be conducted by the QAC in conjunction with appropriate project staff.

It should be recognized that analytical data documentation available for review is anticipated to be limited to that required by the specified methods.

15.0 CORRECTIVE ACTION

Corrective or preventive action is required when potential or existing conditions are identified that may have an adverse impact on data quantity or quality. Corrective action could be immediate or long-term. In general any member of the program staff who identifies a condition adversely affecting quality can initiate corrective action by notifiying in writing his or her supervisor and the QAC. The written communication will identify the condition and explain how it may affect data quality or quantity.

15.1 IMMEDIATE CORRECTIVE ACTION

This type of corrective action is usually applied to spontaneous, non-recurring problems, such as an instrument malfunction. The individual who detects or suspects non conformance to previously established criteria or protocol in equipment, instruments, data, methods, etc., will immediately notify his/her supervisor. The supervisor and the appropriate task leader will then investigate the extent of the problem and take the necessary corrective steps. If a large quantity of data is affected, the task leader must prepare a memorandum to the Project Manager and the QAC. These individuals will collectively decide how to proceed. If the problem is limited in scope, the task leader will decide on the corrective action measure, document the solution in the appropriate workbook and notify the Project Manager and the QAC in memorandum form.

15.2 LONG-TERM CORRECTIVE ACTION

Long-term corrective action procedures are devised and implemented to prevent the recurrence of a potentially serious problem. The QAC will be notified of the problem and will conduct an investigation to determine the severity and extent of the problem. The QAC will then file a corrective action request with the Project Manager.

In case of dispute between the QAC and the PM, the Responsible Corporate Officer (RCO) will make a final determination for the company.

Corrective actions may also be initiated as a result of other activities, including:

- Performance Audits;
- System Audits;
- Laboratory/field comparison studies; and
- QA program audits.

The QAC will be responsible for documenting all notifications, recommendations, and final decisions. The PM and the QAC will be jointly responsible for notifying program staff and implementing the agreed upon course of action. The

QAC will be responsible for verifying the efficacy of the implemented actions. The development and implementation of preventive and corrective actions will be timed so as to not adversely impact either project schedules or subsequent data generation/processing activities to the extent possible. The QAC will also be responsible for developing and implementing routine program controls to minimize the need for corrective action.

16.0 REPORTS TO MANAGEMENT

Summary reports will be prepared on a periodic basis to inform management of project status. The reports will include:

- periodic assessment of measurement data accuracy, precision and completeness;
- results of performance audits and/or systems audits;
- significant QA problems and recommended solutions; and
- status of solutions to any problems previously identified.

Additionally, any incidents requiring corrective action will be fully documented. Procedurally, the QAC will prepare the reports to management. These reports will be addressed to the Project Manager. The summary of findings shall be factual, concise and complete. Any required supporting information will be appended to the report.

Section No. 17
Revision No. 0
Date July 8, 1985
Page 1 of 1

17. DIMETHYL FORMAMIDE ANALYTICAL METHODOLOGY RHODE ISLAND ANALYTICAL LABORATORIES

Dimethyl formamide analysis will be subcontracted to Rhode Island Analytical Laboratories. This analysis will be performed in accordance with the Administrative Order by Consent for provision of alternate water supply, 1984, as described in the following correspondence.

R.I. Analytical Laboratories, Inc.

SPECIALIZING IN ENVIRONMENTAL ANALYSIS

231 ELM STREET
WARWICK, R. I. 02886

PHONE (401) 467-2452

July 1, 1985

Bruce Wallin, Ph.D
Environmental Laboratory Service
E.C. Jordan Company
562 Congress Street
P.O. Box 7050
Portland, ME 04112

Subject: Dimethylformamide Analysis

Dear Dr. Wallin:

This is the inform you the R.I. Analytical Laboratories, Inc. will be pleased to perform DMF analyses for your firm. The following is a description of the analytical methodology and associated quality control that will employed for this project:

-Analytical Methodology-

Instrument: Tracor Model 565 Gas Chromatograph

Detector: Tracor Model 702 Nitrogen/Phosphorus detector

Column: Glass, 1.8M x 2 mm ID packed with 1% SP-1000 on 60/80 mesh Carbopack B.

Carrier Gas: Helium @ 30 mls./min.

Injection Port Temp: 220°C

Column Temp: 190°C

Detection Temp: 250°C

Samples will be analyzed via direct injection into the instrument. Prior to each sample set, calibration will be performed using three different standard concentrations to generate, with linear regression, a three point standard curve. External standards will be run at periodic intervals, i.e., every 5 to 10 samples.

-Quality Control-

Quality Control will follow the general EPA Guidelines, i.e., 10% duplicates and spikes, as well as method blanks.

Samples will be stored at 4°C when received and analyzed within the recommended holding time requirements.

-Cost-

The cost for the above work will be $100.00/samples.

Thank you for allowing us to submit this proposal and we look forward to working with you on this project.

Sincerely,

Anthony E. Perrotti

PJP

ATTACHMENT IX

INTERIM PERFORMANCE STANDARD

1.0 INTRODUCTION

The purpose of this attachment is to provide specific information concerning Annabessacook Lake water quality at the Winthop Landfill site. This standard will be used until final (ACLs) are established (estimated to be 1 year). The ACLs are to be used to determine the need for additional remedial action described as elements 9 and 10 of the Remedial Action Work Plan for the site. Based on on-site conditions, this attachment presents details for sampling, analysis, the performance and determination of compliance.

2.0 SITE CONDITIONS

2.1 *CHEMICAL DISTRIBUTION*

Annabessacook Lake water quality was determined at locations shown in Figure 1 during the U.S. Environmental Protection Agency (EPA) RI/FS and is summarized in Table 1. Subsequent investigations were conducted by the EPA, Cobbossee Watershed District (CWD) and Maine Department of Environmental Protection (ME DEP) in the lake where a seep was observed in October, 1984. Characteristics of the seep are summarized in Table 2.

Chemicals that potentially discharge to Annabessacook Lake from the landfill migrate in the groundwater. Chemicals present in in groundwater are summarized in Table 3 for the southern plume, Table 4 for the northern deep plume and Table 5 for the northern shallow plume. The seep described above is a suspected discharge of the southern plume. Graphical representation of chemicals in each transport route is provided in Figures 2, 3 and 4. The concentrations shown in these figures indicate chemical concentrations in groundwater near the landfill.

2.2 HEALTH AND ENVIRONMENTAL CRITERIA

Important potential receptors of chemicals migrating from the landfill are expected to be aquatic life and human contact resulting from recreational use (swimming and fishing) of Annabessacook Lake. For the purposes of the INTERIM PERFORMANCE STANDARD, the duration of exposure is expected to be 12 months. Potentially applicable existing criteria for the chemicals identified in the lake, seep and groundwater are summarized in Table 6. These exisiting criteria are typically based on long-term (i.e., lifetime) exposure. Presented in Table 7 are these existing criteria and preliminary surrogate criteria for chemicals which do not have criteria previously developed by EPA or ME DEP. These surrogate criteria were developed and based on preliminary assessment of similar chemical structure and toxicity. Criteria for ingestion of fish shown in Figure 7 are based on lifetime exposure and have not been adjusted to account for the limited (approximately 12 month) exposure period over which this INTERIM PERFORMANCE STANDARD is to be used.

The recreational use of Annabessacook Lake may result in exposure via dermal or eye contact or occasional ingestion during swimming. These possible exposure pathways are more difficult to quantify than those already described. Formulas to determine these less common pathways are not readily available because there has been little experience on which to base the formulas (Draft Superfund Health Assessment Manual, May 1985). It is expected that the risk from these exposure routes will be lower than that from other routes, based on the limited time of exposure (summer only) and quantity of exposure.

3.0 SAMPLING AND ANALYSIS

3.1 SAMPLING

Compliance with the INTERIM PERFORMANCER STANDARD will be based on chemical analysis of samples collected from the lake. Locations of lake samples are shown in Figure 1 and include the seep. To provide a valid data base on which to determine compliance, repeat samples will be collected in the same location. Buoys and electronic distance measurement (EDM) devices will be useful in re-establishing lake sample locations. Movement of buoy anchors due to winter icing and subsequent ice flow movement or vandalism can be reduced by use of double buoys. A buoy is affixed to an anchor with a sturdy line to a height below the thickness of ice. A second buoy floating on the water surface is attached with a low strength (e.g., 6 lb. test) line. Loss of the second buoy will not be expected to cause anchor movement.

Samples will be collected near the bottom (within one foot) of the water column at each lake sample location as recommended by the Cobbossee Watershed District. The bottom of the water column is sampled to detect the presence of chemicals that may seep into the lake from underlying groundwater before these chemicals are diluted to lower concentrations at the lake surface. This will be accomplished using a screw-capped 8 oz. glass bottle affixed to a sampling rod that allows the bottle to be opened and closed at the desired sampling depth. If the seep is exposed, (it was exposed in 1984 for an approximate 2 month period from mid-September to mid-November when the dam on the lake was repaired) water samples will be collected using the 8 oz. glass bottle to assure comparability of sampling procedures.

Quality control samples will be obtained to assess sample contamination during collection, transport and analysis. These quality control samples include sampler and trip blanks collected in duplicate. These blanks consist of volatile organic analysis (VOA) vials filled with reagent grade water. Trip blanks will be filled in the laboratory and sampler blanks are filled with water that has passed through the sampling equipment.

The procedures described in the Quality Assurance Project Plan, Attachment VIII to the Remedial Action Work Plan, shall be untilized for all sampling and analysis. Proper chain of custody shall be maintained.

3.2 ANALYSES

Samples will be assayed for chemicals present in groundwater that may discharge near the sample location i.e., chemicals listed in Table 1 of the Remedial Action Work Plan to which this document is attached. The procedure for chemical analysis is described in the Monitoring Plan, Attachment III to this Remedial Action Work Plan.

Quality control samples will be used in the laboratory to define the validity of analytical results. These control samples will include method blanks and analytic duplicates. Results of these analyses should readily identify the possible presence of chemicals that may be introduced during the analytical procedure. Method blanks will be used to assess sample preparation and analytic sources of contamination. Analytic duplicates of sample are routinely conducted on a random 10 percent of all samples processed at the laboratory, regardless of project/site origin. Scheduling will be adjusted to require the analytic duplicate to be selected randomly from those samples collected at the Winthrop Landfill site.

Results of each sampling and analytic event shall be provided to EPA and ME DEP immediately upon receipt by Inmont.

If analysis shows that a given constituent is not detected, then the concentration of that constituent shall be the detection limit (minimum reportable concentration) for that particular constituent and analytical protocol. The variance associated with a not detected constituent shall be the analytic uncertainty associated with the constituent's detection limit as determined by the laboratory doing the analysis.

Each of the following five compounds shall be excluded from all calculation of total relative risk unless they are detected at concentrations above their individual detection limits:

1. 2,4-dinitorphenol
2. 2-methoxy ethanol
3. chrysene
4. diethylphthalate
5. di-2-ethylhexyl adipate

4.0 INTERIM PERFORMANCE STANDARD

4.1 PURPOSE

Selection of an INTERIM PERFROMANCE STANDARD for determining the need to implement elements 9 and 10 should consider protection of public health and the environment from significant risks and the lead time and significant resources required if the standard is exceeded. The Interim Performance Standard used until an ACL is established to evaluate the need for Groundwater Extraction and Treatment should consider the public health and environmental significance of:

- increased chemical concentration,
- appearance of new chemicals, and
- effects of existing chemicals

in the water of Annabessacook Lake.

4.2 TOTAL RELATIVE RISK

Establishing a total relative risk limit acknowledges differences in toxicity of chemicals, and assumes additive toxicity effects.

A similar approach, called the hazard index, has been proposed by the USEPA (Fed. Reg., Jan. 9, 1985). Relative risk posed by each chemical is determined by dividing observed chemical concentrations by an appropriate criterion as follows:

$$\text{Relative Risk} = \frac{\text{observed chemical concentration}}{\text{appropriate criterion}}$$

Criteria for use in estimating relative risk are shown in Table 7. As an example, the relative risk to aquatic life for 1,1,1-trichloroethane found in the seep is computed as follows:

$$\text{Relative Risk} = \frac{20 \text{ ug/l (from Table 2)}}{3000 \text{ ug/l (from Table 7)}}$$

$$= 0.007$$

If the computed relative risk exceeds 1.0, then there is a potential for significant threat to receptors because the observed concentration exceeds the criterion for protecting public health and the environment. The total relative risk can be determined by assuming all chemicals detected have additive effects and summing the relative risk posed by each chemical. As the sum of relative risks approaches 1.0 the risk posed by the combined presence of chemicals approaches a potentially significant threat to receptors. For example, based on the maximum concentrations observed in the seep, the relative risk and total relative risk for protection of aquatic life and human health would be:

Chemical	Relative Risk Aquatic Life	Relative Risk Ingestion of Fish
1,1,1-TCA	0.0067	0.00002
1,1-DCA	0.0090	0.0011
toluene	0.0406	0.0016
TOTAL RELATIVE RISK	0.0563	0.0027

In this example, the total relative risk to aquatic life posed by chemicals in the seep (assuming additive effects) is approximately 17 times less than the threshold for potentially significant effects, while for the human ingestion of fish it is 370 times less than the threshold.

An upper limit on the total relative risk posed by chemicals found at each sampling location is established as 1 based on maximum total relative risk to aquatic life or to public health from ingestion of fish.

5.0 DETERMINATION OF COMPLIANCE

To determine compliance based on total relative risk, the zone of variance, or error band, for the analytical results will be quantified and accounted for. If the sum of the relative risk and the variance exceeds 1.0, it is possible that the total relative risk actually exceeds 1.0, a condition which may present an unacceptable risk to potential receptors.

The zone of variance will be determined by collecting and analyzing four replicate samples during the first quarterly monitoring round from a minimum of at least three selected sampling locations. The variance for each constituent detected is computed based on the replicate data. The computed variance will be applied to subsequent sampling episodes. The sum of the concentration and variance for a particular constituent divided by an appropriate criterion is the relative risk associated with the constituent. The total relative risk would then be the sum of constituent relative risks at a given sampling location.

If a particular sampling event results in a total relative risk exceeding 1.0, the sampling location in question will be resampled in quadruplicate within seven days after Inmont receives the original sampling results. The variance will then be recalculated based on the replicate data. This recalculated variance will be used to determine compliance with the total relative risk less than 1.0.

Results of any resampling and analysis shall be provided to EPA and ME DEP no later than 30 days from the date the samples are taken in the field.

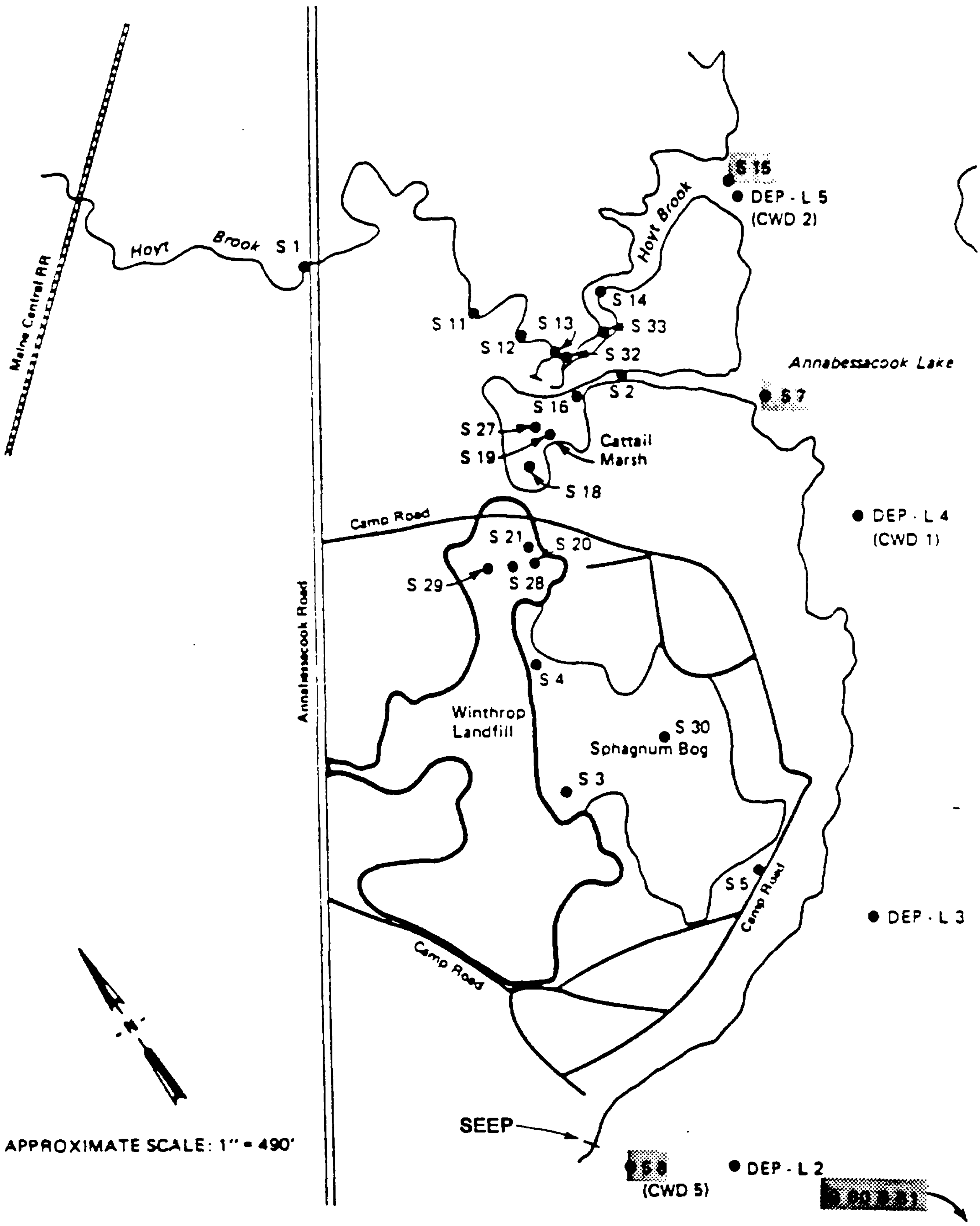


FIGURE 1
LOCATION OF DEEP
WATER SAMPLING STATIONS

E.C.JORDAN CO.

TABLE 1

ANNABESSACOOK LAKE WATER QUALITY - WINTHROP, MAINE[a]

Station	7B[b]		7B		8B	8B	15	60	61
Date	(8-24-82)		(8-25-83)		(8-24-82)	(8-25-83)	(9-24-83)	(8-25-83)	(8-25-83)
Laboratory	EPA	ECJ	EPA	ECJ	EPA	EPA	EPA	EPA	EPA
di-n-butylphthalate	18	--[c]	--	--	--	--	NA[d]	NA	NA
PCB - 1254	--	--	--	NA	0.05	--	NA	NA	NA
PCB - 1248	--	--	--	NA	0.05	--	NA	NA	NA
toluene	--	--	--	--	--	--/5.6[e]	--	--	--
methyl isobutyl ketone	--	--	--	--	--	--/26	--	--	--
methylene chloride	--	12	--	200	--	--	--	--	--

---

[a] µg/ℓ

[b] B indicates sample obtained from bottom of water column

[c] -- indicates sample analyzed, chemical not detected at or above minimum reportable concentration

[d] NA indicates sample not analyzed

[e] / indicates results of duplicate samples

TABLE 2

CHEMICALS DETECTED IN SEEP SAMPLES AT WINTHROP LANDFILL SITE[a]

Chemical	Oct. 9, 1984 ECJ	Oct. 9, 1984 EPA	Oct. 9, 1984 DEP	Nov. 6, 1984 ECJ	Nov. 6, 1984 EPA
1,1-dichloroethane	180 [1.4][b]	--[c]	--[d]	52 [1.4]	15
toluene	71 [2.6]	2-25[e]	--	9.7 [2.6]	5[e]
1,1,1-trichloroethane	--	--	--	20 [1.8]	15
methylene chloride	--	--	--	21 [1.1]	--
trichloroethylene	--	<1[e]	--	--	--
chlorobenzene	--	26-50[e]	--	--	--
ethylbenzene	--	2-25[e]	--	--	--
chromatographically similar to gasoline	NA[f]	NA	100[e] [10]	NA	NA

---

[a] concentrations in μg/ℓ

[b] number shown in [] is the minimum reportable concentration (MRC) for the analytical procedure

[c] -- indicates sample analyzed, chemical not detected at or above MRC

[d] chemical detected but not quantified

[e] estimated concentration

[f] NA indicates sample not analyzed

TABLE 3

VOLATILE AND SEMIVOLATILE ORGANICS DETECTED IN SOUTHERN GROUNDWATER FLOW REGIME WINTHROP LANDFILL SITE[a]

	MW-5A				MW-13A	
	NOV 1982		AUG 1983		NOV 1982	AUG 1983
Chemical	EPA	ECJ	EPA	ECJ	EPA	EPA
2,4-dinitrophenol	210	--[b]	--	--	--	NA[c]
diethyl phthalate	46	110	66	87/--[d]	--	NA
chrysene	20	--	--	--	--	NA
1,2-dichloroethane	8.5	--	--	--	--	--
1,1,1-trichloroethane	1800	2900	530	380/400	47	74
1,1-dichloroethane	340	750	220	150/160	--	--
chloroethane	7.2	--	13	--	--	--
1,1-dichloroethylene	7.0	34	9.0	--	--	--
1,2-dichloroethylene	23	28[e]	43	41/46[e]	--	--
1,2-dichloropropane	5.5	--	5.0	--	--	--
methylene chloride	100	140	60	84/90	--	--
fluorotrichloromethane	50	32	21	16/18	--	--
tetrachloroethylene	76	150	28	32/32	--	--
toluene	25	66	12	14/15	--	--
trichloroethylene	15	32	43	8.4/9.9	--	--
vinyl chloride	7.3	--	18	27/30	--	--
acetone	1400	NA	NA	94/--	--	--
methyl isobutyl ketone	1100	NA	230	7.0/--	--	--
tetrahydrofuran	24	NA	--	--	--	--
dimethyl formamide	NA	NA	600	--	NA	--

---

[a] concentrations in μg/ℓ

[b] -- indicates sample analyzed, chemical not detected at or above minimum reportable concentration

[c] NA indicates sample not analyzed

[d] / indicates results of duplicate samples

[e] trans-1,2-dichloroethylene only. EPA data based on cis-1,2 and trans-1,2-dichloroethylene

TABLE 4

VOLATILE AND SEMIVOLATILE ORGANICS DETECTED IN NORTHERN SHALLOW GROUNDWATER FLOW REGIME WINTHROP LANDFILL SITE[a]

	MW-10C			
	NOV 1982		AUG 1983	
Chemical	EPA	ECJ	EPA	ECJ
benzene	33	57	38	25
1,1-dichloroethane	8.3	10	3.4	--[b]
chloroethane	--	--	6	--
1,2-dichloroethylene	42	44	48	42
ethylbenzene	570	--	650	310
methylene chloride	--	--	17	38
tetrachloroethylene	7.6	29	--	--
toluene	12,000	69,000	28,000	18,000
acetone	27,000	NA	NA[c]	140
methyl ethyl ketone	52,000	40,000[d]	6,200	344
2-hexanone	820	NA	NA	NA
methyl isobutyl ketone	12,000	NA	36,000	6,800
styrene	26	NA	NA	--
xylene	760	NA	NA	1500
2-methoxy ethanol	NA	NA	30,000	NA
tetrahydrofuran	1,114	--	1,000	91
dimethyl formamide	NA	NA	300,000	NA

---

[a] concentrations in µg/ℓ

[b] -- indicates sample analyzed, chemical not detected at or above minimum reportable concentration

[c] NA indicates sample not analyzed

[d] estimated due to low purge rate.

TABLE 5

VOLATILE AND SEMIVOLATILE ORGANICS DETECTED IN NORTHERN DEEP GROUNDWATER FLOW REGIME WINTHROP LANDFILL SITE[a]

	MW-9C				MW-10B		MW-15A	
	NOV 1982		AUG 1983		NOV 1982	AUG 1983	AUG 1983	NOV 1983
Chemical	**EPA**	ECJ	EPA	ECJ	EPA	EPA	EPA	ECJ
benzene	8	10	4.0/5.6[b]	--[c]	--	5.6	--	--
1,1-dichloroethane	20	22	8.5/24	--	--	21	13	6.4
chloroethane	350	34	150/170	89	--	36	--	150
1,1-dichloroethylene	<5	--	8.4/2.9	--	--	--	--	--
1,2-dichloroethylene	57	52[g]	23/27	21[g]	--	43	8.3	4.9[g]
ethylbenzene	21	--	6.0/8.1	--	--	7.6	--	--
methylene chloride	11	--	6.8/6.3	23	--		40	16
toluene	(5)	260	5.2/<2.6	15	800/750	430[d]	--	--
trichloroethylene	--	--	29/6.7	--	--	4.0	--	--
vinyl chloride	(5)	--	3.2/3.5	--	--	4.1	--	--
xylene	25	NA	NA[f]	15	--	NA	NA	--
tetrahydrofuran	1400	NA	110/580	54	--	610	210	30
dimethyl formamide	NA	NA	33,000/29,000	--	NA	26,000	9,000	--

---

[a] concentration in μg/ℓ

[b] / indicates results of duplicate samples

[c] -- indicates sample analyzed, chemical not detected at or above minimum reportable concentration

[d] minimum concentration (see USEPA Remedial Investigation Report)

[e] ( ) indicates approximate concentration

[f] NA indicates sample not analyzed

[g] trans-1,2-dichloroethylene only. EPA data based on Cis-1,2 and trans-1,2-dichloroethylene

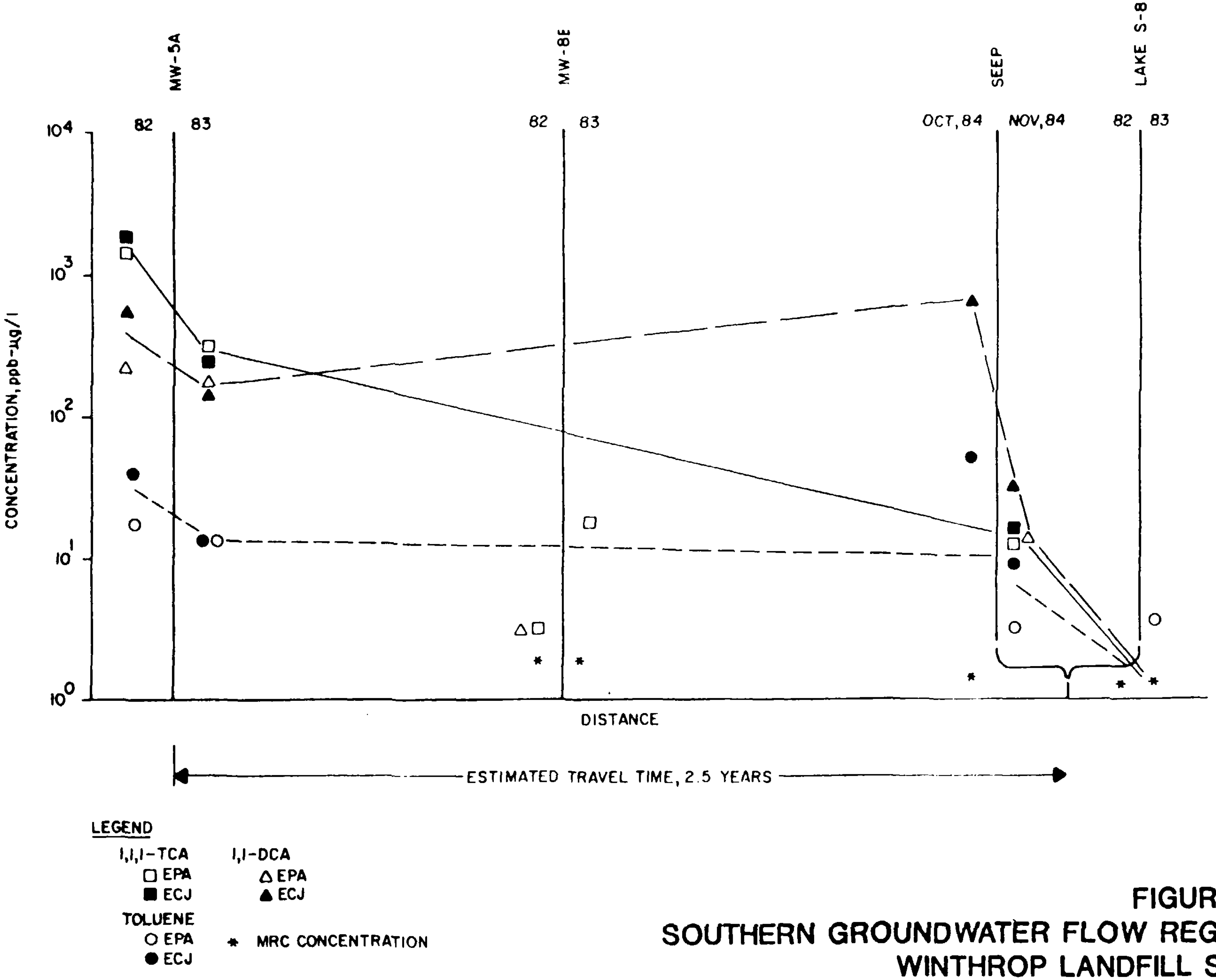


FIGURE 2
SOUTHERN GROUNDWATER FLOW REGIME
WINTHROP LANDFILL SITE

E.C.JORDAN CO.

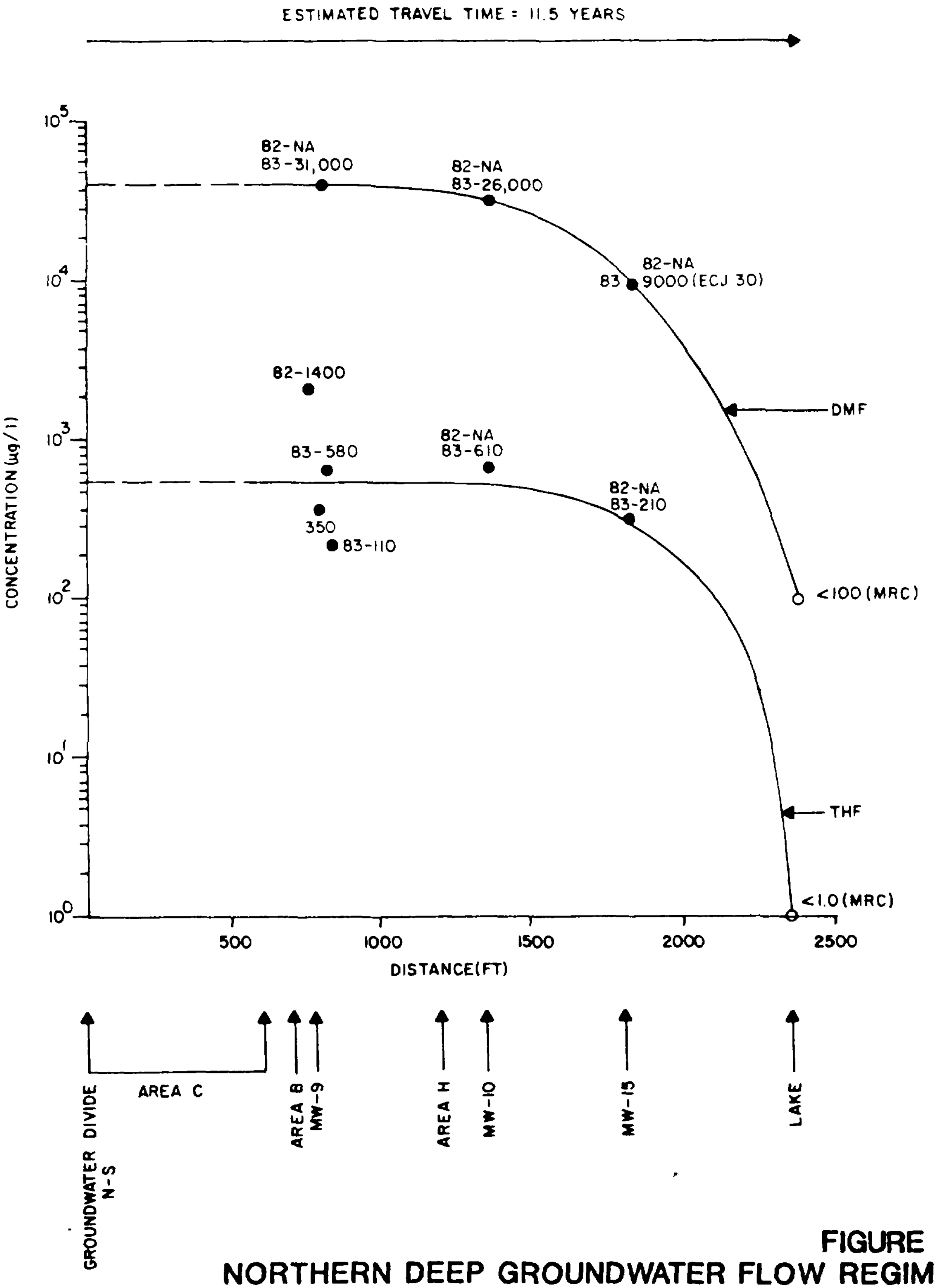


FIGURE 3
NORTHERN DEEP GROUNDWATER FLOW REGIME
WINTHROP LANDFILL SITE

NOTE: MRC IS MINIMUM REPORTABLE CONCENTRATION
(DETECTION LIMIT)

E.C.JORDAN CO.

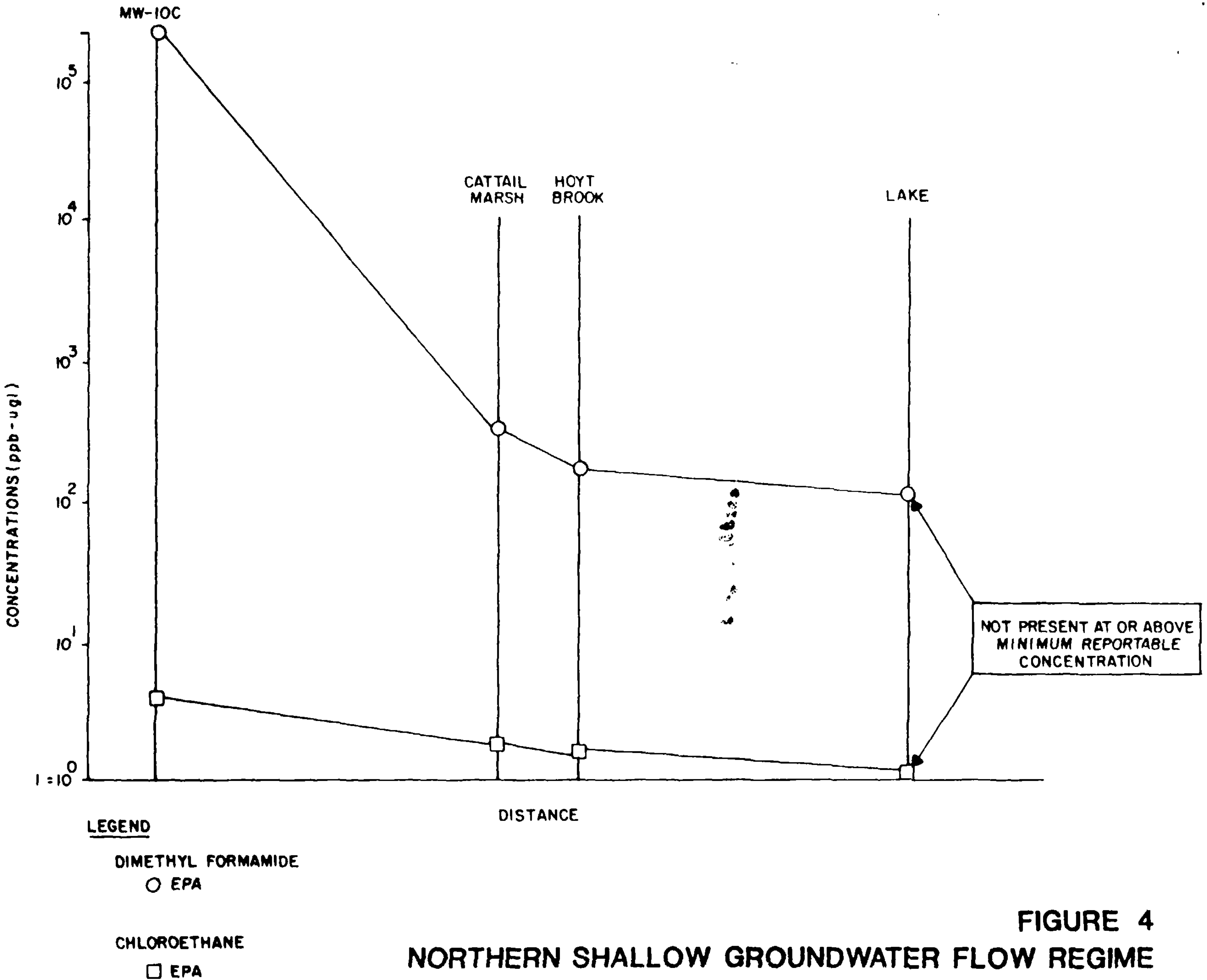


FIGURE 4

NORTHERN SHALLOW GROUNDWATER FLOW REGIME WINTHROP LANDFILL SITE

E.C.JORDAN CO.

TABLE 6

POTENTIALLY APPLICABLE CRITERIA FOR CHEMICALS FOUND AT WINTHROP LANDFILL SITE

Concentrations in µg/ℓ

	Ambient Water Quality Criteria[a]				
	Aquatic Life (Freshwater)[b]		Human Consumption of Fish[e]		
Chemical	Acute[c]	Chronic[d]	10^{-5} Cancer Risk[f]	Conc. Limits[g]	ADI[i]
Phenols and Alcohols					
2,4-dinitrophenol	230[cc]	150cc		14,300	140
2-methoxy ethanol					
phenol	10,200	2,560			7,000
Aromatics					
benzene	5,300		400[h]		
ethylbenzene	32,000			3,280	1,600
styrene					
toluene	17,500			424,000	30,000
xylene					
Chlorinated Aliphatics					
Methanes	11,000[h]		157[h]		
methylene chloride					13,000
fluorotrichloromethane					96,000
Ethanes					
chloroethane					
1,1-dichloroethane					
1,2-dichloroethane	118,000	20,000	2430		520
1,1,1-trichloroethane	18,000			1.03x10^6	38,000
Propane					
1,2-dichloropropane	23,000	5,700			
Ethylenes					
vinyl chloride			5250		
1,1-dichloroethylene	11,600		18.5		
1,2-dichloroethylene	11,600				
trichloroethylene	45,000		310		1,700
tetrachloroethylene	5,280	840	88.5		
Ketones					
acetone					
methyl butyl ketone					
methyl ethyl ketone					
methyl isobutyl ketone					
Others					
chrysene			.311[x]		
di-2-ethylhexyl adipate					
diethylphthalate	940[z]	3[z]		1.8x10^6	880,000
dimethyl formamide					
tetrahydrofuran					

TABLE 7

POTENTIALLY APPLICABLE CRITERIA FOR CHEMICALS FOUND AT WINTHROP LANDFILL SITE

Concentrations in μg/ℓ

	Ambient Water Quality Criteria[a]				
	Aquatic Life (Freshwater)[b]		Human Consumption of Fish[e]		
Chemical	Acute[c]	Chronic[d]	10^{-5} Cancer Risk[f]	Conc. Limits[g]	ADI[i]
Phenols and Alcohols					
2,4-dinitrophenol	230[cc]	150[cc]		14,300	140
2-methoxy ethanol	$[10^6]$[l]	$[10^5]$[l]		[14,300][s]	
phenol	10,200	2,560		[142,000][r]	7,000
Aromatics					
benzene	5,300	[530][m]	400		
ethylbenzene	32,000	[3,200][m]		3,280	1,600
styrene	[25,100][l]	[2,510][m]		[3,280][t]	
toluene	17,500	[1,750][m]		44,000	30,000
xylene	[1,300][l]	[130][m]		[3,280][t]	
Chlorinated Aliphatics					
Methanes	11,000[h]	[1,100][m]	157[h]		
methylene chloride	[11,000][h]	[1,100][h,m]		[228,000][r]	13,000
fluorotrichloromethane	[11,000][h]	[1,100][h,m]			96,000
Ethanes					
chloroethane	$[1.18\times10^6]$[p]	[200,000][p]		[163,000][u]	
1,1-dichloroethane	[118,000][p]	[20,000][p]		[163,000][v]	
1,2-dichloroethane	118,000	20,000	2430		520
1,1,1-trichloroethane	18,000	[3,000][n]		1.03×10^6	38,000
Propane					
1,2-dichloropropane	23,000	5,700		[163,000][u]	
Ethylenes					
vinyl chloride	[11,600][l]	[1,650][o]	5250		
1,1-dichloroethylene	11,600	[1,650][o]	18.5		
1,2-dichloroethylene	11,600	[1,650][o]		[88,100][k,v]	
trichloroethylene	45,000	[6,430][o]	310		1,700
tetrachloroethylene	5,280	840	88.5		
Ketones					
acetone	$[5\times10^6]$[j]	[500,000][m]		[117,000][w]	
methyl butyl ketone	[46,000][dd]	[4,600][m]		[117,000][w]	
methyl ethyl ketone	$[5\times10^6]$[j]	[500,000][m]		[117,000][w]	
methyl isobutyl ketone	[46,000][j]	[4,600][m]		[117,000][v]	
Others					
chrysene	[1,700][z]	[520][z]	.311[x]		
di-2-ethylhexyl adipate	[2,550][q]	[250][q]		[.661][v]	
diethylphthalate	940[y]	3[y]		1.8×10^6	880,000
dimethyl formamide	[10,200][aa]	[1,020][m]		[19,500][v]	
tetrahydrofuran	[225,000][bb]	[22,500][m]		[54,000][v]	

[ ] indicates surrogate or computed criterion. See next page for other footnotes.

NOTES FOR TABLES 6 & 7:

a Ambient Water Quality Criteria were formulated to protect aquatic life and human health from pollutants in surface waters (40 CFR Summary, FR Nov. 28, 1980, p. 79318-79379 and FR Feb. 7, 1984, p. 4551-4554). Ambient Water Quality Criteria are not enforceable but are useful in establishing water quality-based effluent limitations, water quality standards, and toxic pollutant effluent standards, and in assessing potential environmental effects.

b Guidance criteria for the protection of fresh water aquatic life. Concentrations specified should protect most (but not necessarily all) aquatic freshwater life and its uses.

c The acute toxicity level is the maximum value to which organisms can be exposed without significant risk of adverse impact.

d Chronic toxicity level is the 24-hour average value that organisms can be exposed to without significant risk of adverse impact. Weekly (7.5-day) and monthly (27-day) values were established when insufficient data were availble to develop a 24-hour lifetime average value. Monthly and weekly values are set at levels where organisms can be exposed over that time period with no significant risk of adverse effect.

e Human Health Guidelines have been developed by the Office of Research and Development. UCRs (Unit Cancer Risks) for carcinogens, and concentration limits (no effect or specific risk concentrations) have been established to protect a 70-kg adult against average daily consumption of contaminated drinking water and/or fish. The average daily consumption is 2ℓ/day of drinking water and 6.5 gram/day of fish (freshwater, estuarine and shellfish products).

f Unit Cancer Risks (UCRs) have been established assuming lifetime exposure and 10^{-5}, 10^{-6}, and 10^{-7} risk levels. 10^{-5} is used in the USEPA Guidance Document for Feasibility Studies under RCRA (October 18, 1984) and has been presented in this table.

g Concentration limits are set at levels above which health would be affected through ingestion of contaminated drinking water and/or aquatic organisms.

h Criterion for total halomethanes.

i ADI (Acceptable Daily Intake) is defined as the maximum daily dosage of a substance that a human (average weight - 70 kg.) can be exposed to without lifetime risk. They are based on chronic toxicity data without consideration of potential carcinogenic risk.

j Based on LD_{50} for goldfish.

k Based on 1,2-trans-dichloroethylene.

l Based on a literature search conducted by Envirologic Data to identify the lowest LC_{50} level (lethal concentration levels for 50 percent of the test organisms).

m Based on a safety factor of 10 to prevent effects from chronic exposure versus acute exposure recommended by Envirologic Data.

n Based on a safety factor of 6 to prevent effects from chronic exposure versus acute exposure for chlorinated ethanes, based on the ratio between acute and chronic criteria for 1,2 dichloroethane, another chlorinated etane.

o Based on a safety factor of 7 to prevent effects from chronic exposure versus acute exposure for the ratio between acute and chronic criteria generated by EPA for tetrachloroethylene, another chlorinated ethylene.

p Based on the criterion for 1,2-dichloroethane which is more or as chlorinated and, therefore, likely to be at least as toxic.

q Derived by extrapolation of rat LD_{50} (lethal dose for 50 percent of test rats) data for di-2-ethylhexyl adipate) to fish based on rat-to-fish body weight ratio, adsorption coefficient, and ventilation volume of fish.

NOTES: (cont.)

r Based on acceptable daily intake as promulgated by EPA. Criteria were generated based on the ADI, bioconcentration factor (BCF), and average daily intake of fish as follows: $\frac{ADI(\mu g/\ell)}{BCF\ (\ell/kg) \times 0.0065\ kg}$ = Criterion.

The BCF was determined from the chemical's solubility or partition coefficient (Kow).

s Based on the criterion for 2,4-dinitrophenol.

t Based on the most stringent criterion for non-carcinogenic aromatics (ethylbenzene).

u Based on the most stringent criterion for non-carcinogenic chlorinated ethane (1,1-dichloroethane).

v Based on lowest effect levels compiled by Envirologic Data from preliminary literature search. ADI was generated based on 70-kg human and 10,000 safety factor. See footnote "r" for computation of criterion.

w Based on the criterion for methyl isobutyl ketone.

x Based on the UCR for polynuclear aromatic hydrocarbons.

y Criterion for total phthalate esters.

z Based on lowest values for available freshwater aquatic life criteria for polyaromatic hydrocarbons (acenaphthalene). Acute value for bluefish; chronic value for algae.

aa Based on TL_m data for rainbow trout exposed to dimethyl formamide.

bb Concentration of tetrahydrofuran reported to cause inhibition of cell multiplication in algae.

cc Criterion for total nitrophenols.

dd Based on criteria for methyl isobutyl ketone, due to similar chemical structure.