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Work Plan

Comprehensive Investigation
US Ecology - Hanford Operations

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Work Plan

Comprehensive Investigation
US Ecology - Hanford Operations

March 29, 1996

Prepared for

US Ecology
Olympia, WA

Prepared by

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1.0 INTRODUCTION

US Ecology, Inc. operates a commercial low-level radioactive waste (LLRW) disposal facility near the center of the United State Department of Energy (DOE) Hanford Reservation, which is located northwest of Richland, Washington in south-central Washington State (Figure 1). This commercial facility is licensed and regulated by the Washington Department of Health (WDOH) to receive and dispose of radioactive waste. The facility is not a hazardous or mixed waste disposal site and is not regulated under Resource Conservation and Recovery Act (RCRA) authority.

As a result of the issuance of a 1994 DOE Hanford facility RCRA permit, several disposal trenches at US Ecology's facility were identified as solid waste management units (SWMUs) requiring further investigation and possible corrective action. These SWMUs were included in the Hanford facility RCRA permit under a broad definition by the U.S. Environmental Protection Agency (EPA) of the term "facility" and the application of this definition to non-DOE operations within the geographic boundaries of DOE's Hanford Reservation.

While US Ecology disputes the inclusion of its facility in the Hanford RCRA permit, this work plan document presents US Ecology's plan to conduct an investigation of these SWMUs and to evaluate whether any release of hazardous waste constituents from the units could impact groundwater at the site. This program is specifically defined by and limited to the three phases described in this work plan. Conclusions regarding the potential for site impact will be based on findings from this completed program. This work plan also incorporates activities intended to verify performance of the facility as required by the closure plan. While results from the comprehensive investigation presented in this work plan will be used to amend, if appropriate, the current groundwater monitoring program for the facility such that potential releases of hazardous constituents to groundwater can be monitored, no ongoing periodic monitoring is provided for in this plan.

1.1 BACKGROUND

The US Ecology facility has been in operation since 1965. Operations are overseen by the WDOH pursuant to Radioactive Material License WN-I019-2. On November 20, 1991, a RCRA facility assessment (RFA) of US Ecology's facility was conducted on behalf of EPA, and a final report was issued on July 20, 1992. The RFA report indicates that there is a potential for a release at the US Ecology site, and that the SWMUs at the US Ecology facility are part of the Hanford facility. As

a result, EPA incorporated the US Ecology SWMUs into the DOE Hanford facility RCRA permit corrective action requirements contained in the RCRA hazardous waste permit for the Hanford facility issued by EPA to DOE on August 29, 1994.

While US Ecology has appealed this inclusion to the Environmental Appeals Board as part of, and contingent upon, settlement discussions with EPA, US Ecology will address the environmental concerns of the Washington Department of Ecology (WDOE), the EPA, and the WDOH through this work plan, which is designed to investigate and evaluate the potential presence and release of hazardous substances.

Consistent with WDOE's approach to RCRA corrective action, WDOE may, at some point, assume the Hanford site RCRA permit pursuant to recent EPA delegation of such to the state. Therefore, this work plan incorporates the Washington Model Toxics Control Act (MTCA) approach for conducting site investigations and hazard assessments. If this investigation and the hazard assessment indicate that there exists a risk to groundwater, then additional investigation would be conducted to further characterize the risks and, if appropriate, to develop a cleanup action plan.

No release of MTCA-regulated constituents from the disposal trenches has been identified at the facility and no transferral of the Hanford RCRA permit has occurred. However, by using the MTCA approach for conducting the site investigation and hazard assessment, it is expected that confusion and duplication of effort among state and federal agencies can be minimized.

1.2 PURPOSES OF THIS INVESTIGATION

The primary purposes of this investigation are to assess the presence of hazardous waste constituents in the vadose zone beneath the trenches and to confirm the performance of the disposal trenches within the facility with respect to the protection of groundwater from small amounts of hazardous material associated with some LLRW. This three-phase program incorporates existing monitoring facilities (Phase 1), facilities similar to those already proposed to the WDOH to comply with LLRW licensing requirements (Phase 2), and supplemental monitoring facilities (Phase 3) capable of completing an investigation program that would comply with the substantive requirements of the MTCA.

1.3 SUMMARY SITE DESCRIPTION

The US Ecology LLRW facility occupies 100 acres within DOE's Hanford facility and lies within the Pasco Basin, a structural basin defined by anticlinal structures of basalt bedrock within

the Columbia Plateau physiographic province. The climate in the vicinity of the site is semiarid; annual precipitation in the general area averages about 6 inches per year. Average monthly temperatures from 1912 through 1980 ranged from 29°F in January to 76°F in July.

Major stratigraphic units that lie above the water table beneath the US Ecology site are, in ascending order, the middle member of the Ringold Formation, the Hanford Formation, and recent eolian (wind-deposited) sands. The top of the Middle Ringold appears to be relatively flat, averaging 422 ft above mean sea level (MSL) in elevation across the site. The unsaturated portion of this unit averages 17 ft in thickness.

Overlying the Middle Ringold member is a relatively thick unit of unconsolidated sand considered to be part of the glaciofluvial sediment of the Hanford Formation. This unit, which is the host material for the buried waste, is approximately 300 ft thick beneath the site and is capped by a thin (3- to 5-ft thick) veneer of eolian sand.

The water table beneath the site is positioned in the upper part of the middle member of the Ringold Formation making the saturated thickness of the aquifer between 90 and 110 ft under current conditions. The effective bottom of the unconfined aquifer near the site is assumed to be low-permeability silty sand of the lower member of the Ringold Formation. Sedimentary interbeds and basalt flow tops form confined aquifers at depths of 245 to 265 ft below the water table within the underlying basalt bedrock.

Groundwater moves in an easterly to northeasterly direction across the site toward the 200-East Area. Water table conditions are dominated by two remnants of large groundwater mounds that developed beneath the B Pond near the 200-West Area and the U Pond in the 200-West Area, two major wastewater disposal facilities within the Separations Area in the central part of the Hanford site. Depth to groundwater at the site is approximately 315 ft at an elevation between 402 ft and 410 ft MSL. Water levels across the site have dropped an average of 2.9 ft since 1986 in response to pond closure or a decrease in wastewater infiltration (DOE 1994). Once offsite, groundwater moves about 17 to 18 miles toward the Columbia River in an easterly, and then southeasterly direction.

1.4 KEY SITE FEATURES

The US Ecology facility was originally sited based on key geologic and climatic features that would allow the waste materials to be sequestered in accordance with LLRW regulations. The following key features provide some of the bases for that decision and for this current evaluation:

- The paucity of recharge in the area of the US Ecology facility is documented in many studies. An annotated bibliography included in Gee and Heller (1985) summarizes site recharge experiments. The experiments generally support the low recharge rates expected at the facility.
- The planned final site cap, referenced in the US Ecology closure plan, will reduce potential recharge through the disposal trenches.
- Studies of the Hanford Reservation and Richland Radioactive Waste Disposal facility have demonstrated that the potential is limited for constituents of the kinds of waste buried at the US Ecology site to move into the uncontrolled environment (Battelle Pacific Northwest Laboratories 1987).

Data from the proposed investigation will indicate which, if any, waste constituents may be moving into the vadose zone. This information will be studied to evaluate whether waste constituents are moving by gaseous diffusion, liquid flow, or both. The transport mechanism will be evaluated by comparing the measured shapes of vertical constituent profiles with theoretical shapes that would result from the different mechanisms. These comparisons should be definitive if substantial migration is detected, but will be less so for the minor movement expected at the facility.

1.5 PREVIOUS SOIL GAS AND GROUNDWATER MONITORING

Both soil gas and groundwater monitoring are routinely conducted at the U.S. Ecology site as required by the WDOH license. The current soil gas monitoring program consists of three vapor wells sampled for radon, tritium, methane, fixed gases and benzene, toluene, ethylbenzene, and xylene; six trench cap areas sampled for radon; and three solar stills that collect soil vapor tritium samples. The six trench cap samples are periodically collected in the east, central, and west portions of trenches 5 and 7, but not necessarily at the same locations. The three solar stills are located near the three vapor monitoring wells. These monitoring locations are shown on Figure 2. A summary of vadose zone monitoring data through 1994 is shown in Tables 1 through 3.

The data suggest that a small but measurable migration of some volatile constituents, primarily in the gas phase, can be detected at the trench edges. Oxygen is reduced in both trench monitoring wells relative to the background well. Carbon dioxide is elevated in wells VW-101 and VW-102 relative to the background well VW-100. The somewhat elevated carbon dioxide and methane and the reduced oxygen concentrations are indicative of conditions that exist where decomposition of organic wastes is occurring.

Radon is elevated in well VW-101 and is about equivalent to background in well VW-102 (Table 1). Trench cap radon concentrations for trenches 5 and 7 tend to be lower than the vadose zone radon concentrations measured in the background well VW-100 (compare Table 2 to Table 1). Presumably, this is due to dilution with atmospheric gases.

Tritium exceeds background in both trench monitoring wells relative to the background well (Table 1). Similarly, the tritium content of the soil vapor collected by the solar still is greater near the trenches than it is in the background solar still (Table 3). These data suggest tritium is migrating from the trenches and is in the soil vapor around the trenches.

Groundwater monitoring results are routinely reported for the existing system of one upgradient well (MW 13) and four downgradient wells (MW 3, MW 5, MW 8, and MW 10). Well locations are shown on Figure 2. Up to two additional groundwater monitoring wells are currently proposed; one upgradient and one downgradient.

Groundwater analyses are summarized in Tables 4 through 7. Groundwater analyses for gross alpha, gross beta, tritium, and carbon-14 are contained in Table 4. Gross alpha and gross beta at all downgradient wells appear similar to the upgradient well. Tritium concentrations in the downgradient and upgradient wells are similar and may have increased since monitoring began in 1986 due to the movement of tritium plumes from the 200 East and 200 West facilities. Carbon-14 also appears to be similar in the downgradient and upgradient wells.

The groundwater gamma ray spectroscopy analyses are summarized in Table 5. Since about 1991, there does not appear to be much difference in the downgradient monitoring wells compared to the upgradient well (MW-13). Prior to 1991, data are presented in two different formats, and they display much more variability. It is not clear if this is a real difference or if it is a laboratory artifact.

Indicator parameters for groundwater monitoring are summarized in Table 6. All parameters appear to be in their normal range. Nitrate appears to have decreased from 15 to 20 ppm to less than about 5 ppm at the end of 1990. It is not clear from the data if this is real or an artifact of the laboratory analysis.

In late 1993, MW 10 and MW 13 were sampled for Appendix IX analyses (volatile organic compounds, semivolatile organic compounds, pesticides/PCBs, organophosphorus, herbicides, metals, dioxins/dibenzofurans, cyanide, and total sulfide). No significant detections resulted from these analyses for either well. MW 10 had barium and chromium at concentrations below their respective MCLs. MW 13 exhibited those elements in addition to lead, vanadium, and zinc. Appendix IX groundwater monitoring results are provided in Table 7.

Soil testing was accomplished on samples collected during the installation of the vapor wells in 1991. These results are summarized in Table 8. No volatile constituents were detected.

2.0 SUMMARY OF WORK PLAN

The investigation defined in this work plan consists of three phases. Phases 1 and 2 can occur concurrently, but Phase 3 is dependent on (and will be modified by) the findings of Phase 2. Phase 1 consists of additional analyses that will be incorporated with the next regularly scheduled sampling of the groundwater wells (existing and planned) and the existing vadose zone wells. The groundwater will be analyzed for volatile organic compounds and a suite of metals, including the four identified to date (barium, chromium, vanadium, and lead). The vadose zone soil gas will be analyzed for a broad suite of volatile organic compounds.

During Phase 2, two additional soil gas monitoring installations (each a vertical boring completed at four depths up to 100 ft beneath the bottom of the adjacent trench) will be collocated with two angled soil borings (approximately 70 degrees from horizontal and extending to the centerline of the width of the adjacent trench) (Figure 3). One of these paired installations will be located at the Chemical Trench and the other will be at Trench 5 (Figure 2). These two trenches are the most likely to contain volatile organic compounds such as toluene, xylene, and benzene which were present in certain types of LLRW prior to 1985. This expectation is based on existing knowledge of disposal activities in the Chemical Trench and on existing records that indicate Trench 5 contains higher volumes of tritium-containing waste than most of the other trenches. There should be a reasonable correlation between the tritium content of the trenches and the possible presence of solvents, such as xylene, benzene, and toluene, because they were combined in the scintillation fluids disposed of in these trenches. Soil and soil gas samples will be collected from the vertical monitoring installations. The angled borings will provide soil for analysis. The WDOH and WDOE will be provided an opportunity to comment regarding selection of strata for soil sampling within the angled boring and in identification of strata to be screened in the vertical monitoring installation. Depending on the implications of the chemical and geological data from Phase 2, a contaminant transport model may be developed. Phase 2 replaces the vadose zone monitoring plan previously submitted to WDOH and accommodates its requirements.

Phase 3 will consist of constructing 14 additional soil gas sampling installations (each a vertical boring with monitoring screens placed at two depths up to 50 ft deeper than the bottom of the adjacent trench) (Figures 4 and 5). These installations will be located between the trenches of interest which include the chemical trench and trenches 1 through 11A. Soil and soil gas samples will be collected from these Phase 3 installations. Design and placement of the Phase 3 installations will

be finalized and will incorporate refinements based on Phase 2. The WDOH and WDOE will be consulted during finalization of Phase 3.

2.1 CONTAMINANTS OF INTEREST

The wastes disposed of in Trenches 1 through 11A are not well documented with respect to chemical constituents. Available records reveal the total amount of radioactivity that was disposed of in each trench, but do not reveal either the kinds or volumes of hazardous waste constituents that may have been incorporated with the radiological wastes. Scintillation vials were routinely disposed of in the trenches prior to 1985 and they typically contain toluene, benzene and/or xylene. Other reported materials include beryllium and copper shavings, phenolic waste, contaminated lead shielding and hardware, and decontamination equipment. There is very limited documentation regarding the contents of the chemical trench; however, this trench was dedicated to the disposal of other than radioactive waste and therefore may contain different chemical constituents than the other trenches.

This investigation will focus on the volatile organic compounds, because some of them are thought to have been disposed of and because they are likely to be the most mobile. Since it is possible that some of the nonvolatile Appendix IX hazardous waste constituents (see Appendix C, Table C-4) could be present in the trenches, limited testing for Appendix IX constituents will also be conducted (see Figure 3).

The contaminants of interest will be identified based on the findings of this program. No detections of hazardous waste constituents in concentrations that can be attributed to materials disposed of in the trenches have been documented at the site to date. If detections of hazardous waste constituents occur during this investigation, they will be evaluated sufficiently to develop an assessment of their potential to migrate to and impact groundwater. Contaminants that may present a potential risk to groundwater will be incorporated into the existing monitoring programs, and an evaluation of the need for and feasibility of remedial actions will be conducted.

2.2 CONTAMINANT TRANSPORT PROCESSES

The primary mechanisms whereby mobile contaminants could migrate from the trenches to groundwater include diffusive and advective vapor transport and liquid via unsaturated flow. Vapor migration is limited to volatile substances such as the volatile organic compounds, tritium

(e.g., in water vapor), radon, and carbon-14 (e.g., in carbon dioxide or methane). Volatile contaminant migration could occur by diffusive and advective flow of a gaseous phase.

Diffusion results from the natural thermal motion of gas molecules. When concentration gradients are present, these motions will cause mass transfer to occur as the molecules migrate from areas of higher concentration to areas of lower concentration. Consequently, volatile contaminants released in the trenches could potentially reach groundwater as a result of diffusion.

The gaseous phase present in the pore spaces of the vadose zone may also exhibit some overall advective flow movements in response to pressure changes. Advective flow could occur, for example, in response to changes in barometric pressure, changes in groundwater levels, or by the generation of a gaseous phase in the subsurface, such as the formation of methane as a result of anaerobic processes occurring within the trenches. Advective flow, if present, would increase the migration rate of volatile contaminants over that caused by diffusion alone.

The rate of migration of gaseous contaminants is also affected by how strongly they sorb to the soil particles and soil moisture. As a result, vapor molecules that are more strongly sorbed to soil will migrate more slowly than those that are not. In the case of radioactive materials, the decay rate (i.e., half life) is also important, particularly in the case of short lived isotopes.

Migration of vapor contaminants would occur both vertically and laterally. Given the distance to the water table from the bottom of the disposal trenches (275 to 300 ft), the horizontal stratification of the soil, the sensitive detection limits for volatile constituents in soil gas, and the relatively high soil vapor concentrations required to cause MCL exceedances in the groundwater, it is likely that detectable concentrations of the contaminant vapors would migrate laterally at least a distance equal to the depth to groundwater before migrating vertically and reaching the water table. Therefore, a vapor monitoring system with a well spacing of about 300 ft should conservatively detect organic vapors migrating laterally before they migrate vertically and reach the water table in concentrations sufficient to adversely impact the groundwater.

Subsurface flow of liquids occurs as a result of gravity, adsorption (the attraction of the liquid to the soil solids), and capillarity (the tendency of liquids to flow into and remain in the soil pore spaces). Gravity is the dominant force controlling liquid flow when the soil is saturated, or close to saturation, with a liquid. When the soil is unsaturated, the other forces control flow.

The forces of adsorption and capillarity combine in unsaturated soils to create a suction (also called tension) force. Movement is from a zone of low suction to one of high suction. The movement of liquids under these conditions is very slow compared to that occurring under saturated flow.

The migration of a liquid via unsaturated flow would depend on the rate and volume of release. If a relatively large volume release occurs, gravity will strongly affect the liquid, and it will tend to flow downward. Some lateral spreading is likely to occur as the liquid encounters fine-grained soil strata. To reach the water table, a release from a trench moving mainly under the influence of gravity is estimated to require a volume of at least a few thousand gallons to overcome the soil's residual saturation, or the tendency of a liquid to adhere to soil in the vadose zone as it passes through the soil column. A release of this size should be readily detectable with the planned wells if the liquid contains volatile organic compounds. However, there is no evidence that liquids were disposed of in the trenches in large tanks, or free discharge, or by other methods that would create a release of this size.

The migration to the water table of a slow release of liquid (e.g., from sequential small releases or from infiltrating rainfall) would more likely involve capillary flow away from the source area along preferred pathways as the dominant flow mechanism. Unsaturated flow under the low moisture conditions present in the soil beneath the US Ecology site is likely to be very slow and stratification is likely to cause lateral flow to occur in the finer grain strata.

The planned vapor monitoring network would be likely to detect such a slow, unsaturated flow if the release contains sufficient concentrations of volatile organic compounds. Otherwise, such a release might also be detected during field screening of the soil samples that will be collected (for instance if the soil displayed anomalous moisture, color, radiation level or an oily sheen) or from laboratory testing of the soil samples that will be obtained from the angled borings beneath the trenches.

Tritium is a radioactive isotope of hydrogen that is present in some of the contents of the disposal trenches, in surface water and precipitation as a result of nuclear explosions around the world, and in the groundwater beneath the US Ecology site as a result of releases from the 200 West area. Most of the tritium is probably in the form of tritium oxide ($H_2{}^3O$, a radioactive form of water). However, because tritium is chemically identical to hydrogen, it potentially could substitute for hydrogen anywhere hydrogen occurs.

The major mechanisms responsible for tritium oxide transport are the same as those for water transport and include saturated and unsaturated subsurface flow for liquid tritium oxide, vapor transport for gaseous tritium oxide, hydrolysis reactions whereby the tritium mobility is reduced by incorporation into a precipitate or by becoming strongly sorbed, and reduction reactions (that convert tritium oxide to tritium or tritiated methane gas) that could occur under anaerobic conditions. In addition, radioactive decay is important to tritium transport. Tritium has a relatively

short half life of 12.26 years, and it decays into nonradioactive products. Depending on the transport process, substantial amounts of tritium would decay before it reaches the atmosphere or groundwater.

In summary, subsurface contaminant migration is expected to occur by vapor or liquid migration. Vapor migration is anticipated to be easy to detect. Released liquids are anticipated to migrate horizontally in the fine-grained strata as well as vertically downward. Liquid migration would be detected with the proposed vertical and angle borings during visual inspection and field screening of soil samples. Otherwise, a liquid release would be detected if volatile hazardous waste or radioactive constituents are present in the liquid.

The contents of the disposal trenches are not well documented. The most likely hazardous waste constituents present are toluene, benzene, or xylene. There is no evidence indicating large volumes of these chemicals were disposed of in the trenches. Other Appendix IX constituents may be present, even though there is no evidence indicating large volumes were disposed of.

Tritium and radon are the only radioactive waste constituents included in this work plan. Limited testing for these constituents will be performed. Planned field screening should detect a significant radioactive waste release, if present.

3.0 PHASE 1 INVESTIGATION OBJECTIVE

The objective of the Phase 1 investigation is to evaluate soil gas and groundwater at existing monitoring well locations on the US Ecology site for a broader suite of volatile organic compounds than has been studied during the sampling program conducted to date. In addition, groundwater will be evaluated for a suite of metals including barium, vanadium, chromium, and lead; four metals of interest because of their detection during the 1993 Appendix IX groundwater sampling event. Detection of substances that can be associated with the disposed waste will be evaluated further to assess whether they should be added to the routine soil gas and groundwater monitoring programs and whether additional study is appropriate.

3.1 PHASE 1 SAMPLING AND ANALYSES

The soil gas and groundwater sampling and analyses to be conducted in Phase 1 are summarized in Table 9. Soil gas samples will be collected from the three existing soil gas monitoring wells (VW-100, VW-101, and VW-102) and analyzed for the suite of volatile organic compounds reported by EPA Method TO-14. These samples will be collected during the first scheduled quarterly soil gas sampling event following agreement on this plan.

Groundwater samples will be collected during Phase 1 from all five of the existing groundwater monitoring wells (MW 3, MW 5, MW 8, MW 10 and MW 13) in addition to the planned groundwater monitoring well(s) (Figure 2). Phase 1 groundwater sampling will be conducted during the first scheduled groundwater sampling event that occurs after completion of the new wells or agreement on this plan (whichever occurs later). Groundwater samples will be analyzed for volatile organic compounds using EPA Method 8240, and for a suite of metals, including barium, chromium (total), vanadium and lead using EPA Method 6010/7000. Well construction, including type and placement of groundwater sampling pumps, will be reviewed prior to sampling to confirm they are compatible with the types of samples collected.

Soil gas and groundwater will be sampled using the methods described in Appendices A and B. Field activities will be accomplished in compliance with the existing site health and safety plans (American Ecology 1993, US Ecology 1994).

3.2 PHASE 1 REPORTING

A data report will be prepared following receipt of the analytical results. The report will describe soil gas and groundwater sampling, summarize the analytical data in tabular form, and identify any necessary data qualifications, as described in Appendix C. Laboratory reports and chain-of-custody forms will be included. The report will address any detected constituents that are potentially attributable to the disposal trenches. If appropriate, report conclusions will identify any additional studies or changes to subsequent phases of the investigation.

4.0 PHASE 2 INVESTIGATION OBJECTIVES

The objectives of the Phase 2 investigation are to:

- Assess the soil beneath, and the soil and soil gas adjacent to, the chemical trench and trench 5 for the presence of hazardous waste and radioactive waste constituents
- Develop site-specific screening models that can be used to evaluate contaminant release and transport
- Assess the nature of any detections for their potential to impact site groundwater
- Develop recommendations for modification of the Phase 3 investigation plan.

4.1 PHASE 2 FIELD ACTIVITIES

4.1.1 VERIFICATION OF TRENCH BOUNDARIES

The first Phase 2 field activity will involve the use of geophysical methods, such as a ground penetrating radar (GPR) or a magnetometer to refine the trench boundaries near the planned drilling locations. While the trench boundaries will be initially located using record survey points, there appear to be some survey discrepancies and limited survey information, particularly for the Chemical Trench. Location of the trench boundaries will be particularly important to allow location of the planned borings as close to the trench as possible without impinging on any buried waste.

4.1.2 VERTICAL BORING INVESTIGATIONS AND WELL INSTALLATION

Figure 2 shows the two planned locations for the Phase 2 investigation borings; one near the north side of the Chemical Trench and the second near the east end of Trench 5. US Ecology will confer with agency representatives and reach agreement on precise boring locations. As discussed previously, these trenches were selected based on existing records that suggest them to be the most likely disposal locations to detect volatile organic compounds. A vertical boring will be drilled at each location using cable tool drilling methods. Four nested vapor monitoring wells will be constructed in each boring.

Soil samples will be collected at 2.5-ft intervals beginning approximately 5 ft below ground surface following the methods described in Appendix D. All soil samples will be described and examined visually by the field geologist for signs of contamination (stains, unusual moisture content, oil sheens, etc.). The samples will then be screened using a photoionizing detector (PID), which is sensitive to many volatile organic compounds, and a Geiger-Muller (GM) radiation detection device.

Unused portions of the soil sample will be archived. All field information will be recorded on the boring log maintained by the field geologist. A US Ecology radiation safety officer will also be present during all field activities.

After reaching the target depth for each boring, approximately 100 ft below the bottom of the respective trench, the boring log will be reviewed and appropriate strata selected for screen placement. Conceptually, one each of four nested wells will be screened in each of the following specified depth intervals: 0 to 10 ft, 10 to 30 ft, 30 to 60 ft, and 60 to 100 ft below the bottom of the adjacent trench (Figure 3 and Figure E-1). Within each of the specified depth intervals, a coarse-grained stratum will be identified, if possible, for placement of the soil gas monitoring well screens. Consideration will also be given to any PID or GM detections, as well as the presence of possible vapor barriers such as caliche horizons, in placing the well screens. Fine-grained strata will also be identified, if possible, especially if they overlay much coarser grained strata. Because these fine-grained strata are more likely to host contaminants from a liquid release from the trenches, they will become the targets for soil sampling and analysis in the angled borings (see section 4.1.3).

At least eight soil samples from each Phase 2 vertical boring will be analyzed for volatile organic compounds. These samples will be collected adjacent to and just above the depth intervals where the well screens are placed. In addition, any sample presenting indications of volatile organic compounds (as indicated by the PID screening) or radioactivity (as indicated by GM screening) would be evaluated further. Up to four samples from each vertical boring will be analyzed for total organic carbon (TOC), particle size distribution, specific gravity, moisture content, and unit weight.

Thermocouple junctions will be attached to the outside of the well casing just above the deepest and shallowest well screens in each of the two Phase 2 well clusters. The temperature information obtained will be used to model vapor transport in the vadose zone. Monitoring wells will be constructed in accordance with specifications provided in Appendix E.

4.1.3 Installation of Angled Borings

An angled boring (approximately 20 degrees from vertical) will originate near each of the two Phase 2 vertical borings previously discussed, and will be oriented to allow the collection of soil samples from beneath the Chemical Trench and Trench 5 (see Figure 3). Angled borings will be installed using air rotary drilling equipment. Soil samples will be collected by determining the depths of the fine-grained target strata identified in the vertical borings (see section 4.1.2) and drilling to within approximately 5 ft of this depth. The borehole plunge (angle from vertical) will be checked

at least once during drilling to determine whether any corrections need to be made in estimating the target strata depth. Split spoon soil samples will then be collected at 2.5-ft intervals until the target stratum has been sampled. As described in Appendix D, drilling air pressure will be reduced before reaching the sampling depth to reduce potential aeration of soil samples. The angled borings will not extend beyond the centerline of the width of the trench being studied.

The soil samples will be described and examined visually by the field geologist for signs of contamination (stains, unusual moisture content, oil sheens, etc.). The field geologist or engineer will then screen samples using a PID and a GM radiation detection device. Based on this initial screening, at least one, and as many as three, soil samples from each angled boring will be selected for laboratory analysis of Appendix IX constituents. If the field screening does not provide a basis for sample selection, the uppermost soil sample will be selected for laboratory analysis of Appendix IX constituents.

Following completion of each angled boring, the boring will be abandoned by backfilling with bentonite grout.

4.1.4 PHASE 2 SOIL GAS SAMPLING

The eight Phase 2 soil gas monitoring wells (four wells nested at each of two locations) will be sampled for tritium, radon, volatile organic compounds, methane, and fixed gases according to the field procedures in Appendix F. A period of 2 weeks will be allowed, between well completion and soil gas sampling, for equilibration of conditions near the well screens after drilling. This period of time is based principally on the schedule. The true period of equilibration is not known. Furthermore, if a release has occurred, equilibrium may not be achievable. In addition, the *in situ* temperature and pressure will be measured according to the field procedures in Appendix G. These data will be used to evaluate whether volatile radioactive or chemical substances are migrating from the trenches, and whether such migration is being facilitated by gas generation in the trenches.

4.2 DEVELOPMENT OF MODELS FOR CONTAMINANT RELEASE AND TRANSPORT

During Phase 2, the development of relatively simple models for contaminant release and transport will be considered in concert with similar models associated with vadose zone monitoring for LLRW. Such models would be used only to bound what is physically or chemically likely to occur so that the significance of any detected constituents can be evaluated. Two potential

applications of modeling would be to evaluate the minimum volume of liquid release that could adversely impact groundwater and to evaluate soil gas concentration distributions that might represent potential threats to groundwater.

4.3 PHASE 2 SAMPLE ANALYSES

Phase 2 soil and soil gas samples will be obtained as indicated in Table 10. Table 11 presents soil and soil gas analytical methods to be used.

Phase 2 soil samples collected from the vertical borings will be analyzed for volatile organic compounds as well as for parameters supporting the soil gas transport model, including total organic carbon, particle size distribution, unit weight, and water content.

Phase 2 soil gas samples collected from the nested vertical wells will be analyzed for volatile organic compounds and for methane and fixed gases (carbon dioxide, nitrogen, and oxygen). Tritium in the soil gas will be sampled with silica gel as described in Appendix F. The tritium will be analyzed in water extracted from the silica gel. Radon in the soil gas will be sampled using Radtrack detectors, available from Landauer, Inc. These detectors will be inserted into the soil gas well as described in Appendix F.

Total pressure in the vapor monitoring wells will be determined in the field using a magnehelic gauge, as described in Appendix G.

Phase 2 soil samples collected from the angled borings will be analyzed for Appendix IX constituents and a radiological suite using the methods in Table 11. Specific analytes included within each analysis are listed in Appendix C.

Metal analytes will include the following suite: antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, silver, thallium, tin, vanadium, and zinc.

The radiological analyses to be performed in Phase 2 will be in conformation with WDOH requirements.

4.4 REPORTING

Phase 2 investigation results will be reported in a Phase 2 report after the laboratory results have been received. The report will provide: 1) a detailed description of the field investigation activities, including summary logs of the borings and well completion diagrams; 2) a summary of laboratory test results, including all detected constituents, an assessment of the quality of the

laboratory test results as described in Appendix C; 3) a description of any problems encountered in obtaining the samples that might have impacted sample quality; and 4) laboratory reports and chain-of-custody forms.

The Phase 2 report also will discuss contaminant release and transport models developed during Phase 2 and their implications with respect to interpretations of data generated in Phases 1 and 2 and for the planned Phase 3 activities. The conclusions of this report will include recommendations regarding the approach, investigation methods, and the scope of Phase 3 activities. The Phase 2 report will be submitted for review by the agencies and finalized by addressing any comments provided by the agencies on Phase 1 and 2 data interpretation and plans for Phase 3.

5.0 PHASE 3 INVESTIGATION OBJECTIVES

Phase 3 will build directly on the findings of Phases 1 and 2 and will provide a broader assessment of soil gas in the vadose zone beneath trenches 1 through 11A and the chemical trench. Soil gas monitoring will focus on detecting the presence of volatile organic compounds. If a constituent is detected that can be potentially related to the waste disposal activities, its potential impact on groundwater will be evaluated according to procedures identified in the MTCA. The Phase 3 activities described below may, of course, be modified based on the findings of Phases 1 and 2 and with the concurrence of the regulatory agencies.

5.1 PHASE 3 FIELD ACTIVITIES

5.1.1 INSTALLATION OF VERTICAL WELLS

During Phase 3, two nested soil gas monitoring wells will be installed in vertical borings near each of 14 locations shown on Figure 4. The wells will be located about 300 ft apart, as indicated by the circles' diameters. US Ecology will confer with agency representatives and reach agreement on precise boring locations. The borings will be drilled using either hollow-stem auger or cable tool methods. Hollow-stem auger drilling is preferred because it does not require that air or water be introduced to the hole during drilling, increasing the probability of higher quality samples. If the hollow-stem auger method cannot reach the desired depths (85 ft to 100 ft below ground surface), cable tool drilling methods will be used.

Soil samples will be collected at 2.5-ft intervals beginning at approximately 5 ft below ground surface and continuing to a depth of 50 ft below the bottom of the adjacent trench(es). All soil samples will be described, screened, and selected for analysis as shown on Figure 5 and as described above in section 4.1.2 for Phase 2. Two vapor well screen intervals will be selected in each boring, and soil samples will be selected for analysis of volatile organic compounds using the criteria described above for the Phase 2 well completions.

The two vapor wells installed in each of the borings will be screened in coarse textured strata in the depth ranges of 0 to 20 ft and 20 to 50 ft below the level of the bottom of the adjacent trenches. They will be constructed according to the specifications provided in Appendix E. At least four soil samples from each Phase 3 boring will be analyzed for volatile organic compounds. These samples will be collected adjacent to and just above the depth intervals where the well screens are placed.

In addition, any sample presenting indications of volatile organic compounds (as indicated by the PID screening) or radioactivity (as indicated by GM screening) would be evaluated further.

5.2 PHASE 3 SAMPLE ANALYSES

Soil gas from the 28 Phase 3 soil gas monitoring wells will be sampled and analyzed for volatile organic compounds and atmospheric gases, including methane (Tables 12 and 13). A period of at least 2 weeks will be allowed, between well completion and soil gas sampling, for equilibration of conditions near the monitoring screens after drilling. In addition, the pressure in each well will be measured according to the procedure in Appendix G. These data will be used to determine whether volatile organic compounds are present and, if present, whether their migration is likely to be influenced by gas formation in the trenches. If volatile organic compounds are detected in the soil gas from any monitoring well, confirmatory soil gas samples will be collected and analyzed for volatile organic compounds, for methane plus fixed gases, and for total pressure. Analytical methods to be used are summarized in Table 13.

5.3 REPORTING

Phase 3 investigation activities will be described in a final report prepared after the Phase 3 laboratory results have been received. The report will provide: 1) a detailed description of the field investigation activities for Phase 3, including summary logs of the borings and well completion diagrams; 2) a summary of Phase 3 laboratory test results, including all detected constituents and an assessment of the quality of the Phase 3 laboratory test results as described in Appendix C; 3) a description of any problems encountered in obtaining the samples that might have had an impact on the sample quality plus laboratory reports and chain-of-custody forms; and 4) an interpretation of the significance of the findings of the program.

Figure 6 is a decision diagram which indicates how the data developed during this investigation program will be evaluated for potential impact to groundwater. The simplified contaminant release and transport models developed in Phase 2 will be refined, if necessary, and used to assist in data interpretation. Soil concentrations will be compared directly to MTCA soil criteria for protection of groundwater. Soil gas concentrations will be used to estimate potential soil and groundwater concentrations that could develop due to vapor migration. However, in the absence of detections of hazardous waste constituents in either the soil or soil gas, no further field monitoring of the vadose zone will be performed.

Detection of hazardous constituents in soil and soil gas will initiate further investigation and analysis as displayed in Figure 6. Remedial actions beyond those already proposed in the comprehensive facility closure plan are unlikely. The allowance for such a circumstance is included in Figure 6. Any continuous monitoring resulting from this program would be implemented through conditions of the Radioactive Materials License and become part of US Ecology's overall environmental monitoring program for the facility.

6.0 SCHEDULE/COST ESTIMATE

A general project time line is shown on Figure 7. This time line is provided for use in evaluating the overall project schedule and is not intended to provide specific dates for the tasks shown. For example, Phases 1 and 2 could be undertaken concurrently. As discussed above Phase 1 sampling activity will be coordinated with ongoing sampling and with the construction of additional groundwater monitoring wells. The time line begins at the initiation of field activities, however, approximately 2 to 4 weeks of preparation and mobilization activity would be necessary to initiate field activity.

A cost estimate for conduct of this comprehensive investigation is presented in Appendix H.

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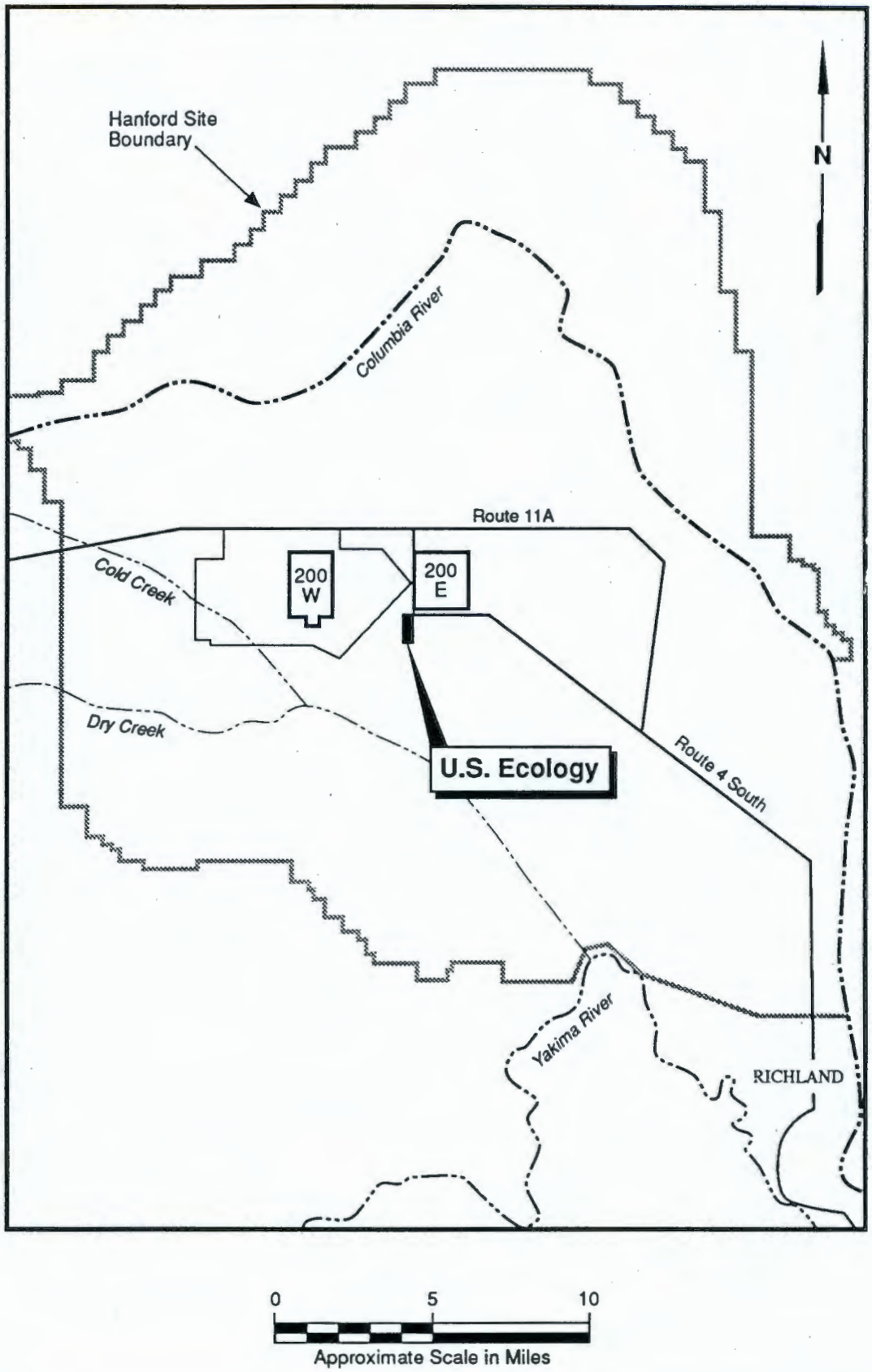
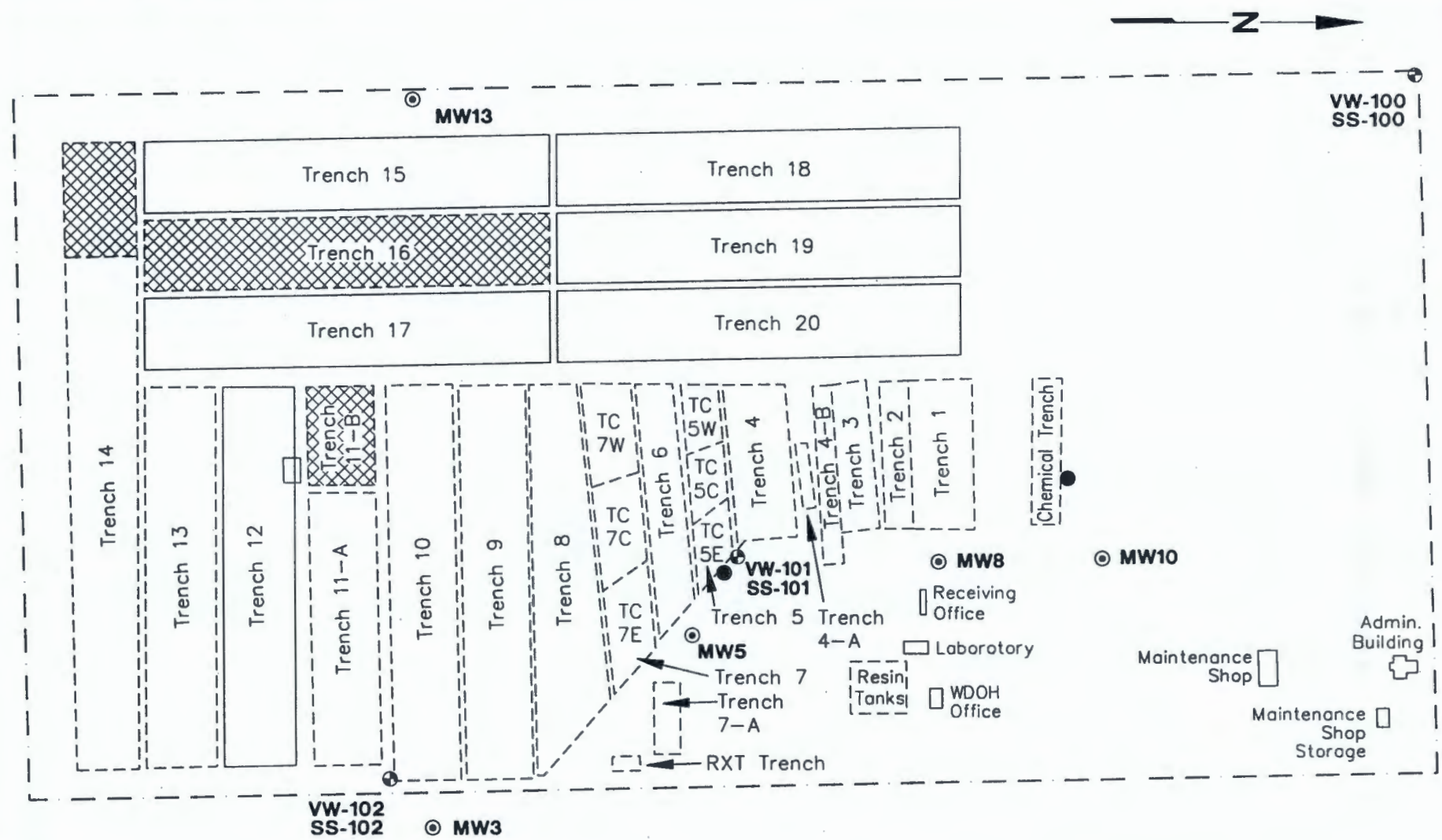


3230001.10 U.S. Ecology/Work Plan (M) 3/96

Vicinity Map

Figure 1



KEY

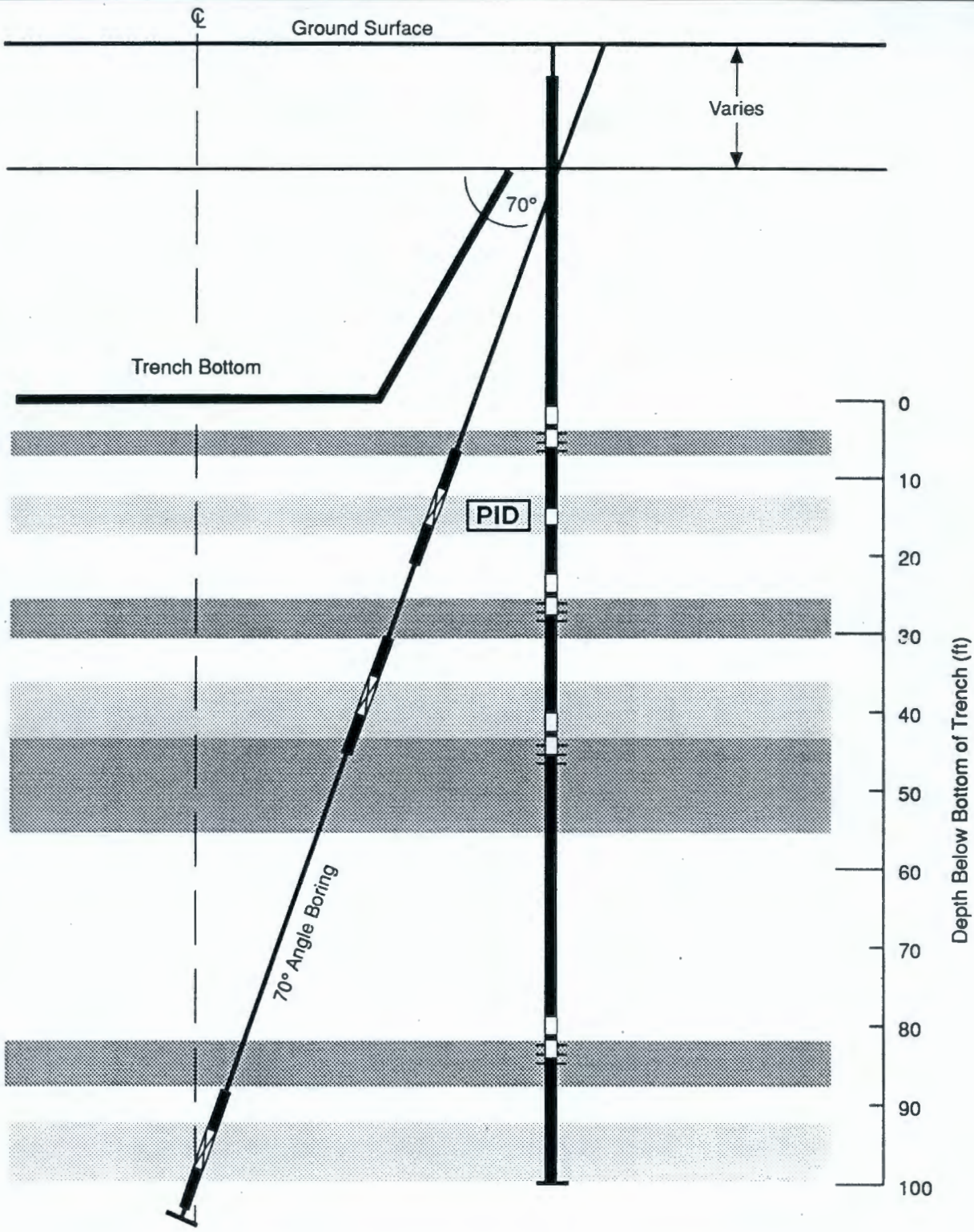
- Property Line
- Closed Trench
- Future Trench
- Active Trench
- TC 7W — Trench Cap Vapor Sampling Area
- Planned Phase 2 Monitoring Well Cluster
- Existing Vadose Zone Monitoring Well (VW-1) and Solar Still (SS-1) Location
- Existing Groundwater Monitoring Well

0 320 640

Scale in Feet

Site Map Showing Existing Wells and Planned Phase 2 Wells

Figure 2



KEY

- Borehole
- 2.5-ft Sampling Interval
- Possible Sample for Appendix IX Analyses
- Sample for VOA (Method 8240) Analysis
- Soil Vapor Monitoring Screen (1-2 ft)
- Bottom of Borehole

- Coarse Textured Strata
- Fine Textured Strata
- PID — Hypothetical Photoionization Detection

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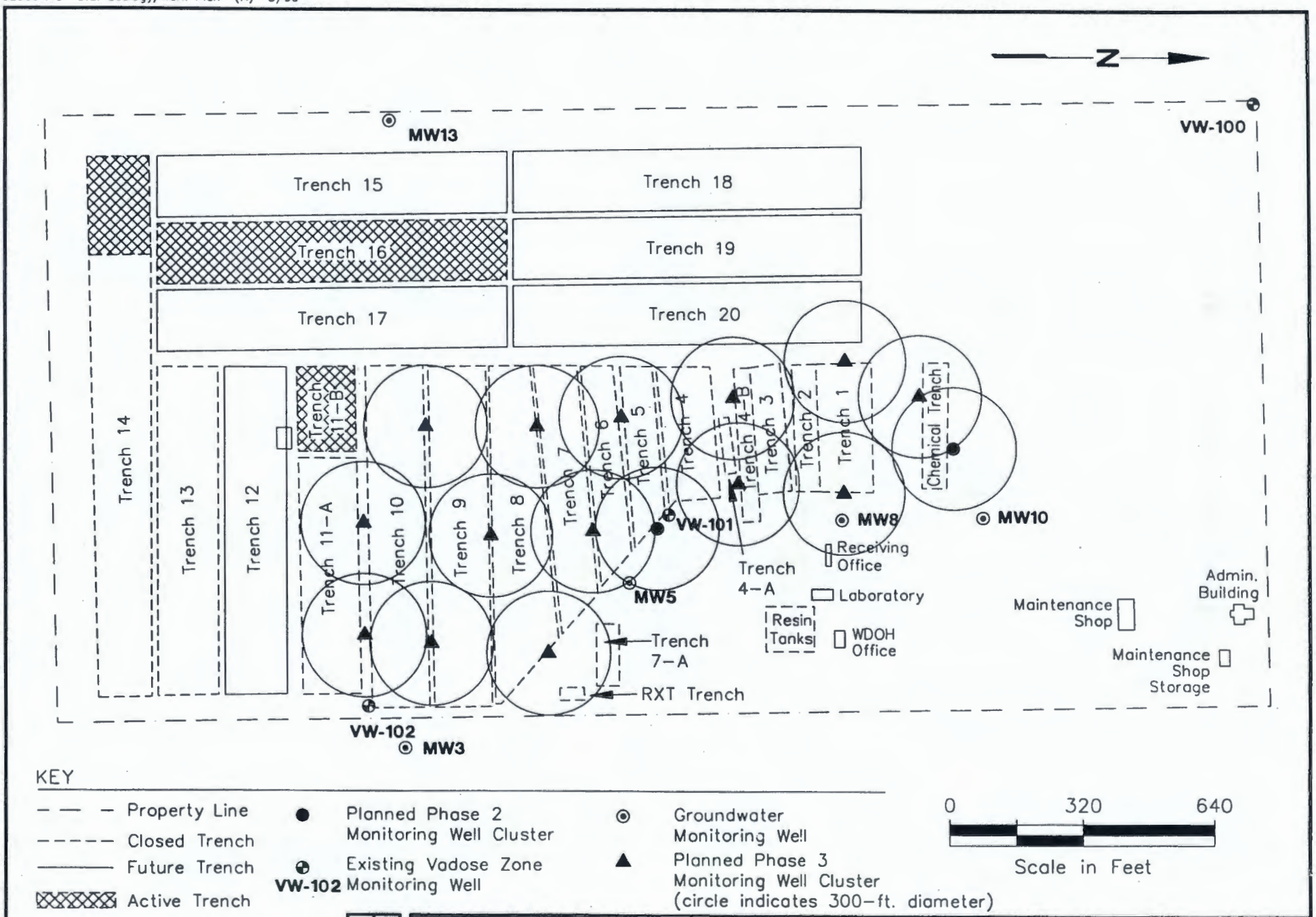
Example of Phase 2 Drilling and Soil Sampling Scheme

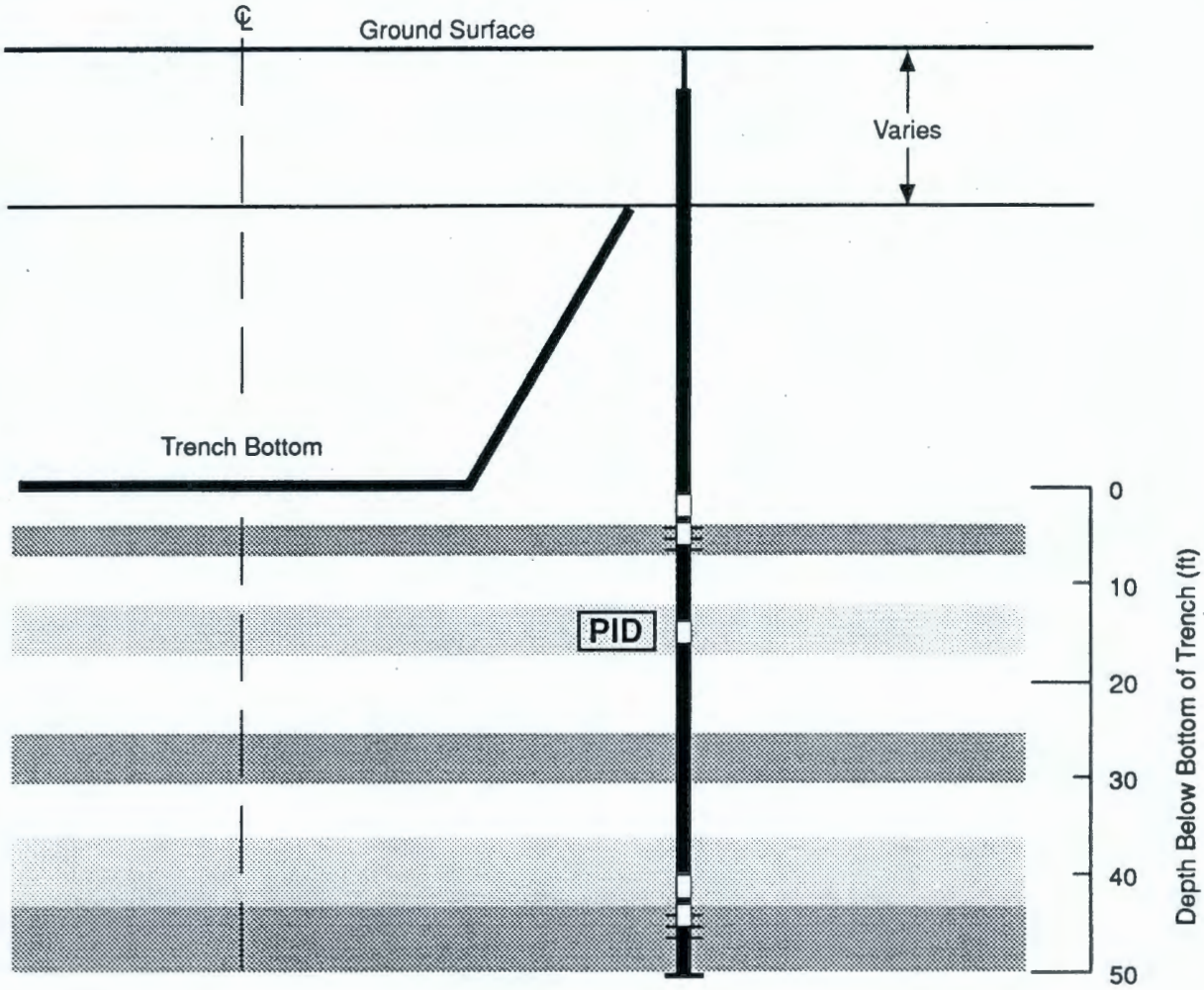
Figure 3



Planned Phase 3 Vadose Zone Monitoring Well Clusters

Figure 4

LANDAU ASSOCIATES, INC.



KEY

- Borehole
- 2.5-ft Sampling Interval
- Sample for VOA (Method 8240) Analysis
- Soil Vapor Monitoring Screen (1-2 ft)
- Bottom of Borehole

- Coarse Textured Strata
- Fine Textured Strata
- PID — Hypothetical Photoionization Detection

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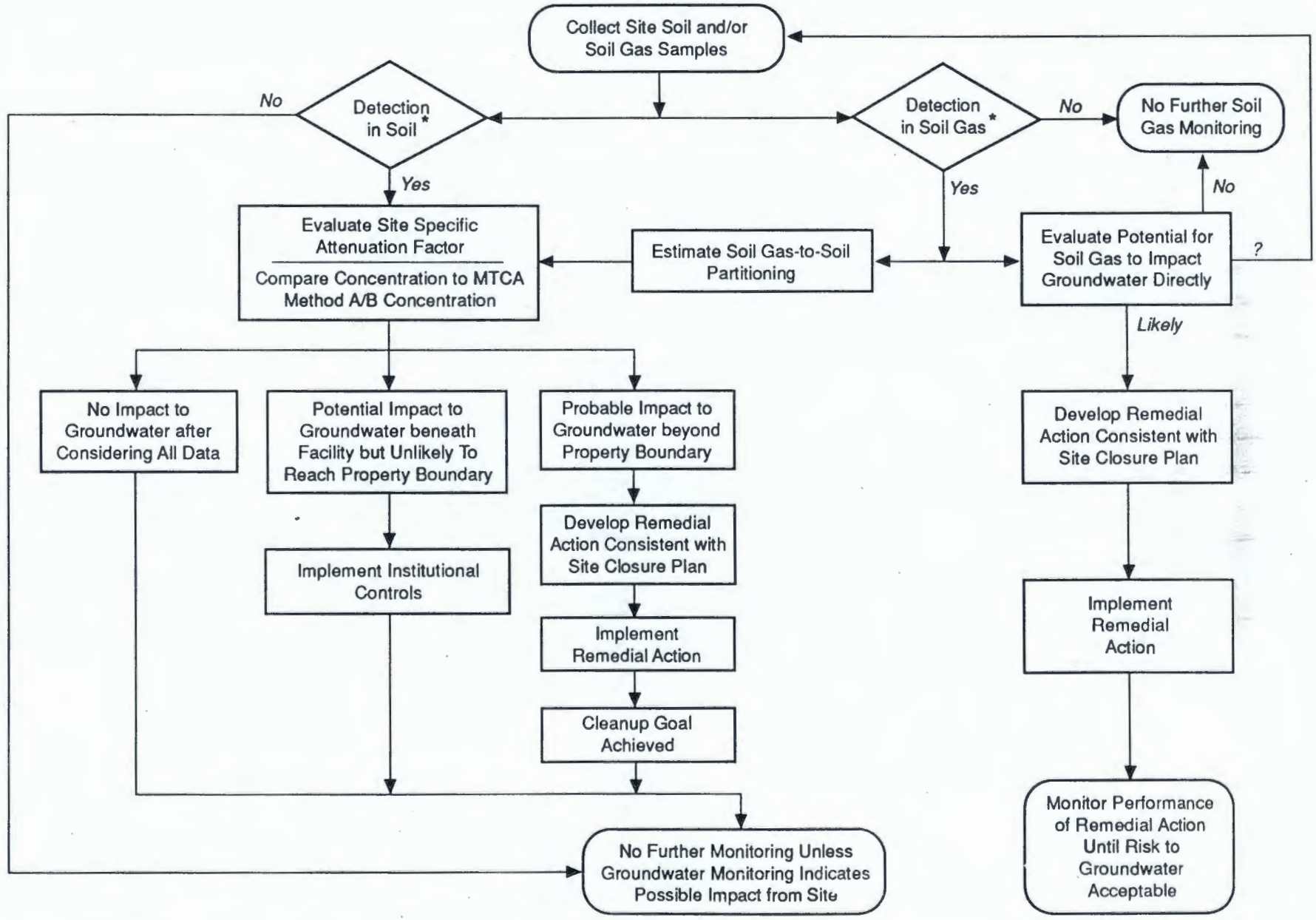
Example of Phase 3 Drilling and Soil Sampling Scheme

Figure 5

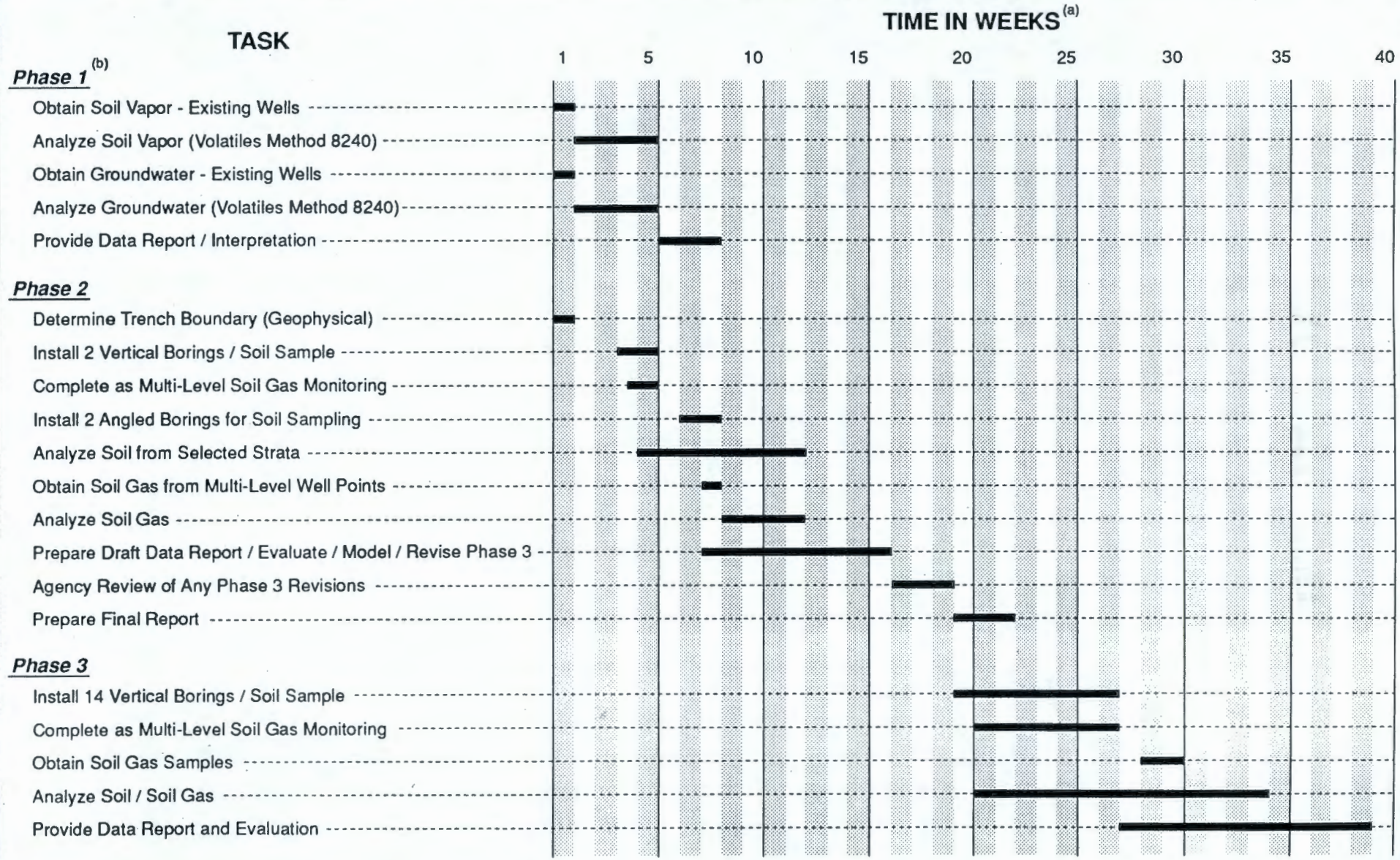


* "Detection" is defined as a concentration above background.

Impact Assessment Decision Methodology
U.S. Ecology - Hanford

Figure 6

LANDAU ASSOCIATES, INC.



Notes:

(a) Two-to-four week mobilization period not shown.

(b) Phase 1 sampling will be accomplished during the next scheduled soil vapor and groundwater sampling events.

U.S. Ecology, Inc. - Hanford Operations
Schedule for Investigation of Trench Performance

Figure 7

LANDAU ASSOCIATES, INC.

TABLE 1

VAPOR DATA ANALYSIS SUMMARY
VADOSE ZONE ORGANIC AND RADIOLOGIC VAPOR RESULTS

Well No./Report Date			Benzene (mg/m³)	Ethyl Benzene (mg/m³)	Toluene (mg/m³)	Xylene (mg/m³)	Total Petroleum Hydrocarbons (mg/m³)	Carbon Monoxide (ppm)	Carbon Dioxide (ppm)	Methane (ppm)	Nitrogen (%)	Oxygen (%)	Radon (pCi/L)	Tritium (uCi/cc)
VW-100	QTR 3	1992	< 1	1	< 5	3	< 500	5	1600	2	79	21		
VW-100	QTR 4	1992	< 1	< 1	< 5	< 2	< 500	< 1	1200	2.2	85	23		
VW-100	QTR 1	1993	< 1	< 1	< 5	< 2	< 500	< 1	10400	47	82	18	350	1.44+-0.13 E(-6)
VW-100	QTR 2	1993	< 1	< 1	< 5	< 2	< 500	< 5	1100	< 5	74	21	249.0	-2.23+-9.51 E(-8)
VW-100	QTR 3	1993	< 1	< 1	< 5	< 2	< 500	< 10	1500	< 10	79	21	337.8	9.19+-9.39 E(-8)
VW-100	QTR 4	1993	< 1	< 1	< 5	< 2	< 500	< 50	820	< 50	88	22	315.7	3.77+-9.58 E(-8)
VW-100	QTR 1	1994	< 1	< 1	< 5	< 2	< 500	< 100	1600	< 100	78	22	281	1.66+-1.02 E(-7)
VW-100	QTR 2	1994	< 1	< 1	< 5	< 2	< 500	< 10	1400	< 10	77	23	311.0	1.22+-0.96 E(-8)
VW-100	QTR 3	1994	< 1	< 1	< 5	< 2	< 500	< 10	1500	< 10	76	20	315.8	1.56+-0.81 E(-7)
VW-100	QTR 4	1994	< 1	< 1	< 5	< 2	< 500	< 500	1600	< 500	79	22	344.0	-3.70+-8.21 E(-8)
VW-101	QTR 3	1992	< 1	1	< 5	3	< 500	< 1	38000	62	83	15		
VW-101	QTR 4	1992	< 1	< 1	< 5	< 2	< 500	4.7	15000	50	76	16		
VW-101	QTR 1	1993	< 1	< 1	< 5	< 2	< 500	< 1	36100	66	81	15	> 1627.9	2.03+-0.01 E(-4)
VW-101	QTR 2	1993	< 1	< 1	< 5	< 2	< 500	< 5	22700	36	77	18	768	2.14+-0.01 E(-4)
VW-101	QTR 3	1993	< 1	< 1	< 5	< 2	< 500	< 10	30000	44	82	16	737	2.16+-0.01 E(-4)
VW-101	QTR 4	1993	< 1	< 1	< 5	< 2	< 500	< 50	40000	< 50	90	15	879	2.39+-0.01 E(-4)
VW-101	QTR 1	1994	< 1	< 1	< 5	< 2	< 500	< 100	37000	< 100	80	16	> 1556	2.46+-0.01 E(-4)
VW-101	QTR 2	1994	< 1	< 1	< 5	< 2	< 500	< 10	20000	22	79	20	1007	2.40+-0.01 E(-4)
VW-101	QTR 3	1994	< 1	< 1	< 5	< 2	< 500	< 10	26000	52	79	17	512	2.26+-0.01 E(-4)
VW-101	QTR 4	1994	< 1	< 1	< 5	< 2	< 500	< 500	39000	< 500	82	16	1060	2.83+-0.01 E(-4)
VW-102	QTR 3	1992	< 1	< 1	< 5	2	< 500	< 1	10000	41	75	19		
VW-102	QTR 4	1992	< 1	< 1	< 5	< 2	< 500	7.9	11000	52	86	19		
VW-102	QTR 1	1993	< 1	< 1	< 5	< 2	< 500	< 1	10700	47	81	19	384.0	4.50+-0.02 E(-4)
VW-102	QTR 2	1993	< 1	< 1	< 5	< 2	< 500	< 5	13300	53	77	17	306.0	4.22+-0.02 E(-4)
VW-102	QTR 3	1993	< 1	< 1	< 5	< 2	< 500	< 10	12000	46	82	17	343	4.22+-0.01 E(-4)
VW-102	QTR4	1993	< 1	< 1	< 5	< 2	< 500	< 50	< 50	< 50	89	17	339	4.05+-0.01 E(-4)
VW-102	QTR 1	1994	< 1	< 1	< 5	< 2	< 500	< 100	18000	< 100	76	22	313	4.97+-0.01 E(-4)
VW-102	QTR 2	1994	< 1	< 1	< 5	< 2	< 500	< 10	15000	38	80	19	440	4.12+-0.01 E(-4)
VW-102	QTR 3	1994	< 1	< 1	< 5	< 2	< 500	< 10	18000	35	80	17	354	3.96+-0.02 E(-4)
VW-102	QTR 4	1994	< 1	< 1	< 5	< 2	< 500	< 500	9200	< 500	80	20	360	4.76+-0.02 E(-4)

Source: US Ecology 1993-1995.

TABLE 2

VAPOR DATA ANALYSIS SUMMARY
TRENCH CAP SOIL GAS RADON MEASUREMENTS

Month	Year	Radon (pCi/L)[a] BKGD	Radon (pCi/L) T5E	Radon (pCi/L) T5C	Radon (pCi/L) T5W	Radon (pCi/L) T7E	Radon (pCi/L) T7C	Radon (pCi/L) T7W
AUG-SEP[b]	1992	80.4	76.1	65.3	137.7	66.3	48.0	50.1
OCTOBER	1992	57.9	94.4	71.7	141.7	47.0	127.9	113.1
NOVEMBER	1992	75.1	94.5	100.7	105.7	111.4	83.2	92.0
DECEMBER	1992	56.5	188.4	96.3	206.3	79.1	76.8	79.1
AVERAGE	1992	70.1	105.9	79.9	145.8	74.0	76.8	76.9
JANUARY	1993	88.1	379.9	121.6	112.1	110.9	65.4	146.7
FEBRUARY	1993	97.1	291.1	72.9	100.6	63.6	69.4	104.0
MARCH	1993	101.5	205.9	84.8	156.7	100.5	46.0	77.9
APRIL	1993	84.5	135.8	51.8	112.6	59.1	36.3	45.7
MAY	1993	59.0	269.1	33.3	42.9	67.9	26.0	35.7
JUNE	1993	38.2	99.2	58.9	67.0	51.7	42.7	47.2
JULY	1993	86.9	133.0	125.7	153.7	348.0	299.4	71.1
AUGUST	1993	74.2	145.7	47.5	97.7	120.1	138.2	80.6
SEPTEMBER	1993	47.6	73.4	46.6	85.1	93.4	121.5	99.2
OCTOBER	1993	43.6	85.3	41.6	87.3	61.9	91.4	47.7
NOVEMBER	1993	85.3	175.6	96.3	180.6	97.3	112.4	90.3
DECEMBER	1993	82.1	220.8	81.2	107.6	143.2	177.0	177.9
AVERAGE	1993	74.0	184.6	71.9	108.7	109.8	102.1	85.3
JANUARY	1994	73.8	274.6	78.4	109.5	164.6	138.6	73.2
FEBRUARY	1994	81.2	311.3	66.1	94.1	200.6	150.0	137.1
MARCH	1994	77.5	212.1	46.5	111.1	121.8	147.5	62.4
APRIL	1994	86.1	127.0	46.3	99.0	101.2	125.9	63.5
MAY	1994	98.4	218.9	59.3	96.4	192.8	101.4	87.4
JUNE	1994	60.3	145.6	72.3	111.5	116.5	125.5	67.3
JULY	1994	47.7	109.8	61.3	99.1	81.7	111.8	67.1
AUGUST	1994	61.7	115.1	62.4	67.9	79.5	71.7	56.2
SEPTEMBER	1994	58.2	103.3	75.5	85.3	92.3	80.8	79.3
OCTOBER	1994	39.4	122.2	85.8	74.2	99.0	81.7	56.8
NOVEMBER	1994	80.5	171.8	110.0	87.0	179.6	122.2	87.8
DECEMBER	1994	66.7	[c]	[c]	[c]	134.4	114.7	63.0
AVERAGE	1994	69.3	173.8	69.4	94.1	130.3	114.3	75.1

Source: US Ecology 1993, 1994, and 1995.

(a) Readings provided in units of pCi/liter of soil gas.

(b) August-September 1992 readings were weighted twice in determining average concentration results.

(c) Trial radon monitoring was temporarily suspended from Trench 5 (T5E, T5C, T5W) during December 1994 to remove surcharge for backfill material.

TABLE 3

VAPOR DATA ANALYSIS SUMMARY
SOLAR STILL TRITIUM VAPOR

Location	Month	Year	Tritium (pCi/L)
SS-100	OCTOBER	1994	50+-81
SS-100	NOVEMBER	1994	74+-81
SS-100	DECEMBER	1994	163+-88
SS-101	OCTOBER	1994	4177+-187
SS-101	NOVEMBER	1994	3345+-171
SS-101	DECEMBER	1994	3288+-176
SS-102	OCTOBER	1994	2381+-150
SS-102	NOVEMBER	1994	2345+-159
SS-102	DECEMBER	1994	2065+-148

Source: US Ecology 1995.

TABLE 4

GROUNDWATER DATA ANALYSIS SUMMARY
RADIOLOGIC RESULTS - ONSITE WELLS

Well Number/ Report Date	Gross Alpha (Dis pCi/L)	Gross Beta (Dis pCi/L)	Tritium (H-3) (nCi/L)	Carbon-14 (pCi/L)
3 QTR 1 1986	3.49	9.36	0.99	
3 QTR 2 1986	1.76	4.49	1.74	
3 QTR 3 1986	1.49	7.27	3.55	
3 QTR 4 1986	2.71	7.57	1.69	
3 QTR 1 1987	1.20+-0.93	8.11+-3.06	2.37+-0.34 E(3)	0.00
3 QTR 2 1987	3.53+-1.54	7.87+-3.05	3.00+-0.41 E(3)	0.00
3 QTR 3 1987	3.50+-1.66	6.96+-3.45	1.95+-0.33 E(3)	0.00
3 QTR 4 1987	2.20+-1.39	5.92+-3.34	1.38+-0.30 E(3)	0.00
3 QTR 1 1988	2.65+-1.41	8.62+-2.90	1590+-468	147+-154
3 QTR 2 1988	2.53+-1.33	9.36+-3.75	1350+-367	211+-168
3 QTR 3 1988	1.93+-1.25	7.09+-3.4	1720+-455	3.83+-170
3 QTR 4 1988	1.38+-1.18	8.13+-3.67	2380+-603	117+-166
3 QTR 1 1989	2.63+-1.28	5.9+-1.45	1460+-394	8.63+-169
3 QTR 2 1989	2.96+-1.37	4.95+-1.32	1560+-267	177+-158
3 QTR 3 1989	1.67+-1.78	6.49+-3.30	1450+-267	64.9+-161
3 QTR 4 1989	2.87+-1.37	5.89+-1.45	1750+-291	214+-165
3 QTR 1 1990	2.98+-1.41	5.77+-1.45	1.54+-0.267 E(-3)	-1.78+-4.01
3 QTR 2 1990	1.25+-0.971	5.96+-1.45	1.57+-0.299 E(-3)	66.7+-154
3 QTR 3 1990	2.99+-1.99	7.73+-2.89	1.61+-0.296 E(-3)	44.1+-159
3 QTR 4 1990	2.90+-1.65	5.65+-2.62	1.60+-0.284 E(-3)	55.9+-150
3 QTR 1 1991	2+-1	< 3	< 300	< 200
3 QTR 2 1991	< 2	< 3	2075+-593	< 200
3 QTR 3 1991	< 2	6+-3	< 300	< 200
3 QTR 4 1991	< 2	7+-3	2399+-559	< 200
3 QTR 1 1992	< 2	9+-3	1525+-534	< 200
3 QTR 2 1992	< 2	7.1+-0.7	2150+-150	< 200
3 QTR 3 1992	< 2	7.0+-0.8	1951+-147	< 200
3 QTR 4 1992	< 2	6.4+-0.8	2030+-150	< 200
3 QTR 1 1993	< 2	5.0+-0.7	2000+-150	< 200
3 QTR 2 1993	< 2	5.6+-0.7	2370+-160	< 200
3 QTR 3 1993	2.0+-0.6	6.0+-0.8	2615+-176	< 200
3 QTR 4 1993	< 2	7.1+-0.8	2543+-165	< 200
3 QTR 1 1994	2.5+-0.7	8.6+-0.9	3242+-187	-61.4+-113
3 QTR 2 1994	0.6+-0.5	8.4+-0.8	2544+-152	-28+-49
3 QTR 3 1994	1.6+-0.7	7.2+-0.7	2737+-161	21+-36
3 QTR 4 1994	1.1+-0.5	6.8+-0.6	3250+-177	12+-39
5 QTR 1 1986	3.72	9.32	0.60	
5 QTR 2 1986	2.07	6.51	0.51	
5 QTR 3 1986	1.71	9.01	0.70	
5 QTR 4 1986	2.75	6.88	0.95	
5 QTR 1 1987	2.28+-1.18	7.53+-2.89	1.14+-0.28 E(3)	0.00
5 QTR 2 1987	2.58+-1.29	5.70+-2.71	8.19+-3.13 E(2)	0.00
5 QTR 3 1987	3.26+-1.31	7.32+-3.48	1.12+-0.29 E(3)	0.00
5 QTR 4 1987	2.76+-1.42	10.7+-4.1	1.04+-0.29 E(3)	0.00
5 QTR 1 1988	2.72+-1.32	9.73+-3.14	1190+-444	75.7+-152
5 QTR 2 1988	1.67+-1.07	7.39+-3.5	842+-338	18.9+-163
5 QTR 3 1988	2.05+-1.36	11.6+-4.21	1610+-448	68.0+-172
5 QTR 4 1988	3.05+-1.62	9.47+-4.08	1240+-537	103+-165
5 QTR 1 1989	3.01+-1.47	5.32+-1.4	1110+-375	8.63+-169
5 QTR 2 1989	3.69+-1.50	4.84+-1.36	1420+-259	246+-160
5 QTR 3 1989	4.82+-2.56	8.44+-3.38	1210+-253	-6.49+-157
5 QTR 4 1989	3.93+-1.46	4.86+-1.38	1580+-279	92.8+-162
5 QTR 1 1990	3.43+-1.53	5.73+-1.44	1.27+-0.249 E(-3)	0.225+-4.06
5 QTR 2 1990	3.72+-1.53	5.28+-1.39	1.55+-0.298 E(-3)	-34.2+-151
5 QTR 3 1990	4.75+-2.41	4.23+-2.41	1.35+-0.279 E(-3)	-20.7+-158

TABLE 4

GROUNDWATER DATA ANALYSIS SUMMARY
RADIOLOGIC RESULTS - ONSITE WELLS

Well Number/ Report Date			Gross Alpha (Dis pCi/L)	Gross Beta (Dis pCi/L)	Tritium (H-3) (nCi/L)	Carbon-14 (pCi/L)
5	QTR 4	1990	2.30+-0.769	5.67+-2.66	1.38+-0.269 E(-3)	-18.9+-148
5	QTR 1	1991	3+-2	4+-2	1595+-573	< 200
5	QTR 2	1991	< 2	4+-3	1833+-598	< 200
5	QTR 3	1991	< 2	< 3	< 300	< 200
5	QTR 4	1991	< 2	5+-3	2188+-559	< 200
5	QTR 1	1992	2+-1	10+-3	1386+-533	< 200
5	QTR 2	1992	< 2	6.8+-0.7	1740+-140	< 200
5	QTR 3	1992	2.1+-0.8	6.9+-0.8	1546+-137	< 200
5	QTR 4	1992	< 2	6.2+-0.7	1550+-140	< 200
5	QTR 1	1993	2.0+-0.8	6.3+-0.8	1730+-140	< 200
5	QTR 2	1993	< 2	6.7+-0.7	1570+-140	< 200
5	QTR 3	1993	< 2	7.6+-0.8	1830+-156	< 200
5	QTR 4	1993	< 2	6.2+-0.8	1847+-148	< 200
5	QTR 1	1994	1.3+-0.5	6.4+-0.7	1749+-152	109+-112
5	QTR 2	1994	1.5+-0.6	5.4+-0.7	1678+-132	11+-47
5	QTR 3	1994	1.6+-0.6	6.2+-0.7	1789+-138	35+-42
5	QTR 4	1994	1.1+-0.5	5.4+-0.5	1920+-139	-1+-34
8	QTR 1	1986	9.58	8.80	0.36	
8	QTR 2	1986	0.0	5.75	0.42	
8	QTR 3	1986	0.0	7.94	0.65	
8	QTR 4	1986	3.73	10.7	1.18	
8	QTR 1	1987	2.80+-1.43	8.61+-3.13	1.01+-0.28 E(3)	0.00
8	QTR 2	1987	2.17+-1.28	6.88+-2.94	7.38+-3.10 E(2)	0.00
8	QTR 3	1987	2.54+-1.29	7.59+-3.54	8.11+-2.83 E(2)	0.00
8	QTR 4	1987	3.04+-1.55	10.2+-4.2	7.81+-2.81 E(2)	0.00
8	QTR 1	1988	2.83+-1.49	10.7+-3.45	889+-427	95.5+-153
8	QTR 2	1988	2.82+-1.52	7.72+-3.66	644+-327	117+-165
8	QTR 3	1988	5.04+-2.03	9.34+-4.00	925+-409	75.7+-172
8	QTR 4	1988	2.11+-1.41	6.48+-3.24	640+-505	67.1+-164
8	QTR 1	1989	2.52+-1.23	7.08+-1.57	690+-351	23+-169
8	QTR 2	1989	2.93+-1.38	1.24+-1.58	865+-224	273+-160
8	QTR 3	1989	2.90+-1.85	5.42+-2.51	966+-238	-9.91+-159
8	QTR 4	1989	1.85+-1.00	6.41+-1.49	1080+-248	168+-164
8	QTR 1	1990	3.68+-1.58	6.73+-1.53	1.03+-0.235 E(-3)	-1.76+-4.01
8	QTR 2	1990	2.50+-1.92	5.54+-1.41	0.952+-0.262 E(-3)	3.60+-152
8	QTR 3	1990	3.78+-2.31	5.44+-2.59	1.14+-0.267 E(-3)	24.3+-159
8	QTR 4	1990	1.56+-1.49	5.59+-2.67	1.10+-0.253 E(-3)	62.2+-150
8	QTR 1	1991	< 2	6+-4	< 300	< 200
8	QTR 2	1991	3+-2	7+-3	873+-585	< 200
8	QTR 3	1991	< 2	4+-3	< 300	< 200
8	QTR 4	1991	< 2	5+-3	1830+-534	< 200
8	QTR 1	1992	< 2	9+-3	1494+-534	< 200
8	QTR 2	1992	3.6+-0.8	7+-0.7	1540+-130	< 200
8	QTR 3	1992	2.5+-0.7	7.2+-0.7	1707+-141	< 200
8	QTR 4	1992	< 2	7.1+-0.8	1660+-140	< 200
8	QTR 1	1993	< 2	6.9+-0.7	1750+-140	< 200
8	QTR 2	1993	< 2	7.1+-0.7	1850+-140	< 200
8	QTR 3	1993	2.4+-0.8	7.1+-0.8	2094+-163	< 200
8	QTR 4	1993	2.0+-0.8	6.9+-0.8	1855+-148	< 200
8	QTR 1	1994	1.6+-0.8	6.4+-0.8	1900+-156	86+-89
8	QTR 2	1994	1.8+-0.7	6.2+-0.7	1912+-138	-2+-58
8	QTR 3	1994	1.4+-0.8	7.8+-0.8	2006+-144	18+-39
8	QTR 4	1994	1.5+-0.5	5.9+-0.6	2091+-151	20+-37
10	QTR 1	1986	3.49	7.33	0.47	

TABLE 4

GROUNDWATER DATA ANALYSIS SUMMARY
RADIOLOGIC RESULTS - ONSITE WELLS

Well Number/ Report Date	Gross Alpha (Dis pCi/L)	Gross Beta (Dis pCi/L)	Tritium (H-3) (nCi/L)	Carbon-14 (pCi/L)
10 QTR 2 1986	2.60	5.70	0.48	
10 QTR 3 1986	2.32	6.91	0.56	
10 QTR 4 1986	1.63	8.37	0.88	
10 QTR 1 1987	0.00	7.51+-3.00	8.83+-2.72 E(2)	0.00
10 QTR 2 1987	1.41+-1.06	6.26+-2.82	7.70+-3.11 E(2)	0.00
10 QTR 3 1987	3.14+-1.47	8.47+-3.69	8.05+-2.82 E(2)	0.00
10 QTR 4 1987	2.73+-1.46	9.52+-3.98	7.00+-2.79 E(2)	0.00
10 QTR 1 1988	1.24+-1.04	4.57+-2.13	947+-431	94.6+-153
10 QTR 2 1988	1.82+-1.13	7.15+-3.44	4490+-566	129+-166
10 QTR 3 1988	2.07+-1.37	10.5+-4.13	776+-401	47.9+-171
10 QTR 4 1988	2.83+-1.62	8.7+-3.77	848+-516	117+-166
10 QTR 1 1989	1.74+-1.11	4.88+-1.35	802+-356	-1.92+-169
10 QTR 2 1989	2.52+-1.30	4.83+-1.35	719+-215	258+-160
10 QTR 3 1989	1.43+-1.34	2.60+-2.01	773+-227	-35.1+-158
10 QTR 4 1989	0.815+-0.793	5.19+-1.38	873+-235	125+-163
10 QTR 1 1990	2.86+-1.43	5.44+-1.41	0.390+-0.220 E(-3)	-1.06+-4.03
10 QTR 2 1990	2.24+-1.71	4.56+-1.32	0.952+-0.262 E(-3)	-57.7+-150
10 QTR 3 1990	2.79+-1.76	7.54+-2.78	0.779+-0.245 E(-3)	104+-161
10 QTR 4 1990	2.68+-1.97	5.10+-2.58	0.934+-0.242 E(-3)	24.3+-149
10 QTR 1 1991	4+-2	7+-4	< 300	< 200
10 QTR 2 1991	< 2	< 3	849+-582	< 200
10 QTR 3 1991	3+-2	4+-2	941+-252	< 200
10 QTR 4 1991	< 2	4+-3	892+-578	< 200
10 QTR 1 1992	< 2	7+-3	849+-527	< 200
10 QTR 2 1992	2.4+-0.8	6.0+-0.8	1270+-130	< 200
10 QTR 3 1992	< 2	4.2+-0.7	1204+-128	< 200
10 QTR 4 1992	< 2	4.2+-0.7	1250+-130	< 200
10 QTR 1 1993	< 2	6.0+-0.7	1230+-130	< 200
10 QTR 2 1993	< 2	5.0+-0.7	1340+-130	< 200
10 QTR 3 1993	< 2	6.1+-0.8	1553+-148	< 200
10 QTR 4 1993	< 2	4.4+-0.7	1442+-138	< 200
10 QTR 1 1994	1.1+-0.6	6.1+-0.8	1604+-147	95+-84
10 QTR 2 1994	1.1+-0.7	6.3+-0.7	1538+-128	1+-60
10 QTR 3 1994	1.4+-0.6	7.6+-0.7	1728+-137	-15+-50
10 QTR 4 1994	1.1+-0.4	4.6+-0.5	1698+-142	-22+-43
13 QTR 1 1986	11.5	7.82	0.71	
13 QTR 2 1986	2.54	6.83	0.65	
13 QTR 3 1986	2.01	8.43	0.65	
13 QTR 4 1986	1.71	7.92	1.19	
13 QTR 1 1987	3.28+-1.57	6.23+-2.72	9.77+-2.76 E(2)	0.00
13 QTR 2 1987	3.68+-1.63	7.70+-3.04	9.10+-3.18 E(2)	0.00
13 QTR 3 1987	3.14+-1.61	10.6+-4.2	1.12+-0.29 E(3)	0.00
13 QTR 4 1987	2.99+-1.59	9.16+-3.94	5.78+-2.75 E(2)	0.00
13 QTR 1 1988	2.16+-1.25	9.82+-3.27	923+-429	124+-154
13 QTR 2 1988	2.98+-1.32	5.97+-3.21	829+-337	49.5+-163
13 QTR 3 1988	2.55+-1.48	9.27+-3.88	1430+-440	55.6+-172
13 QTR 4 1988	1.4+-1.23	7.38+-3.55	1020+-525	74.8+-165
13 QTR 1 1989	3.6+-1.41	4.71+-1.35	972+-1.35	32.6+-170
13 QTR 2 1989	2.44+-1.22	4.94+-1.37	1150+-241	196+-158
13 QTR 3 1989	2.08+-1.67	7.90+-3.02	1480+-270	58.6+-161
13 QTR 4 1989	2.61+-1.3	5.7+-1.43	1470+-273	162+-164
13 QTR 1 1990	2.86+-1.32	5.53+-1.40	0.143+-0.260 E(-3)	-1.44+-0.402
13 QTR 2 1990	2.99+-2.18	5.34+-1.40	1.57+-0.299 E(-3)	4.5+-152
13 QTR 3 1990	1.79+-1.65	4.55+-2.77	1.54+-0.291 E(-3)	-28.8+-157
13 QTR 4 1990	0.304+-0.829	7.49+-2.81	1.50+-0.278 E(-3)	288+-149

TABLE 4

GROUNDWATER DATA ANALYSIS SUMMARY
RADIOLOGIC RESULTS - ONSITE WELLS

Well Number/ Report Date	Gross Alpha (Dis pCi/L)	Gross Beta (Dis pCi/L)	Tritium (H-3) (nCi/L)	Carbon-14 (pCi/L)
13 QTR 1 1991	3+-2	< 3	1100+-560	< 200
13 QTR 2 1991	< 2	< 3	1441+-583	< 200
13 QTR 3 1991	< 2	< 3	< 300	< 200
13 QTR 4 1991	< 2	6+-3	1950+-522	< 200
13 QTR 1 1992	5+-2	7+-3	1811+-544	< 200
13 QTR 2 1992	2.6+-0.7	6.6+-0.7	2270+-110	< 200
13 QTR 3 1992	2.0+-0.7	6.3+-0.8	2399+-158	< 200
13 QTR 4 1992	< 2	5.7+-0.7	2450+-160	< 200
13 QTR 1 1993	< 2	4.9+-0.7	2720+-160	< 200
13 QTR 2 1993	< 2	7.0+-0.7	2810+-170	< 200
13 QTR 3 1993	< 2	6.9+-0.8	3114+-187	< 200
13 QTR 4 1993	< 2	7.6+-0.8	2998+-175	< 200
13 QTR 1 1994	1.5+-0.6	6.6+-0.8	3010+-181	52+-108
13 QTR 2 1994	2.0+-0.8	7.6+-0.7	3108+-164	-17+-42
13 QTR 3 1994	1.3+-0.7	8.6+-0.8	3559+-178	0+-49
13 QTR 4 1994	1.4+-0.6	5.9+-0.6	3477+-173	-46+45

Notes:
Dis signifies the dissolved fraction of the water sample.
Well 13 is an upgradient well.
0.0 signifies that the analytical results were less than or equal to zero at twice the standard deviation.
Analytical uncertainties presented are two sigma of sample analytical results for years 1987-1990.
Source: US Ecology 1987-1995.

TABLE 5

GROUNDWATER DATA ANALYSIS SUMMARY
GAMMA RAY SPECTROSCOPY RESULTS - ONSITE WELLS

Well Number/ Report Date			Pu-239/40 (pCi/L)	Pu-238 (pCi/L)	Co-60 (pCi/L)	Cs-137 (pCi/L)	Ru-106 (pCi/L)	U-234 (pCi/L)	U-235 (pCi/L)	U-238 (pCi/L)	Total Uranium (U-234+U-235+ U-238 Conc.) (pCi/L)
3	QTR 1	1986									
3	QTR 2	1986									
3	QTR 3	1986									
3	QTR 4	1986	0.129								
3	QTR 1	1987	0.00	0.00	0.00	0.00	0.00	1.91+-0.23	2.28+-1.46 E(-2)	1.12+-0.15	
3	QTR 2	1987	0.00	0.00	0.00	0.00	0.00	1.65+-0.19	6.23+-2.28 E(-2)	1.05+-0.14	
3	QTR 3	1987	0.00	0.00	0.00	2.83+-2.80	0.00	1.72+-0.22	3.70+-2.01 E(-2)	1.06+-0.15	
3	QTR 4	1987	0.00	0.00	0.00	0.00	0.00	1.97+-0.22	5.32+-2.14 E(-2)	1.80+-0.21	
3	QTR 1	1988	0.00+-9.15 E(-3)	4.57+-9.15 E(-3)	1.27+-4.25	-0.318+-2.91	10.9+-27.9	1.74+-0.204	0.0362+-0.0174	0.993+-0.13	
3	QTR 2	1988	1.81+-6.84 E(-3)	-0.77+-9.98 E(-3)	2.72+-3.42	0.285+-4.39	21.7+-36.8	1.59+-0.214	0.0255+-0.0222	1.14+-0.167	
3	QTR 3	1988	-0.165+-11.5 E(-3)	-0.144+-1.15 E(-2)	-2.65+-5.65	-0.354+-4.53	-21.0+-43.6	1.34+-0.168	0.0284+-0.0183	0.869+-0.121	
3	QTR 4	1988	-0.165+-8.72 E(-3)	-0.144+-1.16 E(-2)	0.606+-5.82	2.5+-4.95	-9.91+-48.2	1.46+-0.18	0.0453+-0.0222	0.892+-0.123	
3	QTR 1	1989	-0.165+-7.15 E(-3)	-3.79+-4.91 E(-3)	1.02+-3.94	-2.64+-4.6	32.1+-37.9	1.61+-0.211	0.0044+-0.0195	1.11+-0.158	
3	QTR 2	1989	1.59+-3.69 E(-3)	1.44+-5.43 E(-3)	3.91+-5.31	-0.0552+-5.22	5.57+-37.9	1.48+-0.187	0.0413+-0.0275	0.923+-0.129	
3	QTR 3	1989	0.872+-3.90 E(-3)	3.05+-6.31 E(-3)	0.708+-5.8	0.751+-3.83	-12.6+-38.7	1.40+-0.196	0.0286+-0.0269	0.819+-0.132	
3	QTR 4	1989	-0.017+-11.8 E(-3)	18.2+-17.6 E(-3)	-1.6+-5.12	0.331+-4.44	214+-165	1.67+-0.204	0.0230+-0.0231	0.923+-0.129	
3	QTR 1	1990	-0.165+-6.12 E(-3)	-1.44+-6.17 E(-3)	3.62+-3.97	2.48+-4.91	8.35+-39.3	1.90+-0.228	0.0182+-0.0180	1.13+-0.152	
3	QTR 2	1990	1.69+-3.90 E(-3)	11.1+-12.0 E(-3)	1.32+-5.03	3.65+-4.47	31.7+-41.0	1.62+-0.204	0.0322+-0.0254	0.988+-0.141	
3	QTR 3	1990	3.66+-5.54 E(-3)	-1.44+-5.90 E(-3)	-2.13+-4.27	-0.110+-5.68	-14.3+-41.9	1.64+-0.215	0.0359+-0.0240	0.979+-0.146	
3	QTR 4	1990	-2.20+-2.12 E(-3)	-1.39+-2.17 E(-3)	ND	-0.756+-2.51	ND	1.84+-0.213	0.0441+-0.0194	1.27+-0.157	
3	QTR 1	1991	< 0.1	< 0.1	< 11	< 10	< 85	1.7+-0.9	< 0.1	1.9+-1.4	
3	QTR 2	1991	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
3	QTR 3	1991	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
3	QTR 4	1991	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
3	QTR 1	1992	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
3	QTR 2	1992	< 0.01	< 0.01	< 11	< 10	< 85	1.88+-0.4	< 0.1	1.0+-0.3	
3	QTR 3	1992	< 0.01	< 0.01	< 11	< 10	< 85	1.62+-0.3	< 0.1	0.6+-0.2	
3	QTR 4	1992	< 0.01	0.02+-0.04	< 11	< 10	< 85	1.65+-0.4	< 0.1	1.11+-0.3	
3	QTR 1	1993	0.01+-0.01	< 0.01							2.34+-0.23
3	QTR 2	1993	< 0.01	< 0.01							2.35+-0.34
3	QTR 3	1993	< 0.01	< 0.01							2.45+-0.60
3	QTR 4	1993	< 0.01	< 0.01							1.87+-0.31
3	QTR 1	1994	0.00+-0.01	-0.01+-0.02							2.84+-0.35
3	QTR 2	1994	0.001+-0.009	0.003+-0.007							2.45+-0.26
3	QTR 3	1994	0.001+-0.008	0.004+-0.009							1.66+-0.47
3	QTR 4	1994	-0.001+-0.005	-0.002+-0.005							2.27+-0.44
5	QTR 1	1986									
5	QTR 2	1986									
5	QTR 3	1986									
5	QTR 4	1986									
5	QTR 1	1987	0.00	0.00	5.62+-4.02	0.00	0.00	1.77+-0.22	5.53+-2.37 E(-2)	1.32+-0.17	
5	QTR 2	1987	0.00	0.00	0.00	0.00	0.00	1.88+-0.22	5.40+-2.18 E(-2)	1.17+-0.15	
5	QTR 3	1987	0.00	0.00	3.05+-2.51	0.00	0.00	2.04+-0.25	8.08+-3.26 E(-2)	1.43+-0.19	
5	QTR 4	1987	0.00	0.00	0.00	0.00	0.00	1.89+-0.32	6.23+-4.22 E(-2)	1.27+-0.24	
5	QTR 1	1988	0.00+-0.0105	3.5+-7.01 E(-3)	4.27+-4.19	2.24+-4.09	24.3+-38.1	1.83+-0.287	0.129+-0.0557	1.18+-0.21	
5	QTR 2	1988	-0.151+-1.08 E(-2)	-0.77+-10.7 E(-3)	3.54+-2.7	1.38+-3.69	9.31+-32.1	1.89+-0.255	0.136+-0.0501	1.28+-0.19	
5	QTR 3	1988	-0.165+-7.23 E(-3)	-1.44+-7.28 E(-3)	1.51+-3.83	-1.47+-4.25	16.4+-46.4	1.73+-0.205	0.0474+-0.0222	0.965+-0.129	
5	QTR 4	1988	-4.57+-6.36 E(-3)	-1.44+-6.76 E(-3)	-0.103+-5.28	-0.559+-3.76	-14.1+-45.3	1.76+-0.221	0.0327+-0.0227	1.2+-0.163	
5	QTR 1	1989	-0.165+-8.11 E(-3)	1.24+-5.33 E(-3)	-4.35+-5.3	-1.77+-3.94	-2.97+-32.0	1.76+-0.247	0.0395+-0.0321	1.12+-0.176	
5	QTR 2	1989	-0.165+-6.13 E(-3)	-1.44+-6.18 E(-3)	0.178+-4.48	2.87+-4.47	-18.0+-34.5	1.91+-0.227	0.0799+-0.0329	1.33+-0.169	

TABLE 5

GROUNDWATER DATA ANALYSIS SUMMARY
GAMMA RAY SPECTROSCOPY RESULTS - ONSITE WELLS

Well Number/ Report Date			Pu-239/40 (pCi/L)	Pu-238 (pCi/L)	Co-60 (pCi/L)	Cs-137 (pCi/L)	Ru-106 (pCi/L)	U-234 (pCi/L)	U-235 (pCi/L)	U-238 (pCi/L)	Total Uranium (U-234+U-235+ U-238 Conc.) (pCi/L)
5	QTR 3	1989	-0.165+-5.70 E(-3)	7.12+-8.61 E(-3)	-5.06+-5.54	-5.07+-5.62	-6.29+-45.3	1.58+-0.230	0.0327+-0.0358	1.16+-0.182	
5	QTR 4	1989	-0.165+-14.7 E(-3)	-5.36+-5.73 E(-3)	4.09+-4.33	3.2+-4.52	92.8+-162	1.71+-0.207	0.0476+-0.0294	1.13+-0.149	
5	QTR 1	1990	-0.165+-7.40 E(-3)	-1.44+-7.44 E(-3)	1.04+-3.99	0.745+-5.05	33.6+-43.5	1.92+-0.231	0.0454+-0.0248	1.23+-0.163	
5	QTR 2	1990	-0.165+-6.90 E(-3)	10.5+-9.18 E(-3)	-3.62+-4.95	-0.621+-5.25	-23.6+-43.4	1.89+-0.233	0.0494+-0.0247	1.20+-0.164	
5	QTR 3	1990	7.90+-8.18 E(-3)	-1.44+-6.21 E(-3)	-1.61+-4.93	3.95+-4.31	24.2+-34.6	1.78+-0.226	0.0484+-0.0266	1.14+-0.161	
5	QTR 4	1990	0.086+-6.96 E(-3)	-2.40+-2.93 E(-3)	ND	1.85+-2.06	ND	1.83+-0.217	0.0488+-0.0214	1.26+-0.161	
5	QTR 1	1991	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
5	QTR 2	1991	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
5	QTR 3	1991	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
5	QTR 4	1991	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
5	QTR 1	1992	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
5	QTR 2	1992	< 0.01	< 0.01	< 11	< 10	< 85	3.54+-0.6	< 0.1	1.02+-0.3	
5	QTR 3	1992	< 0.01	< 0.01	< 11	< 10	< 85	1.73+-0.5	< 0.1	1.08+-0.4	
5	QTR 4	1992	< 0.01	0.01+-0.02	< 11	< 10	< 85	1.94+-0.2	< 0.1	1.2+-0.2	
5	QTR 1	1993	< 0.01	< 0.01							2.42+-0.49
5	QTR 2	1993	0.01+-0.01	0.01+-0.03							2.9+-0.28
5	QTR 3	1993	< 0.01	< 0.01							2.91+-1.01
5	QTR 4	1993	< 0.01	< 0.01							2.16+-0.39
5	QTR 1	1994	0.00+-0.01	0.00+-0.02							2.79+-0.43
5	QTR 2	1994	0.008+-0.009	0.008+-0.013							2.74+-0.18
5	QTR 3	1994	-0.004+-0.006	0.005+-0.007							2.10+-0.42
5	QTR 4	1994	0.006+-0.009	0.000+-0.011							2.99+-0.57
8	QTR 1	1986									
8	QTR 2	1986									
8	QTR 3	1986									
8	QTR 4	1986									
8	QTR 1	1987	0.00	0.00	2.83+-2.55	0.00	0.00	2.01+-0.23	3.05+-1.60 E(-2)	1.40+-0.17	
8	QTR 2	1987	0.00	0.00	0.00	0.00	0.00	1.98+-0.23	9.35+-2.99 E(-2)	1.44+-0.18	
8	QTR 3	1987	0.00	0.00	0.00	0.00	0.00	2.05+-0.25	3.70+-2.06 E(-2)	1.35+-0.18	
8	QTR 4	1987	0.00	0.00	0.00	0.00	0.00	2.01+-0.23	4.69+-2.04 E(-2)	1.64+-0.19	
8	QTR 1	1988	2.87+-5.74 E(-3)	2.87+-5.75 E(-3)	-0.762+-4.93	1.06+-3.64	19.6+-31.5	1.96+-0.223	0.0621+-0.0227	1.31+-0.16	
8	QTR 2	1988	-0.151+-1.56 E(-2)	3.11+-7.8 E(-3)	3.73+-2.85	1.32+-4.19	-13.9+-36.5	1.99+-0.249	0.052+-0.0263	1.31+-0.178	
8	QTR 3	1988	-1.05+-1.48 E(-2)	-0.144+-1.56 E(-2)	-2.48+-4.97	4.66+-5.67	-47.1+-58.0	1.67+-0.206	0.049+-0.0249	1.27+-0.166	
8	QTR 4	1988	-0.165+-9.48 E(-3)	-7.72+-9.01 E(-3)	-0.826+-4.53	-1.3+-4.8	0.00+-34.2	1.58+-0.199	0.0274+-0.0205	1.08+-0.148	
8	QTR 1	1989	-2.7+-5.21 E(-3)	-3.98+-5.27 E(-3)	4.09+-4.33	2.54+-4.42	-14.8+-40.6	2.01+-0.317	0.0437+-0.0467	1.43+-0.246	
8	QTR 2	1989	-0.165+-6.13 E(-3)	-1.44+-5.62 E(-3)	0.84+-3.71	0.916+-4.42	7.69+-37.1	1.87+-0.228	0.0667+-0.0329	1.38+-0.179	
8	QTR 3	1989	1.65+-3.81 E(-3)	3.99+-6.45 E(-3)	1.51+-4.73	-1.06+-2.74	17.8+-32.6	1.69+-0.222	0.0350+-0.0279	1.26+-0.177	
8	QTR 4	1989	4.61+-9.64 E(-3)	20.6+-21.9 E(-3)	-0.310+-4.38	0.621+-4.61	168+-164	2.86+-0.347	0.506+-0.0969	2.12+-0.270	
8	QTR 1	1990	-0.165+-8.34 E(-3)	-1.44+-23.5 E(-3)	1.54+-3.37	0.945+-4.50	6.90+-33.6	2.02+-0.241	0.0300+-0.0199	1.41+-0.180	
8	QTR 2	1990	3.45+-5.26 E(-3)	7.61+-8.26 E(-3)	1.96+-3.75	-1.16+-4.75	-6.90+-40.4	1.97+-0.246	0.0408+-0.0263	1.37+-0.186	
8	QTR 3	1990	-1.87+-6.04 E(-3)	44.7+-18.4 E(-3)	0.930+-5.04	0.186+-4.68	-28.1+-41.1	1.87+-0.235	0.0507+-0.0258	1.40+-0.187	
8	QTR 4	1990	1.81+-9.27 E(-3)	-1.11+-2.40 E(-3)	ND	-0.229+-2.32	ND	1.85+-0.214	0.0436+-0.0192	1.26+-0.161	
8	QTR 1	1991	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
8	QTR 2	1991	< 0.1	< 0.1	< 11	< 10	< 85	1.2+-0.6	< 0.1	1.5+-0.6	
8	QTR 3	1991	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
8	QTR 4	1991	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
8	QTR 1	1992	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
8	QTR 2	1992	< 0.01	< 0.01	< 11	< 10	< 85	1.77+-0.4	< 0.1	1.18+-0.3	
8	QTR 3	1992	0.02+-0.05	< 0.01	< 11	< 10	< 85	1.87+-0.5	< 0.1	0.96+-0.4	
8	QTR 4	1992	< 0.01	0.01+-0.02	< 11	< 10	< 85	3.16+-0.5	0.18+-0.15	1.45+-0.3	

TABLE 5

GROUNDWATER DATA ANALYSIS SUMMARY
GAMMA RAY SPECTROSCOPY RESULTS - ONSITE WELLS

Well Number/ Report Date			Pu-239/40 (pCi/L)	Pu-238 (pCi/L)	Co-60 (pCi/L)	Cs-137 (pCi/L)	Ru-106 (pCi/L)	U-234 (pCi/L)	U-235 (pCi/L)	U-238 (pCi/L)	Total Uranium (U-234+U-235+ U-238 Conc.) (pCi/L)
8	QTR 1	1993	0.01+-0.02	< 0.01							3.21+-0.61
8	QTR 2	1993	< 0.01	0.02+-0.02							2.72+-0.26
8	QTR 3	1993	< 0.01	< 0.01							2.79+-0.58
8	QTR 4	1993	< 0.01	0.011+-0.011							1.82+-0.25
8	QTR 1	1994	0.00+-0.01	0.01+-0.02							2.63+-0.33
8	QTR 2	1994	0.005+-0.012	0.008+-0.013							2.82+-0.42
8	QTR 3	1994	0.002+-0.013	-0.001+-0.013							3.10+-1.06
8	QTR 4	1994	-0.001+-0.010	0.004+-0.008							1.94+-0.43
10	QTR 1	1986									
10	QTR 2	1986									
10	QTR 3	1986									
10	QTR 4	1986	5.29		5.35						
10	QTR 1	1987	0.00	0.00	0.00	0.00	0.00	1.60+-0.19	2.09+-1.28 E(-2)	0.82+-0.11	
10	QTR 2	1987	0.00	0.00	0.00	0.00	0.00	1.50+-0.18	6.12+-2.31 E(-2)	0.79+-0.11	
10	QTR 3	1987	0.00	0.00	0.00	7.68+-3.23	0.00	1.63+-0.20	3.83+-1.95 E(-2)	0.84+-0.12	
10	QTR 4	1987	0.00	0.00	0.00	7.89+-5.63	1.05+-0.53 E(2)	1.79+-0.24	11.0+-4.1 E(-2)	0.93+-0.15	
10	QTR 1	1988	0.00+-0.0454	0.00+-4.55 E(-2)	-2.08+-4.2	-3.25+-3.34	-2.98+-35.3	1.64+-0.2	0.0688+-0.026	0.906+-0.126	
10	QTR 2	1988	-0.151+-1.07 E(-2)	-0.77+-10.6 E(-3)	1.65+-4.18	-1.49+-4.22	-17.2+-44.5	1.61+-0.209	0.0112+-0.0138	0.85+-0.129	
10	QTR 3	1988	0.838+-1.72 E(-2)	0.711+-1.72 E(-2)	0.845+-4.29	-1.54+-3.66	-11.6+-36.6	1.30+-0.171	0.095+-0.0343	0.546+-0.0917	
10	QTR 4	1988	-1.3+-1.37 E(-2)	-1.44+-7.84 E(-3)	-1.74+-5.32	-0.881+-4.43	-41.0+-46.1	1.31+-0.168	0.0336+-0.0202	0.725+-0.108	
10	QTR 1	1989	-8.27+-9.47 E(-3)	3.97+-7.79 E(-3)	0.783+-5.08	4.21+-3.73	-10.1+-34.9	1.55+-0.247	0.0095+-0.0265	0.783+-0.154	
10	QTR 2	1989	-0.165+-5.37 E(-3)	-1.44+-5.43 E(-3)	-0.0946+-4.84	1.06+-4.06	-14.9+-33.2	1.37+-0.175	0.0168+-0.021	0.695+-0.106	
10	QTR 3	1989	1.67+-3.85 E(-3)	-1.07+-4.43 E(-3)	0.93+-4.38	-1.12+-3.87	-10.9+-30.3	1.17+-0.218	0.0217+-0.0336	0.653+-0.15	
10	QTR 4	1989	-5.06+-7.04 E(-3)	59.7+-39.4 E(-3)	-0.304+-4.29	-6.2+-4.7	125+-163	1.43+-0.196	0.0401+-0.031	0.774+-0.125	
10	QTR 1	1990	-0.165+-7.09 E(-3)	3.22+-6.75 E(-3)	-2.65+-4.05	-1.65+-4.83	-12.9+-44.0	1.73+-0.241	0.0350+-0.0300	0.854+-0.154	
10	QTR 2	1990	-0.165+-5.68 E(-3)	5.98+-9.22 E(-3)	-4.45+-5.99	1.12+-3.73	6.79+-44.3	1.46+-0.199	0.0351+-0.0245	0.804+-0.129	
10	QTR 3	1990	-0.165+-5.54 E(-3)	-1.44+-5.59 E(-3)	-0.576+-3.46	-4.58+-4.23	-20.9+-36.3	1.63+-0.251	0.0243+-0.0244	0.968+-0.174	
10	QTR 4	1990	8.01+-12.3 E(-3)	-0.866+-1.96 E(-3)	ND	2.40+-2.35	ND	1.57+-0.198	0.0490+-0.0225	0.868+-0.125	
10	QTR 1	1991	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
10	QTR 2	1991	< 0.1	< 0.1	< 11	< 10	< 85	1.3+-0.6	< 0.1	0.9+-0.5	
10	QTR 3	1991	< 0.1	< 0.1	< 11	< 10	< 85	2.3+-1.1	< 0.1	1.9+-1.1	
10	QTR 4	1991	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
10	QTR 1	1992	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
10	QTR 2	1992	< 0.01	< 0.01	< 11	< 10	< 85	3.7+-0.6	< 0.1	0.61+-0.3	
10	QTR 3	1992	0.011+-0.013	< 0.01	< 11	< 10	< 85	1.09+-0.3	< 0.1	0.6+-0.2	
10	QTR 4	1992	< 0.01	0.01+-0.02	< 11	< 10	< 85	1.14+-0.3	< 0.1	0.64+-0.2	
10	QTR 1	1993	0.01+-0.01	< 0.01							2.10+-0.040
10	QTR 2	1993	0.01+-0.01	0.01+-0.01							1.98+-0.23
10	QTR 3	1993	< 0.01	< 0.01							2.3+-0.16
10	QTR 4	1993	< 0.01	0.017+-0.014							1.25+-0.22
10	QTR 1	1994	0.00+-0.01	0.01+-0.01							2.26+-0.29
10	QTR 2	1994	-0.004+-0.010	0.001+-0.011							2.19+-0.38
10	QTR 3	1994	0.005+-0.007	0.002+-0.007							1.87+-0.40
10	QTR 4	1994	0.002+-0.008	0.000+-0.006							2.22+-0.42
13	QTR 1	1986									
13	QTR 2	1986									
13	QTR 3	1986									
13	QTR 4	1986	0.33								
13	QTR 1	1987	0.00	0.00	0.00	0.00	0.00	1.98+-0.24	4.13+-2.05 E(-2)	1.21+-0.16	
13	QTR 2	1987	0.00	0.00	3.53+-2.69	0.00	0.00	2.04+-0.24	4.26+-2.00 E(-2)	1.25+-0.16	

TABLE 5

GROUNDWATER DATA ANALYSIS SUMMARY
GAMMA RAY SPECTROSCOPY RESULTS - ONSITE WELLS

Well Number/ Report Date			Pu-239/40 (pCi/L)	Pu-238 (pCi/L)	Co-60 (pCi/L)	Cs-137 (pCi/L)	Ru-106 (pCi/L)	U-234 (pCi/L)	U-235 (pCi/L)	U-238 (pCi/L)	Total Uranium (U-234+U-235+ U-238 Conc.) (pCi/L)
13	QTR 3	1987	0.00	0.00	0.00	0.00	0.00	1.95+-0.24	5.16+-2.36 E(-2)	1.31+-0.17	
13	QTR 4	1987	0.00	0.00	0.00	0.00	0.00	1.97+-0.26	11.3+-4.4 E(-2)	1.30+-0.19	
13	QTR 1	1988	0.00+-0.0112	0.745+-1.06 E(-2)	2.65+-4.15	1.03+-3.56	8.96+-31.1	1.66+-0.2	0.0475+-0.0208	1.11+-0.144	
13	QTR 2	1988	-0.151+-1.67 E(-2)	06.32+-11.1 E(-3)	-1.32+-4.88	3.01+-4.64	3.94+-39.8	1.94+-0.261	0.0404+-0.0268	1.11+-0.171	
13	QTR 3	1988	-0.165+-7.03 E(-3)	-1.44+-7.07 E(-3)	-1.85+-3.74	-1.32+-3.82	24.4+-31.6	1.77+-0.219	0.04+-0.0236	1.12+-0.153	
13	QTR 4	1988	-0.165+-0.91 E(-3)	-8.26+-8.03 E(-3)	-2.25+-4.53	-1.64+-4.3	-5.79+-42.8	1.51+-0.195	0.0896+-0.0331	1.06+-0.148	
13	QTR 1	1989	-0.165+-9.85 E(-3)	-1.44+-9.88 E(-3)	-1.96+-4.83	0.745+-2.79	9.4+-32.6	1.99+-0.290	0.0082+-0.0256	1.33+-0.217	
13	QTR 2	1989	1.72+-3.95 E(-3)	0.446+-4.02 E(-3)	1.01+-4.91	3.01+-4.99	-6.28+-45.3	1.83+-0.219	0.033+-0.0242	1.19+-0.155	
13	QTR 3	1989	-2.19+-2.62 E(-3)	-0.429+-3.89 E(-3)	2.46+-3.88	1.24+-3.91	23.8+-33.7	1.48+-0.237	0.0280+-0.0326	1.09+-0.19	
13	QTR 4	1989	-5.97+-5.95 E(-3)	30.5+-23.8 E(-3)	-0.284+-4.01	0.471+-3.91	162+-164	1.8+-0.223	0.0527+-0.0302	1.21+-0.163	
13	QTR 1	1990	-0.165+-9.99 E(-3)	-1.44+-10.0 E(-3)	0.00+-3.89	-1.70+-4.04	13.9+-37.2	1.83+-0.225	0.0449+-0.0252	1.27+-0.168	
13	QTR 2	1990	-0.165+-6.02 E(-3)	4.46+-6.98 E(-3)	-0.379+-4.64	3.36+-4.62	-11.9+-47.0	1.75+-0.220	0.0486+-0.0248	1.18+-0.163	
13	QTR 3	1990	1.58+-3.68 E(-3)	-1.44+-5.41 E(-3)	-1.64+-4.70	4.03+-3.82	7.95+-37.9	1.83+-0.276	0.0454+-0.0325	1.30+-0.217	
13	QTR 4	1990	-0.022+-6.52 E(-3)	-1.49+-2.30 E(-3)	ND	-1.14+-2.09	ND	1.73+-0.219	0.0469+-0.0232	1.13+-0.157	
13	QTR 1	1991	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
13	QTR 2	1991	< 0.1	< 0.1	< 11	< 10	< 85	1.2+-0.5	< 0.1	0.8+-0.4	
13	QTR 3	1991	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
13	QTR 4	1991	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
13	QTR 1	1992	< 0.1	< 0.1	< 11	< 10	< 85	< 0.1	< 0.1	< 0.1	
13	QTR 2	1992	< 0.01	< 0.01	< 11	< 10	< 85	1.68+-0.4	< 0.1	1.14+-0.03	
13	QTR 3	1992	< 0.01	< 0.01	< 11	< 10	< 85	1.77+-0.4	< 0.1	1.02+-0.3	
13	QTR 4	1992	< 0.01	0.01+-0.02	< 11	< 10	< 85	1.59+-0.3	0.1+-0.1	0.68+-0.23	
13	QTR 1	1993	< 0.01	< 0.01							3.67+-0.55
13	QTR 2	1993	< 0.01	0.02+-0.02							2.74+-0.28
13	QTR 3	1993	< 0.01	< 0.01							3.51+-0.65
13	QTR 4	1993	< 0.01	< 0.01							1.89+-0.35
13	QTR 1	1994	0.00+-0.01	0.00+-0.01							2.52+-0.38
13	QTR 2	1994	0.002+-0.008	-0.001+-0.009							2.77+-0.47
13	QTR 3	1994	0.005+-0.009	0.002+-0.008							2.55+-0.55
13	QTR 4	1994	0.000+-0.014	0.007+-0.016							2.50+-0.40

Notes:
Well 13 is an upgradient well.
0.0 signifies that the analytical results were less than or equal to zero at twice the standard deviation.
Analytical uncertainties presented are two sigma of sample analytical results for years 1987-1990.
ND signifies nondetect.
Source: US Ecology 1987-1995.

TABLE 6

GROUNDWATER DATA ANALYSIS SUMMARY
CONVENTIONAL RESULTS - ONSITE WELLS

Well Number/ Report Date	NO3 (ppm)	pH	Specific Cond. (µmho/cm)	TOC (ppb) P1	TOC (ppb) P2	TOC (ppb) P3	TOC (ppb) P4	TOX	Temp (degC)	TDS (ppm)
3 QTR 1 1986	18.72	7.87	395	< 1000	< 1000	< 1000	< 1000	< 20		
3 QTR 2 1986	21.36	7.46	380	< 1000	< 1000	< 1000	< 1000	< 20		
3 QTR 3 1986	21.89	7.57	405	< 1000	< 1000	< 1000	< 1000	< 20		
3 QTR 4 1986	22.67	7.50	400	< 1000	< 1000	< 1000	< 1000	< 20		
3 QTR 1 1987	23.70		414	< 1000	< 1000	< 1000	< 1000			
3 QTR 2 1987	22.28		443	< 1000	< 1000	< 1000	< 1000			
3 QTR 3 1987	22.97		408	< 1000	< 1000	< 1000	< 1000			
3 QTR 4 1987	22.69		396	< 1000	< 1000	< 1000	< 1000			
3 QTR 1 1988	23.421		467.9	< 1000	< 1000	< 1000	< 1000			
3 QTR 2 1988	21.19		400.8	< 1000	< 1000	< 1000	< 1000			
3 QTR 3 1988	NR		346	< 1000	< 1000	< 1000	< 1000			
3 QTR 4 1988	22.3		400	< 1000	< 1000	< 1000	< 1000			
3 QTR 1 1989	20.5		356.3	< 1000	< 1000	< 1000	< 1000			
3 QTR 2 1989	22.2		364.5	< 1000	< 1000	< 1000	< 1000			
3 QTR 3 1989	21.4		407.3	< 1000	< 1000	< 1000	< 1000			
3 QTR 4 1989	22.2		373.8	< 1000	< 1000	< 1000	< 1000			
3 QTR 1 1990	22.6		430	< 1000	< 1000	< 1000	< 1000		18	263
3 QTR 2 1990	24.2		437	< 1000	< 1000	< 1000	< 1000		20	252
3 QTR 3 1990	22.1		449	< 1000	< 1000	< 1000	< 1000		22	246
3 QTR 4 1990	21.5		337	< 1000	< 1000	< 1000	< 1000		19	264
3 QTR 1 1991	4.6		322	< 1000	< 1000	1300	< 1000		18.4	265
3 QTR 2 1991	4.7		408	< 1000	< 1000	< 1000	< 1000		20.2	570
3 QTR 3 1991	6.5		415	< 1000	< 1000	< 1000	< 1000		23.1	292
3 QTR 4 1991	4.8		440	< 1000	< 1000	< 1000	< 1000		18.3	265
3 QTR 1 1992	4.6		424	< 1000	< 1000	< 1000	< 1000		19.4	277
3 QTR 2 1992	4.6		310	< 1000	< 1000	< 1000	< 1000		21.2	258
3 QTR 3 1992	5.8		360	< 1000	< 1000	< 1000	< 1000		22.5	235
3 QTR 4 1992	4.4		439	< 1000	< 1000	< 1000	< 1000		19.7	219
3 QTR 1 1993	4.9		421	1100	< 1000	< 1000	< 1000		18.6	329
3 QTR 2 1993	4.9		433	< 1000	< 1000	< 1000	< 1000		20.8	340
3 QTR 3 1993	4.6		396	< 1000	1200	< 1000	< 1000		20.5	282
3 QTR 4 1993	4.8		379	< 1000	< 1000	< 1000	< 1000		18.8	253
3 QTR 1 1994	5.0		442	< 1000	< 1000	< 1000	< 1000		19.2	267
3 QTR 2 1994	4.6		446	< 1000	< 1000	< 1000	< 1000		20.8	260
3 QTR 3 1994	4.4		408	2000	1700	1100	1500		22.3	251
3 QTR 4 1994	4.4		441	< 1000	< 1000	< 1000	< 1000		19.8	267
5 QTR 1 1986	17.36	7.89	415	< 1000	< 1000	< 1000	< 1000	< 20		
5 QTR 2 1986	18.80	7.41	380	< 1000	< 1000	< 1000	< 1000	< 20		
5 QTR 3 1986	18.72	7.52	400	< 1000	< 1000	< 1000	< 1000	< 20		
5 QTR 4 1986	20.00	7.60	390	< 1000	< 1000	< 1000	< 1000	< 20		
5 QTR 1 1987	20.91		410	< 1000	< 1000	< 1000	< 1000			
5 QTR 2 1987	19.84		440	< 1000	< 1000	< 1000	< 1000			
5 QTR 3 1987	20.38		427	< 1000	< 1000	< 1000	< 1000			
5 QTR 4 1987	19.31		375	< 1000	< 1000	< 1000	< 1000			
5 QTR 1 1988	20.289		429.2	< 1000	< 1000	< 1000	< 1000			
5 QTR 2 1988	18.234		397.8	< 1000	< 1000	< 1000	< 1000			
5 QTR 3 1988	NR		333	< 1000	< 1000	< 1000	< 1000			
5 QTR 4 1988	19.4		403	< 1000	< 1000	< 1000	< 1000			

TABLE 6

GROUNDWATER DATA ANALYSIS SUMMARY
CONVENTIONAL RESULTS - ONSITE WELLS

Well Number/ Report Date			NO3 (ppm)	pH	Specific Cond. (µmho/cm)	TOC (ppb) P1	TOC (ppb) P2	TOC (ppb) P3	TOC (ppb) P4	TOX	Temp (degC)	TDS (ppm)
5	QTR 1	1989	18.2		363.0	< 1000	< 1000	< 1000	< 1000			
5	QTR 2	1989	19.3		353.5	< 1000	< 1000	< 1000	< 1000			
5	QTR 3	1989	19.9		409.5	< 1000	< 1000	< 1000	< 1000			
5	QTR 4	1989	19.3		358.8	< 1000	< 1000	< 1000	< 1000			
5	QTR 1	1990	19.6		409	< 1000	< 1000	< 1000	< 1000		18	249
5	QTR 2	1990	19.4		434	< 1000	< 1000	< 1000	< 1000		21	252
5	QTR 3	1990	19.3		447	< 1000	< 1000	< 1000	< 1000		22	256
5	QTR 4	1990	19.9		332	< 1000	< 1000	< 1000	< 1000		19	263
5	QTR 1	1991	4.8		226	< 1000	< 1000	< 1000	< 1000		17.9	195
5	QTR 2	1991	4.4		388	< 1000	< 1000	< 1000	< 1000		19.6	255
5	QTR 3	1991	3.5		393	< 1000	< 1000	< 1000	< 1000		22.9	293
5	QTR 4	1991	4.3		404	< 1000	< 1000	< 1000	< 1000		17.6	267
5	QTR 1	1992	4.6		392	< 1000	< 1000	< 1000	< 1000		18.6	269
5	QTR 2	1992	4.3		300	1200	1100	< 1000	< 1000		20.0	258
5	QTR 3	1992	4.7		360	< 1000	< 1000	< 1000	< 1000		22.3	224
5	QTR 4	1992	4.3		435	< 1000	< 1000	< 1000	< 1000		18.8	123
5	QTR 1	1993	4.5		393	< 1000	< 1000	< 1000	1700		18.3	190
5	QTR 2	1993	4.1		424	< 1000	< 1000	< 1000	< 1000		20.9	348
5	QTR 3	1993	3.8		399	1300	< 1000	1300	< 1000		20.4	256
5	QTR 4	1993	3.9		379	< 1000	< 1000	< 1000	< 1000		18.7	255
5	QTR 1	1994	3.9		440	< 1000	< 1000	< 1000	< 1000		20.2	442
5	QTR 2	1994	3.9		420	< 1000	< 1000	< 1000	< 1000		20.1	282
5	QTR 3	1994	3.4		424	< 1000	1100	< 1000	< 1000		21.8	292
5	QTR 4	1994	3.7		436	< 1000	< 1000	< 1000	< 1000		18.3	275
8	QTR 1	1986	16.55	7.99	365	< 1000	< 1000	< 1000	< 1000	< 20		
8	QTR 2	1986	18.51	7.44	385	< 1000	< 1000	< 1000	< 1000	< 20		
8	QTR 3	1986	18.86	7.58	400	< 1000	< 1000	< 1000	< 1000	< 20		
8	QTR 4	1986	19.83	7.54	390	< 1000	< 1000	< 1000	< 1000	< 20		
8	QTR 1	1987	21.02		412	< 1000	< 1000	< 1000	< 1000			
8	QTR 2	1987	19.80		438	< 1000	< 1000	< 1000	< 1000			
8	QTR 3	1987	21.04		401	< 1000	< 1000	< 1000	< 1000			
8	QTR 4	1987	19.53		382	< 1000	< 1000	< 1000	< 1000			
8	QTR 1	1988	20.597		436.5	< 1000	< 1000	< 1000	< 1000			
8	QTR 2	1988	18.122		409.0	< 1000	< 1000	< 1000	< 1000			
8	QTR 3	1988	NR		354	< 1000	< 1000	< 1000	< 1000			
8	QTR 4	1988	19.8		401	< 1000	< 1000	< 1000	< 1000			
8	QTR 1	1989	18.9		349.8	< 1000	< 1000	< 1000	< 1000			
8	QTR 2	1989	19.8		368.8	< 1000	< 1000	< 1000	< 1000			
8	QTR 3	1989	20.3		406.3	< 1000	< 1000	< 1000	< 1000			
8	QTR 4	1989	19.8		371.8	< 1000	< 1000	< 1000	< 1000			
8	QTR 1	1990	20.1		398	< 1000	< 1000	< 1000	< 1000		19	260
8	QTR 2	1990	25.6		436	< 1000	< 1000	< 1000	< 1000		20	265
8	QTR 3	1990	19.7		450	< 1000	< 1000	< 1000	< 1000		23	258
8	QTR 4	1990	19.8		356	< 1000	< 1000	< 1000	< 1000		19	266
8	QTR 1	1991	4.8		256	< 1000	< 1000	< 1000	< 1000		18.9	177
8	QTR 2	1991	4.6		398	< 1000	< 1000	< 1000	< 1000		19.6	279
8	QTR 3	1991	3.6		404	< 1000	< 1000	< 1000	< 1000		22.2	288
8	QTR 4	1991	4.5		427	< 1000	< 1000	< 1000	< 1000		19.8	269

TABLE 6

GROUNDWATER DATA ANALYSIS SUMMARY
CONVENTIONAL RESULTS - ONSITE WELLS

Well Number/ Report Date			NO3 (ppm)	pH	Specific Cond. (µmho/cm)	TOC (ppb) P1	TOC (ppb) P2	TOC (ppb) P3	TOC (ppb) P4	TOX	Temp (degC)	TDS (ppm)
8	QTR 1	1992	4.1		388	< 1000	< 1000	< 1000	< 1000		19.4	275
8	QTR 2	1992	4.2		300	< 1000	< 1000	1600	< 1000		21.1	255
8	QTR 3	1992	5.1		360	1300	1700	1200	1200		23.1	232
8	QTR 4	1992	4.3		430	< 1000	< 1000	< 1000	< 1000		18.0	216
8	QTR 1	1993	6.1		402	< 1000	< 1000	< 1000	< 1000		19.0	225
8	QTR 2	1993	4.4		423	< 1000	< 1000	< 1000	< 1000		21.1	352
8	QTR 3	1993	4.2		441	1200	1400	< 1000	< 1000		20.7	350
8	QTR 4	1993	4.1		371	< 1000	< 1000	< 1000	< 1000		19.3	268
8	QTR 1	1994	4.1		425	< 1000	< 1000	< 1000	< 1000		20.7	241
8	QTR 2	1994	4.3		436	< 1000	< 1000	< 1000	< 1000		20.8	256
8	QTR 3	1994	3.8		419	< 1000	< 1000	< 1000	< 1000		22.4	279
8	QTR 4	1994	4.0		446	< 1000	< 1000	1200	< 1000		19.5	262
10	QTR 1	1986	14.37	7.86	390	< 1000	< 1000	< 1000	< 1000	< 20		
10	QTR 2	1986	16.40	7.42	380	< 1000	< 1000	< 1000	< 1000	< 20		
10	QTR 3	1986	16.22	7.49	385	< 1000	< 1000	< 1000	< 1000	< 20		
10	QTR 4	1986	16.71	7.50	375	< 1000	< 1000	< 1000	< 1000	< 20		
10	QTR 1	1987	17.80		395	< 1000	< 1000	< 1000	< 1000			
10	QTR 2	1987	16.96		427	< 1000	< 1000	< 1000	< 1000			
10	QTR 3	1987	17.86		396	< 1000	< 1000	< 1000	< 1000			
10	QTR 4	1987	17.13		375	< 1000	< 1000	< 1000	< 1000			
10	QTR 1	1988	17.463		428.8	< 1000	< 1000	< 1000	< 1000			
10	QTR 2	1988	15.833		391.0	< 1000	< 1000	< 1000	< 1000			
10	QTR 3	1988	NR		339	< 1000	< 1000	< 1000	< 1000			
10	QTR 4	1988	16.9		397	< 1000	< 1000	< 1000	< 1000			
10	QTR 1	1989	16.0		363.8	< 1000	< 1000	< 1000	< 1000			
10	QTR 2	1989	16.8		350.0	< 1000	< 1000	< 1000	< 1000			
10	QTR 3	1989	17.1		375.8	< 1000	< 1000	< 1000	< 1000			
10	QTR 4	1989	NR		358.5	< 1000	< 1000	< 1000	< 1000			
10	QTR 1	1990	17.1		396	< 1000	< 1000	< 1000	< 1000		18	253
10	QTR 2	1990	17.1		425	< 1000	< 1000	< 1000	< 1000		20	226
10	QTR 3	1990	16.8		439	< 1000	< 1000	< 1000	< 1000		22	251
10	QTR 4	1990	16.8		345	< 1000	< 1000	< 1000	< 1000		19	260
10	QTR 1	1991	4.2		212	< 1000	< 1000	< 1000	< 1000		19.1	178
10	QTR 2	1991	3.9		385	< 1000	2400	< 1000	< 1000		20.0	267
10	QTR 3	1991	3.2		404	< 1000	< 1000	< 1000	< 1000		22.5	283
10	QTR 4	1991	3.6		392	< 1000	< 1000	< 1000	< 1000		19.1	259
10	QTR 1	1992	4.3		403	< 1000	< 1000	< 1000	< 1000		18.0	278
10	QTR 2	1992	4.0		300	< 1000	3400	< 1000	1900		21.5	270
10	QTR 3	1992	2.0		350	< 1000	< 1000	< 1000	< 1000		21.4	209
10	QTR 4	1992	3.7		428	< 1000	< 1000	< 1000	< 1000		18.7	224
10	QTR 1	1993	4.7		397	< 1000	1100	< 1000	< 1000		17.8	318
10	QTR 2	1993	3.8		421	< 1000	< 1000	< 1000	< 1000		20.6	342
10	QTR 3	1993	3.6		452	1000	1100	< 1000	1200		20.7	263
10	QTR 4	1993	3.5		375	< 1000	< 1000	< 1000	< 1000		18.0	255
10	QTR 1	1994	3.7		427	< 1000	< 1000	< 1000	< 1000		18.3	261
10	QTR 2	1994	3.6		423	< 1000	< 1000	< 1000	< 1000		20.2	264
10	QTR 3	1994	3.2		416	< 1000	< 1000	< 1000	< 1000		22.4	294
10	QTR 4	1994	3.9		436	< 1000	1200	< 1000	1100		18.9	274

TABLE 6

GROUNDWATER DATA ANALYSIS SUMMARY
CONVENTIONAL RESULTS - ONSITE WELLS

Well Number/ Report Date	NO3 (ppm)	pH	Specific Cond. (µmho/cm)	TOC (ppb) P1	TOC (ppb) P2	TOC (ppb) P3	TOC (ppb) P4	TOX	Temp (degC)	TDS (ppm)
13 QTR 1 1986	17.47	7.94	370	< 1000	< 1000	< 1000	< 1000	< 20		
13 QTR 2 1986	19.76	7.43	380	< 1000	< 1000	< 1000	< 1000	< 20		
13 QTR 3 1986	20.69	7.61	410	< 1000	< 1000	< 1000	< 1000	< 20		
13 QTR 4 1986	23.65	7.57	385	< 1000	< 1000	< 1000	< 1000	< 20		
13 QTR 1 1987	22.27		408	< 1000	< 1000	< 1000	< 1000			
13 QTR 2 1987	21.02		417	< 1000	< 1000	< 1000	< 1000			
13 QTR 3 1987	22.08		373	< 1000	< 1000	< 1000	< 1000			
13 QTR 4 1987	22.32		376	< 1000	< 1000	< 1000	< 1000			
13 QTR 1 1988	21.452		425.9	< 1000	< 1000	< 1000	< 1000			
13 QTR 2 1988	19.364		394.0	< 1000	< 1000	< 1000	< 1000			
13 QTR 3 1988	NR		343	< 1000	< 1000	< 1000	< 1000			
13 QTR 4 1988	20.8		395	< 1000	< 1000	< 1000	< 1000			
13 QTR 1 1989	19.9		331.8	< 1000	< 1000	< 1000	< 1000			
13 QTR 2 1989	20.8		361.5	< 1000	< 1000	< 1000	< 1000			
13 QTR 3 1989	21.4		387.5	< 1000	< 1000	< 1000	< 1000			
13 QTR 4 1989	17.1		353.8	< 1000	< 1000	< 1000	< 1000			
13 QTR 1 1990	20.9		408	< 1000	< 1000	< 1000	< 1000		19	251
13 QTR 2 1990	20.6		429	< 1000	< 1000	< 1000	< 1000		20	262
13 QTR 3 1990	20.5		439	< 1000	< 1000	< 1000	< 1000		23	265
13 QTR 4 1990	21.1		305	< 1000	< 1000	< 1000	< 1000		19	232
13 QTR 1 1991	4.8		212	< 1000	< 1000	< 1000	< 1000		19.0	178
13 QTR 2 1991	4.7		377	< 1000	< 1000	< 1000	< 1000		19.8	271
13 QTR 3 1991	3.8		404	< 1000	< 1000	< 1000	< 1000		22.4	290
13 QTR 4 1991	4.6		404	< 1000	< 1000	< 1000	< 1000		19.6	255
13 QTR 1 1992	3.7		397	< 1000	< 1000	< 1000	< 1000		19.3	287
13 QTR 2 1992	4.9		300	< 1000	< 1000	< 1000	1300		20.8	266
13 QTR 3 1992	4.5		350	< 1000	< 1000	< 1000	< 1000		21.7	202
13 QTR 4 1992	4.4		429	< 1000	< 1000	< 1000	< 1000		19.5	228
13 QTR 1 1993	5.2		400	< 1000	< 1000	< 1000	< 1000		18.2	278
13 QTR 2 1993	4.5		424	< 1000	< 1000	< 1000	< 1000		20.7	141
13 QTR 3 1993	4.4		394	1600	< 1000	1100	< 1000		20.6	264
13 QTR 4 1993	4.2		365	< 1000	< 1000	< 1000	< 1000		18.8	259
13 QTR 1 1994	4.3		406	< 1000	< 1000	< 1000	< 1000		19.9	379
13 QTR 2 1994	4.3		419	< 1000	< 1000	< 1000	< 1000		19.9	243
13 QTR 3 1994	4.0		414	< 1000	< 1000	< 1000	< 1000		21.2	295
13 QTR 4 1994	4.3		438	1000	< 1000	< 1000	< 1000		18.4	261

Notes:
Well 13 is an upgradient well.
Specific conductivity is the average value obtained from four split samples from each well for years 1987-1990.
NR signifies results were not reported.
Source: US Ecology 1987 - 1995.

TABLE 7

APPENDIX IX GROUNDWATER DATA ANALYSIS SUMMARY
ONSITE WELLS 10 AND 13

	WELL 10 4G-10 11/17/93	WELL 13 3G-13 09/27/93
VOLATILES (µg/L) (Method EPA SW846-8240)		
Chloromethane	10 ND	10 ND
Bromomethane	10 ND	10 ND
Vinyl chloride	10 ND	10 ND
Chloroethane	10 ND	10 ND
Methylene chloride	5 ND	16 [a]
Acetone	10 ND	5 J
Carbon Disulfide	5 ND	5 ND
1,1-Dichloroethene	5 ND	5 ND
1,1-Dichloroethane	5 ND	5 ND
Total-1,2-Dichloroethene	5 ND	5 ND
Chloroform	5 ND	5 ND
1,2-Dichloroethane	5 ND	5 ND
2-Butanone	10 ND	10 ND
1,1,1-Trichloroethane	5 ND	5 ND
Carbon tetrachloride	5 ND	5 ND
Vinyl acetate	10 ND	10 ND
Bromodichloromethane	5 ND	5 ND
1,1,2,2-Tetrachloroethane	5 ND	5 ND
1,2-Dichloropropane	5 ND	5 ND
trans-1,3-Dichloropropene	5 ND	5 ND
Trichloroethene	5 ND	5 ND
Dibromochloromethane	5 ND	5 ND
1,1,2-Trichloroethane	5 ND	5 ND
Benzene	5 ND	5 ND
cis-1,3-Dichloropropene	5 ND	5 ND
2-Chloroethyl vinyl ether	10 ND	10 ND
Bromoform	5 ND	5 ND
2-Hexanone	10 ND	10 ND
4-Methyl-2-Pentanone	10 ND	10 ND
Tetrachloroethene	5 ND	5 ND
Toluene	5 ND	5 ND
Chlorobenzene	5 ND	5 ND
Ethylbenzene	5 ND	5 ND
Styrene	5 ND	5 ND
Total Xylenes	5 ND	5 ND
Acrolein	50 ND	50 ND
Methyl Iodide	5 ND	5 ND
Alkyl Chloride	5 ND	5 ND
Chloroprene	5 ND	5 ND
trans-1,4-Dichloro-2-butene	5 ND	5 ND
Pentachloroethane	5 ND	5 ND
Acetonitrile	100 ND	100 ND
Acrylonitrile	50 ND	50 ND
Propronitrile	10 ND	10 ND
Methacrylonitrile	50 ND	50 ND
Isobutyl alcohol	100 ND	100 ND
1,4-Dioxane	500 ND	500 ND
Methyl methacrylate	5 ND	5 ND
Pyridine	100 ND	100 ND
Ethyl methacrylate	5 ND	5 ND

TABLE 7

APPENDIX IX GROUNDWATER DATA ANALYSIS SUMMARY
ONSITE WELLS 10 AND 13

	WELL 10 4G-10 11/17/93	WELL 13 3G-13 09/27/93
1,2-Dibromoethane	5 ND	5 ND
1,1,1,2-Tetrachloroethane	5 ND	5 ND
1,2,3-Trichloropropane	5 ND	5 ND
Dichlorodifluoromethane	5 ND	5 ND
Trichlorofluoromethane	5 ND	5 ND
Dibromomethane	10 ND	10 ND
SEMIVOLATILES (µg/L) (Method EPA SW846-8270)		
Phenol	10 ND	10 ND
Bis(2-chloroethyl)ether	10 ND	10 ND
2-Chlorophenol	10 ND	10 ND
1,3-Dichlorobenzene	10 ND	10 ND
1,4-Dichlorobenzene	10 ND	10 ND
Benzyl alcohol	10 ND	10 ND
1,2-Dichlorobenzene	10 ND	10 ND
2-Methylphenol	10 ND	10 ND
Bis(2-chloroisopropyl)ether	10 ND	10 ND
4-/3-Methylphenol	10 ND	10 ND
N-nitrosodi-n-propylamine	10 ND	10 ND
Hexachloroethane	10 ND	10 ND
Nitrobenzene	10 ND	10 ND
Isophorone	10 ND	10 ND
2-Nitrophenol	10 ND	10 ND
2,4-Dimethylphenol	10 ND	10 ND
Benzoic acid	50 ND	50 ND
Bis(2-chloroethoxy)methane	10 ND	10 ND
2,4-Dichlorophenol	10 ND	10 ND
1,2,4-Trichlorobenzene	10 ND	10 ND
Naphthalene	10 ND	10 ND
4-Chloroaniline	10 ND	10 ND
Hexachlorobutadiene	10 ND	10 ND
4-Chloro-3-methylphenol	10 ND	10 ND
2-Methylnaphthalene	10 ND	10 ND
Hexachlorocyclopentadiene	10 ND	10 ND
2,4,6-Trichlorophenol	10 ND	10 ND
2,4,5-Trichlorophenol	50 ND	50 ND
2-Chloronaphthalene	10 ND	10 ND
2-Nitroaniline	50 ND	50 ND
Dimethyl phthalate	10 ND	10 ND
Acenaphthylene	10 ND	10 ND
3-Nitroanilne	50 ND	50 ND
Acenaphthene	10 ND	10 ND
2,4-Dinitrophenol	50 ND	50 ND
4-Nitrophenol	50 ND	50 ND
Dibenzofuran	10 ND	10 ND
2,4-Dinitrotoluene	10 ND	10 ND
2,6-Dinitrotoluene	10 ND	10 ND
Diethyl phthalate	10 ND	10 ND
4-Chlorophenyl phenyl ether	10 ND	10 ND
Fluorene	10 ND	10 ND
4-Nitroaniline	50 ND	50 ND
4,6-Dinitro-2-methylphenol	50 ND	50 ND

TABLE 7

APPENDIX IX GROUNDWATER DATA ANALYSIS SUMMARY
ONSITE WELLS 10 AND 13

	WELL 10 4G-10 11/17/93	WELL 13 3G-13 09/27/93
N-nitrosodiphenylamine	10 ND	10 ND
4-Bromophenyl phenyl ether	10 ND	10 ND
Hexachlorobenzene	10 ND	10 ND
Pentachlorophenol	10 ND	10 ND
Phenanthrene	10 ND	10 ND
Anthracene	10 ND	10 ND
Di-n-butylphthalate	10 ND	10 ND
Fluoranthene	10 ND	10 ND
Pyrene	10 ND	10 ND
Butyl benzyl phthalate	10 ND	10 ND
3,3-Dichlorobenzidine	20 ND	20 ND
Benzo(a)anthracene	10 ND	10 ND
Bis(2-ethylhexyl)phthalate	10 ND	10 ND
Chrysene	10 ND	10 ND
Di-n-octyl phthalate	10 ND	10 ND
Benzo(b)fluoranthene	10 ND	10 ND
Benzo(k)fluoranthene	10 ND	10 ND
Benzo(a)pyrene	10 ND	10 ND
Indeno(1,2,3-cd)pyrene	10 ND	10 ND
Dibenz(a,h)anthracene	10 ND	10 ND
Benzo(g,h,i)perylene	10 ND	10 ND
Parathion	20 ND	20 ND
Ethyl methanesulfonate	10 ND	10 ND
P-Phenylenediamine	10 ND	10 ND
N-nitrosodiethylamine	10 ND	10 ND
N-nitrosomethylethylamine	10 ND	10 ND
N-nitrosodibutylamine	10 ND	10 ND
N-nitrosopiperidine	10 ND	10 ND
5-Nitro-o-toluidine	10 ND	10 ND
Methyl yellow	10 ND	10 ND
Methyl parathion	10 ND	10 ND
Safrole	20 ND	20 ND
Isosafrole	20 ND	20 ND
2-Picoline	10 ND	10 ND
Phenacetin	10 ND	10 ND
O-Toluidine	10 ND	10 ND
3,3-Dimethylbenzidine	50 ND	50 ND
1,3-Dinitrobenzene	10 ND	10 ND
A,A-Dimethylphenethylamine	10 ND	10 ND
O,O,O-Triethylphosphorothioate	10 ND	10 ND
Methapyrilene hydrochloride	20 ND	20 ND
Diallate	20 ND	20 ND
1,3,5-Trinitrobenzene	100 ND	100 ND
Famphur	10 ND	10 ND
4-Nitroquinoline-n-oxide	100 ND	100 ND
1,2,3,5-Tetrachlorobenzene	10 ND	10 ND
Pentachloronitrobenzene	10 ND	10 ND
Phorate	10 ND	10 ND
7,12-Dimethyl benz(a)anthracene	10 ND	10 ND
N-Nitrosodimethylamine	10 ND	10 ND
2,3,4,6-Tetrachlorophenol	10 ND	10 ND

TABLE 7

APPENDIX IX GROUNDWATER DATA ANALYSIS SUMMARY
ONSITE WELLS 10 AND 13

	WELL 10 4G-10 11/17/93	WELL 13 3G-13 09/27/93
Chlorobenzilate	10 ND	10 ND
Thionazin	20 ND	20 ND
Disulfoton	10 ND	10 ND
Isodrin	100 ND	100 ND
N-Nitrosomorpholine	10 ND	10 ND
Pentachlorobenzene	10 ND	10 ND
4-Aminobiphenyl	10 ND	10 ND
Hexachloropropene	10 ND	10 ND
2,6-Dichlorophenol	10 ND	10 ND
Sulfotepp	10 ND	10 ND
Methyl methanesulfonate	10 ND	10 ND
1,4-Naphthaquinone	10 ND	10 ND
N-Nitrosopyrollidine	10 ND	10 ND
Acetophenone	10 ND	10 ND
Dimethoate	10 ND	10 ND
3-Methyl cholanthrene	10 ND	10 ND
2-Acetylaminofluorene	10 ND	10 ND
Aniline	50 ND	50 ND
1,2-Dibromo-3-chloropropane	10 ND	10 ND
Hexachlorophene	10 ND	10 ND
Kepone	50 ND	50 ND
1-Naphthylamine	10 ND	10 ND
2-Naphthylamine	10 ND	10 ND
Pronamide	50 ND	50 ND
Aramite	100 ND	100 ND
PESTICIDES/PCBs (µg/L) (Method EPA SW846-8080)		
Alpha-BHC	0.05 ND	0.05 ND
Beta-BHC	0.05 ND	0.05 ND
Delta-BHC	0.05 ND	0.05 ND
Gamma-BHC (Lindane)	0.05 ND	0.05 ND
Heptachlor	0.05 ND	0.05 ND
Aldrin	0.05 ND	0.05 ND
Heptachlor epoxide	0.05 ND	0.05 ND
Endosulfan I	0.05 ND	0.05 ND
Dieldrin	0.1 ND	0.1 ND
4,4-DDE	0.1 ND	0.1 ND
Endrin	0.1 ND	0.1 ND
Endosulfan II	0.1 ND	0.1 ND
4,4-DDD	0.1 ND	0.1 ND
Endosulfan sulfate	0.1 ND	0.1 ND
4,4-DDT	0.1 ND	0.1 ND
Endrin ketone	0.1 ND	0.1 ND
Endrin aldehyde	0.1 ND	0.1 ND
Methoxychlor	0.5 ND	0.5 ND
Alpha-chlordane	0.05 ND	0.05 ND
Gamma-chlordane	0.05 ND	0.05 ND
Toxaphene	5.0 ND	5.0 ND
Arochlor-1016	1.0 ND	1.0 ND
Arochlor-1221	2.0 ND	2.0 ND
Arochlor-1232	1.0 ND	1.0 ND
Arochlor-1242	1.0 ND	1.0 ND
Arochlor-1248	1.0 ND	1.0 ND
Arochlor-1254	1.0 ND	1.0 ND
Arochlor-1260	1.0 ND	1.0 ND

TABLE 7

APPENDIX IX GROUNDWATER DATA ANALYSIS SUMMARY
ONSITE WELLS 10 AND 13

	WELL 10 4G-10 11/17/93	WELL 13 3G-13 09/27/93
ORGANOPHOSPHOROUS PESTICIDES (µg/L) (Method EPA SW846-8140)		
Dichlorvos	2.9 ND	5.8 ND
Mevinphos	4.1 ND	8.2 ND
Demeton S	3.1 ND	6.2 ND
Ethoprop	3.5 ND	7.0 ND
Naled	4.6 ND	9.2 ND
Phorate	2.0 ND	4.0 ND
Diazinon	4.5 ND	9.0 ND
Disulfuton	3.7 ND	7.4 ND
Methyl parathion	0.50 ND	1.00 ND
Ronnel	3.8 ND	7.6 ND
Fenthion	1.4 ND	2.8 ND
Chloropyrifos	4.1 ND	8.2 ND
Trichloroanate	2.1 ND	4.2 ND
Stirophos	17 ND	34 ND
Tokuthion	3.6 ND	7.2 ND
Merphos	5.9 ND	11.8 ND
Fensulfothion	10 ND	20 ND
Bolstar	2.2 ND	4.4 ND
Azinphos methyl	6.8 ND	13.6 ND
Coumaphos	12 ND	24 ND
HERBICIDES (µg/L) (Method EPA SW846-8150)		
2-4-D	1.0 ND	0.2 ND
2,4,5-TP (Silvex)	1.0 ND	0.2 ND
2,4,5-T	1.0 ND	0.2 ND
METALS (mg/L)		
Antimony (ICP)	0.05 ND	0.05 ND
Barium (ICP)	0.04	0.04
Beryllium (ICP)	0.001 ND	0.001 ND
Cadmium (ICP)	0.005 ND	0.005 ND
Chromium (ICP)	0.04	0.08
Cobalt (ICP)	0.01 ND	0.02 ND
Copper (ICP)	0.01 ND	0.01 ND
Nickel (ICP)	0.01 ND	0.01 ND
Silver (ICP)	0.01 ND	0.005 ND
Tin (ICP)	0.01 ND	1.0 ND
Vanadium (ICP)	0.02 ND	0.03
Zinc (ICP)	0.005 ND	0.005
Arsenic (SW 7060)	0.010 ND	0.010 ND
Lead (SW 7421)	0.01 ND	0.016
Mercury (SW 7470/7471)	0.0002 ND	0.0002 ND
Selenium (SW 7740)	0.005 ND	0.005 ND
Thallium (SW 7841)	0.01 ND	0.010 ND
DIOXINS (ng/L) (Method EPA SW846-8280)		
Total Tetra CDD	0.851 ND	1.5 ND
Total Penta CDD	3.263 ND	3.2 ND
Total Hexa CDD	1.860 ND	3.4 ND
Total Hepta CDD	1.132 ND	6.1 ND
Total Octa CDD	3.931 ND	10.2 ND

TABLE 7

APPENDIX IX GROUNDWATER DATA ANALYSIS SUMMARY ONSITE WELLS 10 AND 13

	WELL 10 4G-10 11/17/93	WELL 13 3G-13 09/27/93
DIBENZOFURANS (ng/L) (Method EPA SW846-8280)		
Total Tetra CDF	1.434 ND	2.3 ND
Total Penta CDF	1.258 ND	1.7 ND
Total Hexa CDF	0.641 ND	1.2 ND
Total Hepta CDF	0.805 ND	1.5 ND
Total Octa CDF	1.810 ND	3.1 ND
TOTAL CYANIDE (mg/L) (Method SM 412D)	0.01 ND	0.1 ND
TOTAL SULFIDE (mg/L) (Method SM427D)	0.01 ND	

(a) Field blank indicated presence of MEK.
ND Not detected above quantitation limit.
J Estimated value: concentration below limit of quantitation.
Source: American Analytical & Technical Services 1993a and 1993b.

TABLE 8

SOIL DATA ANALYSIS SUMMARY

Sample Description:	SHSO-618	SHSO-622	SHSO-623	SHSO-619	SHSO-620,621	SHSO-624	SHSO-625	SHSO-626
	47-49 ft	52-54 ft	57-59 ft	62-64 ft	67-69 ft	72-74 ft	77-79 ft	82-84 ft
Sample Number:	154017	154020	154021	154018	154019	154022	154023	154024
Date Collected:	11/17/91	11/17/91	11/17/91	11/17/91	11/17/91	11/17/91	11/17/91	11/17/91
Well VW-100								
Total Solids (percent)	96.13	98.82	88.73	95.03	80.74	97.66	96.82	98.56
Volatile Organic Compounds (µg/kg) (8240 Nonaqueous)								
Acrolein	NT	NT	NT	NT	NT	NT	NT	NT
Acrylonitrile	NT	NT	NT	NT	NT	NT	NT	NT
Benzene	NT	NT	NT	NT	NT	NT	NT	NT
Bromodichloromethane	NT	NT	NT	NT	NT	NT	NT	NT
Bromoform	NT	NT	NT	NT	NT	NT	NT	NT
Bromomethane	NT	NT	NT	NT	NT	NT	NT	NT
Carbon tetrachloride	NT	NT	NT	NT	NT	NT	NT	NT
Chlorobenzene	NT	NT	NT	NT	NT	NT	NT	NT
Chloroethane	NT	NT	NT	NT	NT	NT	NT	NT
2-Chloroethylvinylether	NT	NT	NT	NT	NT	NT	NT	NT
Chloroform	NT	NT	NT	NT	NT	NT	NT	NT
Chloromethane	NT	NT	NT	NT	NT	NT	NT	NT
Dibromochloromethane	NT	NT	NT	NT	NT	NT	NT	NT
1,2-Dichlorobenzene	NT	NT	NT	NT	NT	NT	NT	NT
1,3-Dichlorobenzene	NT	NT	NT	NT	NT	NT	NT	NT
1,4-Dichlorobenzene	NT	NT	NT	NT	NT	NT	NT	NT
1,1-Dichloroethane	NT	NT	NT	NT	NT	NT	NT	NT
1,2-Dichloroethane	NT	NT	NT	NT	NT	NT	NT	NT
1,1-Dichloroethene	NT	NT	NT	NT	NT	NT	NT	NT
trans-1,2-Dichloroethene	NT	NT	NT	NT	NT	NT	NT	NT
cis-1,2-Dichloroethene	NT	NT	NT	NT	NT	NT	NT	NT
1,2-Dichloropropane	NT	NT	NT	NT	NT	NT	NT	NT
cis-1,3-Dichloropropene	NT	NT	NT	NT	NT	NT	NT	NT
trans-1,3-Dichloropropene	NT	NT	NT	NT	NT	NT	NT	NT
Ethylbenzene	NT	NT	NT	NT	NT	NT	NT	NT
Methylene chloride	NT	NT	NT	NT	NT	NT	NT	NT
1,1,2,2-Tetrachloroethane	NT	NT	NT	NT	NT	NT	NT	NT
Tetrachloroethene	NT	NT	NT	NT	NT	NT	NT	NT
Toluene	NT	NT	NT	NT	NT	NT	NT	NT
1,1,1-Trichloroethane	NT	NT	NT	NT	NT	NT	NT	NT
1,1,2-Trichloroethane	NT	NT	NT	NT	NT	NT	NT	NT
Trichloroethene	NT	NT	NT	NT	NT	NT	NT	NT
Trichlorofluoromethane	NT	NT	NT	NT	NT	NT	NT	NT
Vinyl chloride	NT	NT	NT	NT	NT	NT	NT	NT
Xylenes, Total	NT	NT	NT	NT	NT	NT	NT	NT
BETX (µg/kg) (8020 Nonaqueous)								
Benzene	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Chlorobenzene	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
1,2-Dichlorobenzene	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
1,3-Dichlorobenzene	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Ethylbenzene	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Toluene	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Xylenes, Total	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
MTBE	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10

TABLE 8

SOIL DATA ANALYSIS SUMMARY

Sample Description:	SHSO-611 25-27 ft	SHSO-612 30-32 ft	SHSO-613 35-37 ft	SHSO-614 40-42 ft	SHSO-615 45-47 ft	SHSO-616 50-52 ft	SHSO-617 55-57 ft
Sample Number:	154010	154011	154012	154013	154014	154015	154016
Date Collected:	11/15/91	11/15/91	11/15/91	11/15/91	11/16/91	11/16/91	11/16/91
Well VW-101							
Total Solids (percent)	95.51	95.56	98.36	96.51	78.54	86.02	83.28
Volatile Organic Compounds (µg/kg) (8240 Nonaqueous)							
Acrolein	< 50	< 50	< 50	< 50	NT	NT	NT
Acrylonitrile	< 50	< 50	< 50	< 50	NT	NT	NT
Benzene	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
Bromodichloromethane	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
Bromoform	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
Bromomethane	< 50	< 50	< 50	< 50	NT	NT	NT
Carbon tetrachloride	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
Chlorobenzene	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
Chloroethane	< 50	< 50	< 50	< 50	NT	NT	NT
2-Chloroethylvinylether	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
Chloroform	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
Chloromethane	< 50	< 50	< 50	< 50	NT	NT	NT
Dibromochloromethane	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
1,2-Dichlorobenzene	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
1,3-Dichlorobenzene	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
1,4-Dichlorobenzene	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
1,1-Dichloroethane	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
1,2-Dichloroethane	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
1,1-Dichloroethene	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
trans-1,2-Dichloroethene	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
cis-1,2-Dichloroethene	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
1,2-Dichloropropane	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
cis-1,3-Dichloropropene	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
trans-1,3-Dichloropropene	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
Ethylbenzene	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
Methylene chloride	< 25	< 25	< 25	< 25	NT	NT	NT
1,1,2,2-Tetrachloroethane	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
Tetrachloroethene	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
Toluene	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
1,1,1-Trichloroethane	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
1,1,2-Trichloroethane	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
Trichloroethene	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
Trichlorofluoromethane	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
Vinyl chloride	< 50	< 50	< 50	< 50	NT	NT	NT
Xylenes, Total	< 5.0	< 5.0	< 5.0	< 5.0	NT	NT	NT
BETX (µg/kg) (8020 Nonaqueous)							
Benzene	NT	NT	NT	NT	< 2.0	< 2.0	< 2.0
Chlorobenzene	NT	NT	NT	NT	< 2.0	< 2.0	< 2.0
1,2-Dichlorobenzene	NT	NT	NT	NT	< 2.0	< 2.0	< 2.0
1,3-Dichlorobenzene	NT	NT	NT	NT	< 2.0	< 2.0	< 2.0
Ethylbenzene	NT	NT	NT	NT	< 2.0	< 2.0	< 2.0
Toluene	NT	NT	NT	NT	< 2.0	< 2.0	< 2.0
Xylenes, Total	NT	NT	NT	NT	< 2.0	< 2.0	< 2.0
MTBE	NT	NT	NT	NT	< 10	< 10	< 10

TABLE 8

SOIL DATA ANALYSIS SUMMARY

Sample Description:	SHSO-627	SHSO-628	SHSO-629	SHSO-630	SHSO-631,632	SHSO-631,632	SHSO-633	SHSO-634	SHSO-635
	33-35 ft	38-40 ft	43-45 ft	48-52 ft	53-55 ft	53-55 ft Dup	58-63 ft	63-65 ft	68-70 ft
Sample Number:	154025	154026	154027	154028	154029	154030	154031	154032	154033
Date Collected:	11/14/91	11/14/91	11/14/91	11/14/91	11/14/91	11/14/91	11/14/91	11/14/91	11/14/91
Well VW-102									
Total Solids (percent)	98.88	98.44	99.06	99.26	99.34	99.44	98.94	99.25	99.21
Volatile Organic Compounds (µg/kg) (8240 Nonaqueous)									
Acrolein	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Acrylonitrile	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Benzene	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Bromodichloromethane	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Bromoform	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Bromomethane	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Carbon tetrachloride	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Chlorobenzene	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Chloroethane	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
2-Chloroethylvinylether	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Chloroform	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Chloromethane	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Dibromochloromethane	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,2-Dichlorobenzene	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,3-Dichlorobenzene	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,4-Dichlorobenzene	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1-Dichloroethane	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,2-Dichloroethane	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1-Dichloroethene	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
trans-1,2-Dichloroethene	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
cis-1,2-Dichloroethene	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,2-Dichloropropane	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
cis-1,3-Dichloropropene	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
trans-1,3-Dichloropropene	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Ethylbenzene	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Methylene chloride	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25
1,1,2,2-Tetrachloroethane	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Tetrachloroethene	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Toluene	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1,1-Trichloroethane	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1,2-Trichloroethane	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Trichloroethene	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Trichlorofluoromethane	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Vinyl chloride	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Xylenes, Total	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
BETX (µg/kg) (8020 Nonaqueous)									
Benzene	NT	NT	NT	NT	NT	NT	NT	NT	NT
Chlorobenzene	NT	NT	NT	NT	NT	NT	NT	NT	NT
1,2-Dichlorobenzene	NT	NT	NT	NT	NT	NT	NT	NT	NT
1,3-Dichlorobenzene	NT	NT	NT	NT	NT	NT	NT	NT	NT
Ethylbenzene	NT	NT	NT	NT	NT	NT	NT	NT	NT
Toluene	NT	NT	NT	NT	NT	NT	NT	NT	NT
Xylenes, Total	NT	NT	NT	NT	NT	NT	NT	NT	NT
MTBE	NT	NT	NT	NT	NT	NT	NT	NT	NT

All results are reported on a dry weight basis.
NT = Not tested.
Source: National Environmental Testing, Inc. 1991.

TABLE 9

PHASE 1 SAMPLING AND ANALYTICAL METHODS[a]

Matrix	Location	Analysis[b]
Soil gas	VW-100, VW-101, VW-102	Volatile organics (EPA TO-14)
Groundwater	5 existing plus 1 or 2 new wells	Volatile organics (EPA 8240)
		Metals (including barium, chromium, lead, vanadium) (EPA 6010/7000)

(a) Samples will be collected during the next regularly scheduled quarterly monitoring event following the installation of the required additional groundwater monitoring wells.

(b) The analyses listed will be added to those specified in the next quarterly monitoring event.

TABLE 10

PHASE 2 SAMPLING SUMMARY

Matrix	Location	Type of Boring	Number of Samples per Boring[a]	Analysis
Water	Driller's water	Vertical	At least 1	Volatile organics and tritium
Soil	Chemical trench and trench 5	Angled	Up to 3	Appendix IX analyses
			Up to 3	Radiological (uranium, radium, tritium, gross alpha, gross beta, gamma isotopic)
		Vertical	Up to 9[b]	Volatile organics
			4	Total organic carbon and physical parameters (unit weight, particle size distribution, and water content)
			2	Temperature
			Continuous sampling	Field screening using PID meter and GM detector
Soil gas	Chemical trench and trench 5	Vertical	4	Volatile organics
			4	Methane plus fixed gases (carbon dioxide, methane, nitrogen, and oxygen)
			4	Tritium and radon
			4	Total pressure (field measurement)

(a) Number of samples listed does not include field QC samples, which are described in Appendix C, or samples obtained for other than chemical analyses.

(b) Additional samples will be analyzed for volatile organics, if significant detections occur during field screening.

TABLE 11

PHASE 2 ANALYTICAL METHODS

Sample Matrix	Analysis	Method No.[a]
Water	Volatile organics	EPA 8240
	Tritium	T-02
Soil gas	Volatile organics	EPA TO-14[b]
	Methane plus fixed gases	ASTM D 1946[c]
	Tritium	T-02, T-06[d]
	Radon	Radtrack Detector, Landauer, Inc.
	Total pressure	Field procedure
Soil	PID volatile organics screening	Field procedure
	GMD radioactivity screening	Field procedure
	Volatile organics	EPA 8240
	Appendix IX	
	Volatile organics	EPA 8240
	Semivolatile organics	EPA 8270
	Chlorinated pesticides/PCBs	EPA 8080A
	Herbicides	EPA 8150
	Organophosphorus pesticides	EPA 8140
	Polychlorinated dioxins/furans	EPA 8280
	Cyanide	EPA 9010
	Sulfide	EPA 9030
	Metals	EPA 6010/7000
	Radiological	
	Uranium-234	PRO-052-32[d]
	Uranium-235	PRO-052-32[d]
	Uranium-238	PRO-052-32[d]
	Radium-226	RA-01[d]
	Radium-228	RA-01[d]
	Tritium	T-02, T-06[d]
	Gross alpha	AB-01[d]
	Gross beta	AB-01[d]
	Gamma isotopic	GS-01[d]
	Total organic carbon	EPA 415.1[e]
	Physical analyses	
	Unit weight	COE EM 1110-2-1906, App II[f], ASTM D 4718[g]
	Particle size distribution	ASTM D 422[h]
	Water content	ASTM D 2216[i]
	Specific gravity	ASTM D 854

(a) All methods are from EPA 1986 unless otherwise noted.
(b) EPA 1984.
(c) ASTM 1982.
(d) Teledyne Isotopes Midwest Laboratory procedure.
(e) EPA. 1983
(f) COE. 1970.
(g) ASTM. 1987a.
(h) ASTM. 1987b.
(i) ASTM. 1987c.

TABLE 12

PHASE 3 SAMPLING SUMMARY

Matrix	Location	Type of Boring	Number of Samples per Boring[a]	Analysis
Soil	Phase 3 borings (14)	Vertical	At least 4[b]	Volatile organics
			Continuous	Field screening using PID meter and GM detector
Soil gas	Phase 3 borings (14)	Vertical	2	Volatile organics (TO-14)
			[c]	Methane plus fixed gases (carbon dioxide, methane, nitrogen, and oxygen)
			[c]	Total pressure

(a) Number of samples listed does not include field QC samples, which are described in Appendix C.

(b) Additional samples will be analyzed for volatile organics, if significant detections occur during field screening.

(c) Fixed gases and total pressure will be sampled and analyzed only if volatile organics are detected at that location.

TABLE 13

PHASE 3 ANALYTICAL METHODS

Sample Matrix	Analysis	Method No.
Soil	PID volatile organics screening	Field procedure
	GMD radioactivity screening	Field procedure
	Volatile organics	EPA 8240[a]
Soil gas	Volatile organics	EPA TO-14[b]
	Methane plus fixed gases	ASTM D 1946[c]
	Total pressure	Field procedure

(a) EPA. 1986.
(b) EPA. 1984.
(c) ASTM. 1982

APPENDICES

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APPENDIX C

Quality Assurance Project Plan

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1.0 INTRODUCTION

This quality assurance project plan (QAPP) establishes the quality assurance and quality control (QA/QC) objectives for Phase 1, 2, and 3 of the Comprehensive Investigation Program, US Ecology, Hanford operations work plan (work plan). This plan also presents the QA organization and procedures developed to meet project QA objectives. The goal of the project QA program is to provide a reasonable degree of confidence in project data and results by establishing a system of quality and performance checks on data collection, analysis, and reporting activities, as well as to provide for appropriate and timely corrective action to achieve compliance with established performance and quality criteria.

This QAPP is divided into the following sections:

- Project QA organization and responsibilities (Section 2.0)
- Data quality objectives (Section 3.0)
- Analytical procedures (Section 4.0)
- Data reduction, validation, and reporting (Section 5.0)
- Internal quality control (Section 6.0)
- Specific routine procedures used to assess data (Section 7.0)
- Reporting (Section 8.0).

2.0 PROJECT QA ORGANIZATION AND RESPONSIBILITIES

Specific project QA responsibilities are listed in Table C-1. The QA officer will be responsible for directing/conducting data validation and confirming that the QA objectives of the project are met. The project manager is responsible for overall implementation of this QAPP. Laboratory analyses will be performed by American Analytical and Technical Services, Inc. in Baton Rouge, LA; Analytical Technologies, Inc. in Pensacola, FL; Teledyne Brown Engineering Environmental Services Midwest Laboratory in Northbrook, IL; and Landauer, Inc. in Glenwood, IL. Soil physical parameter analyses will be performed by the technical consultant.

3.0 DATA QUALITY OBJECTIVES

The overall objective of the QA/QC program is to establish confidence in project data to assure that data are of known and appropriate quality sufficient to support its intended use. To accomplish this goal, project data should be technically sound, statistically valid, and properly documented, having been evaluated against established criteria for precision, accuracy, representativeness, completeness, and comparability (PARCC), as defined in EPA guidance (1988).

The QA procedures presented in this QAPP are based on data quality objectives that were developed in accordance with EPA (1987, 1988) guidance documents and reflect the intended use of project data. The project data quality objectives prescribe the sampling program design (e.g., type of analysis, sampling protocols) and the level of quality, precision, accuracy, representativeness, completeness, and comparability of data to be collected and analyzed for site activities.

The target control limits (the range within which project data of acceptable quality should fall) for the PARCC parameters are those developed by the individual laboratories as directed by the specified analytical methods. The laboratory control limits will be used to evaluate data acceptability as noted in Section 3.0. The control limits will be the QC goals for data acceptance. Field and laboratory precision will be determined through the collection and analysis of duplicate samples. Field precision will be assessed on a case-by-case basis. Laboratory accuracy will be determined through the use of laboratory spiked samples as specified in the cited methods. In field duplicates, both field variability and laboratory variability are potential sources of error; therefore, both will be considered in any investigation of relative percent difference (RPD) values outside the target control limits. Data acceptability will be determined on the basis of the results of this qualitative review of error sources and, therefore, will be case-specific.

The QA objectives for representativeness, completeness, and comparability will be achieved by:

- Choosing sample locations to produce adequate distribution of data
- Implementing standardized, uniform field sampling procedures as directed in Sections 3.1, 4.1, and 5.1 of the work plan
- Collecting field equipment blanks for nondedicated equipment and analyzing laboratory method blanks to verify that the analytical results are representative of the sampled item and not influenced by cross contamination
- Reporting data in conventional and standard units.

PARCC parameters are defined and discussed further in Section 7.0.

Quantitation limits are presented in Table C-2 and quantitation limits and relevant standards are presented in Tables C-3 and C-4. They may vary depending on effects by matrix interferences.

4.0 ANALYTICAL PROCEDURES

The Phase 1 soil gas samples will be analyzed for volatile organics analysis by EPA method TO-14 from the three existing soil vapor wells, VW 100, VW 101, and VW 102.

The Phase 1 groundwater samples, collected concurrently with the quarterly monitoring, will be analyzed for volatile organics by EPA method 8240 and for the metals: barium, chromium (total), lead, and vanadium in addition to those analyses routinely performed as part of the quarterly monitoring event.

Phase 2 soil samples collected from the vertical borings will be analyzed for volatile organics using EPA method 8240 as well as for parameters supporting the vapor transport model including total organic carbon by EPA method 415.1, particle size distribution by ASTM D 422, unit weight by COE ME 1110-2-1906 (US Army Corps of Engineers 1970), and water content by ASTM D 2216. Corrections for oversized particles will be made, where necessary, using ASTM D 4718.

Temperature will also be measured in the vertical boring soils by reading the thermocouples installed during well completion, as described in Section 4.1.2 of the work plan.

Phase 2 soil gas samples collected from the multilevel completions in the vertical borings will be analyzed for volatile organics, EPA method TO-14; and for methane plus the fixed gases, carbon dioxide, nitrogen, and oxygen, ASTM D 1946. Tritium in the soil gas will be sampled by inserting a tube containing silica gel into the well, as described in Appendix F of this work plan. Tritium is then analyzed in the water extracted from the silica gel. Radon in the soil gas will be sampled using Radtrack detectors, available from Landauer, Inc. in Glenwood, Illinois. These detectors will be inserted into the soil gas well as described in Appendix F of this work plan.

Total pressure in the vapor monitoring wells will be determined in the field through use of a magnehelic gauge, as described in Appendix G of this work plan.

Phase 2 soil samples collected from the angle borings will be analyzed for Appendix IX constituents as well as a radiological suite, including uranium isotopes 234, 235, and 238, radium isotopes 226 and 228, tritium, gross alpha, gross beta, and gamma-emitting isotopes. The methods to be used for these were developed at the Teledyne Isotopes Midwest Laboratory. In-house method

numbers are referenced in Table C-5. Appendix IX constituents will be analyzed through analyzing the Appendix IX compounds included in the following methods: volatile organics, EPA method 8240; semivolatile organics, EPA method 8270; chlorinated pesticides and PCBs, EPA method 8080A; organophosphorus pesticides, EPA method 8140; herbicides, EPA method 8150; polychlorinated dioxins and furans, reported as tetra-, penta-, and hexa- congener classes and 2,3,7,8-TCDD, EPA method 8280; cyanide, EPA method 9010; sulfide, EPA method 9030; and the following metals: antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, silver, thallium, tin, vanadium, and zinc, EPA method 6010 with EPA method 7000 used where necessary to achieve detection limits. Specific analytes included within each analysis are listed in Tables C-2 through C-4.

Phase 3 soil samples will be analyzed for volatile organics, EPA method 8240. The soil gas samples will be analyzed for volatile organics, EPA method TO-14. If volatile organics are detected at any gas monitoring well, additional gas samples will be collected and analyzed for methane plus fixed gases, ASTM D 1946, and for total pressure using the field measurement procedure described in Appendix G of this work plan. The analytical methods are summarized on Table C-5.

5.0 DATA REDUCTION, VALIDATION, AND REPORTING

Analytical reports from the laboratory will be accompanied by QC results and any other necessary analytical information to enable reviewers to determine the quality of the data. The technical consultant's QA officer will be responsible to the project manager for conducting checks for adherence to the QC elements specified in this QAPP. The technical consultant's QA officer (or designee) will prepare a laboratory data validation report, as described below. If significant nonconformities are found, additional laboratory data will be evaluated by the technical consultant's QA officer.

Analytical data for the specific tasks will be reported in the units specified by the quantitation limits as listed in Tables C-2 through C-4.

The analytical laboratory will provide reports that include the following elements:

- Case narrative, including adherence to prescribed protocols, nonconformity events, corrective measures, and/or data deficiencies
- Sample analytical results
- Surrogate recoveries
- All spike/spike duplicate results

- Laboratory duplicate results
- Blank results
- Sample custody (including signed, original chain-of-custody records, sample log-in forms, air or freight bills, and documentation of condition of custody seals)
- Analytical responsibility

The analytical laboratory will routinely archive raw laboratory data, including initial and continuing calibration data, chromatograms, quantitation reports, blank sheets, and sampling logs, and will provide these data in addition to those deliverables listed above, if requested by the technical consultant's QA officer.

Data validation will be performed based on data in the laboratory report package. Validation will be performed according to portions of the EPA guidelines on data validation (EPA 1994a;b) and will include evaluations of the following QA components:

- Chain-of-custody records
- Holding times
- Field blanks
- Laboratory method blanks
- Surrogate recoveries
- Laboratory spikes and spike duplicates (including blank and matrix spikes)
- Laboratory duplicates
- Field duplicates
- Audit/corrective action records
- Completeness
- Overall assessment of data quality.

Section 7.0 presents statistical tests used to determine data precision, accuracy, and completeness during data evaluation and validation. If a portion of the data is outside the limits presented by the laboratories methods, or EPA guidelines (EPA 1994a;b), or if sample collection and/or documentation practices are deficient, corrective action(s) will be initiated. Corrective action will be determined by the technical consultant's QA officer in consultation with the project manager and may include any of the following actions:

- Rejection of the data and resampling
- Qualification of the data

- Modification of field and/or laboratory procedures.

Data qualification arising from data validation activities will be described in the data validation report, rather than in individual corrective action reports.

6.0 INTERNAL QUALITY CONTROL

Internal quality control will be accomplished through specific quality control samples collected or measurements taken in the field or laboratory. The quality control samples will be used to evaluate data precision, accuracy, representativeness, completeness, and comparability of the analytical results for this project (see detailed discussion of these parameters in Section 7.0). Analytical methods (referenced in Table C-5) specify routine procedures required to evaluate if data are within proper QC limits. Additional internal QC includes collection and analysis of a number of field and laboratory QC samples, which are described in the following subsections.

Field and laboratory QC samples will be used to evaluate data validity and representativeness. Field and laboratory QC samples will include blind field duplicates, field equipment blanks, field trip blanks, laboratory matrix or blank spikes, laboratory matrix spike duplicates, laboratory duplicates, and laboratory method blanks. Field QC samples are listed by analysis and matrix on Table C-6. Laboratory QC samples shall be prepared and analyzed in accordance with method requirements.

A sampling event, as defined for the purpose of QC sample frequency, consists of a set of groundwater, soil, or soil gas samples collected during a specified phase, during a 2-week period, or the set of soil samples collected during the drilling of a borehole.

6.1 BLIND FIELD DUPLICATES

Blind field duplicates for groundwater, soil, and soil vapor will consist of a split sample collected at a sample location which will be given a separate sample number that cannot be associated by the laboratory to the specific sample location. Soil samples will be collected during drilling of borings. Duplicate soil samples to be analyzed for VOCs will be collected from co-located areas within the same depth interval and placed directly into separate sample containers immediately following collection. Duplicate soil samples for other analyses will be collected from the same depth interval, homogenized by mixing in a stainless-steel bowl, and split into duplicate sample containers. Duplicate water quality samples (groundwater) will be collected by alternately

filling sample containers for both the original and the corresponding duplicate sample at the same sample location to decrease variability between duplicates. Duplicate soil vapor samples will be collected by consecutively filling sample containers at the same sample location.

Blind field duplicates will be collected at a frequency of at least one per 20 samples, not including QC samples, but not less than one duplicate per sampling event per matrix (soil, groundwater, and soil vapor).

6.2 FIELD EQUIPMENT BLANKS

Field equipment rinsate blanks will be collected for groundwater and soil samples where undedicated equipment is used. The rinsate blanks will consist of deionized water (supplied by the analytical laboratory) passed over or through decontaminated sampling equipment and collected in the appropriate sample containers. Equipment surfaces actually exposed to the samples being collected will be rinsed. No rinsate blanks will be collected from dedicated or disposable field equipment. Field equipment rinsate blanks will be collected at a rate of one blank per 20 samples per sample type (i.e., groundwater and soil), not including QC samples, but not less than one blank per sampling event.

6.3 DRILLER'S WATER SAMPLE

The water the drillers use while drilling, decontaminating, and mixing grout will be sampled at least once during the field program. An additional sample will be collected whenever the driller changes his source of water (Table C-6).

Driller's water samples will be tested for volatile organic compounds and tritium. The methods that will be used are shown in Table C-5.

6.4 FIELD TRIP BLANKS

Field trip blanks will consist of deionized water sealed in a sample container by the analytical laboratory. The trip blank will be transported to and from the field, then returned to the laboratory unopened for analysis. One trip blank per cooler containing samples for VOC analysis will be evaluated to determine possible sample contamination during transport. Trip blanks may be omitted from coolers containing corresponding field equipment blanks.

7.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA

Analytical laboratory data will be reviewed to confirm that the QA/QC objectives for the PARCC parameters are met. The PARCC parameters and the associated statistical test used in their evaluation are described in the following sections.

7.1 PRECISION

Precision is a measure of "the reproducibility of analyses under a given set of conditions" (EPA 1989). Precision is best expressed in terms of the standard deviation or relative percent difference (RPD). QA/QC sample types that test precision include field and laboratory duplicates and matrix or blank spike duplicates. The estimate of precision of duplicate measurements will be expressed as an RPD, which is calculated:

$$RPD = \left| \frac{D_1 - D_2}{(D_1 + D_2)/2} \right| x \ 100$$

where: D_1 = first sample value
D_2 = second sample value (duplicate).

The RPDs will be routinely calculated and compared with data quality objective control limits provided by the laboratories. For field duplicates, RPD control limits shall be 20 percent for groundwater and 35 percent for soil. If duplicate sample values are within five times the quantitation limit (QL), then the control limit will be plus or minus the QL for water or plus or minus two times the QL for soil.

7.2 ACCURACY

Accuracy is a measure of "the bias in a measurement system" (EPA 1989). Numerically, accuracy can be described as an average of measurements of the same property, X, with an accepted reference or true value, T, usually expressed as the difference between the two values (X-T), the difference as a percentage of the reference or true value (100 (X-T)/T), or as a ratio (X/T). Accuracy is expressed as the percent recovery of spiked (matrix or surrogate spike) samples:

$$\text{Percent Recovery} = \frac{(\text{Total Analyte Found})}{\text{Analyte Added}} \ x \ 100$$

The percent recovery will be routinely calculated and checked against data quality objective control limits.

7.3 REPRESENTATIVENESS

Representativeness expresses "the degree to which data accurately and precisely represent selected characteristics" (EPA 1989). Representativeness can be evaluated using replicate samples, additional sampling locations, and blanks. Representativeness for the project will be monitored as outlined in Section 3.0.

7.4 COMPLETENESS

Completeness is a measure of "the amount of valid data obtained from a measurement system compared to the amount that could be expected to be obtained under 'normal' conditions" (EPA 1989). It is calculated as the number of valid (i.e., nonrejected) data points divided by the total number of data points requested. Completeness for the project will be established as outlined in Section 3.0. Completeness will be routinely evaluated and compared to the data quality objective acceptable percentage of 90 percent.

7.5 COMPARABILITY

Comparability is the "degree of confidence with which one data set can be compared to another" (EPA 1989). QA procedures in this document will provide for measurements that are consistent and representative of the media and conditions measured and will provide comparability of results for samples and split samples. Data collected under this QAPP also will be calculated, qualified, and reported in units consistent with EPA guidelines. Quantitation limits are listed in Tables C-2 through C-4 and QC samples are described in Section 6.0.

8.0 REPORTING

The laboratory project manager will transmit written reports that summarize the test procedures and provide test results and QC data required for validation, as well as the elements listed in Section 5.0. Laboratory reports and analysis results will be signed by the laboratory project manager and submitted in data packages to the US Ecology project manager and the technical consultant's project manager.

QA reports will include analysis reports from the laboratory and corrective action reports as part of the data validation from the technical consultant's QA officer. All reports required under this QAPP will be submitted to the project manager.

All reported data will include results of the QA data validation review and conclusions containing information regarding data accuracy, precision, completeness, and any corrective action and sampling procedure alteration documentation.

9.0 REFERENCES

EPA. 1994a. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review.* EPA 540/R-94/012. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC. February.

EPA. 1994b. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.* EPA 540/R-94/013. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC. February.

EPA. 1989. *Report on Minimum Criteria to Assure Data Quality.* EPA/530-SW-90-021. December. U.S. Environmental Protection Agency.

EPA. 1988. *You and Quality Assurance.* U.S. Environmental Protection Agency, Region 10. March.

EPA. 1987. *Data Quality Objectives for Remedial Response Activities, Development Process.* 540/G-87/003a. U.S. Environmental Protection Agency. March.

U.S. Army Corps of Engineers (COE). 1970. *Engineering and Design Laboratory Soils Testing, Engineer Manual, ME 1110-2-1906, Appendix II: Unit Weights, Void Ratio, Porosity, and Degree of Saturation.* November.

TABLE C-1

QUALITY ASSURANCE RESPONSIBILITIES

Personnel	Responsibilities
Project Coordinator US Ecology	Provide technical project direction and coordinate project-agency communication or liaison, review project QA needs, and approve appropriate QA corrective actions as required.
Project Manager Technical Consultant	Direct and supervise project technical team activities to successfully accomplish technical and QA project objectives, establish and review project QA requirements and activities, and approve appropriate QA corrective actions.
QA Officer Technical Consultant	Assist project manager in the establishment and review of project QA requirements and activities, recommend and review corrective action responses and deviations from the QAPP, direct or perform data validation and prepare data validation reports, and review QA reports.
Laboratory QA Officers Subcontract Laboratory	Direct and supervise laboratory implementation of QA/QC protocols so that QA objectives are met and properly documented and reported laboratory QA/QC information is provided.

TABLE C-2

SOIL GAS QUANTITATION LIMITS

Analyte	Quantitation Limit
Volatile Organics, EPA TO-14	**(mg/m^3)**
Chloromethane	0.03
Vinyl Chloride	0.03
Bromomethane	0.03
Chloroethane	0.03
1,1-Dichloroethene	0.03
Methylene Chloride	0.07
1,1-Dichloroethane	0.03
cis-1,2-Dichloroethene	0.03
Chloroform	0.03
1,1,1-Trichloroethane	0.03
Carbon Tetrachloride	0.03
Benzene	0.03
1,2-Dichloroethane	0.03
Trichloroethene	0.03
1,2-Dichloropropane	0.03
cis-1,3-Dichloropropene	0.03
Toluene	0.03
trans-1,3-Dichloropropene	0.03
1,1,2-Trichloroethane	0.03
Tetrachloroethene	0.03
Ethylene Dibromide	0.03
Chlorobenzene	0.03
Ethylbenzene	0.03
m,p-Xylene	0.03
o-Xylene	0.03
Styrene	0.03

TABLE C-2

SOIL GAS QUANTITATION LIMITS

Analyte	Quantitation Limit
1,1,2,2-Tetrachloroethane	0.03
1,3,5-Trimethylbenzene	0.03
1,2,4-Trimethylbenzene	0.03
1,3-Dichlorobenzene	0.03
1,4-Dichlorobenzene	0.03
Chlorotoluene	0.03
1,2-Dichlorobenzene	0.03
1,2,4-Trichlorobenzene	0.03
Hexachlorobutadiene	0.03
4-Ethyltoluene	0.03
Dichlorodifluoromethane	0.03
Dichlorotetrafluoroethane	0.03
Trichlorofluoromethane	0.03
Trichlorotrifluoroethane	0.03
Methane plus Fixed Gases ASTM D 1946 modified	**Percent**
Oxygen	0.01
Nitrogen	0.01
Methane	0.01
Carbon Dioxide	0.01
Argon	0.01
Radionuclides (US Ecology SOP)	
Radon-222	--
Tritium	--

TABLE C-3

GROUNDWATER QUANTITATION LIMITS AND STANDARDS

Analyte	Quantitation Limit	MTCA[a] Method B Formula Values	US[b] MCL	MTCA[c] Method A	Laboratory PQL Range[d] 8240
Volatile Organics, EPA 8240	µg/L	(µg/L)	(µg/L)	(µg/L)	(µg/L)
Chloromethane	10	3.37			1-10
Bromomethane	10	11.2			
Vinyl chloride	10	0.023	2	0.2	1-10
Chloroethane	10	--			
Methylene chloride	5	5.83	5	5	
Acetone	10	800			
Carbon disulfide	5	800			
1,1-Dichloroethene	5	0.0729	7		1-10
1,1-Dichloroethane	5	800			
Total-1,2-Dichloroethene	5	80/160[e]	70/100[e]		
Chloroform	5	7.17			
1,2-Dichloroethane	5	0.481	5	5	0.2-10
2-Butanone	10	4,800			
1,1,1-Trichloroethane	5	7,200	200	200	
Carbon tetrachloride	5	0.337	5		1-10
Vinyl acetate	10	8,000			
Bromodichloromethane	5	0.706			0.2-10
1,1,2,2-Tetrachloroethane	5	0.219			0.2-10
1,2-Dichloropropane	5	0.643	5		1-10
trans-1,3-Dichloropropene	5	0.243			0.2-10
Trichloroethene	5	0.768	5	5	2-5
Dibromochloromethane	5	0.521	100[f]		--
1,1,2-Trichloroethane	5	0.768	5		0.5-10
Benzene	5	1.51	5	5	0.5-10
cis-1,3-Dichloropropene	5	0.243			0.2-10

TABLE C-3

GROUNDWATER QUANTITATION LIMITS AND STANDARDS

Analyte	Quantitation Limit	MTCA[a] Method B Formula Values	US[b] MCL	MTCA[c] Method A	Laboratory PQL Range[d] 8240
2-Chloroethylvinylether	10	--			
Bromoform	5	5.54			
2-Hexanone	10	--			
4-Methyl-2-Pentanone	10	640			
Tetrachloroethene	5	0.858	5	5	0.2-10
Toluene	5	1,600	1,000	40	
Chlorobenzene	5	160	100		
Ethylbenzene	5	800	700	30	
Styrene	5	1.46	100		1-10
Total xylenes	5	16,000[g]	10,000[g]	20[g]	
Metals, EPA 6010/7000	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**
Barium	0.025	1.12	2.0		
Chromium	0.010	0.08[h]	0.1	0.05	
Lead	0.005	--	--	0.005	
Vanadium	0.015	0.112			

-- Data not available.

(a) Model Toxics Control Act Method B formula values, 2/28/96 from *Cleanup Levels and Risk Calculations (CLARC II) Update*, February 1996.

(b) Federal maximum concentration level values as listed in Model Toxics Control Act *Cleanup Levels and Risk Calculations (CLARC II) Update*, February 1996.

(c) Method A values from Model Toxics Control Act Cleanup Regulation, chapter 173-340 WAC, amended December 1993.

(d) Practical quantitation limit (PQL) ranges are from Ecology Implementation Memo No. 3, from Steve Robb, Toxics Cleanup Program, dated November 24, 1993. Values are included where reporting limit exceeds a criterion.

(e) Cis/trans isomer, respectively.

(f) Proposed MCL.

(g) Value is for each isomer.

(h) Value assumes all chromium is chromium (VI).

TABLE C-4

SOIL QUANTITATION LIMITS AND STANDARDS

Analyte	Quantitation Limit	MTCA[a] Method B Formula Values	MTCA Method B 100 x Groundwater[b]	MTCA[c] Method A Industrial Soil	Laboratory PQL Range[d]
Volatile Organics, Appendix IX/ EPA 8240	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)
Chloromethane	10	76,900	337		
Bromomethane	10	112,000	1,120		
Vinyl Chloride	10	526	2.3		1-10
Chloroethane	10	--	--		
Methylene Chloride	5	133,000	583	500	
Acetone	10	8,000,000	80,000		
Carbon Disulfide	5	8,000,000	80,000		
1,1-Dichloroethene	5	1,670	7.29		
1,1-Dichloroethane	5	8,000,000	80,000		
Trans-1,2-Dichloroethene	5	1,600,000	16,000		
Chloroform	5	164,000	717		
1,2-Dichloroethane	5	11,000	48.1		
2-Butanone	10	48,000,000	480,000		
1,1,1-Trichloroethane	5	72,000,000	720,000	20,000	
Carbon Tetrachloride	5	7,690	33.7		
Vinyl Acetate	10	80,000,000	800,000		
Bromodichloromethane	5	16,100	70.6		
1,1,2,2-Tetrachloroethane	5	5,000	21.9		
1,2-Dichloropropane	5	14,700	64.3		
trans-1,3-Dichloropropene	5	5,560[e]	24.3[e]		
Trichloroethene	5	90,900	39.8	500	
Dibromochloromethane	5	11,900	52.1		
1,1,2-Trichloroethane	5	17,500	76.8		
Benzene	5	34,500	151	500	
cis-1,3-Dichloropropene	5	5,560[e]	24.3[e]		
2-Chloroethylvinylether	10	--	--		
Bromoform	5	127,000	554		
2-Hexanone	10	--	--		
4-Methyl-2-Pentanone	10	6,400,000	64,000		
Tetrachloroethene	5	19,600	85.8	500	
Toluene	5	16,000,000	160,000	40,000	

TABLE C-4

SOIL QUANTITATION LIMITS AND STANDARDS

Analyte	Quantitation Limit	MTCA[a] Method B Formula Values	MTCA Method B 100 x Groundwater[b]	MTCA[c] Method A Industrial Soil	Laboratory PQL Range[d]
Chlorobenzene	5	1,600,000	16,000		
Ethylbenzene	5	8,000,000	80,000	20,000	
Styrene	5	33,300	146		
Total Xylenes	5	160,000,000[e]	1,600,000	20,000	
Acrolein	50	1,600,000	16,000		
Methyl Iodide	5	--	--		
Allyl Chloride	5	4,000,000	80,000		
Chloroprene	5	--	--		
trans-1,4-Dichloro-2-butene	5	--	--		
Pentachloroethane	5	--	--		
Acetonitrile	100	480,000	4,800		
Acrylonitrile	50	1,850	8.1		
Propionitrile	10	--	--		
Methacrylonitrile	50	8,000	160		
Isobutyl Alcohol	100	24,000,000	480,000		
1,4-Dioxane	500	90,900	795		
Methyl Methacrylate	5	6,400,000	64,000		
Ethyl Methacrylate	5	7,200,000	72,000		
1,2-Dibromoethane	5	11.8	0.0515		
1,1,1,2-Tetrachloroethane	5	38,500	168		
1,2,3-Trichloropropane	5	143	0.625		
Dichlorodifluoromethane	5	16,000,000	160,000		
Trichlorofluoromethane	5	24,000,000	240,000		
Dibromomethane	10	800,000	8,000		
Semivolatile Organics, Appendix IX, EPA 8270	**(µg/kg)**	**(µg/kg)**	**(µg/kg)**	**(µg/kg)**	**(µg/kg)**
Phenol	330	48,000,000	960,000		
bis(2-Chloroethyl)ether	330	909	3.98		17-660
2-Chlorophenol	330	400,000	8,000		
1,3-Dichlorobenzene	330	--	--		
1,4-Dichlorobenzene	330	41,700	182		10-660
Benzyl Alcohol	330	24,000,000	480,000		
1,2-Dichlorobenzene	330	7,200,000	72,000		

TABLE C-4

SOIL QUANTITATION LIMITS AND STANDARDS

Analyte	Quantitation Limit	MTCA[a] Method B Formula Values	MTCA Method B 100 x Groundwater[b]	MTCA[c] Method A Industrial Soil	Laboratory PQL Range[d]
2-Methylphenol	330	4,000,000	80,000		
bis(2-Chloroisopropyl)ether	330	3,200,000	32,000		
4-/3-Methylphenol	330	400,000/ 4,000,000	8,000/80,000		
n-Nitroso-di-n-propylamine	330	143	1.25		33-1,300
Hexachloroethane	330	71,400	625		
Nitrobenzene	330	40,000	800		
Isophorone	330	1,050,000	9,210		
2-Nitrophenol	330	--	--		
2,4-Dimethylphenol	330	1,600,000	32,000		
Benzoic Acid	1,600	320,000,000	6,400,000		
bis(2-Chloroethoxy)methane	330	--	--		
2,4-Dichlorophenol	330	240,000	4,800		
1,2,4-Trichlorobenzene	330	800,000	8,000		
Naphthalene	330	3,200,000	32,000		
4-Chloroaniline	330	320,000	6,400		
Hexachlorobutadiene	330	12,800	56.1		33-660
4-Chloro-3-methylphenol	330	--	--		
2-Methylnaphthalene	330	--	--		
Hexachlorocyclopentadiene	330	560,000	11,200		
2,4,6-Trichlorophenol	330	90,900	795		
2,4,5-Trichlorophenol	1,600	8,000	160,000		
2-Chloronaphthalene	330	--	--		
2-Nitroaniline	1,600	--	--		
Dimethylphthalate	330	80,000,000	1,600,000		
Acenaphthylene	330	--	--		
3-Nitroaniline	1,600	--	--		
Acenaphthene	330	4,800,000	96,000		
2,4-Dinitrophenol	1,600	160,000	3,200		
4-Nitrophenol	1,600	--	--		
Dibenzofuran	330	--	--		
2,4-Dinitrotoluene	330	160,000	3,200		
2,6-Dinitrotoluene	330	80,000	1,600		

TABLE C-4

SOIL QUANTITATION LIMITS AND STANDARDS

Analyte	Quantitation Limit	MTCA[a] Method B Formula Values	MTCA Method B 100 x Groundwater[b]	MTCA[c] Method A Industrial Soil	Laboratory PQL Range[d]
Diethylphthalate	330	64,00,000	1,280,000		
4-Chlorophenylphenylether	330	--	--		
Fluorene	330	3,200,000	64,000		
4-Nitroaniline	1,600	--	--		
4,6-Dinitro-2-methylphenol	1,600	--	--		
n-Nitrosodiphenylamine	330	204,000	1,790		
4-Bromophenylphenylether	330	--	--		
Hexachlorobenzene	330	625	5.47		17-660
Pentachlorophenol	330	8,330	72.9		
Phenanthrene	330	--	--		
Anthracene	330	24,000,000	480,000		
Di-n-butylphthalate	330	8,000,000	160,000		
Fluoranthene	330	3,200,000	64,000		
Pyrene	330	2,400,000	48,000		
Butylbenzylphthalate	330	16,000,000	320,000		
3,3-Dichlorobenzidine	660	2,220	19.4		33-1,300
Benzo(a)anthracene	330	137	1.2		5.5-660
bis(2-Ethylhexyl)phthalate	330	71,400	625		
Chrysene	330	137	1.2		10-660
Di-n-octylphthalate	330	1,600,000	32,000		
Benzo(b)fluoranthene	330	137	1.2		5-660
Benzo(k)fluoranthene	330	137	1.2		5-660
Benzo(a)pyrene	330	137	1.2		5-660
Indeno(1,2,3-cd)pyrene	330	137	1.2		10-660
Dibenz(a,h)anthracene	330	137	1.2		10-660
Benzo(g,h,i)perylene	330	--	--		
Parathion	660	480,000	9,600		
Ethyl Methanesulfonate	330	--	--		
p-Phenylenediamine	330	21,300 [f]	186[f]		
n-Nitrosodiethylamine	330	6.67	0.058		330-1,300
n-Nitrosomethylethylamine	330	45.5	0.398		330-1,300
n-Nitrosodi-n-butylamine	330	185	1.62		330-1,300
n-Nitrosopiperidine	330	--	--		

TABLE C-4

SOIL QUANTITATION LIMITS AND STANDARDS

Analyte	Quantitation Limit	MTCA[a] Method B Formula Values	MTCA Method B 100 x Groundwater[b]	MTCA[c] Method A Industrial Soil	Laboratory PQL Range[d]
5-Nitro-o-toluidine	330	-	--		
Methyl Yellow	330	--	--		
Methyl Parathion	330	20,000	400		
Safrole	660	--	--		
Isosafrole	660	--	--		
2-Picoline	330	--	--		
Phenacetin	330	--	--		
o-Toluidine	330	5,600[g]	46.1[g]		
3,3-Dimethylbenzidine	1,600	109	0.951		330-1,000
1,3-Dinitrobenzene	330	8,000	160		
a,a-Dimethylphenethylamine	330	--	--		
o,o,o-Triethylphosphorothioate	330	--	--		
Methapyrilene Hydrochloride	660	--	--		
Diallate	660	16,400	143		
1,3,5-Trinitrobenzene	3,300	4,000	80		
4-Nitroquinoline-n-oxide	3,300	--	--		
1,2,4,5-Tetrachlorobenzene	330	24,000	480		
Pentachloronitrobenzene	330	3,850	33.7		
Phorate	330	--	--		
7,12-Dimethylbenz(a)anthracene	330	--	--		
n-Nitrosodimethylamine	330	19.6	0.172		330-1,300
2,3,4,6-Tetrachlorophenol	330	2,400,000	48,000		
Chlorobenzilate	330	3,700	32.4		
Thionazine	660	--	--		
Disulfoton	330	3,200	64		
Isodrin	3,300	--	--		
n-Nitrosomorpholine	330	--	--		
Pentachlorobenzene	330	64,000	1,280		
4-Aminobiphenyl	330	--	--		
Hexachloropropene	330	--	--		
2,6-Dichlorophenol	330	--	--		
Sulfotepp	330	--	--		
Methylmethanesulfonate	330	--	--		

TABLE C-4

SOIL QUANTITATION LIMITS AND STANDARDS

Analyte	Quantitation Limit	MTCA[a] Method B Formula Values	MTCA Method B 100 x Groundwater[b]	MTCA[c] Method A Industrial Soil	Laboratory PQL Range[d]
1,4-Naphthaquinone	330	--	--		
n-Nitrosopyrollidine	330	476	4.17		330-1,300
Acetophenone	330	8,000,000	160,000		
Dimethoate	330	16,000	320		
3-Methylcholanthrene	330	--	--		
2-Acetylaminofluorene	330	--	--		
Aniline	1,600	175,000	1,540		67-660
1,2-Dibromo-3-Chloropropane	330	714	3.12		
Hexachlorophene	330	24,000	480		
Kepone	1,600	--	--		
1-Naphthylamine	330	--	--		
2-Naphthylamine	330	--	--		
Pronamide	1,600	6,000,000	12,000		
Aramite	3,300	40,000	350		
Total PAH		137	1.2	20,000[h]	
Chlorinated Pesticides/PCBs, Appendix IX, EPA 8080A	**(µg/kg)**	**(µg/kg)**	**(µg/kg)**	**(µg/kg)**	**(µg/kg)**
Alpha-BHC	1.7	--	--		
Beta-BHC	1.7	--	--		
Delta-BHC	1.7	--	--		
Gamma-BHC (Lindane)	1.7	769	6.73	20,000	
Heptachlor	1.7	222	1.94		
Aldrin	1.7	58.8	0.515		1.7-3
Heptachlor Epoxide	1.7	110	0.962		1.7-100
Endosulfan I	1.7	480,000[i]	9,600[i]		
Dieldrin	3.3	62.5	0.547		1-10
4,4-DDE	3.3	2,940	25.7		
Endrin	3.3	--	--		
Endosulfan II	3.3	--	--		
4,4-DDD	3.3	4,170	36.5		
Endosulfan Sulfate	3.3	--	--		
4,4-DDT	3.3	2,940	25.7	5,000	
Endrin Ketone	3.3	--	--		

TABLE C-4

SOIL QUANTITATION LIMITS AND STANDARDS

Analyte	Quantitation Limit	MTCA[a] Method B Formula Values	MTCA Method B 100 x Groundwater[b]	MTCA[c] Method A Industrial Soil	Laboratory PQL Range[d]
Endrin Aldehyde	3.3	--	--		
Methoxychlor	17	400,000	8,000		
Alpha-Chlordane	1.7	769[e]	6.73[e]		
Gamma-Chlordane	1.7	769[e]	6.73[e]		
Toxaphene	170	909	7.95		17-100
Aroclor-1016	33	5,600	112		
Aroclor-1221	67	--	--		
Aroclor-1232	33	--	--		
Aroclor-1242	33	--	--		
Aroclor-1248	33	--	--		
Aroclor-1254	33	1,600	32		17-100
Aroclor-1260	33	--	--		
Total PCBs		130	1.14	10,000	
Organophosphorus Pesticides, Appendix IX, EPA 8140	**(µg/kg)**	**(µg/kg)**	**(µg/kg)**	**(µg/kg)**	**(µg/kg)**
Dichlorvos	97	3,440	30.1		
Mevinphos	137	20,000	400		
Demeton S	103	--	--		
Ethoprop	117	--	--		
Naled	153	160,000	3,200		
Phorate	67	--	--		
Diazinon	150	72,000	1,440		
Disulfoton	123	3,200	64		
Methyl Parathion	17	20,000	400		
Ronnel	127	4,000,000	80,000		
Fenthion	47	--	--		
Chlorpyrifos	137	240,000	4,800		
Trichloroanate	70	--	--		
Stirophos	570	--	--		
Tokuthion	120	--	--		
Merphos	197	2,400	48		
Fensulfothion	333	20,000	400		
Bolstar	73	--	--		

APPENDIX A

Soil Vapor Sampling U.S. EPA Method TO-14

RICHLAND OPERATIONAL PROCEDURE

TITLE Soil Vapor Sampling U.S. EPA Method TO-14 ROP NO. 19

TECHNICAL CONCURRENCE PAGE 1 OF 4

APPROVAL REV. 1 DATE 12/03/92

1.0 INTRODUCTION

Air samples shall be collected using an evacuated canister for the analysis of volatile organic compounds. This procedure documents the collection of vapor phase volatile organic compounds within the interstitial soil spaces at vadose monitoring wells 100, 101 and 102.

2.0 EQUIPMENT

1. Sample collection apparatus (Figure 1, ROP 19).
2. Vendor supplied SUMMA(R) passivated six liter stainless steel sample canister. The canister shall be cleaned and certified per U.S. EPA Method TO-14, Section 11.1 and evacuated.
3. Air flow meter.
4. Vacuum pump
5. Vacuum gauge
6. DC power source 12V.
7. Canister sampling field data sheet.

3.0 PRECAUTIONS

Prior to sampling, the sampling apparatus shall be cleaned with alconox or similar detergent, rinsed with deionized water and dried in a oven at 100°C. for a minimum of 12 hours. The sample apparatus shall be free of moisture. Teflon tape may be used to seal the thread connections. The sample equipment must not contact solvents, glue, grease or joint compounds. The polyethelene line, flow meter and vacuum pump do not require decontamination. The vacuum pump shall exhaust to the atmosphere away from personnel and ignition sources. This procedure shall not be conducted while vadose zone radionuclide samples are being taken (see ROP 18).

4.0 PROCEDURE

4.1 Installation of Sample Collection Apparatus

A sample collection assembly diagram is provided in Figure 1, ROP 19. This assembly shall be installed at the top of each two inch PVC well casing as to minimize interaction with the atmosphere. The valves shall remain closed until a vacuum is applied to the sampling system. All connections must be air tight.

4.1.1 Assemble the stainless steel tubing, valves, pressure gauge, ball reducers and two-inch casing adapter as necessary to install on well casing.

4.1.2 Close the needle valve numbers 1 and 2 on the sampling assembly.

4.1.3 Remove the two inch well cap and quickly install the sampling assembly.

4.1.4 Install the sampling canister to the collection assembly and tighten with a wrench.

4.1.5 Install the polyethelene line to the flow meter and vacuum pump.

4.1.6 Record the canister identification number in the field notes and complete the sample tag provided with the canister.

4.2 Purging

To obtain a representative sample, the air within the well bore must be purged prior to sample collection.

4.2.1 Leak check the sampling assembly as follows:

4.2.1.1 Open valve 4 and start the vacuum pump. After vacuum is establis'zd, observe the flow meter for indication of leakage between valve 2 and valve 4. Any flow on flow meter indicates leakage. Correct as necessary.

4.2.1.2 Open valve 2. After vacuum is established, observe the flow meter for indication of leakage between valves 1, 2 and 3. Any flow on flow meter indicates leakage. Correct as necessary.

4.2.2 Start the vacuum pump and open the needle valve number 1 of the sampling apparatus. DO NOT OPEN NUMBER 3 VALVE ON THE SAMPLE CANISTER.

4.2.3 Adjust the valve number 4 on the air flow meter to five liters per minute.

4.2.4 One volume of air will be purged from each well bore. Record the start time on the field data sheet.

The bore hole volume of air within vadose monitoring wells 100, 101 and 102 is approximately 300 liters. The purge time is one hour.

4.2.5 Close needle valve numbers 1 and 2 on the sampling apparatus.

4.2.6 Stop the vacuum pump.

4.2.7 Record the stop time on the field data sheet.

4.2.8 Slowly open valve number 3 on the sample canister while observing the vacuum gauge. The canister should reach equilibrium very quickly. Open valve number 3 on the sample canister completely. Record the vacuum gauge reading on the field data sheet.

4.2.9 Very slowly, open needle valve number 1 (see Figure 1, ROP 19) adjacent to the well casing to begin sample collection. Observe the vacuum gauge and or listen for air flow through the valve. Sample collection should continue for approximately one to two minutes. Adjust the valve to ensure sample collection takes between one and two minutes.

4.2.10 After vacuum reaches 0 inches Hg and air flow is not audible, open needle valve number 1 adjacent to the well casing completely.

4.2.11 Close the sample canister valve number 3 tightly and close needle valve 1.

4.2.12 Remove the sample canister from the collection apparatus and place the brass cap on the canister.

4.2.13 Remove sample apparatus from well head and replace well cap.

4.2.14 Complete the chain-of-custody information for the sample.

Sample containers should remain at ambient temperatures for shipment to the laboratory.

5.0 ACTION LEVEL

No action levels are required for organic vapor sampling from vadose monitoring wells.

6.0 RECORDS

Attachment 1, ROP 19 (Canister Sampling Field Data Sheet)

7.0 BIBLIOGRAPHY

U.S. EPA Method TO-14 - Determination of Volatile Organic Compounds (VOCs) in ambient air using SUMMA(R) Passivated Canister Sampling and Gas Chromatographic Analysis.

ATTACHMENT 1, ROP 19

CANISTER SAMPLING FIELD DATA ANALYSIS SHEET

U.S. EPA Method TO-14

A. GENERAL INFORMATION

Site Location: _____

Site Address: _____

_____

_____

Weather Conditions: _____

Barometric Pressure: _____

Temperature: _____

Well No: _____

Sampling Date: _____

Sampling Time: _____

Sampler ID: _____

Sampler's Initials: _____

Canister Serial No.: _____

B. SAMPLING INFORMATION

Canister Vacuum

Initial Reading in Hg _____

Final Reading in Hg _____

Purge Time		Elapsed Time Minutes (Tm)
Start	_____	
Stop	_____	_____

Flow Rate: Liters/Minute (L/M) X _____

Purge Volume: Liters (Tm * L/M) = _____

C. MISCELLANEOUS

Sample Tag Completed? _____

Chain-of-custody Completed? _____

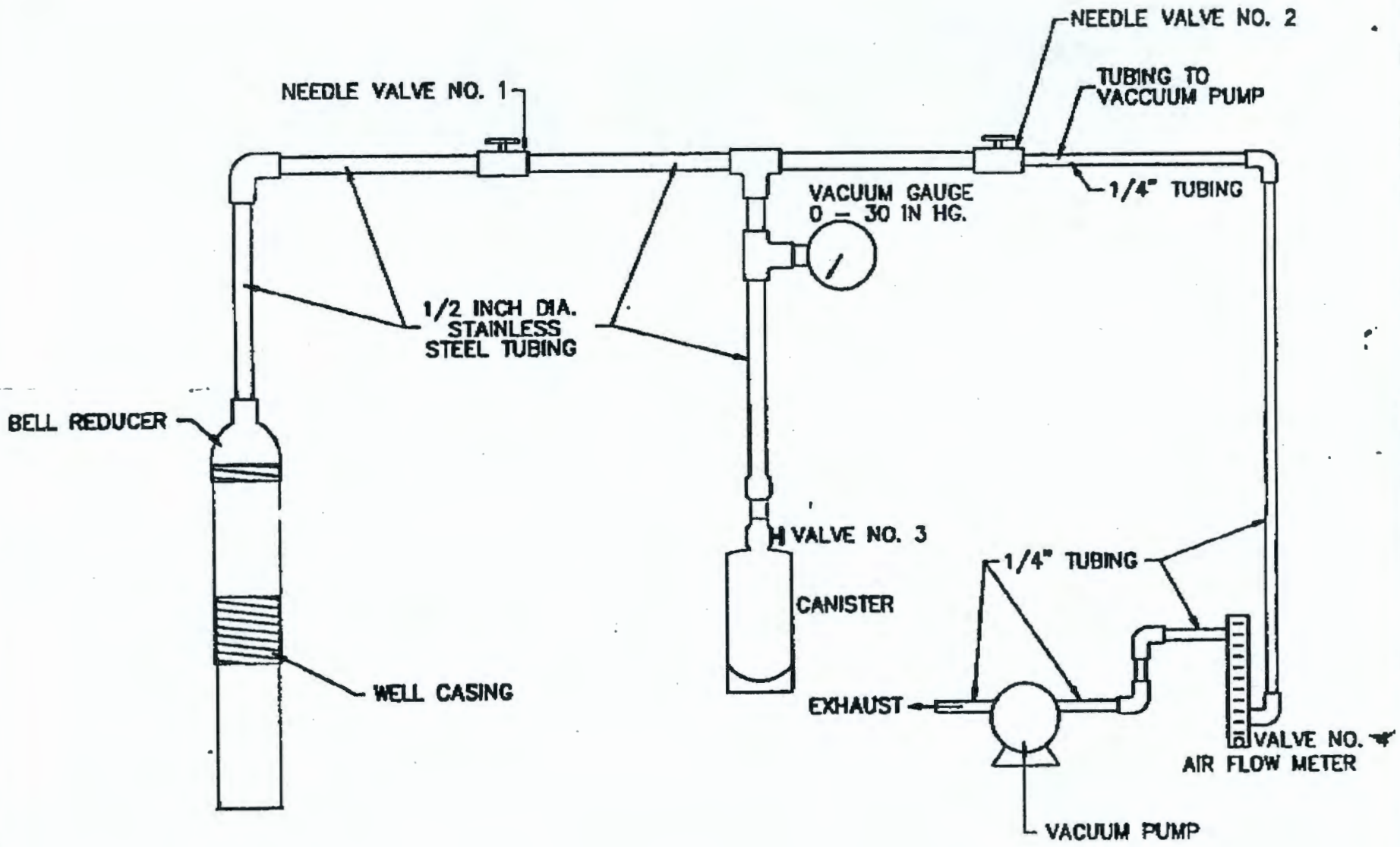
Shipping Date _____

NOTES: _____

_____

_____

_____



RICHLAND WASHINGTON
VADOSE SAMPLE COLLECTION ASSEMBLY DIAGRAM

FIGURE 1: ROP 19
NO SCALE

APPENDIX B

Groundwater Monitoring Procedures

RICHLAND OPERATIONAL PROCEDURE

TITLE GROUNDWATER MONITORING ROP NO. 49

TECHNICAL CONCURRENCE PAGE 1 OF 11

APPROVAL REV. 3 DATE 2-4-94

1.0 INTRODUCTION

Groundwater samples are taken and analyzed to determine the presence of possible contamination from facility or other operations on the Hanford Reservation. This procedure prescribes correct sampling, pretreatment and shipping method to be used.

2.0 EQUIPMENT

The following equipment is required for sampling:

2.1 Sample bottles with required labels and preservatives as supplied by the laboratory;

2.2 Dedicated electronic water level measuring device or monitoring tapes, one for each well;

2.3 Two-way radio, for immediate communications with the FRC&SO;

2.4 Portable pH, conductivity and temperature meters;

2.5 Metal numbered security seals;

2.6 Field Log Book;

2.7 Deionized water, provided by vendor;

2.8 An AC power source;

2.9 A source of regulated compressed air or nitrogen;

2.10 Ice chests and ice for transport of samples to the laboratory;

2.11 Sample pump logic regulator;

2.12 Containers for well evacuation water storage;

2.13 Well evacuation pump discharge hose;

2.14 Clear glass beaker;

2.15 Disposable gloves; and

2.16 MSA, Combustible Gas Meter or functional equivalent.

3.0 PRECAUTIONS

3.1 Do not smoke during well sampling.

3.2 Monitoring shall begin at the upgradient well (13). Downgradient wells shall not, under any circumstances, be sampled prior to the upgradient well.

3.3 All sample bottles shall be inspected for cleanliness and flaws prior to use.

3.4 Prior to sampling, calibrate the conductivity meter and standardize the pH meter per manufacturer's operating instruction. Note completion in the Field Log Book.

3.5 A new pair of gloves must be worn when sampling each well.

3.6 Field blanks, consisting of deionized water, provided by the vendor, shall be poured into the provided sample containers after the last well has been sampled, and before leaving that sample station. They shall then be stored with the actual samples and accompany the samples to the vendor.

The blanks shall be treated as, and resemble, actual samples even to the extent that they shall be identified as Well #16 with fictional sample times and numbers. The water used for blanks shall be tested for all on-site analysis as well samples (pH, Temp., Cond.), and the results logged in the Field Log Book.

3.7 Never start the evacuation pump while the evacuation line cap is still in place. Personal injury and/or equipment damage may result.

3.8 Gloves should be worn and proper care taken when handling pre-preserved sample bottles or the preservatives themselves (especially during receipt inspection).

4.0 PROCEDURE

4.1 Presample Inspection

Inspect the well cap and standpipe to ensure that it has not been tampered with or damaged. Remove the locking and protective cap. Note in the Groundwater Monitoring Field Log any unusual conditions (i.e if the standpipe has unusual odor). The air above the well water level shall be sampled IAW the combustible gas meter's manufacturers instructions to determine the potential for fire or explosion.

4.2 Water Level Measurement

4.2.1 Rinse the water level measuring device at least twice with deionized water and allow to air dry.

4.2.2 Lower the measuring device into the level indication standpipe until water is detected (positive indication on the meter). The distance from the top of the standpipe to water is the depth to water (DW) in feet and inches. Log this level in the Field Log Book. Continue to lower the measuring device to the bottom of the well. Note this depth to bottom (DTB) level in the Field Log Book.

Note: Depth to the bottom of the well shall be measured during first quarter sampling.

4.2.3 Calculate Casing Volume (CV) as follows:

4.2.3.1 DTB - DW = Water Casing Height (WCH).

4.2.3.2 CV = 2.61 x WCH

Note: Use 1.47 for well #5 (6" casing)
Note: 2.61 is derived as follows:
$2.61 = 3.14 \times .\underline{667}^{2} \times 7.481$

Where: .667 is the diameter of the well casing
8in X 1ft (use .5 for well #5)
12in

7.481 converts ft^3 to gallons
pi = 3.14

4.2.3.3 CV X 3 = Gallons of water to be evacuated.

4.2.3.4 Note these calculations in the Field Log Book

4.3 Well Casing Evacuation

4.3.1 Remove evacuation line cap seal and record seal number in the Field Log Book. Remove evacuation line cap.

4.3.2 Connect the evacuation hose to discharge fitting and direct the open end to a container to store the water.

4.3.3 Start the generator, then connect pump to the 240 volt power supply with the extension cable.

NOTE: As the last connection is made, note indications of generator loading. (A momentary drop in RPM.) Record time in Field Log Book, then monitor the discharge hose. Note time flow starts in the Field Log Book. If no flow occurs within 15 minutes, verify the electrical connections and notify the FRC&SO if flow cannot be achieved.

4.3.4 Upon pumping two well casing volumes, sample evacuation discharge with a clean glass beaker. First inspect sample for visual clarity, immiscible layers of fluid in the sample, or any abnormal odors or colors. If any such abnormalities exist, notify the FRC&SO immediately and note results in Field Log Book.

4.3.5 Analyze sample for pH, conductivity and temperature and note results in the Field Log Book. If pH is greater than 8.00 or less than 5.00, or conductivity is greater than 1000 umhos/cm^2, inform the FRC&SO immediately.

4.3.6 Pump a third casing volume into a storage container, then draw another sample. Analyze for pH, temperature and conductivity as was performed in 4.3.4. If results are within 0.5 pH units and 100 umhos/cm^2 of results from 4.3.4, then pumping may be secured. If not, resample and call FRC&SO for guidance.

4.4 Sample Pump Installation and Operation

NOTE: This step may be performed while evacuation is in progress.

4.4.1 Connect the pressure regulator to a compressed air or nitrogen tank and connect the hose from the regulator to the logic unit at the port marked IN. Connect the tube from the sample pump with the male quick connect fitting to the port marked OUT. The tube with the female fitting is the sample line. Connect the sample line extension, and direct the line into a container so the water drained prior to sampling can be consolidated with the evacuation water.

4.4.2 Connect the logic unit to either the 12 V DC supply cable, or the 110 outlet using the appropriate connections and switch settings. Rotate the charge knob to 20 seconds, and the exhaust knob to 20 seconds (black arrows on logic unit). Adjust the pressure regulator to 180 psi. (Caution: Damage to the bladder pump may occur if pressure is greater than 200 psi.). Pump at least three gallons of water into a container for consolidation with the evacuation water.

4.4.3 Carefully fill the sample bottles, allowing each to overflow except for sample bottles containing preservatives. Fill the pH-conductivity and radioactivity sample bottles last. The samples should be poured directly into each bottle. It is not an acceptable practice to pour samples into a wide-mouth container and transfer them to a sample bottle. The samples should be taken in the order of their volatility (VOA, TOX, TOC, Phenols and Metals (2nd Qtr) NO_3, RAD, TDS AND pH-Cond.). Cap each sample bottle securely and complete the labeling. The following information shall be noted:

Date of sample;

Time of sample;

Analysis;

Sample location;

Sample number (The sample number is in three parts. The first part is the quarter; second part, the well number; the third part, sequential number of sample as it is taken from the well); and

Sampler's signature and printed name.

4.4.4 Place all samples in an ice chest to assure maintaining temperatures at less than 4° C and to maintain sample security. Samples shall be packed to eliminate the chance of breakage during shipment. As the samples are packed, the sample type and number shall be recorded on the chain of custody form. When all the samples have been packed, the ice chest shall be security sealed per Step 6.3., and the seal number recorded on the chain of custody form.

4.4.5 pH and Conductivity Measurement

4.4.5.1 Fill a clear glass beaker with well water.

4.4.5.2 Analyze for conductivity as follows:

1. Rinse the probe with DI water. Insert the probe into the sample.

2. Hold the probe vertically and at least 1/2" from the surfaces of the beaker.

3. Turn the selection switch to the scale. Note the conductivity in the Field Log Book and Groundwater Monitoring Log. Turn off the meter, remove the probe from the sample and rinse.

4.4.5.3. Analyze for pH as follows:

1. Rinse the probe with DI water and insert the probe into the sample.

2. Holding the probe vertically and at least one-half inch from all surfaces of the beaker, turn on the pH meter. Allow the reading to stabilize and record the results (including temperature) in the Field Log Book.

3. Rinse the probe in DI water and store.

4. Dump the sample water into the water saved from

4.4.6 After completion of step 4.4.5 for the last sample well, fill the field blank samples (per Section 3.6) and analyze for pH, conductivity and temperature per 4.4.5.

4.4.7 Cap and security seal the well to assure its integrity for the next sampling. Record seal numbers in the Field Log Book.

4.4.8 Review the logs for completeness prior to moving to the next sample point.

5.0 ACTION LEVELS

5.1 Field Observation

If pH is greater than 8.0 or less than 5.0 or conductivity is noted greater than 1000 umhos/cm^2 or immiscible layers, unusual odor or loss of security is noted, the FRC&SO shall be notified immediately.

5.2 Lab Results - See Table 6.1 of the FSM and ROP 15.

If levels of greater than twice background are reported, the facility manager, FRC&SO and radiological operations officer shall be notified immediately.

6.0 RECORDS

6.1 Field Log Book. All information pertinent to field sampling must be recorded in a log book, regardless of the type of sample. The field log book should be a bound book, preferably with consecutively numbered pages. A log entry shall contain at a minimum the following information:

6.1.1 Collector's sample number;

6.1.2 Location of sampling;

6.1.3 Name of collector;

6.1.4 Security seal numbers removed;

6.1.5 Date and time of sampling;

6.1.6 Number and volume of sample(s);

6.1.7 Method of sampling;

6.1.8 Purpose of sampling;

6.1.9 Field observations - Sampling situations vary widely, so no general rule can be given for the amount of information required. The best guideline is to record sufficient information, including date necessary to complete the Groundwater Monitoring Log (Attachment 49-2), so that someone could reconstruct the sampling without relying on the collector's memory. The field Log book(s) shall be maintained and filed chronologically, when full; and

6.1.10 Security seal numbers applied.

6.2 Chain of Custody Record (Attachment 49-1)

6.2.1 A work request must accompany the C of C form and the samples. The request form is a cover letter and must contain the following:

6.2.1.1 Purchase order number,

6.2.1.2 Work order number, issued from the work order log,

6.2.1.3 Within the text of the request, it must refer the vendor to the specifications, and limits set forth in the purchase order,

6.2.1.4 Current vendor address, including the name of the contact person; and

6.2.1.5 A request of the work to be performed with a general description of the samples which refers the vendor to the C of C for specific sample numbers.

6.2.2 The chain of custody form will be filled out as follows:

6.2.2.1 Project name - in block provided after "Richland Facility." Groundwater - type in reason for sample (i.e. "grab sample" or "quarterly").

6.2.2.2 Work order number - same as on the cover letter.

6.2.2.3 Sample number (three part) - number being; well number, then quarter, then sample number in order drawn (i.e. 3-13-1).

6.2.2.4 Date - date of sample.

6.2.2.5 Time - time of sample.

6.2.2.6 Well number - number of well sampled (trip blanks call "blanks", field blanks call "Well 16."

6.2.2.7 Total No. of Cont. - the number of containers for that sample.

6.2.2.8 Analysis/Parameters - check the blocks appropriate to the sample and write in any extra analysis in "Remark." Normal analysis are as follows:

1. Routine Quarterly - blocks 1, 2, 3, 4, 5, 6, and 7
2. 2nd Quarter - blocks 1, 2, 3, 4, 5, 6, 7, 8 and 9.
3. Grab samples - as directed by FRC&SO.

6.2.2.9 Security seal number - shall be the work order number (see 6.3 for seal requirements).

6.2.2.10 Samplers - signature of person who took the sample(s).

6.2.2.11 relinquished by - signature of person who sends samples, (verifying that samples have left site enroute to vendor by mail or some other authorized carrier).

6.2.2.12 Certification of seal and receipt block is to be filled out by vendor upon receipt.

6.3 Requirements for Security Seals

6.3.1 Each well shall have its own seal, therefore, samples must be packaged so the entire set of samples is in a single package (no splitting the samples of one well between two or more shipping containers). More than one well may be placed in a single shipping container so long as shipping weight permits.

6.3.2 Each sample taken shall be listed on the seal for its well, and it shall include with it, its volume, analysis and number of parts.

6.3.3 The sample technician shall sign the seals verifying that all those samples are present and packaged for shipping.

6.4 Routing of Cover Letters and C of C's

6.4.1 Cover letters:

1. Original to vendor
2. To billing (our front desk)
3. To work order book
4. Attached to the third copy of the C of C, and placed in C of C log.

6.4.2 Chain of Custody:

1. Original to vendor, to be signed and returned to the site
2. Vendor's copy
3. To vendor to be signed and returned to site.

4. Removed at site prior to shipping, after "relinquished by" signature, and is attached to the fourth copy of the cover letter and placed in the C of C log.

6.5 Groundwater Monitoring Log (Attachment 49-2)

6.5.1 Complete Attachment 49-2 using data recorded in the Field Log Book.

6.5.2 Route for review to the FRC&SO, Facility Manager and the R.O.O.

7.0 BIBLIOGRAPHY

1. RCRA Part B Application, Section 5.0
2. Washington State Radioactive Material License WN-I019-2
3. Nuclear Regulatory Commission Special Nuclear Material License 16-19204-01
4. US Ecology Facility Standards Manual

ATTACHMEI .9-1

CHAIN OF CUSTODY RECORD

PROJECT NAME: RICHLAND FACILITY GROUNDWATER
REASON:
WORK ORDER #: _____

SAMPLERS: _____
(SIGNATURE)

SAMPLE NUMBER	DATE	TIME	WELL NUMBER	TOTAL NO. OF CONT.	ANALYSIS / PARAMETERS 1 VOA	2 TOX	3 TOC	4 Radionuclides	5 Nitrates	6 pH/Conductivity	7 TDS, Chlorides, Sulfates	8 Metals	9 Phenols	REMARKS

RELINGUISHED BY: DATE/TIME

REMARKS:

I HEREBY CERTIFY THAT SEAL #_____ WAS INTACT UPON RECEIPT OF THE ABOVE DESCRIBED SAMPLES, AND ALL WERE IN GOOD CONDITION EXCEPT AS NOTED.

(SIGNATURE AND TITLE) (COMPANY) (DATE)

ATTACHMENT 49-2

GROUNDWATER MONITORING LOG

US ECOLOGY, INC.
RICHLAND, WASHINGTON

Month_____ Day_____ Year_____

WELL NO.	DATE/TIME OF INSPECTION	DEPTH TO WATER (ft)	AMOUNT OF WATER PURGED (gal)	pH	TEMP (°C)	SPECIFIC CONDUCTANCE (uMhos)	ODOR	APPEARANCE	REMARKS

Sample Technician:_____ Facility Manager:_____

FRC&SO:_____ Mail to R.O.O._____
FRC&SO Initials

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TABLE C-4

SOIL QUANTITATION LIMITS AND STANDARDS

Analyte	Quantitation Limit	MTCA[a] Method B Formula Values	MTCA Method B 100 x Groundwater[b]	MTCA[c] Method A Industrial Soil	Laboratory PQL Range[d]
Azinphos Methyl	227	--	--		
Coumaphos	400	--	--		
Herbicides, Appendix IX, EPA 8150	**(µg/kg)**	**(µg/kg)**	**(µg/kg)**	**(µg/kg)**	**(µg/kg)**
2,4-D	100	640,000	12,800		
2,4,5-TP (Silvex)	100	640,000	12,800		
Polychlorinated dioxins/furans, Appendix IX; EPA 8280	**(µg/kg)**	**(µg/kg)**	**(µg/kg)**	**(µg/kg)**	**(µg/kg)**
Total Tetra CDD	1[j]	--	--		
Total Penta CDD	2.5[j]	--	--		
Total Hexa CDD	2.5[j]	--	--		
Total Tetra CDF	1[j]	--	--		
Total Penta CDF	2.5[j]	--	--		
Total Hexa CDF	2.5[j]	--	--		
2,3,7,8-TCDD	1[j]	6.67e-3	5.83e-5		
Cyanide, EPA 335.2	0.5 mg/kg	1,600,000	32,000		
Sulfide, EPA 9030	5.0 mg/kg	--	--		
Metals, Appendix IX, EPA 6010/7000	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**
Antimony	1.5	--	--		
Arsenic	1.0	1.67	0.00583	200	0.00025-0.5
Barium	1.0	5,600	112		
Beryllium	0.1	0.233	0.002		0.125-0.25
Cadmium	0.5	80	1.6	10	
Chromium	1.0	400[k]	8[k]	500	
Cobalt	0.5	--	--		
Copper	0.5	2,960	59.2		
Lead	0.5	--	--	1,000	
Mercury	0.1	24	0.48	1.0	
Nickel	1.0	1,600	32		
Selenium	0.5	400	8		
Silver	1.0	400	8		
Thallium	1.0	5.6	0.112		

TABLE C-4

SOIL QUANTITATION LIMITS AND STANDARDS

Analyte	Quantitation Limit	MTCA[a] Method B Formula Values	MTCA Method B 100 x Groundwater[b]	MTCA[c] Method A Industrial Soil	Laboratory PQL Range[d]
Tin	100	48,000	960		
Vanadium	0.5	560	11.2		
Zinc	1.5	24,000	480		
Total Organic Carbon, EPA 415.1	0.01%	--	--		
Radiological Analyses	**(pCi/g)**				
Uranium-234	0.05				
Uranium-235	0.05				
Uranium-238	0.05				
Radium-226	0.1				
Radium-228	1.0				
Tritium	0.3				
Gross Alpha	5				
Gross Beta	5				
Gamma Isotopic	0.03				

-- Data not available.

(a) Model Toxics Control Act Method B formula values, 2/28/96 from *Cleanup Levels and Risk Calculations (CLARC II) Update*, February 1996.

(b) Federal maximum concentration level values as listed in Model Toxics Control Act *Cleanup Levels and Risk Calculations (CLARC II) Update*, February 1996.

(c) Method A values from Model Toxics Control Act Cleanup Regulation, chapter 173-340 WAC, amended December 1993.

(d) Practical quantitation limit (PQL) ranges are from Ecology Implementation Memo No. 3, from Steve Robb, Toxics Cleanup Program, dated November 24, 1993. Values are included where reporting limit exceeds a criterion.

(e) Isomer not specified.

(f) Value is for o-isomer.

(g) Value is for p-isomer.

(h) Total carcinogenic PAH.

(i) Value is for Endosulfan.

(j) Detection limits for dioxins and furans may change depending on signal-to-noise ratio.

(k) Value assumes all chromium is chromium (VI).

TABLE C-5

LABORATORY ANALYSES

Sample	Analysis	Method No.[a]
Soil gas	Volatile organics	EPA TO-14[b]
	Methane plus fixed gases	ASTM D 1946[c]
	Tritium	T-02, T-06[d]
	Radon	Radtrack Detector, Landauer, Inc.
	Total pressure	Field procedure
Soil	PID Volatile organics screening	Field procedure
	Volatile organics	EPA 8240
	Appendix IX	
	Volatile organics	EPA 8240
	Semivolatile organics	EPA 8270
	Chlorinated pesticides/PCBs	EPA 8080A
	Herbicides	EPA 8150
	Organophosphorus pesticides	EPA 8140
	Polychlorinated dioxins/furans	EPA 8280
	Cyanide	EPA 9010
	Sulfide	EPA 9030
	Metals	EPA 6010/7000
	Radiological	
	Uranium-234	PRO-052-32[d]
	Uranium-235	PRO-052-32[d]
	Uranium-238	PRO-052-32[d]
	Radium-226	RA-01[d]
	Radium-228	RA-01[d]
	Tritium	T-02, T-06[d]
	Gross alpha	AB-01[d]
	Gross beta	AB-01[d]
	Gamma isotopic	GS-01[d]
	Total organic carbon	EPA 415.1[e]
	Physical analyses	
	Unit weight	COE EM 1110-2-1906, App II[f], ASTM D 4718[g]
	Particle size distribution	ASTM D 422[h]
	Water content	ASTM D 2216[i]
Water	Volatile organics	EPA 8240
	Metals (barium, chromium, lead, vanadium)	EPA 6010/7000
	Tritium	T-02[d]

(a) All methods are from EPA 1986 unless otherwise noted.
(b) EPA. 1984.
(c) ASTM 1982.
(d) Teledyne Isotopes Midwest Laboratory procedure.
(e) EPA. 1983.
(f) COE. 1970.
(g) ASTM. 1987a.
(h) ASTM. 1987b.
(i) ASTM. 1987c.

TABLE C-6

FIELD QC SAMPLES

	Matrix	Analysis	Total Number of Samples	Field Duplicates	Field Blanks[a]
Phase 1	Soil gas	Volatile organics (TO-14)	3	1	–
	Groundwater	Volatile organics (8240)	7	1	1 ERB or 1 TB/cooler[b]
		Metals (4)	7	1	1 ERB
Phase 2	Driller's water	Tritium	≥1	0	–
		Volatile organics	≥1	0	–
	Soil	Appendix IX	≤6	1	–
		Radiological	≤6	1	–
		Volatile organics (8240)	≥16	1:20[c]	1:20 ERB
		Total organic carbon	8	1	–
		Physical parameters	8	0	–
	Soil gas	Volatile organics (TO-14)	≤8	1	–
		Methane plus fixed gases	≤8	1	–
		Tritium and radon	≤8	0	–
Phase 3	Soil	Volatile organics (8240)	≥56	≥3 (1:20)	1:20 ERB
	Soil gas	Volatile organics (TO-14)	28	2	–
		Methane plus fixed gases	[d]	1:20	–

(a) TB = Trip Blank
ERB = Equipment Rinsate Blank. ERB samples may be omitted if only dedicated or disposable sampling equipment is used.

(b) The TB sample will be included only if the ERB is not collected.

(c) One QC sample is to be collected for every 20 samples. If fewer than 20 samples are collected, one QC sample shall be submitted.

(d) Methane samples will be collected based on results of TO-14 analyses.

APPENDIX D

Drilling and Soil Sampling Collection Methods

APPENDIX D

DRILLING AND SOIL SAMPLING COLLECTION METHODS

PHASE 2 VERTICAL BORINGS

Phase 2 vertical borings will be drilled using cable tool methods and a 10-inch diameter casing. Water will be added to the casing during drilling so the cuttings will form a slurry that can be removed from the casing. The water the drillers use will be sampled at least once and tested for volatile organic compounds and tritium.

Samples will be collected every 2.5 ft, beginning 5 ft below ground surface. The casing will be driven to the top of the sample interval, and the soil cuttings removed prior to collecting each sample.

Samples will be collected with a 2.4-inch internal diameter split-spoon sampler. The sampler will be driven ahead of the casing. After the sampler is removed, it will be opened and a representative portion of the undisturbed sample will be collected with a stainless steel spoon and placed into labeled, laboratory-supplied containers for possible volatile organic compound analysis. A second portion will be placed in a disposable container for screening with a portable photoionizing detector(PID) and a Geiger-Mueller detector (GMD).

The sample description will include the following information: depth interval; penetration resistance; amount recovered; interval placed in sample container; soil color; texture; stratification; and signs of potential contamination such as stains, excess moisture, oily residues, odors, etc. In addition, notes will be kept during drilling regarding progress, when water is added, drilling ease, equipment and personnel performance, etc.

Periodically, samples will be screened for organic vapors. The PID will be calibrated. Then, the headspace in each container will be tested and the highest PID reading recorded. Occasionally water and container blanks will be tested. The PID calibration will be checked immediately following each sample screening event to verify that no drift has occurred.

The samples will be screened for radioactivity after PID screening. Sample container covers will be removed and the container placed in a semishielded location away from other samples and potential contamination. The GMD sensor will be placed over the sample container and the total counts for one minute recorded.

All drilling equipment will be decontaminated before drilling each boring and before leaving the site. The drilling equipment will be washed with a high pressure, hot water washer. Sampling

equipment will be decontaminated by rinsing off the loose soil with water, scrubbing with alconox solution, rinsing with clean tap water, and rinsing with distilled water. The used water and drill cuttings will be disposed of in a manner consistent with current site procedures and regulatory criteria.

The site activities will be performed in accordance with US Ecology, Inc., Richland, Washington *Facility Standards Manual* (1994) and the *American Ecology Safety and Loss Control Manual* (1993).

PHASE 2 ANGLE BORINGS

Phase 2 angle borings will be drilled with air rotary equipment. The drilling angle, direction, and sample intervals will be selected after reviewing the logs of the vertical borings using the criteria discussed in Section 4.1.1. The boring will be drilled to the top of the desired sample interval. The loose cuttings will be blown out of the casing using the lowest air pressure possible. The samples will then be collected at 2.5-ft (lineal) intervals using a split-spoon sampler, subsampled into containers and described and screened in the same manner as described above. Equipment will be decontaminated and drill cuttings will be disposed of in the same manner as described above.

Each angle boring will be surveyed about half way to its anticipated final depth. First the angle of the boring from vertical will be measured. The offset from the predicted depth will be calculated. This information will be used to determine at what location the next sample will be collected and the need to survey at deeper depths.

After the samples have been collected, each angle boring will be backfilled with bentonite chips. Each surface location will be marked and the horizontal (about 1 ft accuracy) and vertical (about 0.1 ft accuracy) position determined.

PHASE 3 VERTICAL BORINGS

Phase 3 vertical borings will be drilled using either 6-inch diameter cable tool or 3 to 4-inch ID hollow-stem auger methods. Hollow-stem auger is preferred because no fluids are required, but the auger may be unable to achieve the required depths. Otherwise, sampling, screening, and decontamination methods are essentially the same as described above for Phase 2 vertical borings.

APPENDIX E

Well Construction Methods for Phases 2 and 3

APPENDIX E

WELL CONSTRUCTION METHODS FOR PHASES 2 AND 3

PHASE 2 VAPOR WELLS

The well screen locations for the Phase 2 vapor monitoring wells will be selected after the borings have been drilled and logged. As described in Section 4.1.2, a well screen will be placed in each of the following depth intervals below the bottom of the adjacent trench: 0 to 10 ft, 10 to 30 ft, 30 to 60 ft, and 60 to 100 ft. The screen will be placed in a coarse-grained stratum in each interval or near locations where signs of contamination are present.

Four nested wells will be constructed in each of the two Phase 2 borings. Each well will be constructed of 2-inch diameter Schedule 40 PVC and will have well screens up to 5 ft long. The PVC casing will have flush, threaded, O-ring sealed joints. Each bottom cap will be drilled with small holes to prevent the accumulation of condensation. The screens will be surrounded by 10-20 sand with at least 1 ft of sand between the screen and bentonite pellets. About ½ ft of bentonite pellets will separate the bentonite grout from the sand pack. After placing the pellets, at least 5 ft of bentonite grout will be tremmied into place before placing the next sand pack and screen.

The top of each PVC casing will have an air tight, removable cap with a bulkhead fitting. One-quarter inch polyethylene tubing will be suspended from the bulkhead fitting so that the tubing terminates in the well screen. The tubing will terminate in a ¼ inch valve located outside the cap (and inside the protective monument). Each of the deepest and shallowest wells will have copper-constantan thermocouple junctions placed just above their well screens attached to the outside of the PVC casing. The labeled wires from each thermocouple will terminate inside the well monument.

The well will be completed by surrounding the four PVC casings with a locking protective monument grouted into place with concrete grout. The monument will have weep holes to prevent the accumulation of condensation. Each monument will be surrounded by bollards grouted into the ground with concrete grout. The planned construction is summarized on Figure E-1.

The horizontal (1-ft accuracy) and vertical (0.1-ft accuracy) locations of the monitoring wells will be determined by survey after completion.

PHASE 3 VAPOR WELLS

The well screen locations for the Phase 3 vapor monitoring wells will be selected after the borings have been drilled and logged. As described in Section 5.1, a well screen will be placed in

each of the following depth intervals below the bottom of the adjacent trench: 0 to 20 ft and 20 to 50 ft. The screen will be placed in a coarse-grained stratum in each interval, or near locations where signs of contamination are present.

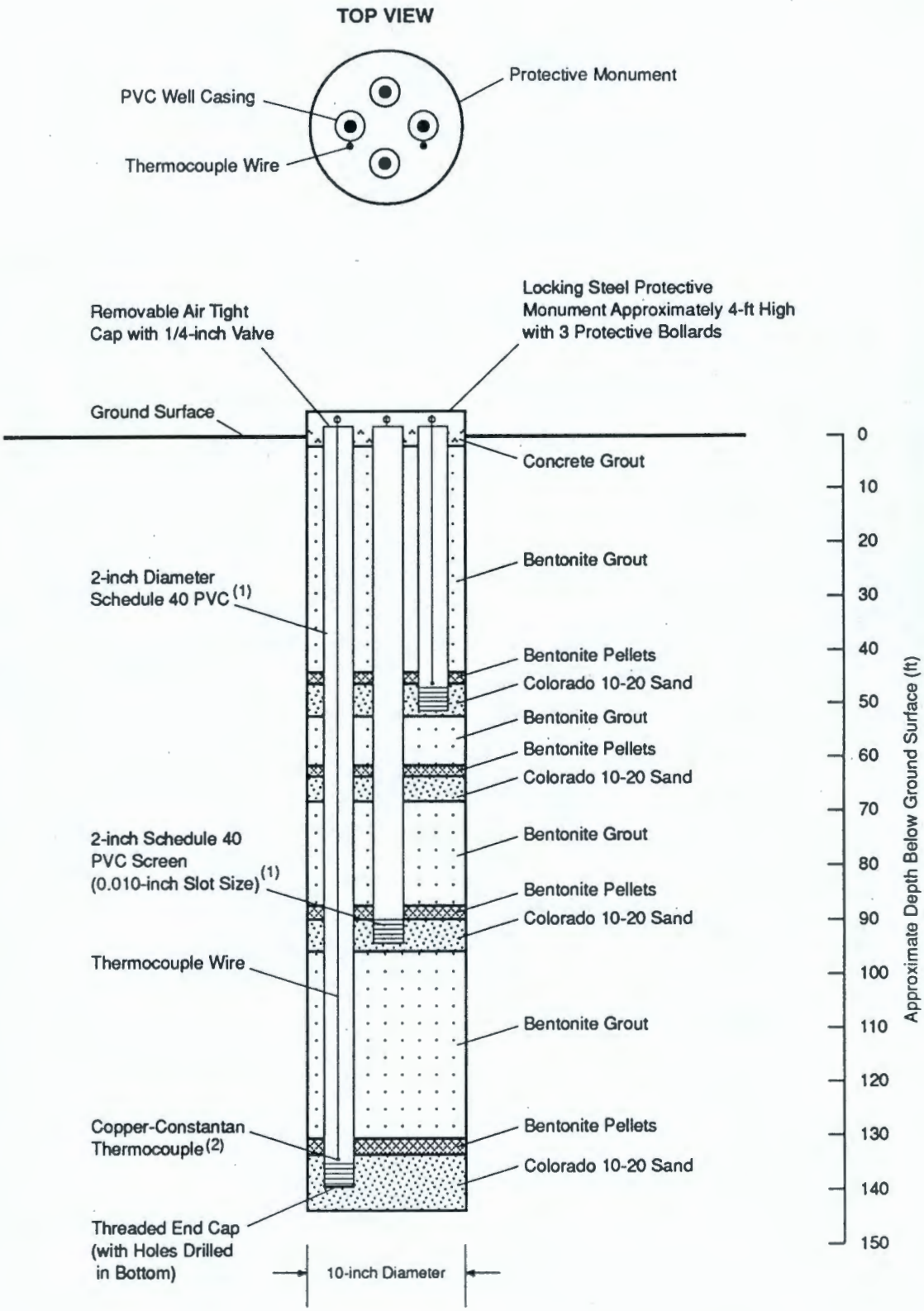
Two nested wells will be constructed in each of the 14 Phase 3 borings. Each well will be constructed of ½-inch diameter Schedule 80 PVC and will have well screens up to 5 ft long. The PVC casing will have flush, threaded, O-ring sealed joints. Each bottom cap will be drilled with three small holes to prevent the accumulation of condensation. The screens will be surrounded by 10-20 sand with at least 1 ft of sand between the screen and bentonite pellets. About ½ ft of bentonite pellets will separate the bentonite grout from the sand pack. After placing the pellets, at least 5 ft of bentonite grout will be tremmied into place before placing the next sand pack and screen.

The top of each PVC casing will be capped with a reducer and ¼-inch valve.

The well will be completed by surrounding the two PVC casings with a locking protective monument grouted into place with concrete grout. The monument will have weep holes to prevent the accumulation of condensation. Each monument will be surrounded by bollards grouted into the ground with concrete grout. The planned construction is summarized on Figure E-2.

The horizontal (1 ft accuracy) and vertical (0.1 ft accuracy) locations of the monitoring wells will be determined by survey after completion.

All site activities for both Phase 2 and Phase 3 vapor wells will be performed in accordance with US Ecology, Inc., Richland, Washington *Facility Standards Manual* (1994) and the *American Ecology Safety and Loss Control Manual* (1993).

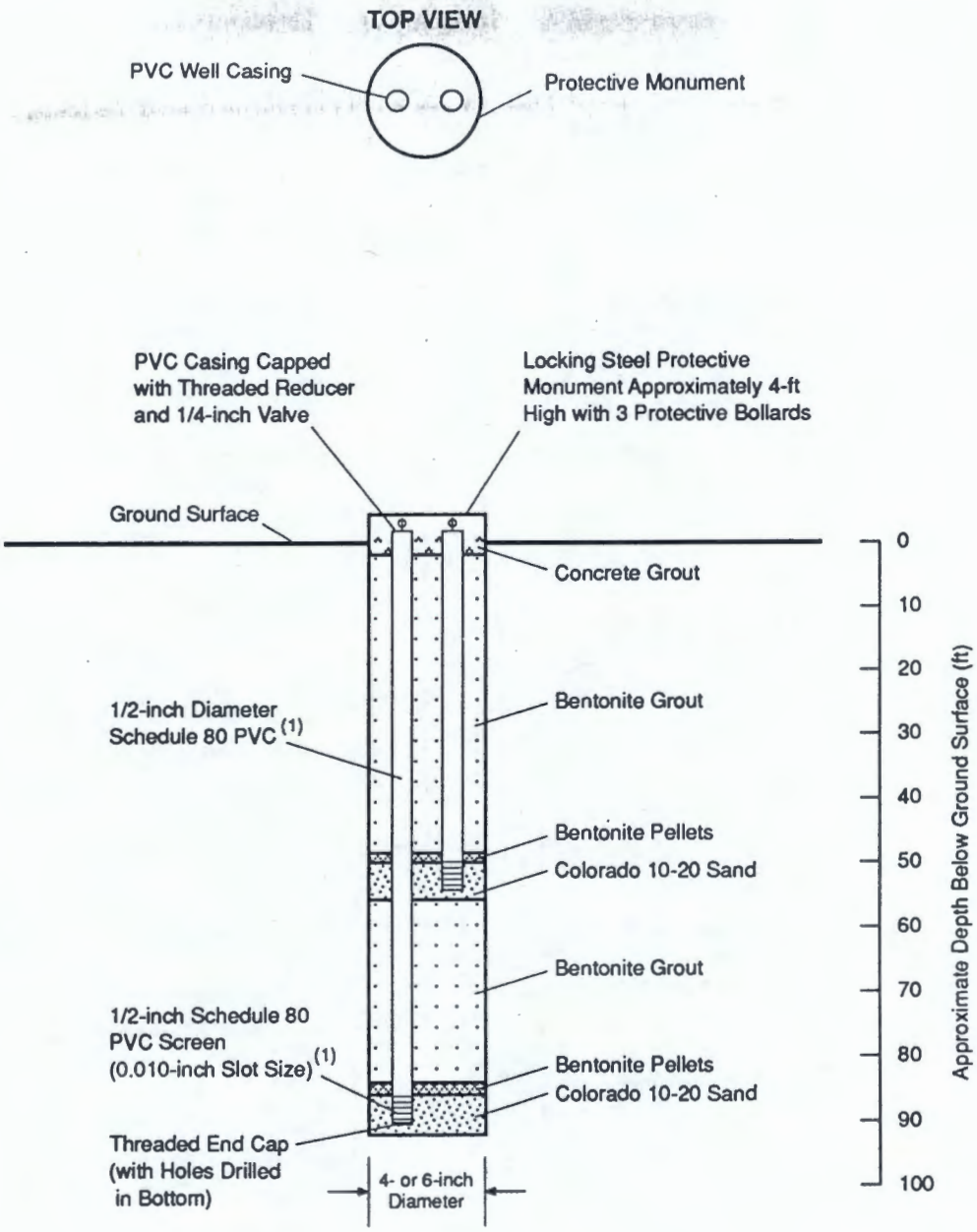


Notes: 1. Subsurface PVC will have flush threaded joints with O-ring seals.
2. Only the deepest and shallowest casings will have thermocouples.

323001.10 U.S. Ecology/Work Plan (M) 3/98

Phase 2 Vapor Well Construction

Figure E-1



Note: 1. Subsurface PVC will have flush threaded joints with O-ring seals.

3230001.10 U.S. Ecology/Work Plan (M) 3/96

Phase 3 Vapor Well Construction

Figure E-2

APPENDIX F

Vadose Well Sampling for Tritium and Radon-222

RICHLAND OPERATIONAL PROCEDURE

TITLE Vadose Well Sampling for Tritium and Radon-222 ROP NO. 18

TECHNICAL CONCURRENCE _____ PAGE 1 OF 3

APPROVAL _____ REV. 1 DATE 12/03/92

1.0 INTRODUCTION

Determination of tritium and radon-222 in vadose monitoring wells is desired for purposes of identifying any migration of these radionuclides from the burial trenches. This procedure documents the steps to follow in obtaining vadose well samples.

2.0 EQUIPMENT

1. Silica gel, 6-16 mesh.
2. Tritium sample chamber.
3. Landauer Radtrak detectors, or equivalent, with thoron diffusion barriers.
4. Tritium sample chamber and radon detector suspension device.
5. Airtight sample shipment containers.
6. Sampling field log.
7. Drying oven.

3.0 PRECAUTIONS

1. Keep dried silica gel, for tritium samples, in sealed bags and radon detectors in sealed shipment containers prior to exposure in the well.
2. Exposure of silica gel and radon detectors to ambient air shall be minimized to the extent practicable.
3. Sampling equipment shall be dedicated to individual wells.

4.0 PROCEDURE

4.1 Prepare silica gel for use as follows:

4.1.1 Ensure silica gel is completely dry by baking at 140° C, in the drying oven, for a minimum of four hours.

4.1.2 After allowing silica gel to completely cool, seal in individual packets until ready to use.

4.2 At the Well site perform the following:

Note: Ensure shipment containers for samples in service are available to minimize exposure to ambient air.

4.2.1 Unlock and open well head cover.

4.2.1.1 Remove well cap;

4.2.1.2 Check for unusual odor. If present, perform vapor sampling to determine potential for fire, explosion or toxic vapors.

4.2.2 Remove tritium sample chambers and radon detectors from the well. Remove silica gel from tritium sample chamber, place in plastic bag and seal. Place radon detectors in original shipment container and seal.

NOTE: If soil vapor sampling is required, perform in accordance with ROP 19 prior to replacing sample canisters or detectors.

4.2.3 Refill tritium sample chambers with dried silica gel, remove sample radon detectors from their shipment containers and attach to the suspension device.

4.2.4 Lower the sample chamber and detectors into the well using the suspension device (this will position the monitors in the screened portion of the well).

4.2.5 Resecure the well head by replacing the well cap and closing and locking the cover.

4.2.6 The sample containers and detectors shall be sent to vendor laboratories for analysis. A chain of custody shall accompany the samples.

4.3 Log the following in the vadose well field log book:

4.3.1 Date, time, well and samplers name;

4.3.2 General weather conditions;

4.3.3 Serial numbers of sample chambers and detectors placed in and removed from service;

4.3.4 Any other unusual or pertinent information.

5.0 ACTION LEVELS

No action levels are associated with the vadose zone well sampling program.

6.0 RECORDS

A field log book shall be maintained for all vadose zone well samples and shall contain the following information:

- Sample date and time,
- General weather conditions,
- Name of sampler,
- Sample location, and
- Serial numbers of samplers (as appropriate).

7.0 BIBLIOGRAPHY

National Council on Radiation Protection and Measurements Report No. 47, Tritium Measurement Techniques, May 28, 1976.

APPENDIX G

Temperature and Pressure Measurements in Vapor Wells

APPENDIX G

TEMPERATURE AND PRESSURE MEASUREMENTS IN VAPOR WELLS

Site activities will be performed in accordance with US Ecology, Inc., Richmond, Washington *Facility Standards Manual* (1994) and the *American Ecology Safety and Loss Control Manual* (1993).

TEMPERATURE MEASUREMENT

EQUIPMENT LIST

- Well key
- Notebook
- Pyromation Model 01800 meter.

PROCEDURE

1. Check meter calibration according to manufacturer's instructions.
2. Unlock well monument.
3. Remove protective rubber bootie from miniplug and clean off any dust and moisture.
4. Connect miniplug to meter and allow reading to stabilize. Record temperature, time, location, etc.
5. Disconnect miniplug, replace bootie, and repeat procedure with other thermocouple. Lock monument when through.

PRESSURE MEASUREMENT

EQUIPMENT LIST

- Well key
- Notebook
- Magnehelic pressure gauges with pressure ranges from -1 to +1, -10 to +10, and -100 to +100 inch water connected to a manifold
- Tygon tubing
- Barometer or weather radio.

PROCEDURE

1. Record zero readings on all gauges before starting. Make sure gauge is in same position when pressure readings are taken.
2. Record time and barometric pressure before starting. If a vapor sample is required, collect the sample only after completing all pressure measurements at that well cluster.
3. Unlock well. Connect pressure gauge manifold to well.
4. Slowly open valve on top of well casing. Working from the least sensitive to the most sensitive gauges, slowly open and close manifold valves until an accurate pressure reading can be taken. Record the well ID, the time, and the pressure (as positive or negative inches of water). If the reading is not steady, record the changes that occur.
5. Close the valve at the top of the well casing. Repeat the procedure at the rest of the wells at that cluster before collecting any samples. When finished, lock the well, record the time and barometric pressure.
6. Convert barometric pressure to millibars.
7. Convert magnehelic gauge reading (retaining positive or negative sign) to millibars.
8. Add or subtract (depending on the sign) the magnehelic gauge pressure (in millibars) to the barometric pressure (in millibars) at the time the magnehelic measurements were made. If the barometric pressure was made at a different time, use a linear interpolation to estimate the barometric pressure.

APPENDIX H

Cost Estimate

TABLE H-1

COST ESTIMATE SUMMARY

Task		Cost Estimate
Phase 1		
Prepare field plan (HASP, SAP)	$	4,980.00
Field Technical Supervision	$	19,530.00
Analyses	$	3,110.00
Reporting	$	16,980.00
TOTAL - Phase 1	$	44,600.00
Phase 2		
Prepare field plan	$	8,300.00
Drilling	$	72,200.00
Field technical supervision	$	42,736.00
Analyses	$	32,070.00
Modeling/reporting	$	42,660.00
TOTAL - Phase 2	$	197,966.00
Phase 3		
Prepare field plan	$	1,660.00
Drilling	$	285,600.00
Field technical supervision	$	148,521.00
Analyses	$	25,200.00
Reporting	$	45,100.00
TOTAL - Phase 3	$	506,081.00
TOTAL PHASES 1, 2, AND 3	$	748,647.00

TABLE H-2

DETAILED COST ESTIMATE

Task	Quantity/unit	Unit Cost	Cost	Task Subtotal
Phase 1				
Prepare field plan (HASP, SAP)	60 hours	$ 83.00	$ 4,980.00	$ 4,980.00
Field technical supervision				
Field preparation time	40 hours	$ 83.00	$ 3,320.00	
Sample collection - vapor	40 hours	$ 83.00	$ 3,320.00	
Sample collection - Groundwater	80 hours	$ 83.00	$ 6,640.00	
Project management/review	24 hours	$ 125.00	$ 3,000.00	
Truck rental	10 days	$ 50.00	$ 500.00	
Equipment rental	10 days	$ 100.00	$ 1,000.00	
Supplies	10 days	$ 25.00	$ 250.00	
Per diem	15 days	$ 100.00	$ 1,500.00	
Subtotal - field supervision				$ 19,530.00
Analyses				
Water - VOA	7 each	$ 250.00	$ 1,750.00	
Gas - TO14	4 each	$ 340.00	$ 1,360.00	
Subtotal - analyses				$ 3,110.00
Reporting				
Report preparation	80 hours	$ 83.00	$ 6,640.00	
Drafting	20 hours	$ 51.00	$ 1,020.00	
Computer time	20 hours	$ 10.00	$ 200.00	
Report review	40 hours	$ 125.00	$ 5,000.00	
Project management	40 hours	$ 103.00	$ 4,120.00	
Subtotal - reporting				$ 16,980.00
Total - Phase 1				$ 44,600.00

TABLE H-2

DETAILED COST ESTIMATE

Task	Quantity/unit	Unit Cost	Cost	Task Subtotal
Phase 2				
Prepare field plan	100 hours	$83.00	$8,300.00	$8,300.00
Drilling				
Vertical holes, 145 ft, 2.5-ft sample spacing	2 each	$20,400.00	$40,800.00	
Angled holes, 150' ft, 3-4 samples	2 each	$15,700.00	$31,400.00	
Subtotal - drilling				$72,200.00
Field technical supervision				
Geophysical survey	1 each	$3,000.00	$3,000.00	
Field preparation time	40 hours	$83.00	$3,320.00	
Drilling supervision	240 hours	$83.00	$19,920.00	
Vapor sampling	12 hours	$83.00	$996.00	
Project management/review	50 hours	$125.00	$6,250.00	
Truck rental	30 days	$50.00	$1,500.00	
Equipment rental	30 days	$100.00	$3,000.00	
Field supplies	30 days	$25.00	$750.00	
Per diem	30 days	$100.00	$3,000.00	
Survey well locations	1 lump sum	$1,000.00	$1,000.00	
Subtotal - field supervision				$42,736.00
Analyses				
Soil - VOA	17 each	$250.00	$4,250.00	
Soil - TOC	8 each	$40.00	$320.00	
Soil - physical parameters (grain size, etc.)	8 each	$100.00	$800.00	
Soil - Appendix IX	6 each	$3,940.00	$23,640.00	
Gas - TO14	9 each	$340.00	$3,060.00	
Subtotal - analyses				$32,070.00
Reporting				
Modeling/report preparation	240 hours	$83.00	$19,920.00	
Drafting	40 hours	$51.00	$2,040.00	
Computer time	40 hours	$10.00	$400.00	
Report review	80 hours	$125.00	$10,000.00	
Project management	100 hours	$103.00	$10,300.00	
Subtotal - reporting				$42,660.00
Total - Phase 2				$197,966.00

TABLE H-2

DETAILED COST ESTIMATE

Task	Quantity/unit	Unit Cost	Cost	Task Subtotal
Phase 3				
Prepare field plan	20 hours	$83.00	$1,660.00	$1,660.00
Drilling				
Vertical holes, 145 ft, 2.5 ft sample spacing	14 each	$20,400.00	$285,600.00	
Subtotal - drilling				$285,600.00
Field technical supervision				
Field preparation time	40 hours	$83.00	$3,320.00	
Drilling supervision	1008 hours	$83.00	$83,664.00	
Sample collection - vapor	64 hours	$83.00	$5,312.00	
Project management/review	107 hours	$125.00	$13,375.00	
Truck rental	138 days	$50.00	$6,900.00	
Equipment rental	138 days	$100.00	$13,800.00	
Field supplies	138 DAY	$25.00	$3,450.00	
Per diem	138 days	$100.00	$13,800.00	
Travel(air fare)	26 trips	$150.00	$3,900.00	
Survey well locations	1 lump sum	$1,000.00	$1,000.00	
Subtotal - field supervision				$148,521.00
Analyses				
Soil - VOA	60 each	$250.00	$15,000.00	
Gas - TO14	30 each	$340.00	$10,200.00	
Subtotal - analyses				$25,200.00
Reporting				
Report preparation	240 hours	$83.00	$19,920.00	
Drafting	80 hours	$51.00	$4,080.00	
Computer time	80 hours	$10.00	$800.00	
Report review	80 hours	$125.00	$10,000.00	
Project management	100 hours	$103.00	$10,300.00	
Subtotal - reporting				$45,100.00
Total - Phase 3				$506,081.00
Total Phases 1, 2, and 3				$748,647.00