1992 ANNUAL RCRA GROUNDWATER MONITORING REPORT FOR REGULATED UNITS AT THE ROCKY FLATS PLANT

MARCH 1, 1993

EG&G Rocky Flats, Inc
Environmental Management Department

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ADMIN RECORD

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EG&G ROCKY FLATS

INTEROFFICE CORRESPONDENCE

DATE: March 6, 1992

TO: P. L. Fuller, Remediation Programs Division, Bldg. T130B, X5744

FROM: R. B. Hoffman, Classification Office, T893B, X4598 SLC for RBH

SUBJECT: **CLASSIFICATION EXEMPTION WAIVER FOR REMEDIATION PROGRAMS DIVISION (RPD) DOCUMENTS**

Your request for exemption from classiification/UCNI review of Remediation Programs Division (RPD) documents as proposed in your letter of March 5, 1992 has been considered.

Based upon a substantial historical perspective, we have concluded that the reporting activities in which your Division of the Environmental Management Department is involved are unclassified and UCNI-free in nature and content.

All reporting activities for those Operable Units (OUs) one thru sixteen, except, Operable Unit 15 -- Inside Building Closures, can be considered as exempt from further classification/UCNI review by the Classification Office. This waiver includes internal, as well as, external letters, work plans, reports, interim measures, RCRA facilities investigations, interim remedial actions, site characterization studies, human health risk assessments, environmental evaluations and assessments, comparative analyses, and other environmental and administrative documentation, as outlined in your letter. At this time sufficient knowledge of the type of information which OU 15 will comprise has not been established and until this can be acertained, classification review will be necessary.

In general, should RPD documents begin to differ in scope and context from past practice, it will become mandatory that you contact this office to ensure that this classification review waiver be justified and correct.

Should you require any further information or have any questions regarding this matter, please feel free to contact me or Karl Dallarosa (X3792) at any time.

kld

cc:
P. S. Bunge
J. E. Evered
W. A. Hunt

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ACRONYMS

RCRA	Resource Conservation and Recovery Act
RFP	Rocky Flats Plant
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compounds
IM/IRA	Interim Measure/Interim Response Action
IAG	Interagency Agreement
GWAP	Groundwater Assessment Plan
RFI/RI	RCRA Facility Investigation/Remedial Investigation
USDOE	U.S. Department of Energy
CEARP	Comprehensive Environmental Assessment and Response Program
IHSS	Individual Hazardous Substance Site
HSL	Hazardous Substance List
TCL	Target Compound List
TAL	Target Analyte List
GC/MS	gas chromatograph/mass spectrometer
CUSUM	Cumulative Sum
ANOVA	analysis of variance
PA	Protected Area
TDS	total dissolved solids
TSS	total suspended solids
BDL	below the detection limit

EXECUTIVE SUMMARY

The 1992 Annual Resource Conservation and Recovery Act (RCRA) Groundwater Monitoring Report presents 1992 interim status quarterly groundwater monitoring results for the Solar Evaporation Ponds, West Spray Field, and Present Landfill at the Rocky Flats Plant (RFP) in compliance with Colorado Hazardous Waste Act Regulations 6 CCR 1007-3, Subpart F, Section 265.90 for RCRA interim status waste management units. The purpose of the RCRA groundwater monitoring program at RFP is to determine the impact of waste management activities at the RCRA-regulated units on groundwater quality in the uppermost aquifer beneath and hydraulically downgradient of the units. This report also includes an assessment of the current groundwater monitoring activities, an evaluation of the effectiveness of the monitoring program, and recommendations concerning future monitoring activities at the RCRA-regulated units.

This report consists of (1) an assessment of the presence of hazardous waste or hazardous waste constituents associated with each unit in groundwater monitoring wells located hydraulically downgradient of the RCRA-regulated unit and (2) an evaluation of the nature and extent of hazardous waste or hazardous waste constituents within the RCRA-regulated units. The presence of hazardous waste or hazardous waste constituents in groundwater at each RCRA unit was assessed by statistically comparing groundwater quality data from upgradient monitoring wells with data from downgradient monitoring wells. The methodology for statistical comparisons of groundwater quality data followed U.S. Environmental Protection Agency (USEPA) guidance. The nature and extent of contamination was evaluated by assessing the spatial distribution of constituents associated with past waste management practices at each RCRA unit. Where applicable, groundwater quality within each RCRA unit was assessed by comparing analytical data with sitewide background values for chemical constituents presented in the 1992 Background Geochemical Characterization Report (EG&G, 1992)

The Solar Evaporation Ponds area is currently undergoing groundwater assessment monitoring. Review of water elevation data collected throughout 1992 indicates that large areas of surficial materials are unsaturated and groundwater flow from the solar ponds diverges along two major flowpaths. Groundwater flows northeast toward North Walnut Creek and east-southeast toward South Walnut Creek. Groundwater quality data from 1992 indicate that the solar ponds contribute inorganic analytes (primarily nitrate/nitrite), total dissolved solids, radionuclides, and volatile organic compounds (VOCs) to downgradient wells screened in surficial materials and weathered bedrock immediately north, east, and southeast of the ponds. The detection of VOCs upgradient of the ponds suggests another potential source of contamination. Elevated levels of nitrate/nitrite, radionuclides, organics, and other analytes detected in alluvial and bedrock wells north and downgradient of the intercept trench system may result from contaminant migration despite the presence of this containment system, or spray evaporation operations on the hillside north of South Walnut Creek.

An alternate groundwater monitoring program is underway at the West Spray Field. Groundwater flow in the uppermost aquifer is relatively uniform in an east-northeast direction. Groundwater elevations observed in 1992 were consistent with those reported in 1989, 1990, and 1991. Calculated groundwater flow velocities for 1992 were higher due to the use of a higher value for hydraulic conductivity used in 1992 calculations. Statistical evaluations of groundwater quality data indicate that the West Spray Field unit may have contributed radionuclides (gross alpha, U-233, 234, U-238), dissolved metals (calcium, sodium, and vanadium), and inorganic analytes (bicarbonate, chloride, fluoride, and silicon) to groundwater in surficial materials. Occasional detections of VOCs in monitoring wells at the West Spray Field have not been repeated during subsequent sampling and analyses.

The Present Landfill is also undergoing alternate groundwater monitoring. Review of groundwater elevation data collected for the landfill in 1992 indicates that groundwater flows easterly through surficial materials within the landfill toward the East Landfill Pond.

The groundwater flow regime in weathered bedrock units is similar to that observed in the surficial units. Examination of chemical data collected during 1992 indicates that groundwater quality in downgradient geologic materials and in weathered bedrock beneath the landfill appears unaffected by the RCRA unit with respect to VOCs, radionuclides, metals, and other inorganic analytes. The Present Landfill is impacting surficial groundwater beneath the unit with increased concentrations of VOCs, radionuclides, some metals, and major inorganic ions typical of landfill leachate. The groundwater intercept system appears effective in limiting the migration of contaminants except possibly along the south side. Contaminants detected in monitoring wells south of the Present Landfill may be due to (1) an inadequately functioning groundwater intercept system, (2) emplacement of wastes beyond the limit of the groundwater intercept system, and/or (3) impacts to groundwater associated with individual hazardous substance site Nos. 166.1, 166.2, and 166.3 located adjacent to the landfill. These conclusions are consistent with groundwater impacts described in previous groundwater monitoring reports for the Present Landfill.

1.0 INTRODUCTION

This report presents 1992 groundwater monitoring data as required under Colorado Hazardous Waste Act Regulations, 6 CCR 1007-3, Subpart F, Section 265.90 for RCRA interim status waste management units at the RFP. These units are currently undergoing closure and include the Solar Evaporation Ponds, West Spray Field, and Present Landfill. The report includes available groundwater elevation and quality data (Appendices A and B, respectively) for the first through fourth quarters of 1992 and an evaluation of previous data in accordance with 6 CCR 1007-3, Part 264.94(b).

The 1992 groundwater quality data presented in this report consist of laboratory analytical results for inorganics (approximately 99 percent complete), metals (approximately 99 percent complete), volatile organics (approximately 99 percent complete), and radionuclides (approximately 80 percent complete). All additional 1992 data not included in this report will be presented at a later date as an addendum to this report. Data obtained during 1992 and presented in this report are in the process of being validated in accordance with Environmental Management Program Quality Assurance procedures. At the time this report was prepared, approximately 70 percent of the data had been validated. Therefore, conclusions made in this report are based in part on unvalidated data and may change as the remaining data are validated. Data obtained prior to 1992 are discussed in this report where necessary and presented in other documents referenced in this report.

The regulations contained in Section 265.90 require that a groundwater monitoring program be implemented that is capable of determining the facility's impact on the uppermost aquifer underlying the facility. Implementation of the groundwater monitoring program includes the installation, operation, and maintenance of a groundwater monitoring system that meets the requirements of Sections 265.91 through 265.94. If the owner or operator assumes that groundwater monitoring of indicator parameters in accordance with 265.91 and 265.92 would show statistically significant increases when evaluated under 265.93(b), the owner/operator may install, operate, and maintain an alternate groundwater monitoring system (other than the one specified in Sections 265.91 and 265.92) that satisfies the requirements specified in 265.90(d). Because assumed releases of hazardous constituents have occurred from the West Spray Field and Present Landfill, an alternate groundwater monitoring program as required pursuant to 265.90(d) is ongoing for these units. The Solar Evaporation Ponds area is currently undergoing groundwater assessment monitoring as specified in Section 265.93(d) because it has already been established that the ponds have affected groundwater quality downgradient from the waste management unit.

Interim status groundwater monitoring of each unit will continue until the closure of the unit is certified (6 CCR 1007-3 100.20(c)). The closure plans for the interim status RCRA-regulated units will be prepared in accordance with applicable Colorado Hazardous Waste Regulations and the Interagency Agreement (IAG) through the Interim Measure/Interim Response Action (IM/IRA) process.

The Groundwater Assessment Plan (GWAP) (USDOE, 1992a) describes the process for conducting the RCRA interim-status groundwater monitoring program for the three RCRA-regulated units at RFP. The GWAP combines the initial GWAP (USDOE, 1989), the Groundwater Assessment Plan Addendum (USDOE, 1990a), and additional information in response to agency comments on these documents. The GWAP integrates the RCRA interim-status groundwater monitoring requirements (6CCR 1007-3, Part 265) for the three regulated units with those of the IAG, which is the primary document governing RFP compliance with applicable environmental restoration requirements.

The GWAP outlines methods for determining the following:

- RFP background and upgradient groundwater characteristics

- Whether hazardous waste or hazardous waste constituents have entered the groundwater system from one of the RCRA-regulated units

- The rate and extent of migration of hazardous waste or hazardous constituents in groundwater

- The concentrations of hazardous waste or hazardous waste constituents in groundwater at the regulated units

The GWAP presents an overview of the current interim-status groundwater monitoring program (6 CCR 1007-3, Part 265, Subpart F). As more information is obtained and as monitoring strategies change or become more specific, revisions will be proposed in the RCRA Annual Reports. Monitoring wells proposed in the GWAP are part of the ongoing RCRA Facility Investigation/Remedial Investigation (RFI/RI) activities governed by the IAG. Recommendations for additional modifications to the monitoring well network beyond those proposed in the GWAP are based on an evaluation of 1992 groundwater data and discussed in Section 5.0 of this document.

1.1 History of Groundwater Monitoring at the Rocky Flats Plant

Groundwater monitoring for radionuclides and other chemical constituents has been conducted at RFP since 1960. A total of 56 wells was installed at RFP between 1960 and 1985 and were routinely sampled for radionuclides. Beginning in 1985, additional analytes such as volatile organics, trace metals, and major ions were added to the sampling routine. Some well completion details for wells installed prior to 1986 do not exist, are incomplete, or are of questionable quality.

In late 1986, Phase I of a comprehensive program of site characterizations, remedial investigations, feasibility studies, and remedial/corrective actions began at RFP. These investigations were initiated pursuant to the U.S. Department of Energy (USDOE) Comprehensive Environmental Assessment and Response Program (CEARP) and a Compliance Agreement finalized by representatives of the USDOE and the USEPA on July 31, 1986. CEARP is now known as the Environmental Restoration Program.

Phase I investigations included:

- Detailed characterization of groundwater flow and quality in the vicinity of the Solar Evaporation Ponds

- Preparation of the groundwater monitoring and protection section of the RFP RCRA Part B permit application (Rockwell International, 1986a)

- Preparation of closure plans for the Solar Evaporation Ponds, West Spray Field, and Present Landfill

- Preparation of a RCRA Post-Closure Care permit application for regulated units undergoing closure

Seventy monitoring wells were installed in 1986 to characterize facility-wide hydrogeology and groundwater quality at RFP and to satisfy RCRA Subpart F requirements. The work plan for installation, sampling, and analysis of these wells is presented in the Geological and Hydrological Site Characterization Draft Work Plan for RFP (Rockwell International, 1986b). Groundwater monitoring wells were installed at the Solar Evaporation Ponds, West Spray Field, and Present Landfill as part of the facility-wide characterization program.

An additional 67 wells were installed at RFP in 1987 to characterize groundwater quality and flow at various Individual Hazardous Substance Sites (IHSSs) and the three RCRA-regulated units. The work plans for installation, sampling, and analysis of these wells are presented in the CEARP Installation Generic and Site Specific (Remedial Investigation) Work Plans (USDOE, 1987a and b).

A total of 160 wells and piezometers was installed in 1989. Of these, 53 wells were installed at the RCRA-regulated units. Thirty-two of the 53 wells were installed in the Solar Evaporation Ponds area. Of the remaining 21 wells, 13 were installed in the Present Landfill and 8 were installed in the West Spray Field during 1989. During 1992, three additional wells were installed in the West Spray Field.

Routine quarterly sampling of monitoring wells at RFP is initiated immediately upon their completion and development. In general, the 1986 and 1987 wells were sampled once during the year they were installed and quarterly in subsequent years. The 1989 wells were added to the monitoring program upon completion in the third and fourth quarters, but each well was sampled only once. All samples collected in 1989 are considered to be fourth quarter samples, even though some were actually sampled during the third quarter. Water-level measurements were obtained from each 1989 well during September as well as prior to sampling; monthly measurements were not taken. The three wells installed in the West Spray Field in 1992 were sampled during September and October of that year.

Groundwater at RFP has been analyzed for the USEPA Contract Laboratory Program Hazardous Substance List (HSL), Target Compound List (TCL), and Target Analyte List (TAL), as well as other inorganic and radiochemical parameters. The TCL and TAL superseded the HSL in late 1988. A comparison of the HSL and TCL lists to the RCRA Appendix IX Groundwater Monitoring List (40 CFR Part 264, Appendix IX) is shown in Table 1-1. Groundwater samples will be analyzed annually for the Appendix IX list for regulated units in compliance monitoring (Solar Evaporation Ponds) once a Post-Closure Care Permit is issued. During 1986, groundwater samples were analyzed for HSL volatile organics, semivolatile organics, and metals as well as major ions and radionuclides. An on-site Rockwell International laboratory performed analyses in 1987 and 1988. During the first three quarters of 1987, the volatile organic analyte list was reduced to the nine volatile compounds previously detected in groundwater at RFP: tetrachloroethene (PCE), trichloroethene (TCE), 1,1-dichloroethene (1,1-DCE), 1,2-dichloroethane (1,2-DCA), 1,2-dichloroethene (1,2-DCE), 1,1,1-trichloroethane (1,1,1-TCA), 1,1,2-trichloroethane (1,1,2-TCA), carbon tetrachloride (CCl_4), and chloroform ($CHCl_3$). During the fourth quarter of 1987, the Rockwell International laboratory obtained a gas chromatograph/mass spectrometer (GC/MS) and began analyzing for HSL VOCs. The current (1992) groundwater monitoring analytical suite is shown in Table 1-2. Other changes in the historical analytical program are identified in the table. The analytical suite for 1992 is identical to that for 1991.

The unconfined water table in surficial materials at RFP is dynamic; thus, some wells are dry upon inspection for quarterly sampling, and no sample is collected. At other times there is insufficient water in wells to analyze for the entire parameter list. When this situation occurred prior to the summer of 1989, sample collection was prioritized as follows:

- VOCs
- Plutonium, uranium, and americium
- Nitrate
- Metals
- Other major ions
- Other radionuclides

During the fourth quarter 1989 sampling effort, the priority list for low production wells was modified as follows:

- VOCs
- Plutonium and uranium
- Major ions

- Nitrate
- Gross alpha and gross beta
- Metals
- Strontium
- Cesium
- Tritium
- Americium
- Cyanide

During the first quarter 1990 sampling effort, the priority list for low-production wells was further modified as follows:

- VOCs
- Inorganics
- Nitrate
- Gross alpha, gross beta, uranium
- Dissolved metals
- Total metals
- Plutonium and americium
- Tritium
- Cesium, radium, and strontium
- Cyanide
- Orthophosphate

This priority list for sampling low-production wells has not changed since the first quarter of 1990.

Sampling and analysis records are maintained quarterly in compliance with 6 CCR 1007-3 and 40 CFR 265.94(b). Annual reports compiled in March 1988, March 1989, and March

1990 and quarterly reports beginning with the first quarter of 1991 describe groundwater elevations, groundwater flow rates, and the results of groundwater quality analyses for the previous sampling year (Rockwell International, 1988 and 1989; USDOE, 1990b and 1991a).

1.2 Groundwater Quality Assessment Approach

The purpose of the RCRA groundwater monitoring program at RFP is to determine the impact of regulated units on groundwater quality in the uppermost aquifer beneath and hydraulically downgradient of the units. The interpretation of the uppermost aquifer, identification of unit-specific upgradient and downgradient monitoring wells, and methods of groundwater data analysis used to evaluate impacts are discussed below.

1.2.1 Interpretation of the Uppermost Aquifer

The term aquifer is defined in 40 CFR B 260.10 and 6 CCR 1007-3 Section 260.10 as a geologic formation, group of formations, or part of a formation that is capable of yielding a significant amount of water to a well or spring. For the purposes of the GWAP and this Annual RCRA Groundwater Monitoring Report, the uppermost aquifer is considered to be the unconfined, saturated zones of the unconsolidated and consolidated water-bearing strata. This definition is consistent with definitions of the uppermost aquifer used in the 1990 and 1991 Annual RCRA Groundwater Monitoring Reports (USDOE, 1990b and 1991a).

The near-surface materials at RFP consist of Rocky Flats alluvium, valley fill alluvium, colluvium, bedrock sandstones, and weathered and unweathered claystones of the Laramie and Arapahoe Formations.

1.2.2 Identification of Downgradient Monitoring Wells

At RFP, the three RCRA-regulated units are sufficiently far apart that groundwater monitoring at a downgradient boundary encircling all units would not provide for immediate detection of releases from the individual units. Therefore, each regulated unit has its own set of upgradient and downgradient monitoring wells, including at least one upgradient and three downgradient monitoring wells. The wells used at each unit are discussed in the section for each respective unit.

1.2.3 Analysis of Groundwater Data

The major objectives of the data analysis component of this report are to verify the following:

- Presence of hazardous waste or hazardous waste constituents in the groundwater

- Rate and extent of migration of the hazardous waste or hazardous waste constituents in the groundwater

- Concentrations of hazardous waste or hazardous waste constituents in groundwater (6 CCR 1007-3 265.93(a))

This report contains groundwater elevation maps, groundwater quality maps, chemical concentration isopleth maps, analytical data tables, and statistical analyses. The statistical analyses evaluate potential contamination in groundwater monitoring wells located downgradient of each RCRA-regulated unit. Comparative statistics for the three RCRA units are presented in Appendix C. The maps and tables summarize the spatial and temporal variability of groundwater elevations and contaminant concentrations within and adjacent to the RCRA-regulated units. All new data were reviewed to determine whether significant changes in flow direction, flow velocity, or contaminant concentrations have occurred since the 1991 sampling period.

Groundwater elevation maps were plotted for all four quarters of 1992. Maps were completed for both the saturated surficial materials and weathered bedrock in the Solar Evaporation Ponds and the Present Landfill. Water-level maps were not plotted for the weathered bedrock in the West Spray Field due to the limited number of control points in that zone. These maps were used to determine groundwater flow directions and the magnitude of hydraulic gradients used to calculate groundwater flow velocities. Alluvial and weathered bedrock water levels were compared to define general areas of recharge and discharge between the two units. For the purposes of constructing groundwater potentiometric surface maps, it was assumed that well construction details, borehole logs, and water-level measurements were accurate. Where measured water levels were lower than published elevations for the bottom of well screens, wells were assumed to be dry for the purposes of constructing potentiometric surfaces. Once a well was identified as being dry, a roughly circular dry area was inferred surrounding the well. The boundaries of the dry area as shown by the shape of the dry area are necessarily approximate. The maximum size of this dry area was constrained by data from neighboring wells. This shape was then modified to reflect effects of the bedrock topography and flow boundaries (natural and man-made), and the thicknesses of saturated material in nearby wells. In many areas, the saturated thickness of surficial materials is only a few feet or less and appears to be controlled by the microtopography of the underlying bedrock surface.

Dry areas were also identified using elevation contours from a map showing the top of the bedrock surface (EG&G, 1991). Where reported water-level elevations were lower than elevations of top of bedrock, water-level elevations were considered in the construction of potentiometric surface maps, but the surficial material was assumed to be unsaturated. In large areas where the groundwater potentiometric surface was lower than the top of the bedrock, dry areas of surficial materials were inferred.

Dry areas shown on potentiometric surface maps from each of the RCRA-regulated units are explained more specifically in Sections 2.3, 3.3, and 4.3. All dry areas were evaluated using one or more of the criteria described above. However, the shapes and sizes of dry areas are based on sparse control data and are approximate. Investigations currently being conducted at OU4, OU6, OU7, and OU8 will provide additional information necessary for detailed analysis of groundwater flow and the fate and transport of contaminants in the groundwater and vadose zone.

Analyte distribution maps were plotted for radionuclides and VOCs. These maps present all detections of radionuclides and VOCs in the uppermost aquifer during 1992 for each of the RCRA-regulated units. VOC data for all four quarters are presented on these maps. No radionuclide data was available for fourth-quarter samples. Therefore the radionuclide distribution maps present only the radionuclide values above detection limits. Chemical concentration isopleth maps were constructed for selected analytes that best illustrate the extent of contamination associated with each RCRA unit and for which sufficient data exist to construct reasonably accurate concentration contours.

Time-series plots showing analyte concentration versus time were prepared for selected analytes in downgradient wells at each of the RCRA units. These plates are included in Appendix E. Analytes of interest were selected primarily on the basis of their occurrence associated with historical waste management practices within each unit and the amount of quantified observations. Time-series plots were used, to the extent possible, in the interpretation of groundwater chemistry and solute migration. However, the time-series plots were generally of limited value for the following reasons:

- Several downgradient wells lack a sufficient number of quantified results (detections) for numerous analytes to construct meaningful time-series plots.

- Changes in the detection limits for several analytes limited the number of quantified results available to assess time trends.

- Variability in the concentrations of analytes prevented any reasonable interpretation of time trends.

- In some individual wells, analytes with similar geochemical behavior in groundwater displayed different trends in the time-series plots.

- An apparent trend for an analyte in one well was inconsistent with or contradicted the trend observed for the same analyte in a nearby well.

Owing to these factors, interpretations of contaminant distribution and migration in this report do not rely on the time-series plots.

An attempt was made to construct Cumulative Sum (CUSUM) control charts for intrawell comparisons of selected analytes in upgradient and downgradient wells at each RCRA unit. Control charts are used to monitor the inherent statistical variation of the analytical data collected within individual wells and to provide a visual tool for detecting both trends and abrupt changes in concentration levels for analyte concentration. Analytes selected for control charts were those considered indicative of possible contamination and that were generally reported as detected.

To construct a meaningful control chart, a minimum of eight consecutive quarters of results are required to estimate the target mean and variance for an individual well/analyte combination. In addition, the well is assumed to be initially uncontaminated (see Interim Final Guidance for Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, USEPA, 1989). For these reasons, no control charts were prepared for the 1991 Annual RCRA Groundwater Monitoring Report. In this report, data meeting the above criteria were tested for normality and were log-transformed if necessary. If the data distributions could not be confidently identified as normal or log-normal, no effort was made to construct a control chart. Based on this approach, CUSUM control charts could be constructed only for selected analytes from Wells 5887 and 0986 (Appendix F). Future control charts for these well/analyte combinations will contain more points as additional data are collected. In addition, it is anticipated that other well/analyte combinations will be included in future reports as more data become available.

CUSUM charts for Wells 5887 and 0986 display cumulative sums of the deviations of subgroup means or individual measurements from a target value. Each CUSUM chart has four observations (one per quarter) for 1992. The upper control limit (h = 4) was selected in part on recommendations made in the Interim Final Guidance for Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities (USEPA, 1989). Individual points falling above the control limit indicate possible contamination from a source upgradient of the well. None of the analytes for which control charts were prepared was measured at concentrations exceeding the control limits.

1.2.3.1 Statistical Evaluations

The impact that each RCRA-regulated unit has on groundwater quality in the uppermost aquifer is assessed by comparing water quality upgradient of the unit with that downgradient of the unit.

In the 1990 Annual RCRA Groundwater Monitoring Report for Regulated Units at Rocky Flats Plant (USDOE, 1991a), groundwater quality data for each RCRA well in a regulated unit were compared with sitewide background values calculated from groundwater quality data obtained for sitewide background wells. The sitewide background wells are predominantly upgradient of the plant's industrial facilities and are unaffected by plant activities, thus providing samples that are representative of background groundwater quality for the entire plant site. Where appropriate, groundwater quality data within each RCRA unit were assessed in this report by comparing analytical data with sitewide background values for chemical constituents in the uppermost and lowermost flow system. Sitewide background groundwater quality exceedence values, calculated at the 5-percent significance level, that were presented in the 1992 Background Geochemical Characterization Report (EG&G, 1992) are listed in Table 1-3.

In this report, as in the 1991 Annual Report, groundwater quality data from monitoring wells located hydraulically upgradient of each RCRA unit are compared with groundwater quality data from monitoring wells located downgradient of that unit. This provides a better qualitative and quantitative assessment of potential contaminants being released downgradient into the uppermost aquifer by the regulated unit. Each unit has at least one upgradient and three downgradient monitoring wells suitable for making statistical comparisons. The wells used and well-selection criteria at each unit are discussed in the section for each respective unit.

1.2.3.2 Statistical Methods

Statistical methods used to compare upgradient to downgradient groundwater quality were selected based in part on recommendations made in Interim Final Guidance for Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities (USEPA, 1989) and the Draft Addendum to Interim Final Guidance, statistical Analysis of Groundwater Monitoring Data at RCRA Facilities (USEPA, 1992). Figure 1-1 presents a revised flowchart for the process used to select the appropriate statistical procedure. The flowchart is used for each analyte at each regulated unit.

The initial step in the statistical analysis requires the determination of the percentage of quantified results versus nondetected results. In the 1991 Annual RCRA Report, a test of proportions was performed on analytes when the proportion of detections in the data was between 10 and 50 percent. In this report, the test of proportions has been abandoned as recommended in the Addendum to Interim Final Guidance (USEPA, 1992) and the data were redistributed according to the revised flowchart. This flowchart was designed to maximize the information that could be reliably extracted from the available data. Excessive proportions of nondetects tend to bias both the variance and mean and may provide misleading results when included in statistical analyses. Therefore, if the proportion of detections (quantified results) in the data is less than 50 percent, or there are less than two results for an individual analyte, then the analyte concentrations are reported for downgradient wells that exceed the detection limit for a particular analyte. If the proportion of detections for a particular analyte is greater than or equal to 50 percent and there are at least two results for a given analyte, an analysis of variance (ANOVA) procedure is performed.

ANOVA is the name given to a wide variety of statistical procedures that compare the means of different groups of observations to determine whether there are significant differences among the groups. The two groups in this case are the mean upgradient analyte concentrations and the mean downgradient analyte concentrations in the groundwater monitoring wells.

The distribution of the data is determined, and if the data are not normally distributed, the data are log-transformed. For those analytes with a normal or log-normal distribution, nondetects are replaced with half the detection limit to perform the statistical analysis. This is consistent with USEPA guidance (USEPA, 1989). A parametric, one-way ANOVA test is performed on the normal or log-normal data. These tests provide an evaluation of the difference in mean analyte concentrations between the upgradient and downgradient monitoring wells.

Under the null hypothesis, it is assumed that there are no differences between upgradient and downgradient mean concentrations for a given analyte. A large difference in means supports rejection of the null hypothesis and, if the downgradient mean is higher, is indicative of downgradient contamination. All tests (parametric and nonparametric) used in this report reject the null hypothesis at the 5 percent level of significance. The observed significance level (value) for a statistical test is the probability that differences in means as large as those observed could be attributed to random chance. Thus, a significance level less than or equal to 5 percent strongly indicates that differences in means between upgradient and downgradient wells are not random.

Analytes that are neither normally nor log-normally distributed are analyzed with a nonparametric one-way ANOVA Kruskal-Wallis test to search for statistically significant differences in analyte concentrations between upgradient and downgradient wells. The Kruskal-Wallis test uses the ranks of the observations to determine if some of the wells tend to have higher concentrations than other wells. If the upgradient wells have a significantly smaller sum of scores than expected, there is evidence of downgradient contamination.

2.0 GROUNDWATER MONITORING AT THE SOLAR EVAPORATION PONDS

The Solar Evaporation Ponds area is located on the northeastern side of the Protected Area (PA) at RFP (Plate 1-1). The Solar Evaporation Pond waste management unit includes Ponds 207-A, 207-B North, 207-B Center, 207-B South, 207-C, and the Interceptor Trench System associated with the Solar Evaporation Ponds (Figure 2-1). A detailed description of the purpose, construction, and operation of the ponds and the Interceptor Trench System is presented in the Closure Plan for the Solar Evaporation Ponds (USDOE, 1988). The Solar Evaporation Ponds were constructed primarily to store and treat low-level radioactive process wastes containing high concentrations of nitrates through evaporation. Pond 207-A was placed in service in August 1956; Ponds 207-B North, Center, and South were placed in service in June 1960; and Pond 207-C was placed in service in December 1970 (USDOE, 1988).

Pond 207-A previously contained liquid with concentrations of nitrate, metals, and radionuclides approximately two orders of magnitude higher than in Ponds 207-B North and Center. Specifically, Pond 207-A liquid was characterized by high concentrations of aluminum, chromium, copper, iron, potassium, sodium, nickel, tin, plutonium, americium, uranium, tritium, and nitrates. Pond 207-A liquid was generally more contaminated than Pond 207-C, except for plutonium and americium. The liquid had particularly high concentrations of chromium and nickel and an alkaline pH ranging from 8.3 to 11.0. Pond 207-A sludge analyses showed high concentrations of nitrates, metals, and radionuclides similar to the pond liquids. In addition to the high analyte concentrations found in the liquid, calcium and magnesium were also found in high concentrations in the sludge (USDOE, 1988). At present, Pond 207-A is nearly empty and the sludge has been removed. This contains water transferred from the 207-B series ponds and water derived from incident precipitation (USDOE, 1988).

Ponds 207-B North, Center, and South contained process wastes until 1977 when the ponds were cleaned and the linings replaced. Since 1977, these ponds have held treated sanitary effluent, treated water from the reverse osmosis facility, backwash brine from the reverse osmosis facility, and groundwater pumped back from the Solar Evaporation Ponds Interceptor Trench System. Ponds 207-B North and Center generally have low concentrations of nitrates, metals, and radionuclides. Metal concentrations in the pond liquids were at or below drinking water standards during the same time period (USDOE, 1988). All 207-B ponds are currently used to store intercepted groundwater collected by the Interceptor Trench System north of the ponds.

Pond 207-C was constructed to provide additional storage capacity and to enable the transfer and storage of liquids from the other ponds while the latter were repaired. Contaminant concentrations in Pond 207-C contaminants are approximately two orders of magnitude higher than in Pond 207-B North and Center for nitrate, metals, and radionuclides. Pond 207-C liquid is generally less contaminated than the analyzed liquids in Pond 207-A, except for plutonium and americium, which have concentrations approximately 10 times higher in Pond 207-C. Pond 207-C is currently used to store process waste water.

An Interceptor Trench System was constructed on the hillside north of the Solar Evaporation Ponds to prevent natural groundwater seepage and pond leakage from entering North Walnut Creek (Figure 2-1). This system was constructed in stages during the 1970s. Liquid collected in the system flows by gravity to the Interceptor Trench System pump house and is then pumped to the 207-B ponds (USDOE, 1988).

The Solar Evaporation Ponds area is being closed in accordance with the IAG (through the IM/IRA process) and applicable Colorado Hazardous Waste Regulations. Post-closure inspection, maintenance, and monitoring of the Solar Evaporation Ponds will be conducted in compliance with 6 CCR 1007-3 Part 264 (40 CFR Part 264).

2.1 Summary of Previous Investigations

2.1.1 Assessment Groundwater Monitoring Program

The Solar Evaporation Ponds area is currently undergoing groundwater monitoring as specified in 6 CCR 1007-3 Section 265.93(d) (i.e., "assessment monitoring") because it has already been established that the ponds have affected groundwater quality downgradient from the waste management unit. The GWAP summarizes the history of previous site-specific hydrogeologic investigations, monitoring well installation programs, sampling and analysis plans, and evaluation procedures used in assessing the groundwater monitoring program at the Solar Evaporation Ponds area. Also included were procedures and techniques for sample collection, sample preservation and shipment, analysis, and custody control.

Table 2-1 presents a summary of the 67 groundwater monitoring wells in the Solar Evaporation Ponds area during 1992. There are 34 alluvial wells; 19 are screened in Rocky Flats alluvium, eight in colluvium, and seven in valley-fill alluvium. There are 33 bedrock wells; 18 wells screened in weathered claystone, five in weathered sandstone, and 10 in unweathered sandstone. Additional wells are being installed as part of the Remedial Investigation, but no information from these wells is currently available.

Groundwater samples were analyzed for the parameters listed in Table 1-2. Sampling and analysis records are maintained in compliance with 6 CCR 1007-3 and 40 CFR 265.94(b). Annual reports compiled in March 1989, March 1990, March 1991, and March 1992 describe groundwater elevations and groundwater flow rates and include the results of 1988, 1989, 1990, and 1991 groundwater sample analyses, respectively (Rockwell International, 1989; USDOE, 1990b; USDOE, 1991a; USDOE, 1992b).

2.1.2 Previous Nature and Extent of Groundwater Contamination

Previous hydrogeologic investigations of the Solar Evaporation Ponds have shown that the ponds have contaminated alluvial groundwater migrating to the north, northeast, and southeast into the Walnut Creek drainages.

Downgradient contaminants north and east of the Solar Evaporation Ponds include total dissolved solids, nitrates, sulfate, sodium, radionuclides, including uranium and tritium, volatile organic compounds, dissolved metals, total suspended solids, and inorganics. High concentrations of nitrate/nitrite, radionuclides, organics, and other analytes in downgradient alluvial and bedrock wells located east and north of the Solar Evaporation Ponds and Interceptor Trench System suggest that the containment system may not completely prevent contaminant migration north of the ponds. Elevated levels of total dissolved solids, nitrates, sulfate, sodium, dissolved radionuclides, volatile organic compounds, metals, inorganics, and total suspended solids were found in groundwater within and adjacent to the Solar Evaporation Ponds area. These contaminants, with the exception of total suspended solids, were also found at elevated levels upgradient of the Solar Evaporation Ponds. Groundwater in the unconfined bedrock also appears impacted by the ponds. Subcropping sandstones occur in the area; however, the extent of these sandstones and the groundwater quality within them are not fully characterized at this time (USDOE, 1990b, 1991a, and 1992b).

2.2 Uppermost Aquifer

The uppermost aquifer in the Solar Evaporation Ponds area is composed of two units. The first unit consists of saturated surficial materials: Rocky Flats alluvium, colluvium, and valley-fill alluvium. The second unit consists of weathered bedrock.

Confined hydrostratigraphic units consisting of unweathered claystone and sandstone are not considered part of the uppermost aquifer because they are not in direct hydraulic connection with the uppermost aquifer and have relatively low hydraulic conductivities.

2.3 Conceptual Model of the Groundwater Flow System

Groundwater occurs in the surficial materials and weathered bedrock portions of the uppermost aquifer in the Solar Evaporation Ponds area. Unconfined groundwater flow in surficial materials at the Solar Evaporation Ponds is influenced by (1) recharge from precipitation, (2) historical leakage from the ponds, (3) drainage into the interceptor trench systems, (4) the topography of the bedrock surface and bedrock lithology, and (5) potential recharge by drainage culverts. Previous interpretations of data from the Solar Evaporation Ponds area identified areas of unsaturated surficial materials primarily associated with the Interceptor Trench System and suggested that two principal flow paths exist in surficial materials: one to the northeast toward North Walnut Creek and the other to the east-southeast toward Walnut Creek. A more recent interpretation of groundwater flow within surficial materials indicates that the saturated thickness of surficial materials and flow directions are principally controlled by the topography of the underlying bedrock surface and that areas of saturated surficial material may be less extensive than previously thought. The basis for this interpretation is explained below. Groundwater flow direction within weathered bedrock underlying the Solar Evaporation Ponds has not been fully characterized. Characterization of the flow direction will be performed as part of the Phase II RFI/RI for the Solar Evaporation Ponds (OU4). At the present time, the general flow direction in weathered bedrock is assumed to be consistent with the predominantly eastward flow observed on a regional scale by Robson et al. (1981).

A new interpretation of groundwater flow within surficial materials at the Solar Evaporation Ponds has been developed using a contour map of the top of the bedrock (EG&G, 1991) and an isopach map of saturated surficial materials. These maps indicate that an east-trending bedrock ridge, located east of the ponds, acts as a groundwater divide and directs flow within surficial materials.

The top of the bedrock surface is relatively flat to gently east-sloping immediately below the Solar Evaporation Ponds. East of the ponds, the bedrock surface forms an east-trending ridge. North of the ponds, the bedrock surface slopes northward toward North Walnut Creek. The thickness of saturated surficial materials is highly variable from well to well and appears controlled primarily by the underlying topography of the bedrock surface. The maximum thickness of saturated material typically occurs at the same locations as topographic depressions in the bedrock surface or in the immediate vicinity of the ponds themselves. Thicker sections of saturated surficial material (relative to other areas near the Solar Evaporation Ponds) also occur in the vicinity of leaking water or stream lines and drainage culverts. For example, saturated surficial materials at Well B208089, located adjacent to the Interceptor Trench System, were approximately 0.5 to 3 feet in thickness throughout 1992. The routine occurrence of groundwater in this well may be related to potential recharge from a drainage culvert that discharges hydraulically upgradient from the well.

Previous models for the Solar Evaporation Ponds area depicted most of the solar ponds and surrounding areas as underlain by saturated surficial materials. Review of isopach maps of saturated thickness of surficial materials and comparison of groundwater elevations to the top of the bedrock surface suggest that far less surficial material is saturated than previously thought. A large area of unsaturated surficial materials is postulated east of the solar ponds where water levels lie below the top of the bedrock. In other areas southeast of the ponds, water levels also lie below the top of the bedrock and the surficial materials are dry. The groundwater potentiometric surface maps compiled for this report reflect this most recent conceptual model and are consistent with available water-level data, borehole lithologic logs, and contour maps of the bedrock surface.

Table 2-2 presents the calculated vertical hydraulic gradients between surficial materials and weathered bedrock for seven well pairs. Water levels used for the calculations were obtained from Appendices A-1 and A-2, which summarize groundwater elevation data measured in 1992. Vertical gradient is the quotient of the difference in water levels measured during equivalent months during 1992 and the vertical distance between the middle of the screened interval in the alluvial well and the elevation of the middle of the screened interval in the associated weathered bedrock well. Calculated vertical gradients indicate that the potential for downward vertical flow from surficial materials into the weathered bedrock is high.

2.3.1 Potentiometric Surface

Water-level data for first through fourth quarters 1992 are presented in Appendices A-1 and A-2 for surficial materials and weathered bedrock, respectively. The potentiometric surface in surficial materials for the Solar Evaporation Ponds area during the four quarters of 1992 is shown in Figures 2-2, 2-3, 2-4, and 2-5. Because the microtopography of the bedrock surface has not been mapped in sufficient detail, any groundwater potentiometric maps created are necessarily generalized. The potentiometric surface maps for surficial materials were compiled from reported water-level elevations, which were higher than elevations of bottoms of the corresponding well screens. When a reported water-level elevation was below the bottom of a well screen, the well was assumed to be dry across its screened interval, and reported water-level elevations were not used. When a reported water-level elevation was lower than the elevation of the top of bedrock, the water-level elevation was considered in the construction of the potentiometric maps, but the surficial material was assumed to be unsaturated. The large, dry area east of the Solar Evaporation Ponds was inferred in this manner. The shape of this dry area and its eastern extend are not known. Table 2-3 contains a list of wells for which reported water levels were lower than published elevations for bottom of well screens and/or published elevations for top of bedrock. The dry area shown north of the Interceptor Trench System has an elongated shape inferred from the bedrock topography and trends in saturated thickness in nearby wells.

The fourth and second quarter of 1992 represent the low- and high-flow regimes, respectively, for surficial materials in the vicinity of the Solar Evaporation Ponds. In 1992, water levels within individual wells generally fluctuated from less than one foot to as much as 5.5 feet. Water-level data are similar to data from 1991, although the conceptual model for groundwater flow in the Solar Evaporation Ponds area has changed as described above. Alluvial groundwater enters the Solar Evaporation Ponds area from the west and flows predominantly to the east and southeast from the ponds area. Downslope of the ponds to the north, most of the colluvial materials on the hill slope were removed during construction of the ponds and the Interceptor Trench System. Groundwater in surficial materials in this area either evapotranspires, is collected by the Interceptor Trench System; or flows in surficial materials filling bedrock valleys. North Walnut Creek is separated from the Solar Evaporation Ponds area by a region of predominantly unsaturated colluvium or the absence of surficial materials.

Groundwater potentiometric surface maps for weathered bedrock materials for the first through fourth quarters of 1992 (Figures 2-6, 2-7, 2-8, and 2-9) show groundwater flowing radially away from the ponds area. Water levels taken during 1992 indicate that the low-flow regime occurs during the fourth quarter, while the high-flow regime occurs during the second quarter. Water levels in weathered bedrock show fluctuations of up to approximately five feet between quarters during 1992. The groundwater-flow regime within weathered bedrock differs from that in surficial materials. A region of unsaturated weathered bedrock probably exists north of the Solar Evaporation Ponds area, but its limited extent does not prevent groundwater flow towards North Walnut Creek. Downgradient flow toward North Walnut Creek also occurs northeast of the ponds.

2.3.2 Groundwater Flow Velocities

Groundwater-flow velocities for saturated materials in the Solar Evaporation Ponds area are presented below. Migration rates for conservative dissolved constituents could equal the average linear groundwater velocity. However, attenuated, volatile, biodegraded, or redox sensitive species would exhibit migration rates less than the average linear groundwater flow velocity.

2.3.2.1 Groundwater Velocity in Surficial Materials

The average linear groundwater-flow velocity in surficial materials was calculated for the three predominant flow paths in the vicinity of the Solar Evaporation Ponds. The geometric mean of hydraulic conductivity values (K) calculated from the EG&G data base of hydraulic conductivities for Rocky Flats alluvium in the vicinity of the Solar Evaporation Ponds area is 5.19×10^{-5} cm/sec. The assumed effective porosity is 0.1, as used in calculations from previous groundwater monitoring reports. The well pairs used to calculate hydraulic gradients for the three flow paths are shown in Table 2-4.

Table 2-4 also presents the calculated average linear groundwater flow velocities for three flow paths at both low-flow and high-flow conditions (October and April, respectively). Calculated flow velocities for 1992 are slightly higher than previous years due to use of a higher value for hydraulic conductivity when calculating 1992 flow velocities.

2.3.2.2 Groundwater Velocity in Weathered Bedrock

The average linear groundwater-flow velocity in weathered bedrock was also calculated for the three predominant flow paths in the vicinity of the Solar Evaporation Ponds. The geometric mean of hydraulic conductivity values (K) calculated from the EG&G data base of hydraulic conductivities for weathered Arapahoe Formation in the vicinity of the Solar

Evaporation Ponds is 1.03 x 10^{-6} cm/sec. The assumed effective porosity is 0.1, as used in calculations from previous groundwater monitoring reports. Well pairs used to calculate hydraulic gradients for the three flow paths are shown in Table 2-4.

Table 2.4 presents the calculated average linear groundwater flow velocities for three flow paths at both low- and high-flow conditions (October and April, respectively). As described above, calculated flow velocities for 1992 are slightly higher than previous years due to use of a higher value for hydraulic conductivity when calculating 1992 flow velocities.

2.4 Groundwater Quality at the Solar Evaporation Ponds

Groundwater quality data for 1992 surficial materials and weathered bedrock are presented on computer disk in Appendix B.

2.4.1 Statistical Evaluation of Downgradient Groundwater Quality with Respect to Upgradient Groundwater Quality

Groundwater quality data from monitoring wells located hydraulically upgradient of the Solar Evaporation Ponds were statistically compared with groundwater quality data from monitoring wells located at the compliance boundaries of the Solar Evaporation Ponds to assess contaminant releases into the uppermost aquifer. Statistical comparisons were made following the methodology discussed in Section 1.2.3. Statistical comparisons were performed on groundwater-quality data from the hydraulically upgradient and downgradient compliance wells listed in Table 2-5. Separate statistical comparisons were performed for the alluvial and weathered bedrock wells. Statistical calculations are presented on computer disk in Appendix C and summarized in Tables 2-6, 2-7, and 2-8.

Table 2-6 lists the analytes for which the proportion of detections (i.e., quantified results) in downgradient wells at the Solar Evaporation Ponds was less than 50 percent, or for which there were less than two reported results. The concentrations of these infrequently detected analytes are also given. Unless verified by subsequent analyses, these infrequently detected analytes are not considered to indicate contamination.

For analytes with greater than 50-percent detections, ANOVA tests were performed to determine whether differences in groundwater quality between upgradient and downgradient wells screened in surficial materials and weathered bedrock are statistically significant. Analytes showing statistically significant differences between the two well groups in surficial materials include gross beta, dissolved metals (lithium, sodium, potassium, selenium, and silicon), inorganic analytes (total dissolved solids, fluoride, sulfate, nitrate/nitrite, and bicarbonate), and pH (Table 2-7). Analytes showing statistically significant differences between the two weathered bedrock well groups include radionuclides (gross beta, gross alpha, tritium, Radium-226, U-233, 234, U-235, U-238), dissolved metals (aluminum, barium, calcium, lithium, magnesium, manganese, potassium, selenium, sodium, strontium, and vanadium), inorganic analytes (chloride, fluoride, nitrate/nitrite, sulfate, total dissolved solids [TDS], and total suspended solid [TSS]), and VOCs (TCE, chloroform, and 1,2-DCA) (Table 2-8).

At the Solar Evaporation Ponds, methylene chloride and acetone infrequently occur in groundwater monitoring wells. However, the presence of these compounds in groundwater may not be due to a release from the Solar Evaporation Ponds area. The occurrence of methylene chloride and acetone may result from an upgradient source or contamination of the samples during laboratory analysis. Methylene chloride and acetone have been recognized by the USEPA as common laboratory contaminants.

2.4.2 Groundwater Quality in the Solar Evaporation Ponds Area

Groundwater quality data for surficial materials and weathered bedrock in the Solar Evaporation Ponds during 1992 are tabulated in Appendix B. Selected analytes are depicted in Figures 2-10 through 2-20. Analytes were selected for mapping based on the history of the waste operations at the unit, the occurrence of the analyte in downgradient wells during 1992, and the frequency of detections during 1992.

Radionuclides were detected in groundwater from both surficial material and weathered bedrock. Radionuclides detected in surficial material groundwater include gross alpha and gross beta (Figure 2-10); tritium, Cs-137, Ra-226, and U-235 (Figure 2-11); and Am-241, Pu-239, 240, U-233, 234, and U-238 (Figure 2-12). Weathered bedrock groundwater contains the same radionuclides, plus Ra-228 and Sr-89,90 (Figures 2-13, 2-14, and 2-15). All of these radionuclides were detected at activities above sitewide background levels in one or more wells during one or more quarters in 1992. In general, higher concentrations of radionuclides occurred in wells immediately adjacent to the evaporation ponds or hydraulically downgradient to the north, east, and southeast. Radionuclides also occurred in wells along North Walnut Creek at activities typically one to two orders of magnitude less than the activities of the individual analytes in wells adjacent to the Solar Evaporation Ponds.

Nitrate/nitrite was detected during 1992 in both surficial material and weathered bedrock groundwater monitoring wells. Nitrate/nitrite appears to be a reasonable indicator of contaminant migration because of its historical presence in the solar ponds liquids, high mobility in groundwater, and its elevated concentrations in groundwater downgradient of the ponds. Isopleth maps were created for nitrate/nitrite occurrences in surficial materials and weathered bedrock for second quarter 1992 (Figure 2-16). In surficial materials, nitrate/nitrite concentrations are highest in monitoring wells north of the Interceptor Trench System along North Walnut Creek. Nitrate/nitrite concentrations in this area range from 0.9 to 510 milligrams per liter (mg/l). To the southeast, nitrate/nitrite was detected in surficial materials at concentrations up to 1.2 mg/l during 1992. Nitrate/nitrite was detected in concentrations ranging from 4.6 to 140 mg/l in surficial materials directly south of the Solar Evaporation Ponds. Nitrate/nitrite concentrations were highest directly north of the

Solar Evaporation Ponds in weathered bedrock wells located due south of the Interceptor Trench System. In this area, concentrations ranged up to 3,900 mg/l in the first quarter and were as high as 8,260 mg/l in the fourth quarter. Nitrate/nitrite concentrations in weathered bedrock east and southeast of the evaporation ponds ranged from 4.8 to 6.3 mg/l. Isopleth maps were also created for fluoride and sulfate (Figures 2-17 and 2-18, respectively). The distributions of these analytes were similar to the distribution of nitrate/nitrite in surficial-material groundwater.

VOCs were detected in seven wells screened in surficial materials and 10 wells screened in weathered bedrock during 1992 (Figures 2-19 and 2-20). VOCs detected in groundwater in surficial materials during 1991 included CCl_4, $CHCl_3$, PCE, TCE, acetone, 1,1-dichloroethane (1,1-DCA), 1,1-DCE, 1,2-DCE, 1,1,1-TCA, vinyl chloride, toluene, carbon disulfate, and total xylenes. VOC detections in weathered bedrock included 1,1-DCE, CCl_4, $CHCl_3$, 1,2-DCE, PCE, TCE, methylene chloride, ethylbenzene, carbon disulfide, toluene, and total xylenes.

VOC concentrations were highest in weathered bedrock in Well P210189, immediately south of Pond 207-C, where chloroform, TCE, PCE, 1,2-DCE, 1,1-DCE, and CCl_4 were detected. In this well, chloroform ranged from 340 to 530 μg/l; TCE ranged from 2,300 to 4,600 μg/l; 1,2-DCE ranged from below the detection limit (BDL) to 160 μg/l; CCL_4 ranged from 830 to 11,000 μg/l; PCE ranged from 8 to 9 μg/l; and 1,1-DCE ranged from 7 to 8 μg/l.

Well 2286, screened in surficial materials and immediately south of Pond 207-C, showed elevated VOC concentrations that include high detections of 1,2-DCE, CCl_4, $CHCl_3$, and TCE. Concentrations of these four VOCs in Well 2286 ranged from 17 to 750 μg/l. Concentrations of CCL_4, TCE, and occasionally $CHCL_3$, typically exceeded 100 μg/l. VOCs were also detected in surficial-materials groundwater from Well 5687 located south of Well 2286 and Pond 2-7-C. VOCs detected included 1,1-DCA, 1,2-DCE, $CHCL_3$, TCE, 1,1,1-TCA, 1,1-DCE, and PCE. Concentrations of these analytes ranged from BDL to 82 μg/l and were approximately one order of magnitude less than the concentrations of VOCs detected in Well 2286. In general, higher concentrations of VOCs are found in wells immediately adjacent to Pond 207-C.

Well 3586, located approximately 1,000 feet southeast of Pond 207-B South, also contained significant concentrations of VOCs, including 1,1,1-TCA (BDL to 9 $\mu g/l$), 1,1-DCA (48 to 62 $\mu g/l$), 1,1-DCE (11 to 58 $\mu g/l$), and vinyl chloride (320 to 720 $\mu g/l$).

2.5 Conclusions

Results of statistical comparisons of upgradient versus downgradient groundwater quality at the Solar Evaporation Ponds compliance boundary show that the uppermost aquifer, composed of surficial materials and weathered bedrock, has been impacted by leakage from the Solar Evaporation Ponds. VOCs detected in groundwater in surficial materials during 1992 include 1,2-DCE, CCl_4, $CHCl_3$, TCE, 1,2-DCA, acetone, 1,1-DCA, 1,1-DCE, 1,1,1-TCA, 1,1,2-TCA, and vinyl chloride. VOC detections in weathered bedrock include 1,1-DCE, CCl_4, $CHCl_3$, 1,2-DCE, PCE, TCE, methylene chloride, ethylbenzene, carbon disulfide, toluene, and total xylenes. Higher concentrations of VOCs are typically found in wells immediately adjacent to Pond 207-C. The most significant inorganic analyte detected in groundwater in both surficial materials and weathered bedrock was nitrate/nitrite. Isopeth maps for sulfate and fluoride in surficial-material groundwater showed distributions similar to the distribution of nitrate/nitrite. Concentrations of these analytes were typically highest in monitoring wells located north of the ponds. Activities of gross alpha, gross beta, tritium, U-235, Ra-226, Ra-228, U-233, 234, and U-238 were observed in both surficial material and weathered-bedrock monitoring wells located in the Solar Evaporation Ponds area. Activities of these analytes were typically highest adjacent to the ponds and along North Walnut Creek.

3.0 GROUNDWATER MONITORING AT THE WEST SPRAY FIELD

The West Spray Field is located in the western portion of the RFP buffer zone and covers approximately 105 acres (Plate 1-1). This area was identified as a regulated waste management unit because liquids contaminated with RCRA-listed hazardous wastes were spray applicated at the West Spray Field.

The West Spray Field was in operation from April 1982 to October 1985. Excess liquids from Solar Evaporation Ponds 207-B North and Center were periodically pumped via pipeline to the West Spray Field for spray application. The liquids pumped to the spray field consisted of treated sanitary effluent and recovered groundwater, both of which contained some hazardous constituents (USDOE, 1988).

The West Spray Field is no longer in operation. Post-closure inspection, maintenance, and monitoring of the West Spray Field will be performed in accordance with 6 CCR 1007-3, Part 264. In accordance with the IAG and applicable Colorado Hazardous Waste regulations, a closure plan will be developed through the IM/IRA process.

3.1 Summary of Previous Investigations

3.1.1 Alternate Groundwater Monitoring Program

An "alternate" groundwater monitoring program (other than the one described in Sections 265.91 and 265.92 of 6 CCR 1007-3) has been implemented for the West Spray Field area because it has been assumed that a statistical evaluation of indicator parameters from upgradient and downgradient monitoring wells would indicate an impact to groundwater quality. The GWAP summarizes the history of previous site-specific hydrogeologic investigations, monitoring well installation programs, sampling and analytical programs, and evaluation procedures for the alternate groundwater monitoring system at the West Spray

Field. The plan also included the procedures and techniques for sample collection, sample preservation and shipment, analytical procedures, and chain-of-custody control.

The groundwater monitoring wells at the West Spray Field are listed in Table 3-1 and shown in Figure 3-1. Twenty-one alluvial wells and four bedrock wells are sampled at the West Spray Field as part of the RFP groundwater monitoring program.

The pre-1986 monitoring wells in the West Spray Field area (Wells 0582, 0682, 0782, 0881, 0981, and 1081) have incomplete or missing well-construction documentation. Because groundwater-elevation data from these wells are not consistent with groundwater data collected from the post-1986 wells, data collected from these wells were not used in the construction of the groundwater potentiometric surface maps in the 1989, 1990, or 1991 RCRA Groundwater Monitoring Reports (USDOE, 1990b, 1991a, 1992b). Likewise, the 1992 groundwater-elevation data from these wells will not be used in the construction of the potentiometric surface maps presented in this report. Groundwater-quality data collected in 1992 from these wells will not be used in the groundwater-quality evaluations presented in this report either.

Groundwater samples were analyzed for the constituents listed in Table 1-2. The records of the analyses and evaluations are maintained in compliance with 6 CCR 1007-3 and 40 CFR 265.94(b). The 1987, 1988, 1989, 1990, and 1991 Annual RCRA Groundwater Monitoring Reports described groundwater elevations, flow rates, and the results of the groundwater sample analyses. In addition, groundwater sampling results for the West Spray Field were presented in the West Spray Field Hydrogeologic Characterization Report (USDOE, 1988).

3.1.2 Previous Nature and Extent of Groundwater Contamination

The nature and extent of groundwater contamination at the West Spray Field was evaluated in the 1989, 1990, and 1991 Annual RCRA Groundwater Monitoring Reports (USDOE, 1990b, 1991a, 1992b). The 1989 report indicated that past operations at the West Spray Field have contributed inorganic constituents, metals, VOCs (including PCE and methylene chloride), and some radionuclides to alluvial groundwater based on sitewide background concentration levels determined in the 1990 Background Geochemical Characterization Report (USDOE, 1990c). Methylene chloride was also frequently detected in field blank samples at concentrations equal to or exceeding the concentrations of these analytes reported in groundwater. The occurrence of these analytes in groundwater samples was considered to represent laboratory contamination rather than actual groundwater contamination.

The groundwater-chemistry data from 1990 suggest that relatively few changes had occurred in water quality since 1989. These data appeared to indicate that the West Spray Field was contributing nitrate/nitrite, TDS, uranium-233, 234, and some metals to the alluvial groundwater. The presence of nitrate/nitrite and TDS in wells throughout the West Spray Field at elevated concentrations was consistent with conclusions made in 1989. Nitrate/nitrite was detected upgradient and in the eastern portion of the West Spray Field at similar concentrations and at concentrations close to sitewide background levels. Total dissolved solids were consistently detected above sitewide background concentrations upgradient, within, and downgradient of the West Spray Field in 1990. U-233, 234 was detected above the sitewide background concentration in two wells in the first quarter of 1990 (Wells B410589 and B110989). U-233, 234 was also detected in Wells 4986 and B410589 in the fourth quarter of 1990. Other radionuclides reported at above sitewide background concentrations in 1989, including Pu-239, 240 (dissolved), tritium, Am-241 (dissolved), and Cs-137 (dissolved), were not detected in groundwater in 1990. U-233, 234 was not analyzed in 1989. Manganese and, to a lesser degree, iron were consistently detected above sitewide background concentrations. Manganese occurred in the western portion of the West Spray Field and at wells along the eastern border of the site.

Statistical evaluation of 1991 groundwater-quality data indicated that the West Spray Field unit may have contributed U-233,234, dissolved metals (sodium, magnesium, strontium, iron, manganese, and zinc), and inorganic analytes (bicarbonate, nitrate/nitrite, chloride, fluoride, and total suspended solids) to groundwater in surficial materials. Occasional detections of VOCs in monitoring wells at the West Spray Field were not verified during subsequent analyses. In addition, past operations at the West Spray Field do not appear to have impacted groundwater quality in bedrock.

3.2 Uppermost Aquifer

The uppermost aquifer in and adjacent to the West Spray Field is composed of saturated Rocky Flats alluvium, valley-fill alluvium, and weathered bedrock, including subcropping sandstones. Wells 4686, 4886, and 5286 at the West Spray Field are screened in an unweathered sandstone unit. Groundwater-quality data from these wells have not been presented in previous reports because unweathered bedrock is not considered part of the uppermost aquifer and because past activities at the West Spray Field were not considered to have impacted groundwater in lower hydrostratigraphic intervals. Inspection of 1990, 1991, and 1992 groundwater-quality data for these wells indicated that past activities have probably not impacted groundwater quality in the unweathered bedrock (USDOE, 1991, 1992). No VOCs were detected in these three wells during 1991 and concentrations of metals, inorganic analytes, and radionuclides, except U-233, 234, were all below sitewide background values. The naturally occurring concentration of this analyte in unweathered bedrock at the West Spray Field has not yet been determined. However, concentrations of U-233, 234 in the unweathered bedrock wells were similar to concentrations observed in alluvial wells. Well 46392 is screened in bedrock, but because the well log has not been available, it is not known whether the well is screened in weathered or unweathered bedrock.

3.3 Conceptual Model of the Groundwater Flow System

Groundwater occurs in surficial materials and weathered and unweathered bedrock in the West Spray Field area. Groundwater enters from the west and flows generally east-northeast along the base of the Rocky Flats alluvium.

As with the Solar Evaporation Ponds area, use of additional information (a structural contour map of the top of bedrock, and isopach maps of thicknesses of saturated surficial materials) has changed the conceptual groundwater model at the West Spray Field slightly. The presence of an east-trending bedrock ridge appears to act as a groundwater divide. Groundwater north of the ridge flows toward the northeast, while groundwater south of the ridge flows south-southeast towards Woman Creek. A valley in the bedrock surface is present south of the bedrock ridge but is not coincident with the topographic valley immediately south of the spray field. Groundwater elevations south of the spray field slope downward toward the topographic valley. Another small bedrock ridge exists northeast of the spray field. This ridge starts northwest of Well B110989 and trends northeast. This ridge appears to locally influence groundwater flow by acting as a groundwater divide. Lastly, a small dammed area located near Well 4586 is seasonally flooded, resulting in a slight and temporary groundwater gradient reversal during times of flooding.

3.3.1 Potentiometric Surface

Figures 3-2 through 3-5 present groundwater potentiometric surface maps for the surficial materials for the first through fourth quarters of 1992, respectively. Water-level data for 1992 are presented in Appendix A-3. Water levels measured in 1992 were similar to water levels measured in 1991. Groundwater elevations in 1992 were relatively stable across the site. Typical seasonal fluctuations were five feet or less but ranged from about 10 feet to about 20 feet in four of the wells (4586, P416089, P416389, and P415989). Depth to groundwater was variable but generally ranged from approximately 60 feet below the ground surface at the west end of the spray field to approximately 30 feet below ground surface at the east end of the spray field and approximately 15 feet below ground surface at the eastern end of the map area. Measured water levels in Well B402689 for January, July, and October were lower than the top of bedrock. Surficial deposits around this well were considered dry for the purpose of constructing groundwater potentiometric maps for these quarters. The elongate dry area south of the west spray field was inferred from water levels in B402689 and the topography of the bedrock surface.

3.3.2 Groundwater Flow Velocities

The average linear velocity of groundwater flow in surficial materials was calculated for three flow paths in the vicinity of the West Spray Field. The flow velocities were calculated using a mean hydraulic conductivity value (K) of 4.57 x 10^{-4} cm/sec determined from EG&G's complete data base of measured hydraulic conductivity values for Rocky Flats Alluvium near the West Spray Field. The assumed effective porosity is 0.1, as used in calculations from previous groundwater monitoring reports.

Table 3-2 presents the calculated average linear flow velocities for these flow paths for all four quarters of 1992. The well pairs used to calculate hydraulic gradients for these flow paths are: 5186/B110989, 5186/B410789, and 5186/B410589. Calculated flow velocities for 1992 are slightly higher than previous years due to use of a higher value for hydraulic conductivity when calculating 1992 flow velocities. Migration rates for conservative dissolved constituents could equal the average linear groundwater flow velocity; however, attenuated, volatile, biodegradable, or redox-sensitive species would exhibit migration rates less than the average linear velocity of groundwater flow.

3.4 Groundwater Quality

Groundwater-quality data for surficial materials at the West Spray Field are presented on computer disk in Appendix B. The following sections describe (1) the statistical evaluation of downgradient groundwater-quality data with respect to unit-specific upgradient groundwater quality, and (2) the distribution and extent of analytes within and adjacent to the West Spray Field.

3.4.1 Statistical Evaluation of Downgradient Groundwater Quality with Respect to Upgradient Groundwater Quality

Groundwater-quality data from a monitoring well located hydraulically upgradient of the West Spray Field were statistically compared with groundwater-quality data from compliance-boundary monitoring wells located downgradient of the unit to assess potential contaminant releases into the uppermost aquifer by the regulated unit. Statistical comparisons between downgradient and upgradient groundwater data were made following the methodology discussed in Section 1.2.3. Statistical calculations for 1992 data at the West Spray Field are presented on computer disk in Appendix C and discussed below.

At the West Spray Field, the uppermost aquifer is composed of alluvial materials (Rocky Flats alluvium and valley-fill alluvium). Upgradient Wells 5186 and the recently installed Well 46192 provide upgradient groundwater-quality data for the West Spray Field. Seven wells, B410589, B410689, B410789, B110889, B110989, B111189, and 5086, monitor downgradient groundwater quality at the compliance boundary.

A summary of the statistical comparisons between upgradient groundwater quality and downgradient groundwater quality is shown in Table 3-3 and 3-4. Table 3-3 lists the analytes for which the proportion of detections (i.e., quantified results) in the downgradient wells was less than 50 percent, or for which there were less than two results. The concentrations of these infrequently detected analytes are also given. Unless verified by subsequent analyses, these infrequently detected analytes are not considered to represent contamination. In particular, the concentrations of dissolved mercury reported in Wells B110889, B110989, B111189, and B410789 during 1992 are not considered to represent groundwater contamination. Mercury was reportedly detected in all four wells at identical concentrations of 0.21 μg/l only during the first quarter of 1992 but was never detected again during subsequent sampling and analysis.

Table 3-4 summarizes the results of ANOVA tests on groundwater data for analytes with more than 50-percent quantified results. Analytes showing statistically significant differences between upgradient and downgradient wells include radionuclides (gross alpha, and U-233, 234, dissolved metals (calcium, sodium, and vanadium), inorganic analytes (chloride, fluoride, and silicon), and pH. The occurrence of these analytes in downgradient wells may indicate contamination. Statistical analysis indicated no significant increases in VOC concentrations downgradient of the West Spray Field. Analytes for which a statistically significant difference in the data set occur, due to comparison between two downgradient wells and not a comparison between upgradient and downgradient wells, include sulfate, total dissolved solids, barium, magnesium, and strontium. The nature and extent of contamination are discussed in Section 3.4.2.

3.4.2 Groundwater Quality Within and Adjacent to the West Spray Field Area

The only VOC detected in surficial material groundwater at the West Spray Field was xylene. Total xylenes were detected at a concentration of 10 μg/l in Well B110889 during the fourth quarter of 1992. Unless detected during subsequent analyses, the single detection is not considered to represent contamination. Xylenes and other VOCs were not detected in any other quarter or well in the West Spray Field area.

The radionuclides detected in groundwater from the West Spray Field monitoring wells include Am-241, Pu-239, 240, U-233, 234, U-238, gross alpha, and tritium (Figure 3-6). Only Am-241, Pu-239, 240, and tritium were detected at activities exceeding sitewide background levels. Am-241 was detected at activities above sitewide background levels in two wells: 4986 at an activity of 0.1214 pCi/l during third quarter 1992, and 5086 at an activity of 0.08772 pCi/l during the first quarter of 1992. Pu-239,240 activity was above sitewide background only in groundwater from Well 5086 (0.2541 pCi/l, first quarter). Tritium activities were above sitewide background values in Wells 5086 and B410589 (second and first quarters, respectively) at 435.1 and 659.5 pCi/l, respectively. Concentrations of U-233,234 were detected in downgradient Wells B410589 (1.061 to 1.395 pCi/l), B410689 (0.709 to 0.918 pCi/l), B410789 (0.8588 pCi/l), B110889 (0.7698 pCi/l), and 4586 (1.014 pCi/l). Concentrations of U-238 were detected in downgradient Wells B410589 (0.8394 pCi/l), B410789 (0.8136 pCi/l), and 4586 (0.6382 pCi/l).

The inorganic analytes and major ions frequently detected include bicarbonate, calcium, chloride, fluoride, magnesium, nitrate/nitrite, silicon, sodium, sulfate, and TDS as discussed in Section 3.4.1, only calcium, chloride, fluoride, silicon, and sodium occur at significantly greater concentrations in the downgradient monitoring wells. Sulfate, nitrate/nitrite, magnesium and TSS all occur at higher concentrations in the upgradient monitoring Well 5186. A concentration isopleth map for nitrate/nitrite during second quarter 1991 (Figure 3-7) shows higher nitrate/nitrite values occurring in Areas 2 and 3. Lower concentrations of nitrate/nitrite were detected in Area 1. High concentrations of nitrate/nitrite and sulfate were also detected in upgradient Well 5186. Chloride concentrations are consistently highest in the southeast and central portions of the West Spray Field (Figure 3-8) where they often exceed the background tolerance limit.

3.5 Conclusions

In summary, statistical comparisons of upgradient verses downgradient groundwater quality at the West Spray Field compliance boundary indicate that this unit may have contributed U-233,234 selected dissolved metals (calcium, sodium, and vanadium), and selected inorganic analytes (chloride, fluoride, and silicon). The only VOC detected in any well at the West Spray Field was total xylene. This analyte was detected in Well B110889 at a concentration equal to the detection limit of 10 $\mu g/l$. High concentrations of nitrate/nitrite occur in Wells 5186 (located upgradient of the West Spray Field), 4986, and B410789.

4.0 GROUNDWATER MONITORING AT THE PRESENT LANDFILL

The Present Landfill began operating on August 14, 1968, for the disposal of RFP solid waste. The historical background of the Present Landfill is discussed briefly below. Details regarding the construction, operation, regulatory history, and site characterization of the Present Landfill are presented in the Phase I RFI/RI Work Plan for Operable Unit No.7-Present Landfill (USDOE, 1991b).

Currently the landfill is only accepting nonhazardous solid waste. However, records indicate that some hazardous waste was disposed at the landfill, making it a RCRA-regulated unit. Disposal of hazardous constituents in the landfill was halted in November 1986. As of July 1988, the landfill covered approximately 765,000 square ft (17.5 acres) of land. The volume of material in the landfill is currently estimated to be approximately 405,000 cubic yards based on historical daily disposal rates, daily soil cover volumes, and the length of operation of the landfill.

In September 1973, tritium was detected in leachate draining from the landfill. In response to this detection, (1) a sampling program was initiated to determine the location of the tritium source, (2) monitoring of waste prior to burial was initiated to prevent further disposal of radioactive material, and (3) interim response measures were undertaken to control the generation and migration of landfill leachate.

Interim response measures included construction of two ponds (Pond No. 1 and No. 2, also known as the West Landfill Pond and East Landfill Pond, respectively) immediately east of the landfill, a subsurface leachate collection system, a subsurface interception system for diverting groundwater around the landfill, and surface water control ditches. The influence of the groundwater diversion and leachate collection system on groundwater flow around the landfill is discussed further in Section 4.3.

The West Landfill Pond (Pond No. 1) embankment was constructed approximately 500 ft east of the 1974 position of the landfill's advancing face. The East Landfill Pond (Pond No. 2) embankment was constructed approximately 1,000 ft east of the West Landfill Pond embankment. A cutoff wall, set in bedrock, was constructed in the East Landfill Pond embankment to reduce seepage through the embankment foundation. The embankments and ponds were built to collect and evaporate groundwater and surface water and leachate from a subsurface drainage control system installed around the perimeter of the landfill in 1974.

The west embankment and West Landfill Pond were removed in 1981 to allow eastward expansion of the landfill. Between 1977 and 1981, the leachate collection system was covered with waste as the landfill expanded beyond the limits of the system. Two slurry walls were constructed in 1981 extending from the ends of the north and south groundwater interceptor ditches. These slurry walls range in depth from 10 to 25 ft and were designed to be seated in bedrock.

Sometime after the Present Landfill went into operation in 1968, excess water from the landfill pond was sprayed onto a ridge south of the East Landfill Pond. The sprayed water collected on the roadway and flowed into North Walnut Creek. When this was discovered, the spraying activities were moved north of the landfill pond adjacent to the irrigation ditch IHSS 167.1 (Figure 4-1). Because the subsequent spray water then collected in local drainage channels and flowed around the landfill pond to the main drainage, the spraying activities were again moved. The final location was south of the west end of the landfill pond adjacent to the pond. The excess spray water flowed back into the East Landfill Pond.

The landfill currently operates under interim status RCRA regulations. Post-closure inspection, maintenance, and monitoring of the Present Landfill will be performed in accordance with 6 CCR 1007-3 Part 264 (40 CFR Part 264). In accordance with the IAG and applicable Colorado Hazardous Waste regulations, a closure plan will be developed through the IM/IRA decision document.

4.1 Summary of Previous Investigations

4.1.1 Alternate Groundwater Monitoring Program

An "alternate" groundwater monitoring program (other than the one described in Sections 265.91 and 265.92 of 6 CCR 1007-3) is being implemented at the Present Landfill because it has been assumed that a statistical evaluation of indicator parameter from upgradient monitoring wells would indicate an impact to groundwater quality. The GWAP summarizes the history of previous site-specific hydrogeologic investigation, monitoring well installation programs, sampling and analytical programs, and evaluation procedures for the alternative groundwater monitoring system at the Present Landfill. The plan also included the procedures and techniques for collection, sample preservation and shipment, analytical procedures, and chain-of-custody control.

Table 4-1 lists wells within and around the Present Landfill, including the geologic unit in which they were screened. Figure 4-1 shows the locations of these wells. Twenty-two wells monitor groundwater quality in surficial materials. Three wells monitor groundwater quality in weathered sandstone. Seven wells monitor groundwater quality in weathered claystone. Additionally, four wells monitor groundwater quality in unweathered bedrock.

Groundwater samples were analyzed for parameters listed in Table 1-2. Sampling and analysis records are maintained in compliance with 6 CCR 1007-3 and 40 CFR 265.94 (b). Annual reports were compiled in March 1989, March 1990, March 1991, and March 1992 that describe groundwater elevations, groundwater flow rates, and include the results of 1988, 1989, 1990, and 1991 groundwater sample analyses, respectively.

4.1.2 Previous Nature and Extent of Groundwater Contamination

The nature and extent of groundwater contamination was most recently evaluated in the 1991 Annual RCRA Groundwater Monitoring Report (USDOE, 1992). Based upon an examination of 1991 alluvial groundwater-quality data from monitoring wells within and surrounding the landfill, the landfill is contributing major inorganic ions (bicarbonate, calcium, chloride, magnesium, sodium, and TDS), dissolved metals (chromium, lithium, potassium, and strontium), radionuclides, and VOCs to shallow groundwater. Dissolved radionuclides include Am-241, Pu-239, 240, U-233, 234, U-238, and Ra-226. VOCs were detected sporadically and infrequently in wells screened in surficial materials during 1991. Verified detections in 1991 included 1,1,1-TCA, 1,1-DCE, 1,2-DCE, PCE, CCl_4, chloroethane, vinyl chloride, and TCE.

Elevated concentrations of analytes in weathered-bedrock wells typically included major ions (bicarbonate, chloride, sulfate, TDS, and nitrate/nitrite). Elevated concentrations of dissolved metals and radionuclides and detections of volatile organic compounds were not seen in weathered-bedrock wells within and around the landfill except in the vicinity of Well B206189. No VOCs were detected in any weathered-bedrock well during all four quarters of 1991.

Concentrations of major ions observed in bedrock wells were typically higher than concentrations seen in alluvial groundwater within the landfill. Therefore, bedrock-groundwater quality has been considered to be largely influenced by mineral dissolution within the sandstone and claystone units (USDOE, 1990b).

Results of hydrogeologic investigations of the Present Landfill suggest that the groundwater-intercept system may not completely isolate the landfill from the surrounding groundwater. Hydraulic assessments for specific areas on the west, north, and south sides of the groundwater-intercept system indicate that groundwater may flow into the landfill on the west or northwest and may be exiting the landfill on the southwest at some times during the year. The intersection of the groundwater-intercept system and the slurry walls may be the location of this inflow (USDOE, 1988).

4.2 Uppermost Aquifer

The uppermost aquifer in the Present Landfill area is composed of saturated surficial materials and weathered bedrock. Rocky Flats alluvium and artificial fill occur upgradient of, and within the landfill; colluvium and North Walnut Creek valley-fill alluvium are present downgradient of the Present Landfill. Weathered claystones and weathered sandstones in direct contact with the overlying surficial materials are considered part of the uppermost aquifer. Unweathered claystones and unweathered sandstones (even if they are in direct contact with the overlying surficial materials) are not considered part of the uppermost aquifer.

4.3 Conceptual Model of the Groundwater Flow System

Groundwater occurs in surficial material (Rocky Flats alluvium, colluvium, valley-fill alluvium, and artificial fill) and in bedrock sandstones and claystones in the area of the Present Landfill.

To control fluid flow in and around the landfill, a leachate collection and surface water/groundwater diversion system was constructed in 1974 (Figure 4-1). This system was designed to collect leachate generated in the landfill and to divert surface water and groundwater around the outside of the landfill. The surface water/groundwater diversion portion of the system is located outside of the leachate collection system and is separated from the leachate collection system by a 4.5-ft-wide zone of clayey soil. It consists of a surface water intercept ditch that diverts surface water north and south of the landfill and a drain system to dewater surficial materials between the interceptor ditch and the clay barrier. Theoretically, landfill leachate is contained within the landfill wastes and underlying materials by the clay barrier, and migrates toward the East Landfill Pond. Additional details regarding the configuration of the leachate collection and surface water/groundwater diversion system are presented in the Phase I RFI/RI Work Plan for Operable Unit No. 7 - Present Landfill (USDOE, 1991b). Slurry walls have been added at the eastern end of the landfill. These walls were added to divert groundwater from, and contain possible leachate generated by, landfill materials placed outside of the pre-existing leachate collection system.

Previous reports indicated that the landfill wastes bury the leachate collection system and extend beyond the system. Therefore, leachate generated outside the landfill trench could be collected by the groundwater diversion system. In addition, the clay cutoff wall no longer extends to the surface of the landfill; this would allow groundwater to flow across the clay cutoff wall if the water table were to rise sufficiently. Landfill wastes do not extend to the surface water interceptor ditch.

Presently, intercepted groundwater is discharged into the East Landfill Pond. Once this intercepted groundwater and groundwater/leachate from within the landfill is discharged to the landfill pond, it is retained within the pond where it either evaporates directly from the pond or evaporates via spray irrigation onto the hillsides adjacent to the pond. Alluvial groundwater upgradient from the landfill could reach the valley fill east of the pond by recharging the groundwater intercept system. This groundwater intercept system can, through a system of valves and piping, discharge to the un-named tributary directly east of the East Landfill Pond. No groundwater-flow rates for valley-fill alluvium in the un-named tributary have been calculated at this time.

The following conclusions regarding the impact of the leachate/groundwater intercept system on groundwater flow have been made based on water level and groundwater-quality data (USDOE, 1988 and 1991b):

- The groundwater intercept system is diverting groundwater away from the west end of the landfill

- The groundwater intercept system is not diverting all groundwater away from the north and south sides of the landfill

- The clay barrier is holding groundwater in the landfill along the west and north sides

- The clay barrier does not appear to be completely effective on the south side of the landfill and may be allowing groundwater to enter the landfill at times

- The groundwater intercept system appears to function intermittently on the north side of the landfill

In general, groundwater flows eastward in surficial materials (i.e., alluvial materials, disposed waste, and daily soil cover) toward the landfill pond, as indicated by the potentiometric surface maps constructed for surficial materials during the first through fourth quarters of 1992 (Figures 4-2 through 4-5, respectively). Near the East Landfill Pond, however, groundwater flows from the north, west, and south toward the pond. Groundwater flow in the weathered bedrock units during 1992 (Figures 4-6 through 4-9, respectively) changes little throughout the year and is similar in direction to groundwater flow in the surficial units.

4.3.1 Potentiometric Surfaces

Groundwater elevations in surficial materials at the landfill are characterized by seasonal fluctuations of up to approximately 10 feet. Relatively higher water-table elevations occur during the second and third quarters of 1992 (April and July). Water-table elevations are comparatively lower during the first and fourth quarters of 1992 (January and October). Groundwater elevations in the weathered bedrock show fluctuations of up to approximately six feet during 1992.

Table 4-2 lists surficial and bedrock wells for which reported water levels were below the published elevation of the bottom of the well screen and/or below the published elevation of the top of bedrock. These wells were assumed to be dry for the purpose of constructing groundwater potentiometric-surface maps.

Nine monitoring wells completed within weathered bedrock in the Present Landfill area are routinely monitored. Typically, the water-level elevation is below that of the top of bedrock, indicating unsaturated weathered bedrock separates groundwater in surficial material from groundwater in weathered bedrock. Only at Wells B206189 and B206589 does the elevation of the water table exceed that of the top of bedrock. At these locations, the weathered bedrock is fully saturated and hydraulically connected to the saturated surficial materials.

Vertical hydraulic gradients were calculated using the three surficial material/weathered bedrock well pairs installed at the Present Landfill. Vertical gradient is the quotient of the difference in water levels measured in the well pair during equivalent months during 1992 and the vertical distance between the middle of the screened interval in the alluvial well and the middle of the screened interval of the associated weathered-bedrock well. Vertical gradients (Table 4-3) fluctuate throughout the year due to seasonal change in groundwater elevations within the surficial materials. Vertical gradients ranging from 0.17 ft/ft to 0.55 ft/ft downward have been calculated for Wells 6487 and B206189 during 1992. Vertical gradients ranging from 0.42 ft/ft to 0.58 ft/ft downward have been calculated for Wells 4087 and B207089 during 1992. Vertical gradients between Wells 4087 and B206989 were not calculated because water levels measured in B206989 were below the published elevation of the bottom of the well screen.

4.3.2 Groundwater Flow Velocities

Groundwater flow velocities for saturated materials in the Present Landfill area are presented below. Migration rates for conservative dissolved constituents approximate the average linear groundwater flow velocity; however, attenuated, volatile, biodegradable, or redox sensitive species probably exhibit migration rates less than the average linear groundwater flow velocity.

4.3.2.1 Groundwater Velocities in Surficial Materials

The average linear groundwater flow velocity in surficial materials was calculated for three flow paths in the vicinity of the Present Landfill. The flow velocities were calculated using a mean hydraulic conductivity value (K) of 3.81×10^{-4} cm/sec determined from EG&G's complete data base of measured hydraulic conductivity values for the Rocky Flats Alluvium in the vicinity of the Present Landfill. Previous flow velocity calculations have used a hydraulic conductivity value of 3.1×10^{-4} cm/sec based on drawdown recovery tests and slug tests performed in wells completed in surficial materials below the landfill (USDOE, 1990b). An effective porosity of 0.1 is assumed as in previous groundwater monitoring reports.

Table 4-4 presents the calculated average linear velocities of groundwater flow during low- and high-flow conditions (January and April, respectively). The well pair used to calculate hydraulic gradients is B106089/0756. Calculated flow velocities for 1992 are slightly higher than previous years due to use of a higher value for hydraulic conductivity when calculating 1992 flow velocities.

4.3.2.1 Groundwater Velocities in Bedrock

The average linear velocity of groundwater flow in weathered bedrock was calculated for two flow paths in the vicinity of the Present Landfill. The flow velocities were calculated using a mean hydraulic conductivity value of 8.90×10^{-7} cm/sec determined from EG&G's complete data base of measured hydraulic conductivity values for weathered bedrock in the vicinity of the Present Landfill. An effective porosity of 0.1 is assumed, as in previous groundwater monitoring reports.

Table 4-4 presents the calculated average linear velocities of groundwater flow for two flow paths at both low and high flow conditions (October and July, respectively). The well pairs used to calculate hydraulic gradients for the two flow paths were: 0986/0886 and B206189/0886. Again, the calculated flow velocities for 1992 are slightly higher than previous years owing to use of a higher value for hydraulic conductivity.

4.4 Groundwater Quality

Groundwater-quality data for surficial materials and weathered bedrock are presented on computer disk in Appendices B-4 and B-5, respectively. The following sections describe (1) the statistical evaluation of downgradient groundwater-quality data with respect to upgradient groundwater quality, and (2) the distribution and extent of detected analytes within and adjacent to the RCRA unit.

4.4.1 Statistical Evaluation of Downgradient Groundwater Quality with Respect to Upgradient Groundwater Quality

Groundwater-quality data from monitoring wells located hydraulically upgradient of the Present Landfill were statistically compared with groundwater-quality data from monitoring wells located downgradient of the Present Landfill to assess potential contaminant releases into the uppermost aquifer by the regulated unit. Statistical comparisons between downgradient and upgradient groundwater data were made following the methodology discussed in Section 1.2.3. Statistical calculations for 1992 data from the Present Landfill are presented on computer disk in Appendix C and discussed below.

At the Present Landfill, the uppermost aquifer is composed of surficial materials and weathered bedrock. Three wells, 1086, 5887, and 6087, provide upgradient groundwater-quality data for surficial materials immediately upgradient of the Present Landfill. Currently, no wells are available to provide comparable upgradient groundwater-quality data for weathered bedrock. Well 0986 monitors groundwater quality in unweathered bedrock. Data from these four wells were combined to establish upgradient groundwater quality. Five wells located east of the East Landfill Pond embankment monitor downgradient groundwater quality. These five wells are not located at the compliance boundary. However, their locations are consistent with EPA's amendment to 40 CFR 265.91 to allow alternate placement of monitoring wells hydraulically downgradient of an interim-status facility where existing physical obstacles prevent installation of wells at the compliance boundary. Downgradient groundwater quality in surficial materials is monitored by Well 4087. However, because the East Landfill Pond dam depresses the potentiometric surface to the east, this surficial well is frequently dry. Therefore, downgradient groundwater quality is monitored by Wells B207089, B206989, B207189, and 4187. Wells B207089 and B206989 monitor groundwater in weathered bedrock. Wells B207189 and 4187 monitor groundwater in unweathered bedrock.

A summary of the statistical comparisons between upgradient groundwater quality and downgradient groundwater quality is shown in Tables 4-5 and 4-6. Table 4-5 lists the analytes for which the proportion of detections (i.e., quantified results) in the downgradient wells was less than 50 percent, or for which there were less than two results. The concentration of these infrequently detected analytes is also given. Unless verified by subsequent analyses, these infrequently detected analytes are not considered to indicate contamination.

For analytes with greater than 50-percent quantifiable results (Table 4-6), ANOVA testing indicates a statistically significant difference (at the 5-percent significance level) between upgradient and downgradient groundwater quality for radionuclides (gross alpha, gross beta, U-235, and U-233, 234), dissolved metals (arsenic, barium, calcium, magnesium, manganese, potassium, sodium, and vanadium), and inorganic analytes (sulfate, TDS, TSS, bicarbonate, chloride, and fluoride). Concentrations of total suspended solids in the upgradient wells exhibit higher concentrations than the downgradient wells. VOCs are not among the analytes for which statistically significant differences have been determined in the upgradient and downgradient groundwater-quality data. Therefore, the Present Landfill does not appear to impact downgradient groundwater quality with respect to VOCs. Statistical comparisons between downgradient wells revealed significant differences in nitrate/nitrite, U-238, and selenium in two downgradient wells. These analyte concentrations were not significantly different in downgradient and upgradient wells.

4.4.2 Groundwater Quality in the Present Landfill Area

Even though several analytes were found to have statistically significant concentration increases in the downgradient wells, many more analytes were detected in one or more of the wells located within and adjacent to the Present Landfill. Analyte distribution maps for VOCs and radionuclides (Figures 4-10, 4-11, 4-12, and 4-13) illustrate the spatial distribution and extent of contamination within the landfill. Concentration isopleth maps for TDS (Figure 4-14) and calcium (Figure 4-15) best illustrate the distribution of inorganic analytes in surficial groundwater associated with the Present Landfill. The distribution of VOCs, radionuclides, dissolved metals, and inorganic analytes in groundwater in and around the Present Landfill is discussed below.

VOCs were detected in groundwater from several alluvial monitoring wells as follows, (see Figure 4-10): 1,1-DCA in Wells B106089 and B206389; 1,1-DCE in Wells 6587 and 6687; 1,2-DCE in Wells B106089, 6387, 6487, 6587, 6687, and B206389; 1,1,1-TCA in Wells B106089, 6587, 6687, and 7287; TCE in Wells B106089, 6587, 6687, B206389, and 7287; toluene in Wells B106089 and B206489; xylenes in Well B206389; vinyl chloride in Well 6487; carbon tetrachloride in Well B106089; chloroform in Well B206389; acetone in Wells B106089, 6487, B206389, 6787, and 7087; and methylene chloride in Well B206389. In general, VOCs were detected in monitoring wells located within the area of the landfill waste or south of the landfill adjacent to IHSS Nos. 166.1, 166.2, and 166.3. No VOCs were detected in downgradient alluvial Well 4087 or in alluvial Wells 0786, 7187, 6887, 6087, 6187, 6287, 5887, or 1086.

VOCs were detected in two weathered-bedrock wells and one unweathered-bedrock well during 1992 (Figure 4-11). Methylene chloride was detected in groundwater from Wells 0886 and 0986 (fourth quarter and third quarter, respectively). Acetone was detected in groundwater from Wells B206589 and 0986 (fourth quarter and third quarter, respectively). The infrequent occurrence of methylene chloride and acetone in these wells may result from landfilled wastes or contamination of the samples during laboratory analysis. Methylene chloride and acetone have been recognized by the USEPA as common laboratory contaminants. Toluene was detected in groundwater from fourth quarter sampling of Well 0986.

VOCs are appropriate parameters for use as indicators of groundwater contamination from the landfill based on their occurrence as primary leachate constituents (USDOE, 1991b) and their environmental fate and transport characteristics. VOCs do not occur naturally, are environmentally persistent, are detectable in low concentrations, and typically exhibit high mobility in groundwater. The absence of VOCs in the weathered-bedrock monitoring wells (excluding methylene chloride and acetone) indicate that the Present Landfill has not adversely impacted weathered-bedrock groundwater even though some contamination of alluvial groundwater overlying the weathered bedrock has occurred.

Radionuclides were detected in both alluvial and weathered-bedrock wells (Figures 4-12 and 4-13). All target radionuclide analytes were detected in surficial material groundwater at one or more wells during one or more quarters during 1992. Pu-234, 240 and Sr-89, 90 were detected in upgradient Well 1086 during the first quarter of 1992 at activities of 0.01174 pCi/l and 1.597 pCi/l, respectively. High activities of radionuclides were observed in wells located (1) within the area of landfilled wastes (B106089, 6387, and 6487), (2) adjacent to one of the discharge valves for the groundwater intercept system (Well 4087), and (3) hydraulically downgradient from IHSS Nos. 166.1, 166.2, and 166.3 (7287, B206489, B206389, and 7087). These IHSSs have been used in the past for disposal of sewage treatment sludge containing elevated radionuclide concentrations of uranium and plutonium (USDOE, 1991b). The presence of radionuclides in these wells may originate from IHSS Nos. 166.1, 166.2, and 166.3 rather than the Present Landfill. Of the groundwater samples with activities of radionuclides above detection limits, only groundwater samples from five wells screened in surficial materials were above sitewide background values, and groundwater samples from only two wells screened in weathered bedrock were above background values. No radionuclide activities in groundwater samples from unweathered bedrock were above sitewide background values.

Radionuclide activities in groundwater from five wells screened in surficial materials were above sitewide background levels. Well 1086 (the upgradient well) reported Sr-89, 90 at 1.597 pCi/l first quarter only). Tritium was reported in Wells 6587 (second quarter only) and 6387 (first three quarters) at 662, 1629, 938.2, and 1142 pCi/l (respectively). Ra-226 was reported in Well 6487 (first quarter only) and Well B206389 (first two quarters) at 0.583, 1.559, and 1.523 pCi/l (respectively). Am-241 and Pu-239, 240 were detected above sitewide background levels in Well 6387 only (first three quarters and third quarter, respectively) at 0.06183, 0.03211, 0.03852, and 0.1206 pCi/l, respectively). Activities in groundwater for two wells screened in weathered bedrock were above sitewide background levels. Well B206589 reported U-235 at 21.28 pCi/l (first quarter only) and Ra-226 at 0.5153 pCi/l (third quarter only). Well B206989 reported Ra-226 at 0.5202 pCi/l (third quarter only).

Major inorganic analytes typically associated with landfill contamination include bicarbonate, TDS, calcium, chloride, and sodium. TDS concentrations serve as an indicator parameter for major inorganic ions associated with landfill leachate. Figure 4-14 illustrates the distribution and extent of TDS in surficial materials at the Present Landfill area. The concentration isopleth map shows that maximum TDS concentrations in surficial materials occur within the groundwater intercept system and/or downgradient of IHSS Nos. 166.1, 166.2, and 166.3. The occurrence of these analytes in groundwater beyond the limit of the groundwater intercept system and slurry walls south and southeast of the landfill may indicate (1) impacts from IHSS Nos. 166.1, 166.2, and 166.3, (2) intercept system at the southeast edge of the landfill may not be functioning adequately, or (3) that landfilled waste emplaced beyond the limit of the intercept system may be impacting groundwater quality.

Figure 4-15 illustrates the distribution and extent of calcium in groundwater from surficial materials. High calcium concentrations occur along the south side of the landfill and downgradient of IHSS Nos. 166.1, 166.2, and 166.3. Both TDS and calcium concentrations are also elevated in Well 4087 on the east side of the East Landfill Pond embankment. The isopleth maps for TSD and calcium show concentration contours penetrating the pond embankment but these contours are marked as questionable on both maps. The current contour shape suggests that the source of TDS and calcium in Well 4087 is to the west, when in fact the source of high TDS and calcium is not known. Because Well 4087 is often dry, water samples collected from the well during wet periods may contain redissolved salts deposited in the nearby valley fill deposits during evapotranspiration.

Dissolved metals were detected in groundwater from both surficial materials and weathered bedrock at the Present Landfill. Dissolved metals occurred at slightly higher concentrations in weathered-bedrock groundwater. This is consistent with results of the 1992 Background Geochemical Characterization Report (USDOE, 1992) and probably represents natural geochemical weathering. Dissolved metal concentrations are only slightly higher than detection limits. The most frequently detected metals are strontium and lithium, with less frequent detections of copper, manganese, nickel, and zinc.

4.5 Conclusions

Analysis of the occurrence and distribution of analytes throughout the landfill area indicates that the landfill is impacting groundwater by the addition of VOCs, radionuclides, dissolved metals, and major inorganic ions typical of landfill leachate, including bicarbonate, calcium, chloride, magnesium, nitrate/nitrite, sodium, sulfate, and TDS. Although the groundwater interceptor system appears effective in limiting the transport of landfill-related constituents, some radionuclide, metal, and inorganic analytes occur both within and outside of the groundwater interceptor system at concentrations exceeding background levels. No VOCs were detected in any of the downgradient monitoring wells east of the East Landfill Pond embankment. The occurrence of VOCs, radionuclides, metals, and inorganic analytes in groundwater to the south and southeast of the Present Landfill (IHSS 114) may be due to (1) impacts from IHSS Nos. 166.1, 166.2, and 166.3, (2) inadequate functioning of the groundwater intercept system at the south edge of the landfill, or (3) impacts from landfilled waste emplaced beyond the limit of the interceptor system.

Evaluation of downgradient and upgradient groundwater quality data at the Present Landfill indicates statistically significant differences in concentrations of radionuclides (gross alpha, gross beta, U-235, and U-233,234), dissolved metals (arsenic, barium, calcium, magnesium, manganese, potassium, sodium, and vanadium), and inorganic analytes (bicarbonate, chloride, fluoride, sulfate, and TDS). Statistically significant increases in the concentrations of these analytes may be the result of migration of landfill-related contamination to the compliance boundary monitoring wells or historical discharges of contaminated groundwater associated with IHSS Nos. 166.1, 166.2, and 166.3 from the groundwater intercept discharge point east of the East Landfill Pond embankment. Alternatively, these differences may result from comparisons of groundwater-quality data from monitoring wells screened in bedrock to monitoring wells screened in surficial materials.

5.0 GROUNDWATER MONITORING ACTIVITIES ASSESSMENT

Groundwater monitoring at the three RCRA-regulated units at RFP continues under interim status guidelines for compliance monitoring. Groundwater monitoring activities at the regulated units will be evaluated further as more hydrologic and analytical data become available and if conditions change in terms of the nature, extent, and migration characteristics of contaminants. The purpose of this portion of the Annual RCRA Groundwater Monitoring Report is to evaluate the effectiveness of the monitoring program and to provide a mechanism for establishing recommendations concerning future monitoring activities at RCRA-regulated units. Recommendations made in this report, and those that will be made in subsequent Annual RCRA Groundwater Monitoring reports, are based on interpretations of the data contained in the annual RCRA reports. Additional recommendations may be made in the RCRA Groundwater Report Addendum or other reports as pertinent information becomes available through other investigations.

The methodology used to assess groundwater monitoring activities includes the following appraisal of existing monitoring wells:

- Appropriateness of location to fulfill required purpose; either monitoring of upgradient groundwater quality, monitoring of groundwater quality at the compliance boundary monitoring of nature and extent of contamination, or characterization of hydrogeologic/aquifer characteristics.

- Hydrogeologic unit in which the monitoring well is screened.

- Completeness of monitoring well construction details. Several monitoring wells, primarily those installed prior to 1986, have incomplete or inadequate "as built" construction details.

- Physical condition of the monitoring well. Some RCRA monitoring wells are damaged.

- Usefulness of the analytes tested for at each well. The analyte suite should meet regulatory requirements, reflect the history and past activities at the regulated unit, and be based on both needs in light of data from previous geochemical investigations.

- The sampling frequency at each well and its relevance to the monitoring program at that regulated unit.

5.1 Well Evaluation Project

A well evaluation project has recently been undertaken at RFP. it is based, in part, on the methodology described above. The project is a three-phased approach to the evaluation of existing wells and the removal of unnecessary wells. All wells at RFP, including RCRA wells, are to be evaluated as part of this project.

Phases I and II have already been implemented. Phase I involves the discontinuance of sampling at wells which have: 1) physical damage, 2) incomplete construction details, and 3) insufficient water for sampling during a majority of the well's life. RCRA wells that have been removed from the sampling program in Phase I are: 2086, 2886, 3787, 5987, 6387, 6787, B207189, P210289, B206189, P207489, 1886, B208389, B208489, P209989, P213889, and P213989.

Phase II well evaluation criteria include discontinuance of sampling based on 1) high pH associated with improper construction and 2) redundancy of wells coverage where newer or other wells serve the same purpose. Phase II RCRA wells that have been removed are: 5286, B208589, P209189, B210389, and 6287.

Phase III consists of a comprehensive review of all wells based on the methodology presented in the previous section. Further reductions in RCRA monitoring wells may be proposed during Phase III. Wells at which sampling was discontinued as part of Phases I and II may be reintroduced into the groundwater sampling program due to the assessment made as part of Phase III. Phase III will be implemented during 1993. Additional information concerning the well evaluation project will be made available in subsequent RCRA Annual and RCRA Quarterly reports, and the RCRA Annual Addendum.

5.2 Recommendations

Recommendations concerning all three RCRA units include the following:

- Once all 1992 data have been received and validated, review QC data to evaluate the occurrence and repeatability of contaminants.

- Perform statistical analysis of groundwater-quality data for 1990 and 1991 using the statistical assessment strategy utilized in this respect to evaluate any differences in the analytes of concern identified in the 1990, 1991, and 1992 Annual RCRA Groundwater Monitoring Reporter.

Recommendations concerning each individual RCRA unit are presented below.

5.2.1 Monitoring at the Solar Evaporation Ponds

Recommendations for upgrading the assessment groundwater monitoring program at the Solar Evaporation Ponds area include the following:

- Increase the number of monitoring wells immediately upgradient of the ponds to better define upgradient groundwater quality.

- Provide additional monitoring well coverage to the north, east, and southeast for better definition of the contaminant plumes in saturated materials. This is particularly important to determine whether analyte concentrations at Well 3586 are related to the Solar Evaporation Ponds, runoff from the industrialized area, or other potential upgradient contaminant sources.

- Replace Well 2086 and other wells east of the Solar Evaporation Ponds that have failed.

- Incorporate information obtained during the Operable Unit No. 4 RFI/RI to better define bedrock topography, areas of saturated materials, and groundwater flow directions. Evaluate geophysical methods for applicability at Solar Evaporation Ponds to better describe the microtopography of the bedrock surface.

5.2.2 Monitoring at the West Spray Field

Recommendations for upgrading the alternate groundwater monitoring program at the West Spray Field include the following:

- Add additional upgradient monitoring wells to provide a better statistical assessment of upgradient groundwater quality.

- Assess the chemistry of surface water in the quarry located approximately 200 ft upgradient of Well 5186.

- Evaluate and reduce, as appropriate, the analytical suite for this unit because of the infrequent detection and/or absence of certain analytes at the West Spray Field.

- Evaluate groundwater-quality data from bedrock monitoring Wells 46392, 4686, 4886, and 5286 in future reports.

5.2.3 Monitoring at the Present Landfill

Recommendations for upgrading the alternate groundwater monitoring program at the Present Landfill include the following:

- Incorporate groundwater-quality data from monitoring wells currently being installed in surficial, weathered bedrock, and unweathered bedrock units immediately upgradient of the Present Landfill as part of the Operable Unit No. 7 RFI/RI and all other applicable information gained from the Operable Unit No. 7 RFI/RI.

- Incorporate groundwater elevation data from additional monitoring wells (such as Wells B208789, P210089, P209989, B210389, and 1786) to better define the potentiometric surface outside of the RCRA waste management area.

- Replace damaged Well 6387 with a piezometer to allow continued assessment of the effectiveness of the groundwater intercept system as a hydraulic barrier.

- Perform pumping tests in Wells 6787 and 6887 to evaluate the effectiveness of the slurry walls as hydraulic barriers.
- Evaluate information from boreholes/monitoring wells recently installed in and downgradient of the East Landfill Pond embankment.

Additional or more specific recommendations regarding portions of each regulated unit where monitoring well data are no longer useful will be delineated in subsequent reports. These recommendations will include references to specific wells and general locations at each unit, areas of each regulated unit where additional monitoring well data would permit better characterization of groundwater conditions and the need for supplemental geochemical data or additional hydrologic information as appropriate.

6.0 REFERENCES

Abbreviations

USDOE	U.S. Department of Energy
USEPA	U.S. Environmental Protection Agency

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To: Steve H. Singer
From: Jim A. Paschis JAP
Subject: QUALITY CONTROL REVIEW
1992 Annual Groundwater Monitoring Report For Regulated Units At The Rocky Flats Plant Dated: March 1, 1993
Date: December 20, 1993

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Comment No.	Location and Comment
1.	Page 1-11, para 2: No radionuclide data given for 4th quarter; Addendum will have to complete this deficiency.
2.	Page 1-13, para 1 and 2: Statistical analysis requires eight consecutive quarters of data. As of the report date, only two wells meet this qualification. Perhaps on-line schedule of future-qualifying wells would be helpful.
3.	Page 1-14, Section 1.2.3.1, para 2, next to last sentence beginning, "Each unit...: It would be valuable to state the other reason to have three down-gradient monitoring wells is that they serve to provide data for evaluating groundwater transport velocity (which may disperse contaminants, if present).
4.	Page 1-14, para 2 first sentence: The explanatory wording of the well location function is reversed. In a monitoring wellfield, the "upgradient well" commonly represents the set of ambient groundwater quality parameters. These parameters set historical precedence against which subsequent "downgradient well" water quality is reviewed.
5.	Figure 1-1: The title wording is unclear with respect to the figure because no wells or comparisons are shown. A more applicable title would simply be to use the definitive wording given in the text page 1-14, third paragraph: "Flowchart to select the appropriate statistical procedure."
6.	Figure 2-1: Although the title is Solar Evaporation Ponds, neither the figure explanation nor the map codes or labels these primary features.
7.	Page 2-1, last sentence: The word "incident" might better be substituted by either meteoric or atmospheric.

8. Table 1-1:
The first 3/4 of this table is unnecessarily repeated on the reverse side of the page.

9. Page 2-7, para 1:
Sufficient and easily retrievable, data for calculating vertical hydraulic gradient is absent. Two parts are necessary: 1) water levels (which are given) and elevations of well screen ends (which are lacking). Well construction data should be supplied for all the well pairs used in this report.

10. Table 2-2:
Well P207389 should be correctly identified. Based upon water level data measurements in the first month of each quarter, the hydraulic gradients given for 14 entries are incorrect. Recalculated values are given below.

Table 2-2. Solar Evaporation Ponds - Vertical Hydraulic Gradients Between Surficial Materials and Weathered Bedrock, 1992

Alluvial Well	Screened Unit	Bedrock Well	Screened Unit	Hydraulic Gradient (ft/ft)			
				1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
P209289	Qrf	P209389	Kass(w)	NA	0.274	NA	NA
2286	Qrf	P210189	Kass(w)	0.625	0.104	0.079	0.080
P207489	Qrf	P07389	Kass(w)	-0.042	0.007	-0.052	0.004
2686	Qrf/Kac(w)	P207589	Kacl(w)	1.185	1.329	1.213	1.155
B208089	Qc	B208189	Kacl(w)	0.576	-0.589*	0.676	0.688
P207889	Qrf	P207989	Kacl(w)	1.120	1.673	1.494	NA
P207689	Qrf	P207789	Kacl(w)	1.480	1.593	1.531	1.446

11. Table 2-8:
The symbol and footnote indicated by ** and *** are superfluous and should be deleted.

12. Pages 2-12 and 2-13:
The order-of-magnitude increase in the measured values of nitrate/nitrite for bedrock water vs surficial water warrants an explanation.

13. Figure 3-4:
The primary feature, the West Spray Field, should be indicated in the explanation and shown by label on the map.

Table 2-2. Solar Evaporation Ponds - Vertical Hydraulic Gradients Between Surficial Materials and Weathered Bedrock, 1992

Alluvial Well	Screened Unit	Bedrock Well	Screened Unit	Hydraulic Gradient (ft/ft)			
				1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
P209289	Qrf	P209389	Kass(w)	NA	0.274	NA	NA
2286	Qrf	P210189	Kass(w)	0.625	0.104	0.079	0.080
P207489	Qrf	P07389	Kass(w)	-0.042	0.007	-0.052	0.004
2686	Qrf/Kac(w)	P207589	Kacl(w)	1.185	1.329	1.213	1.155
B208089	Qc	B208189	Kacl(w)	0.576	-0.589*	0.676	0.688
P207889	Qrf	P207989	Kacl(w)	1.120	1.673	1.494	NA
P207689	Qrf	P207789	Kacl(w)	1.480	1.593	1.531	1.446

Note: Positive vertical hydraulic gradients indicate downward flow. NA indicates vertical gradient could not be calculated because the well pairs were dry.

* Calculated upward hydraulic gradient attributed to possible erroneous water level reading

The vertical gradient was calculated as the quotient of the difference between elevations in water levels divided by the vertical distance between the screened intervals. Specifically, the divisor was the difference between the elevation at the center of the screened interval for the well completed in the surficial materials and the elevation of the screened interval completed in the weathered bedrock.

A vertical gradient cannot be calculated for well pair 1786 (completed in Qrf/Kacl) and B208689 (completed in Kacl) because of overlapping screened intervals.

Qrf: Rocky Flats Alluvium
Qc: Colluvium
Kacl(w): Weathered Arapahoe Formation Claystone
Kass(w): Weathered Arapahoe Formation Sandstone

Table 1-1. Comparison of Hazardous Substance List (HSL), Target Compound List (TCL), and RCRA Appendix IX Constituents

	HSL	TCL	Appendix IX
VOLATILES			
Chloromethane/Methyl chloride	x	x	x
Bromomethane/Methyl bromide	x	x	x
Vinyl chloride	x	x	x
Chloroethane/Ethyl chloride	x	x	x
Methylene chloride/Dichloromethane	x	x	x
Acetone	x	x	x
Carbon disulfide	x	x	x
1,1-Dichloroethene/1,1-Dichloroethylene	x	x	x
1,1-Dichloroethane/Ethylene dichloride	x	x	x
1,2-Dichloroethene (total)	x	x	x
Chloroform	x	x	x
1,2-Dichloroethane/Ethylene dichloride	x	x	x
2-Butanone/Methyl ethyl ketone/MEK	x	x	x
1,1,1-Trichloroethane/Methyl chloroform	x	x	x
Carbon tetrachloride	x	x	x
Vinyl acetate	x	x	x
Bromodichloromethane	x	x	x
1,2-Dichloropropane	x	x	x
cis-1,3-Dichloropropene	x	x	x
Trichloroethene/Trichloroethylene	x	x	x
Dibromochloromethane/Chlorodibromomethane	x	x	x
1,1,2-Trichloroethane	x	x	x
Benzene	x	x	x
trans-1,3-Dichloropropene	x	x	x
2-Chloroethyl vinyl ether	x		
Bromoform/Tribromomethane	x	x	x
4-Methyl-2-pentanone/MIBK	x	x	x
2-Hexanone	x	x	x
Tetrachloroethene/PCE/Tetrachloroethylene	x	x	x
1,1,2,2-Tetrachloroethane	x	x	x
Toluene	x	x	x
Chlorobenzene	x	x	x
Ethylbenzene	x	x	x
Styrene	x	x	x
Xylene (total)	x	x	x
Dichlorodifluoromethane			x
Acetonitrile/Methyl cyanide			x
Iodomethane/Methyl iodide			x
Acrolein			x
Acrylonitrile			x

Table 1-1. Comparison of Hazardous Substance List (HSL), Target Compound List (TCL), and RCRA Appendix IX Constituents

	HSL	TCL	Appendix IX
VOLATILES			
Chloromethane/Methyl chloride	x	x	x
Bromomethane/Methyl bromide	x	x	x
Vinyl chloride	x	x	x
Chloroethane/Ethyl chloride	x	x	x
Methylene chloride/Dichloromethane	x	x	x
Acetone	x	x	x
Carbon disulfide	x	x	x
1,1-Dichloroethene/1,1-Dichloroethylene	x	x	x
1,1-Dichloroethane/Ethylene dichloride	x	x	x
1,2-Dichloroethene (total)	x	x	x
Chloroform	x	x	x
1,2-Dichloroethane/Ethylene dichloride	x	x	x
2-Butanone/Methyl ethyl ketone/MEK	x	x	x
1,1,1-Trichloroethane/Methyl chloroform	x	x	x
Carbon tetrachloride	x	x	x
Vinyl acetate	x	x	x
Bromodichloromethane	x	x	x
1,2-Dichloropropane	x	x	x
cis-1,3-Dichloropropene	x	x	x
Trichloroethene/Trichloroethylene	x	x	x
Dibromochloromethane/Chlorodibromomethane	x	x	x
1,1,2-Trichloroethane	x	x	x
Benzene	x	x	x
trans-1,3-Dichloropropene	x	x	x
2-Chloroethyl vinyl ether	x		
Bromoform/Tribromomethane	x	x	x
4-Methyl-2-pentanone/MIBK	x	x	x
2-Hexanone	x	x	x
Tetrachloroethene/PCE/Tetrachloroethylene	x	x	x
1,1,2,2-Tetrachloroethane	x	x	x
Toluene	x	x	x
Chlorobenzene	x	x	x
Ethylbenzene	x	x	x
Styrene	x	x	x
Xylene (total)	x	x	x
Dichlorodifluoromethane			x
Acetonitrile/Methyl cyanide			x
Iodomethane/Methyl iodide			x
Acrolein			x
Acrylonitrile			x

Table 1-1. Comparison of Hazardous Substance List (HSL), Target Compound List (TCL), and RCRA Appendix IX Constituents (continued)

	HSL	TCL	Appendix IX
Trichlorofluoromethane			x
Propionitrile/Ethyl cyanide			x
3-Chloropropene/Allyl chloride			x
Methacrylonitrile			x
Dibromomethane/Methylene bromide			x
Isobutyl alcohol/Isobutanol			x
1,2-Dibromoethane/Ethylene dibromide/EDB			x
1,1,1,2-Tetrachloroethane			x
1,2,3-Trichloropropane			x
trans-1,4-Dichloro-2-butene			x
1,2-Dibromo-3-chloropropane/DBCP			x
Chloroprene/2-Chloro-1,3-butadiene			x
SEMI-VOLATILES			
Phenol	x	x	x
bis-(2-Chloroethyl) ether	x	x	x
2-Chlorophenol/o-Chlorophenol	x	x	x
1,3-Dichlorobenzene/m-Dichlorobenzene	x	x	x
1,4-Dichlorobenzene/p-Dichlorobenzene	x	x	x
Benzyl alcohol	x	x	x
1,2-Dichlorobenzene/o-Dichlorobenzene	x	x	x
2-Methylphenol/o-Cresol	x	x	x
bis (2-Chloroisopropyl) ether	x	x	x
4-Methylphenol/p-Cresol	x	x	x
N-Nitroso-di-n-propylamine	x	x	x
Hexachloroethane	x	x	x
Nitrobenzene	x	x	x
Isophorone	x	x	x
2-Nitrophenol/o-Nitrophenol	x	x	x
2,4-Dimethylphenol	x	x	x
Benzoic Acid	x	x	x
bis(2-Chloroethoxy)methane	x	x	x
2,4-Dichlorophenol	x	x	x
1,2,4-Trichlorobenzene	x	x	x
Naphthalene	x	x	x
4-Chloroaniline/p-Chloroaniline	x	x	x
Hexachlorobutadiene	x	x	x
4-Chloro-3-methylphenol/p-Chloro-m-cresol	x	x	x
2-Methylnaphthalene	x	x	x
Hexachlorocyclopentadiene	x	x	x

Table 1-1. Comparison of Hazardous Substance List (HSL), Target Compound List (TCL), and RCRA Appendix IX Constituents (continued)

	HSL	TCL	Appendix IX
2,4,6-Trichlorophenol	x	x	x
2,4,5-Trichlorophenol	x	x	x
2-Chloronaphthalene	x	x	x
2-Nitroaniline/o-Nitroaniline	x	x	x
Dimethylphthalate	x	x	x
Acenaphthylene	x	x	x
2,6-Dinitrotoluene	x	x	x
3-Nitroaniline/m-Nitroaniline	x	x	x
4-Nitrophenol/p-Nitroaniline	x	x	x
4-Nitrophenol/p-Nitrophenol	x	x	x
Dibenzofuran	x	x	x
2,4-Dinitrotoluene	x	x	x
Diethylphthalate	x	x	x
4-Chlorophenyl-phenylether	x	x	x
Fluorene	x	x	x
4-Nitroaniline/p-Nitroaniline	x	x	x
4,6-Dinitro-2-methylphenol	x	x	x
N-Nitrosodiphenylamine	x	x	x
4-Bromophenyl-phenylether	x	x	x
Hexachlorobenzene	x	x	x
Pentachlorophenol	x	x	x
Phenanthrene	x	x	x
Anthracene	x	x	x
Di-n-Butylphthalate	x	x	x
Floranthene	x	x	x
Benzidiene	x		
Pyrene	x	x	x
Butylbenzylphthalate	x	x	x
3,3'-Dichlorobenzidine	x	x	x
Benzo [a] anthracene/1,2-Benzanthracene	x	x	x
Chrysene	x	x	x
bis (2-Ethylhexyl) phthalate	x	x	x
Di-n-octylphthalate	x	x	x
Benzo [b] fluoranthene	x	x	x
Benzo [k] fluoranthene	x	x	x
Benzo [a] pyrene	x	x	x
Ideno [1,2,3-cd] pyrene	x	x	x
Dibenz [a,h] anthracene	x	x	x
Benzo [ghi] perylene	x	x	x
1,4-Dioxane/p-Dioxane			x
Methyl methacrylate			x
Pyridine			x

Table 1-1. Comparison of Hazardous Substance List (HSL), Target Compound List (TCL), and RCRA Appendix IX Constituents (continued)

	HSL	TCL	Appendix IX
SEMI-VOLATILES			
N-Nitrosodimethylamine	x		x
Ethyl methacrylate			x
2-Picoline/2-Methylpyridine			x
N-Nitrosomethylethylamine			x
Methyl methanesulfonate			x
N-Nitrosodiethylamine			x
Ethyl methanesulfonate			x
Aniline	x		x
Pentachloroethane			x
3-Methylphenol/m-Cresol			x
N-Nitrosopyrrolidine			x
Acetophenone			x
N-Nitrosomorpholine			x
o-Toluidine			x
N-Nitrosopiperidine			x
alpha, alpha-dimethylphenethylamine			x
2,6-Dichlorophenol			x
Hexachloropropene			x
p-Phenylenediamine			x
N-Nitroso-di-n-butylamine			x
Safrole			x
1,2,4,5-Tetrachlorobenzene			x
Isosafrole			x
1,4-Naphthoquinone			x
1,3-Dinitrobenzene/m-Dinitrobenzene			x
Pentachlorobenzene			x
1-Naphthylamine			x
2-Naphthylamine			x
2,3,4,6-Tetrachlorophenol			x
1,3,5-Trinitrobenzene/sym-Trinitrobenzene			x
Diallate			x
Phenacetin			x
Diphenylamine			x
5-Nitro-o-toluidine			x
4-Aminobiphenyl			x
Pronamide			x
2-sec-Butyl-4,6-dinitrophenol/Dinoseb			x
Pentachloronitrobenzene			x
4-Nitroquinoline-1-oxide			x
Methapyrilene			x

Table 1-1. Comparison of Hazardous Substance List (HSL), Target Compound List (TCL), and RCRA Appendix IX Constituents (continued)

	HSL	TCL	Appendix IX
Aramite			x
Chlorobenzilate			x
p-Dimethylaminoazobenzene			x
3-3'-Dimethylbenzidine			x
2-Acetylaminofluorene/2-AAF			x
7,12-Dimethylbenz [a] anthracene			x
Hexachlorophene			x
3-Methylcholanthrene			x
PESTICIDE/PCBs			
alpha-BHC	x	x	x
beta-BHC	x	x	x
delta-BHC	x	x	x
gamma-BHC/Lindane	x	x	x
Heptachlor	x	x	x
Aldrin	x	x	x
Heptachlor epoxide	x	x	x
Endosulfan I	x	x	x
Dieldrin	x	x	x
4,4'-DDE	x	x	x
Endrin	x	x	x
Endosulfan II	x	x	x
4,4'-DDD	x	x	x
Endosulfan sulfate	x	x	x
4,4'-DDT	x	x	x
Methoxychlor	x	x	x
Endrin ketone	x	x	
alpha-Chlordane (shown as total on Appendix IX and HSL)		x	xx
gamma-Chlordane (shown as total on Appendix IX and HSL)		x	xx
Toxaphene/Camphechlor	x	x	x
Aroclor-1016 (shown as total on Appendix IX)	x	x	x
Aroclor-1221 (shown as total on Appendix IX)	x	x	x
Aroclor-1232 (shown as total on Appendix IX)	x	x	x
Aroclor-1242 (shown as total on Appendix IX)	x	x	x
Aroclor-1248 (shown as total on Appendix IX)	x	x	x
Aroclor-1254 (shown as total on Appendix IX)	x	x	x
Aroclor-1260 (shown as total on Appendix IX)	x	x	x
Isodrin (Stereoisomer of Aldrin)			x
Kepone			x

Table 1-1. Comparison of Hazardous Substance List (HSL), Target Compound List (TCL), and RCRA Appendix IX Constituents (continued)

	HSL	TCL	Appendix IX
Endrin aldehyde	x		x
ORGANOPHOSPHORUS PESTICIDES			
Thionazin			x
Phorate			x
Disulfoton/Di-Syston			x
Dimethoate			x
Methyl Parathion			x
Parathion			x
Famphur/Famophos			x
O,O,O-Triethyl phosphorothioate			x
HERBICIDES			
Sulfotepp/Tetraethyl dithiopyrophosphate			x
2,4-D/2,4-Dichlorophenoxyacetic acid			x
2,4,5-TP/Silvex			x
2,4,5-T/2,4,5-Trichloroacetic acid			x
DIOXINS			
Polychlorinated di-benzo-p-dioxins/PCDDs			x
Polychlorinated di-benzofurans/PCDFs			x
2,3,7,8-Tetrachlorodibenzo-p-dioxin			x
INORGANIC ANALYTES*			
Aluminum	x	x	
Antimony	x	x	x
Arsenic	x	x	x
Barium	x	x	x
Beryllium	x	x	x
Cadmium	x	x	x
Calcium	x	x	
Chromium	x	x	x
Cobalt	x	x	x
Copper	x	x	x
Iron	x	x	
Lead	x	x	x
Magnesium	x	x	
Manganese	x	x	

Table 1-1. Comparison of Hazardous Substance List (HSL), Target Compound List (TCL), and RCRA Appendix IX Constituents (continued)

	HSL	TCL	Appendix IX
Mercury	x	x	x
Nickel	x	x	x
Potassium	x	x	
Selenium	x	x	x
Silver	x	x	x
Sodium	x	x	x
Thallium	x	x	x
Tin	x		x
Vanadium	x	x	x
Zinc	x	x	x
Cyanide		x	x
Sulfide			x

* Current analytical program includes cesium, chromium (VI), lithium, molybdenum, and strontium which are non-Appendix IX and non-TAL constituents. It also includes analysis for tin, a non-TAL constituent.

**TAL - Target Analyte List

Table 1-2. Chemical Constituents Monitored in Groundwater During 1992

FIELD PARAMETERS
pH
Specific Conductance
Temperature
Dissolved Oxygen
Alkalinity

INDICATORS
Total Dissolved Solids (TDS)
Total Suspended Solids (TSS)
pH [(1)]

METALS
Target Analyte List
- Aluminum (Al)
- Antimony (Sb)
- Arsenic (As)
- Barium (Ba)
- Beryllium (Be)
- Cadmium (Cd)
- Calcium (Ca)
- Chromium (Cr) [(2)]
- Cobalt (Co)
- Copper (Cu)
- Iron (Fe)
- Lead (Pb)
- Magnesium (Mg)
- Manganese (Mn)
- Mercury (Hg)
- Nickel (Ni)
- Potassium (K)
- Selenium (Se)
- Silver (Ag)
- Sodium (Na)
- Thallium (Tl)
- Vanadium (V)
- Zinc (Zn)

Cesium (Cs)
Lithium (Li) [(3)]

Table 1-2. Chemical Constituents Monitored in Groundwater During 1992 (continued)

METALS (continued)
Molybdenum (Mo)
Strontium (Sr)
Tin (Sn) (1)

ANIONS
Carbonate (CO_3)
Bicarbonate (HCO_3)
Chloride (Cl)
Fluoride (F)
Sulfate (SO_4)
Nitrate/Nitrite (NO_2/NO_3)
Cyanide (as N) (4)

ORGANICS (5)
Target Compound List - Volatiles:
- Chloromethane (CH_3CL)
- Bromomethane (CH_3Br)
- Vinyl Chloride (C_2H_3CL)
- Chloroethane (C_2H_5Cl)
- Methylene Chloride (CH_2CL_2)
- Acetone
- Carbon Disulfide
- 1,1-Dichloroethane (1,1-DCA)
- 1,1,-Dichloroethene (1,1-DCE)
- trans-1,2-Dichloroethene
- 1,2-Dichloroethene (total) (total 1,2-DCE)
- Chloroform ($CHCl_3$)
- 1,2-Dichloroethane (1,2-DCA)
- 2-Butanone (MEK)
- 1,1,1-Trichloroethane (1,1,1-TCA)
- Carbon Tetrachloride (CCL_4)
- Vinyl Acetate
- Bromodichloromethane
- 1,1,2,2-Tetrachloroethane
- 1,2-Dichloropropane (1,2-DCP)
- trans-1,3-Dichloropropene
- Trichloroethylene (TCE)
- Dibromochloromethane
- 1,1,2-Trichloroethane
- Benzene
- cis-1,3-Dichloropropene

Table 1-2. Chemical Constituents Monitored in Groundwater During 1992 (continued)

ORGANICS [5] (continued)
- Bromoform(CBr_4)
- 2-Hexanone
- 4-Methyl-2-pentanone
- Tetrachloroethene (PCE)
- Toluene (C_7H_8)
- Chlorobenzene (C_6H_5CL)
- Ethyl Benzene
- Styrene
- Xylenes (Total)

RADIONUCLIDES [6]
- Gross Alpha
- Gross Beta
- Uranium 233+234; 234; 235; and 238 (U-233,234, 235, and 238) - dissolved
- Americium 241 (Am-241) - total
- Plutonium 239+240 (Pu-239,240) - total
- Strontium 89+90[7] (Sr-89,90)[8] - dissolved
- Cesium 137 (Cs-137) - total
- Tritium
- Radium 226; 228 (Ra-226,228) - dissolved

(1) Not analyzed prior to 1989.
(2) Analyses in 1990 are for total chromium. Chromium (IV) was analyzed during fourth quarter 1987 only.
(3) Prior to 1989, lithium was only analyzed during fourth quarter 1987 and first quarter 1988.
(4) Cyanide was not analyzed during fourth quarter 1987.
(5) Not analyzed in background samples in 1989.
(6) Dissolved radionuclides replaced total radionuclides (except tritium) beginning with the third quarter 1987. During 1991 and 1992, total concentrations of Am-241, Pu-239,240, and tritium were analyzed.
(7) Strontium 89+90 was not analyzed during first quarter 1988.
(8) Not analyzed prior to 1989 and only analyzed if gross alpha exceeds 5 pCi/l.

Table 1-3. Background Groundwater Quality Exceedance Values in the Uppermost and Lower Flow Systems

Analyte	Background Groundwater Quality Exceedance Value		
	Uppermost Flow System	Lower Flow System	Concentration Unit
Al	0.258#	0.216#	mg/l
Sb	0.046#	0.035#	mg/l
As	u	0.006#	mg/l
Ba	0.167#	0.146#	mg/l
Be	u	u	mg/l
Cd	0.009*	0.007#	mg/l
Ca	155.636#	83.253#	mg/l
Cs	u	u	mg/l
Cr	0.0232*	0.016*	mg/l
Co	u	u	mg/l
Cu	0.175*	u	mg/l
Fe	0.311#	0.232#	mg/l
Pb	0.064*	0.042*	mg/l
Li	0.152#	0.010#	mg/l
Mg	42.066#	13.955#	mg/l
Mn	0.163#	0.026#	mg/l
Hg	0.0004*	0.001*	mg/l
Mo	0.114*	0.047#	mg/l
Ni	u	u	mg/l
K	3.857#	6.447#	mg/l
Se	0.607*	0.006*	mg/l
Ag	u	u	mg/l
Na	186.709#	41.872#	mg/l
Sr	1.321#	0.994#	mg/l
TI	0.328*	u	mg/l
Sn	0.106#	u	mg/l
V	0.017#	u	mg/l
Zn	0.056#	0.049#	mg/l
TDS	1,186.750#	1,422.39#	mg/l
CI	68.469#	355.538#	mg/l
NO_2+NO_3	9.069#	3.146#	mg/l
SO4	353.556#	683.194#	mg/l

Table 1-3. Background Groundwater Quality Exceedance Values in the Uppermost and Lower Flow Systems (continued)

	Background Groundwater Quality Exceedance Value		
Analyte	**Uppermost Flow System**	**Lower Flow System**	**Concentration Unit**
HCO3 as $CaCO_3$	516.771#	336.614#	mg/l
CO3 as $CaCO_3$	54.000*	21.373#	mg/l
pH	8.759#	10.179#	pH unit
CN	u	u	mg/l
Gross Alpha	88.406#	19.590#	pCi/l
Gross Beta	35.591#	10.687#	pCi/l
U -233, 234	58.497#	9.057#	pCi/l
U -235	1.483#	0.184#	pCi/l
U -238	39.814#	4.765#	pCi/l
Sr -89, 90	0.841#	0.975#	pCi/l
Pu -239, 240 (total)	0.056#	0.007#	pCi/l
Am-241 (total)	0.031#	0.042#	pCi/l
Cs -137 (total)	0.692#	0.479#	pCi/l
Ra -226	0.497#	2.981*	pCi/l
Ra -228	DL	DL	pCi/l
Tritium	324.761#	347.42#	pCi/l
Organics	DL	DL	ug/l
Fluoride	2.350#	1.928#	mg/l
Oil and Gas	DL	DL	mg/l
Silica, dissolved	24.202#	15.717#	mg/l
Silicon	13.871#	11.059#	ug/l
Total Suspended Solids	782.782#	1,490.663#	mg/l

u Undetected in background.

\# Background Groundwater Quality Exceedance Value is equal to the upper limit of the tolerance interval reported in the 1992 Background Geochemical Characterization Report (EG&G, 1992).

* Background Groundwater Quality Exceedance Value is equal to the maximum concentration detected in background wells from the 1992 Background Geochemical Characterization Report (EG&G, 1992).

DL Organic and inorganic compounds above detection limit are considered in exceedance of background groundwater levels if they were not included in the 1992 Background Geochemical Characterization Report (EG&G, 1992).

Notes All concentrations presented in this table have been rounded to three significant figures. Representative background values used to evaluate groundwater contamination have not been rounded.

Table 2-1. Solar Evaporation Ponds Groundwater Monitoring Wells

	Well ID	Screened Unit	Status	Well Type
Uppermost Aquifer (Surficial Mateials) and Weathered Bedrock)	0260	Kacl(w)	abandoned	Special Purpose Well
	1386	Qvf	active	RCRA Reg. Well
	1586	Qvf	active	RCRA Reg. Well
	1786	Qvf	active	RCRA Reg. Well
	1886	Qc	active	RCRA Reg. Well
	2086	Qc	inactive	RCRA Reg. Well
	2187	Qc	active	CERCLA Char. Well
	2286	Qrf	active	RCRA Reg. Well
	2486	Qrf	active	RCRA Reg. Well
	2686	Qrf	active	RCRA Reg. Well
	2886	Qrf	damaged	RCRA Reg. Well
	2986	Qrf	active	RCRA Reg. Well
	3086	Kacl(w)	active	RCRA Reg. Well
	3186	Kacl(w)	active	RCRA Reg. Well
	3386	Qc	active	RCRA Reg. Well
	3586	Qvf	active	CERCLA Char. Well
	3686	Qvf	active	CERCLA Char. Well
	3787	Qrf	damaged	RCRA Reg. Well
	3887	Qrf	active	RCRA Reg. Well
	5687	Qrf	active	RCRA Reg. Well
	P207389	Kass(w)	active	RCRA Reg. Well
	P207489	Qvf	active	RCRA Reg. Well
	P207589	Kacl(w)	active	RCRA Reg. Well
	P207689	Qrf	active	RCRA Reg. Well
	P207789	Kacl(w)	active	RCRA Reg. Well
	P207889	Qrf	active	RCRA Reg. Well
	P207989	Kacl(w)	active	RCRA Reg. Well
	B208089	Qc	active	RCRA Reg. Well
	B208189	Kacl(w)	active	RCRA Reg. Well
	B208289	Kacl(w)	active	RCRA Reg. Well
	B208389	Qc	active	RCRA Reg. Well
	B208489	Kacl(w)	active	RCRA Reg. Well
	B208589	Qvf	active	RCRA Reg. Well
	B208689	Kacl(w)	active	RCRA Reg. Well
	B208789	Qc	active	RCRA Reg. Well
	P208989	Kacl(w)	active	RCRA Reg. Well
	P209089	Kacl(w)	active	RCRA Reg. Well
	P209189	Kass(w)	active	RCRA Reg. Well
	P209289	Qrf	active	RCRA Reg. Well
	P209389	Kass(w)	active	RCRA Reg. Well
	P209489	Kacl(w)	active	RCRA Reg. Well
	P209589	Kacl(w)	active	RCRA Reg. Well
	P209689	Kacl(w)	active	RCRA Reg. Well
	P209789	Qrf	active	RCRA Reg. Well

Table 2-1. Solar Evaporation Ponds Groundwater Monitoring Wells (continued)

Well ID	Screened Unit	Status	Well Type
P209889	Kacl(w)	active	RCRA Reg. Well
P209989	Qc	active	RCRA Reg. Well
P210089	Kacl(w)	active	RCRA Reg. Well
P210189	Kass(w)	active	RCRA Reg. Well
P210289	Kass(w)	damaged	RCRA Reg. Well
B210389	Kacl(w)	active	RCRA Reg. Well
B210489	Qc	active	RCRA Reg. Well
B213789	Qrf	active	Special Purpose Well
P213889	Kass(w)	active	RCRA Reg. Well
P213989	Qrf	active	RCRA Reg. Well
P218089	Qrf	active	Special Purpose Well
P218389	Qrf	active	RCRA Reg. Well
P219189	Qrf	active	Special Purpose Well
P219489	Qrf	active	RCRA Reg. Well
P219589	Qrf	active	RCRA Reg. Well
1486	Kass(u)	active	RCRA Char. Well
1686	Kass(u)	active	RCRA Char. Well
2287	Kass(u)	active	CERCLA Char. Well
2386	Kass(u)	active	RCRA Char. Well
2586	Kass(u)	active	RCRA Char. Well
2786	Kass(u)	active	RCRA Char. Well
3286	Kass(u)	active	RCRA Char. Well
3486	Kass(u)	active	CERCLA Char. Well
3987	Kass(u)	active	RCRA Char. Well
P208889	Kass(u)	active	RCRA Char. Well

Qrf: Rocky Flats Alluvium
Qc: Colluvium
Qvf: Valley Fill Alluvium
Kacl(w): Weathered Arapahoe Formation Claystone
Kass(w): Weathered Arapahoe Formation Sandstone
Kass(u): Unweathered Arapahoe Formation Sandstone

Table 2-2. Solar Evaporation Ponds - Vertical Hydraulic Gradients Between Surficial Materials and Weathered Bedrock, 1992

Alluvial Well	Screened Unit	Bedrock Well	Screened Unit	Hydraulic Gradient (ft/ft)			
				1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
P209289	Qrf	P209389	Kass(w)	NA	0.274	NA	NA
2286	Qrf	P210189	Kass(w)	0.625	0.104	0.079	0.080
P207489	Qrf	P07389	Kass(w)	-0.042	0.007	-0.052	0.004
2686	Qrf/Kac(w)	P207589	Kacl(w)	1.185	1.329	1.213	1.155
B208089	Qc	B208189	Kacl(w)	0.576	-0.589*	0.676	0.688
P207889	Qrf	P207989	Kacl(w)	1.120	1.673	1.494	NA
P207689	Qrf	P207789	Kacl(w)	1.480	1.593	1.531	1.446

Note: Positive vertical hydraulic gradients indicate downward flow. NA indicates vertical gradient could not be calculated because the well pairs were dry.

* Calculated upward hydraulic gradient attributed to possible erroneous water level reading

The vertical gradient was calculated as the quotient of the difference between elevations in water levels divided by the vertical distance between the screened intervals. Specifically, the divisor was the difference between the elevation at the center of the screened interval for the well completed in the surficial materials and the elevation of the screened interval completed in the weathered bedrock.

A vertical gradient cannot be calculated for well pair 1786 (completed in Qrf/Kacl) and B208689 (completed in Kacl) because of overlapping screened intervals.

Qrf: Rocky Flats Alluvium
Qc: Colluvium
Kacl(w): Weathered Arapahoe Formation Claystone
Kass(w): Weathered Arapahoe Formation Sandstone

Table 2-3. Solar Evaporation Ponds - Groundwater Monitoring Wells Not Used in Constructing Potentiometric Surface Maps for 1992

		Elev. of Bottom of Screen	Elev. of Top of Bedrock			Water Elevation			
	Well #	from OU8 Draft RFI/RI May 1992	from OU8 Draft RFI/RI May 1992	from OU4 Draft RFI/RI Oct. 1991	from 0U4 Draft RFI/RI Apr. 1992	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Surficial Material Wells	2187	5918.69	5920.43	NA	5919.58		5919.45		
	3887	5964.15	5964.35	5964.0	5963.99	5963.73		5963.99	5962.75
	B208589	NA	NA	5852.9	NA			5852.65	
	B208789	5898.10	5902.60	5902.6	5902.60	5899.48		5902.69	5899.26
	P207489	5974.04	5974.21	5974.2	5974.21				5974.11
	P207889	5955.95	5954.32	5954.3	5954.32				5954.82
	P209289	5970.02	5967.79	5967.8	5967.79	5968.73		5968.73	5968.80
	P209989	5890.82	5890.40	5890.5	5890.50		5890.11	5888.62	
	P218089	5978.86	5979.80	5979.8	5979.80			5979.20	5978.06
	P218389	5944.45	5944.20	5944.2	5944.20	5944.27			5943.92
	P218589	5938.45	5946.60	5946.6	5946.60	5941.35	5941.76	5942.26	5943.18

Table 2-4. Solar Evaporation Ponds - Average Linear Groundwater Flow Velocities, 1992

	Well Pair	Flow Regime	Hydraulic Gradient	Hydraulic Conductivity (cm/sec)	Effective Porosity	Average Linear Velocity (ft/yr)
Surficial Material	3787/	High	4.06×10^{-2}	5.19×10^{-5}	0.1	21
	B208089	Low	3.85×10^{-2}	5.19×10^{-5}	0.1	20
	3787/	High	2.47×10^{-2}	5.19×10^{-5}	0.1	13
	P218389	Low	NA			
	3787/	High	2.07×10^{-2}	5.19×10^{-5}	0.1	11
	2986	Low	NA			
	P207689/	High	NA			
	2187	Low	5.80×10^{-2}	5.19×10^{-5}	0.1	30
	2986/	High	6.83×10^{-2}	5.19×10^{-5}	0.1	36
	3586	Low	NA			
Weathered Bedrock	P209689	High	1.24×10^{-1}	1.03×10^{-6}	0.1	1.3
	P2287BR	Low	1.24×10^{-1}	1.03×10^{-6}	0.1	1.3
	P209089	High	1.70×10^{-2}	1.03×10^{-6}	0.1	0.2
	P209689	Low	2.17×10^{-2}	1.03×10^{-6}	0.1	0.2
	P209089	High	4.81×10^{-3}	1.03×10^{-6}	0.1	0.05
	207989	Low	5.55×10^{-3}	1.03×10^{-6}	0.1	0.06
	P210189	High	4.50×10^{-2}	1.03×10^{-6}	0.1	0.5
	P209889	Low	4.27×10^{-2}	1.03×10^{-6}	0.1	0.4
	P207989	High	1.48×10^{-2}	1.03×10^{-6}	0.1	0.2
	B208189	Low	4.43×10^{-2}	1.03×10^{-6}	0.1	0.5
	P207989	High	5.79×10^{-3}	1.03×10^{-6}	0.1	0.06
	B208289	Low	7.73×10^{-2}	1.03×10^{-6}	0.1	0.8
	P209489	High	1.26×10^{-1}	1.03×10^{-6}	0.1	1.3
	P210089	Low	1.21×10^{-1}	1.03×10^{-6}	0.1	1.3
	3086	High	1.60×10^{-1}	1.03×10^{-6}	0.1	1.7
	B210389	Low	1.54×10^{-1}	1.03×10^{-6}	0.1	1.6
	P209589	High	1.24×10^{-1}	1.03×10^{-6}	0.1	1.3
	B208689	Low	1.17×10^{-1}	1.03×10^{-6}	0.1	1.2

High = April
Low = October

Table 2-5. Solar Evaporation Ponds - Surficial Material and Bedrock Monitoring Wells Used for Statistical Analysis of Upgradient and Downgradient Groundwater Quality Data

Solar Evaporation Ponds

Upgradient Alluvial
2486 (Qrf)
P207489 (Qrf)
P209289 (Qrf)

Downgradient Alluvial
2686 (Qrf)
2886 (Qrf)
3787 (Qrf)
3887 (Qrf)
P207689 (Qrf)
P207889 (Qrf)
P209789 (Qrf)

Upgradient Weathered Bedrock
P207389 (Kacl/Kass [w])
P209389 (Kass [w])

Downgradient Weathered Bedrock
3086 (Kacl/Kass [w])
3186 (Kacl/Kass [w])
P207589 (Kacl/Kass [w])
P207789 (Kacl/Kass [w])
P207989 (Kacl/Kass [w])
P208989 (Kacl/Kass [w])
P209489 (Kacl/Kass [w])
P209589 (Kacl/Kass [w])
P209689 (kacl/Kass [w])

Table 4-5. Present Landfill
Infrequently Detected Analytes
(Less Than 50% Quantified Results) in Downgradient
Monitoring Wells in Surficial Material and Bedrock, 1992

Radionuclides

Well	Date	Analyte	Result
B207089	7/10/92	RADIUM-226	0.52 pCi/L
B207189	7/17/92	GROSS ALPHA - SUSPENDED	4.10 pCi/L

VOCs

Well	Date	Analyte	Result
B206989	10/13/92	ACETONE	12.00 ug/L

Dissolved Metals

Well	Date	Analyte	Result
4087	4/28/92	SILICON	5900.00 ug/L
B207089	4/28/92	MERCURY	0.33 ug/L
B207189	7/17/92	SILICON	4990.00 ug/L

Inorganic Analytes

Well	Date	Analyte	Result
4087	4/28/92	CHLORIDE	84.00 mg/L
4087	2/21/92	SILICA, DISSOLVED	5.60 mg/L
B206989	10/13/92	BICARBONATE AS CACO3	390.00 mg/L
B206989	10/13/92	CHLORIDE	170.00 mg/L
B206989	10/13/92	FLUORIDE, SOLUBLE	0.23 mg/L
B206989	10/13/92	SULFATE	2600.00 mg/L
B206989	10/13/92	TOTAL DISSOLVED SOLIDS	5100.00 mg/L
B206989	10/13/92	TOTAL SUSPENDED SOLIDS	38.00 mg/L
B207089	10/14/92	AMMONIA	0.08 mg/L
B207089	10/14/92	FLUORIDE, SOLUBLE	0.32 mg/L
B207089	2/20/92	SILICA, DISSOLVED	2.60 mg/L
B207189	2/20/92	SILICA, DISSOLVED	4.40 mg/L

Table 4-6. Comparative Statistics for the Present Landfill - Analytes with Greater than 50% Quantified Results, 1992 - Groundwater Quality Data from Upgradient and Downgradient Monitoring Wells Compared Using Analysis of Variance (ANOVA)

Analyte	ANOVA Method Used[1]	Probability Value	<0.05	Well Comparison[2]
pH	N	0.0026	*	B207189 - Pool[3]
Bicarbonate as $CaCO_3$	NP	0.0027	#	
Carbonate as $CaCO_3$	NP	0.7779		
Chloride	NP	0.0037	#	
COD	N	0.6205		
Fluoride	NP	0.0156	*	
Nitrate/Nitrite	NP	0.0023	#	
Orthophosphate	NP	0.7440		
Silicon	NP	0.0578		
Sulfate	LN	0.0001	*	B207089 - Pool 4087 - Pool
Total Dissolved Solids	LN	0.0001	*	B207089 - Pool B207189 - Pool 4087 - Pool
Total Organic Carbon	NP	0.2442		
Total Suspended Solids	LN	0.0001	**	Pool - 4087 Pool - B207189 Pool - B207089
Aluminum	NP	0.1327		
Antimony	LN	0.6248		
Arsenic	NP	0.0396	*	
Barium	LN	0.0059	*	B207189 - Pool
Calcium	N	0.0001	*	B207089 - Pool 4087 - Pool B207189 - Pool
Chromium	N	0.0039	#	
Copper	NP	0.7537		
Iron	LN	0.3672		
Lithium	LN	0.0001	*	B207089 - Pool 4087 - Pool B207189 - Pool
Magnesium	N	0.0001	*	B207089 - Pool 4087 - Pool B207189 - Pool
Manganese	LN	0.0010	*	4087 - Pool

Table 4-6. Comparative Statistics for the Present Landfill - Analytes with Greater than 50% Quantified Results, 1992 - Groundwater Quality Data from Upgradient and Downgradient Monitoring Wells Compared Using Analysis of Variance (ANOVA) (continued)

Analyte	ANOVA Method Used[1]	Probability Value	<0.05	Well Comparison[2]
Molybdenum	NP	0.1158		
Nickel	NP	0.0610		
Potassium	NP	0.0019	#	
Selenium	NP	0.0483	#	
Sodium	NP	0.0007	#	
Strontium	NP	0.0007	#	
Thallium	NP	0.4817		
Vanadium	NP	0.0266	#	
Zinc	LN	0.6563		
Americium - 241	N	0.9633		
Cesium - 137	LN	0.3868		
Gross Alpha	N	0.0001	*	4087 - Pool B207089 - Pool
Gross Beta	N	0.0001	*	4087 - Pool B207189 - Pool B207089 - Pool
Plutonium - 239, 240	N	0.7710		
Strontium - 89, 90	NP	0.0506		
Tritium	LN	0.3117		
Uranium - 233, 234	NP	0.0182	#	
Uranium - 238	NP	0.0268	#	
Uranium - 235	LN	0.0001	*	4087 - Pool
Acetone	NP	0.2099		
Methylene Chloride	NP	0.1669		

1 LN = ANOVA method for lognormally distributed data
N = ANOVA method for normally distributed data
NP = ANOVA method for nonparametric (nondistributed) data

2 Monitoring well pair-wise comparisons if a statistically significant difference exists.

3 Pool consists of upgradient Wells 1086, 5887, and 6087.

* Indicates that the analyte concentrations in the downgradient wells are statistically greater than the analyte concentrations in the upgradient wells. This may indicate downgradient contamination.

** Indicates that the analyte concentrations in the upgradient wells are statistically greater than the downgradient wells. This may indicate a possible upgradient source.

# Indicates a statistically significant difference between some locations within the data set. The statistical method does not identify the locations, and contaminant distribution must be evaluated to determine if downgradient contamination has occurred.

TABLE 2-6. Solar Evaporation Ponds-
Infrequently Detected Analytes
(Less Than 50% Qualified Results) in Downgradient
Monitoring Wells, 1992

Radionuclides in Surficial Material Groundwater

Well	Date	Analyte	Result
2686	4/14/92	AMERICIUM-241-TOTAL	0.003 pCi/L
2686	4/14/92	GROSS ALPHA	42.97 pCi/L
2686	7/21/92	GROSS ALPHA	47.00 pCi/L
2686	4/14/92	GROSS BETA	10.70 pCi/L
2686	7/21/92	GROSS BETA	24.00 pCi/L
2686	4/14/92	RADIUM-226-DISSOLVED	0.13 pCi/L
2686	4/14/92	URANIUM-233,234-DISSOLVED	29.93 pCi/L
2686	4/14/92	URANIUM-235-DISSOLVED	0.54 pCi/L
2686	4/14/92	URANIUM-238-DISSOLVED	19.67 pCi/L
2886	7/21/92	GROSS ALPHA	440.00 pCi/L
2886	7/21/92	GROSS BETA	280.00 pCi/L
2886	1/28/92	RADIUM-226-DISSOLVED	0.81 pCi/L
P207889	4/8/92	RADIUM-226-DISSOLVED	0.13 pCi/L
P207889	4/8/92	STRONTIUM-89,90-DISSOLVED	0.71 pCi/L
P209789	7/20/92	GROSS ALPHA	2.80 pCi/L

VOCs in Surficial Material Groundwater

Well	Date	Analyte	Result
2686	10/12/92	ACETONE	20.00 ug/L
P207689	10/9/92	METHYLENE CHLORIDE	14.00 ug/L
P209789	10/16/92	1,1,1-TRICHLOROETHANE	11.00 ug/L
P209789	10/16/92	ACETONE	12.00 ug/L
P209789	10/16/92	METHYLENE CHLORIDE	16.00 ug/L
P209789	10/16/92	TOLUENE	8.00 ug/L

Dissolved Metals in Surficial Material Groundwater

Well	Date	Analyte	Result
2886	7/21/92	MERCURY	0.28 ug/L
P207689	4/15/92	CADMIUM	49.10 ug/L

TABLE 2-6. Solar Evaporation Ponds-
Infrequently Detected Analytes
(Less Than 50% Qualified Results) in Downgradient
Monitoring Wells, 1992 (Continued)

Inorganic Analytes in Surficial Material Groundwater

Well	Date	Analyte	Result
2686	10/12/92	FLUORIDE, SOLUBLE	5.10 mg/L
2686	4/14/92	ORTHOPHOSPHATE	0.02 mg/L
2686	1/30/92	SILICA, DISSOLVED	8.00 mg/L
2886	1/28/92	SILICA, DISSOLVED	4.50 mg/L
3787	4/14/92	ORTHOPHOSPHATE	0.03 mg/L
3787	2/27/92	SILICA, DISSOLVED	6.00 mg/L
3887	4/21/92	BICARBONATE AS CACO3	680.00 mg/L
3887	4/21/92	CHLORIDE	88.00 mg/L
3887	4/21/92	FLUORIDE	2.70 mg/L
3887	4/21/92	SULFATE	360.00 mg/L
3887	4/21/92	TOTAL DISSOLVED SOLIDS	1600.00 mg/L
3887	4/21/92	TOTAL SUSPENDED SOLIDS	220.00 mg/L
P207689	1/15/92	CARBONATE AS CACO3	32.00 mg/L
P207689	10/9/92	FLUORIDE, SOLUBLE	2.90 mg/L
P207689	1/15/92	SILICA, DISSOLVED	7.30 mg/L
P207689	10/9/92	TOTAL SOLIDS	65.50 mg/L
P207889	1/22/92	SILICA, DISSOLVED	4.10 mg/L
P209789	1/20/92	CARBONATE AS CACO3	2.00 mg/L
P209789	10/16/92	FLUORIDE, SOLUBLE	2.20 mg/L
P209789	1/20/92	SILICA, DISSOLVED	4.70 mg/L

Radionuclides in Weathered Bedrock Groundwater

Well	Date	Analyte	Result
P207989	3/6/92	GROSS ALPHA	51.09 pCi/L
P207989	3/6/92	GROSS BETA	26.11 pCi/L
P207989	3/6/92	URANIUM-233,234-DISSOLVED	34.08 pCi/L
P207989	3/6/92	URANIUM-235-DISSOLVED	1.35 pCi/L
P207989	3/6/92	URANIUM-238-DISSOLVED	26.56 pCi/L
P208989	4/21/92	GROSS ALPHA	68.55 pCi/L
P208989	1/30/92	STRONTIUM-89,90-DISSOLVED	2.02 pCi/L
P209589	7/9/92	TRITIUM-TOTAL	12700.00 pCi/L

VOCs in Weathered Bedrock Groundwater

Well	Date	Analyte	Result
3086	10/9/92	METHYLENE CHLORIDE	12.00 ug/L
P207989	10/8/92	METHYLENE CHLORIDE	7.00 ug/L
P208989	10/9/92	METHYLENE CHLORIDE	37.00 ug/L

TABLE 2-6. Solar Evaporation Ponds-
Infrequently Detected Analytes
(Less Than 50% Qualified Results) in Downgradient
Monitoring Wells, 1992 (Continued)

Dissolved Metals in Weathered Bedrock Groundwater

Well	Date	Analyte	Result
3086	10/9/92	CHROMIUM	3.30 ug/L
3086	1/29/92	MERCURY	0.31 ug/L
P208989	10/9/92	CHROMIUM	22.00 ug/L
P208989	1/30/92	MERCURY	0.26 ug/L

Inorganic Analytes in Weathered Bedrock Groundwater

Well	Date	Analyte	Result
3086	7/8/92	CARBONATE	4.00 mg/L
3086	10/9/92	FLUORIDE, SOLUBLE	2.80 mg/L
3086	1/29/92	SILICA, DISSOLVED	6.70 mg/L
3086	10/9/92	TOTAL SOLIDS	112.00 mg/L
P207989	3/6/92	FLUORIDE	4.60 mg/L
P207989	10/8/92	FLUORIDE, SOLUBLE	4.50 mg/L
P207989	3/6/92	SILICA, DISSOLVED	6.00 mg/L
P207989	10/8/92	TOTAL SOLIDS	12.50 mg/L
P208989	10/9/92	FLUORIDE, SOLUBLE	0.68 mg/L
P208989	1/30/92	SILICA, DISSOLVED	8.70 mg/L
P208989	10/9/92	TOTAL SOLIDS	11.00 mg/L
P209489	10/15/92	FLUORIDE, SOLUBLE	0.62 mg/L
P209489	1/30/92	SILICA, DISSOLVED	7.00 mg/L
P209489	10/15/92	TOTAL SOLIDS	44.80 mg/L
P209589	4/10/92	FLUORIDE	0.60 mg/L
P209589	10/6/92	FLUORIDE, SOLUBLE	0.62 mg/L
P209689	10/13/92	NITRATE/NITRITE	37.00 mg/L

Table 2-7. Comparative Statistics for Solar Evaporation Ponds, Surficial Materials - Analytes with Greater than 50% Quantified Results, 1992 - Groundwater Quality Data from Upgradient and Downgradient Monitoring Wells Compared Using Analysis of Variance (ANOVA)

Analyte	ANOVA Method Used[1]	Probability Value	<0.05	Well Comparison[2]
pH	N	0.0025	**	Pool[3] - 2886 Pool - 3887
Bicarbonate as $CaCO_3$	LN	0.0001	*	2686 - Pool
Carbonate as $CaCO_3$	N	0.4226		
Chloride	NP	0.2904		
Fluoride	N	0.0001	*	2686 - Pool P207689 - Pool 3787 - Pool P207889 - Pool
Nitrate/Nitrite	LN	0.0192	*	2886 - Pool
Orthophosphate	NP	0.1573		
Sulfate	LN	0.0001	*	P207889 - Pool 2686 - Pool
Total Dissolved Solids	NP	0.0028	#	
Total Suspended Solids	LN	0.0205	#	
Barium	LN	0.0382	***	
Calcium	NP	0.6300		
Cobalt	LN	0.4433		
Copper	LN	0.0799		
Iron	LN	0.1864		
Lithium	LN	0.0001	*	2886 - Pool 2686 - Pool P207689 - Pool
Magnesium	NP	0.0599		
Molybdenum	LN	0.1439		
Nickel	LN	0.1467		
Potassium	LN	0.0001	*	2886 - Pool
Selenium	LN	0.0004	*	P207889 - Pool P207689 - Pool 2686 - Pool
Sodium	LN	0.0008	*	2886 - Pool
Strontium	NP	0.0695		
Vanadium	LN	0.4246		

Table 2-7. Comparative Statistics for Solar Evaporation Ponds, Surficial Materials - Analytes with Greater than 50% Quantified Results, 1992 - Groundwater Quality Data from Upgradient and Downgradient Monitoring Wells Compared Using Analysis of Variance (ANOVA) (continued)

Analyte	ANOVA Method Used[1]	Probability Value	<0.05	Well Comparison[2]
Zinc	N	0.0948		
Gross Alpha	NP	0.2499		
Gross Beta	NP	0.0276	#	
Tritium	LN	0.4882		
Uranium - 233, 234	NP	0.1379		
Uranium - 235	NP	0.1592		
Uranium - 238	NP	0.1762		
Trichloroethene	LN	0.2983		

1 LN = ANOVA method for lognormally distributed data
N = ANOVA method for normally distributed data
NP = ANOVA method for nonparametric (nondistributed) data

2 Monitoring well pair-wise comparisons if a statistically significant difference exists

3 Pool consists of upgradient monitoring wells 2486, P207489, and P209289.

* Indicates that the analyte concentrations in the downgradient wells are statistically greater than the analyte concentrations in the upgradient wells. This may indicate downgradient contamination.

** Indicates that the analyte concentrations in the upgradient wells are statistically greater than the downgradient wells. This may indicate a possible upgradient source.

*** Indicates a statistically significant difference between two downgradient wells and not a comparison between upgradient and downgradient wells.

\# Indicates a statistically significant difference between some locations within the data set. The statistical method does not identify the locations, and contaminant distribution must be evaluated to determine if downgradient contamination has occurred.

Table 2-8. Comparative Statistics for Solar Evaporation Ponds, Weathered Bedrock - Analytes with Greater than 50% Quantified Results, 1992 - Groundwater Quality Data from Upgradient and Downgradient Monitoring Wells Compared Using Analysis of Variance (ANOVA)

Analyte	ANOVA Method Used[1]	Probability Value	<0.05	Well Comparison[2]
Bicarbonate as $CaCO_3$	N	0.0649		
Carbonate as $CaCO_3$	N	0.0624		
Chloride	LN	0.0001	*	P209589 - Pool[3] P207989 - Pool P208989 - Pool 3086 - Pool
Fluoride	N	0.0001	*	3086 - Pool
Nitrate/Nitrite	LN	0.0001	*	P209589 - Pool P208989 - Pool 3086 - Pool P209489 - Pool
Orthophosphate	NP	0.1899		
Potassium	N	0.0001	*	P209489 - Pool 3086 - Pool
Silicon	N	0.0841		
Sulfate	LN	0.0001	*	P209589 - Pool P207989 - Pool 3086 - Pool
Total Dissolved Solids	LN	0.0001	*	P209589 - Pool P208989 - Pool 3086 - Pool P209489 - Pool P207989 - Pool
Total Suspended Solids	NP	0.0134	#	
Aluminum	LN	0.0081	*	P208989 - Pool
Barium	NP	0.0006	#	
Calcium	LN	0.0001	*	P208989 - Pool 3086 - Pool P209489 - Pool
Cadmium	LN	0.2174		
Copper	NP	0.8365		
Iron	LN	0.6283		
Lithium	NP	0.0009	#	
Magnesium	NP	0.0008	#	

Table 2-8. Comparative Statistics for Solar Evaporation Ponds, Weathered Bedrock - Analytes with Greater than 50% Quantified Results, 1992 - Groundwater Quality Data fro[m] Upgradient and Downgradient Monitoring Wells Compared Using Analysis of Variance (ANOVA) (continued)

Analyte	ANOVA Method Used[1]	Probability Value	<0.05	Well Comparison[2]
Manganese	N	0.0001	*	P209489 - Pool
Mercury	NP	0.4189		
Nickel	NP	0.1612		
Selenium	N	0.0001	*	P208989 - Pool
Sodium	LN	0.0001	*	3086 - Pool P208989 - Pool P209489 - Pool
Strontium	N	0.0001	*	P208989 - Pool 3086 - Pool
Vanadium	LN	0.0498	*	P208989 - Pool[3]
Zinc	LN	0.4585		
Americium - 241	N	0.1451		
Cesium - 137	N	0.4050		
Gross Beta	LN	0.0001	*	3086 - Pool P209489 - Pool P208989 - Pool
Plutonium - 239, 240	N	0.0457		3086 - Pool
Radium - 226	LN	0.0002	*	P208989 - Pool
Strontium - 89, 90	N	0.1513		
Tritium	LN	0.0001	*	3086 - Pool P208989 - Pool P209489 - Pool P207989 - Pool
Uranium - 233, 234	NP	0.0099	#	
Uranium - 235	NP	0.0106	#	
Uranium - 238	NP	0.0099	#	
Acetone	NP	0.4641		
Benzene	NP	0.1921		
Carbon Disulfide	N	0.0923		
Carbon Tetrachloride	N	0.0911		
Chloroform	N	0.0001	*	P209489 - Pool

Table 2-8. Comparative Statistics for Solar Evaporation Ponds, Weathered Bedrock - Analytes with Greater than 50% Quantified Results, 1992 - Groundwater Quality Data from Upgradient and Downgradient Monitoring Wells Compared Using Analysis of Variance (ANOVA) (continued)

Analyte	ANOVA Method Used[1]	Probability Value	<0.05	Well Comparison[2]
Methylene Chloride	N	0.0759		
Toluene	NP	0.0935		
Total Xylenes	NP	0.0935		

1 LN = ANOVA method for lognormally distributed data
N = ANOVA method for normally distributed data
NP = ANOVA method for nonparametric (nondistributed) data

2 Monitoring well pair-wise comparisons if a statistically significant diff[illegible]

3 Pool consists of upgradient weathered bedrock wells P207389 and P2[illegible]

* Indicates that the analyte concentrations in the downgradient well [illegible] ie analyte concentrations in the upgradient wells. This may indicate downgradi[illegible]

** Indicates that the analyte concentrations in the upgradient wells are st[illegible] lient wells. This may indicate a possible upgradient source.

*** Indicates a statistically significant difference between two downgr[illegible] on between upgradient and downgradient wells.

\# Indicates a statistically significant difference between some locations within [illegible] ical method does not identify the locations, and contaminant distribution must be evaluated to determine [illegible] downgradient contamination has occurred.

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Table 3-1. West Spray Field Groundwater Monitoring Wells

	Well ID	Screened Unit	Status	Well Type
Uppermost Aquifer (Surficial Materials and Weathered Bedrock)	4586	Qrf	active	CERCLA Char. Well
	4786	Qrf	active	Special Purpose Well
	4986	Qrf	active	RCRA Reg. Well
	5086	Qrf	active	RCRA Reg. Well
	5186	Qrf	active	RCRA Reg. Well
	5686	Qvf	active	CERCLA Char. Well
	46192	Qrf	active	RCRA Reg. Well
	46292	Qrf	active	RCRA Reg. Well
	B110889	Qrf	active	RCRA Reg. Well
	B110989	Qrf	active	RCRA Reg. Well
	B111189	Qrf	active	RCRA Reg. Well
	B402689	Qvf	active	Background Char. Well
	B410589	Qrf	active	RCRA Reg. Well
	B410689	Qrf	active	RCRA Reg. Well
	B410789	Qrf	active	RCRA Reg. Well
	B411289	Qrf	active	RCRA Reg. Well
	B411389	Qrf	active	RCRA Reg. Well
	P415889	Qrf	active	Special Purpose Well
	P415989	Qrf	active	Special Purpose Well
	P416089	Qrf	active	Special Purpose Well
	P416389	Qrf	active	Special Purpose Well
Lowermost Aquifer (Unweathered Bedrock)	4686	Kl(u)	active	Special Purpose
	4886	Kl(u)	active	RCRA Char. Well
	5286	Kl(u)	active	RCRA Char. Well
	46392	Kacl(?)	active	RCRA Char. Well
Wells Screened in Unknown Units	0582	?	abandoned	RCRA Reg. Well
	0682	?	abandoned	RCRA Reg. Well
	0782	?	abandoned	RCRA Reg. Well

Qrf: Rocky Flats Alluvium
Qvf: Valley Fill Alluvium
Kacl(w): Weathered Arapahoe Formation Claystone
Kl(u): Unweathered Laramie Formation Sandstone

Table 3-2. West Spray Field - Average Linear Groundwater Flow Velocities, 1992

Well Pair	Quarter	Hydraulic Gradient	Hydraulic Conductivity (cm/sec)	Assumed Effective Porosity	Average Linear Velocity (ft/yr)
5186/	1st Quarter	1.55×10^{-2}	4.57×10^{-4}	0.1	71
B110989	2nd Quarter	1.58×10^{-2}	4.57×10^{-4}	0.1	73
	3rd Quarter	1.49×10^{-2}	4.57×10^{-4}	0.1	69
	4th Quarter	1.49×10^{-2}	4.57×10^{-4}	0.1	69
5186/	1st Quarter	1.16×10^{-2}	4.57×10^{-4}	0.1	54
B410789	2nd Quarter	1.20×10^{-2}	4.57×10^{-4}	0.1	55
	3rd Quarter	1.11×10^{-2}	4.57×10^{-4}	0.1	51
	4th Quarter	1.11×10^{-2}	4.57×10^{-4}	0.1	51
5186/	1st Quarter	1.11×10^{-2}	4.57×10^{-4}	0.1	51
B410589	2nd Quarter	1.19×10^{-2}	4.57×10^{-4}	0.1	55
	3rd Quarter	1.10×10^{-2}	4.57×10^{-4}	0.1	51
	4th Quarter	1.05×10^{-2}	4.57×10^{-4}	0.1	49

Table 3-3. West Spray Field-
Infrequently Detected Analytes
(Less Than 50% Quantified Results) in Downgradient
Monitoring Wells in Surficial Materials, 1992

VOCs

Well	Date	Analyte	Result
B110889	10/9/92	METHYLENE CHLORIDE	20.00 ug/L
B110889	10/9/92	TOTAL XYLENES	10.00 ug/L
B410689	10/8/92	METHYLENE CHLORIDE	19.00 ug/L

Dissolved Metals

Well	Date	Analyte	Result
B110889	10/9/92	LEAD-DISSOLVED	1.50 ug/L
B110889	1/31/92	MERCURY-DISSOLVED	0.21 ug/L
B110989	1/29/92	MERCURY-DISSOLVED	0.21 ug/L
B111189	1/31/92	MERCURY-DISSOLVED	0.21 ug/L
B410589	10/7/92	ANTIMONY-DISSOLVED	25.50 ug/L
B410589	10/7/92	CHROMIUM-DISSOLVED	2.80 ug/L
B410589	10/7/92	COPPER-DISSOLVED	18.90 ug/L
B410689	10/8/92	ARSENIC-DISSOLVED	0.80 ug/L
B410689	10/8/92	BERYLLIUM-DISSOLVED	1.10 ug/L
B410789	1/31/92	MERCURY-DISSOLVED	0.21 ug/L

Inorganic Analytes

Well	Date	Analyte	Result
5086	7/14/92	ORTHOPHOSPHATE	0.02 mg/L
5086	2/11/92	SILICA, DISSOLVED	2.00 mg/L
B110889	3/12/92	CARBONATE AS CACO3	2.00 mg/L
B110889	10/9/92	FLUORIDE, SOLUBLE	0.53 mg/L
B110889	3/12/92	TOTAL SUSPENDED	8.00 mg/L
B110989	10/12/92	FLUORIDE, SOLUBLE	0.31 mg/L
B110989	1/29/92	SILICA, DISSOLVED	2.00 mg/L
B111189	10/12/92	FLUORIDE, SOLUBLE	0.39 mg/L
B410589	10/7/92	FLUORIDE, SOLUBLE	1.60 mg/L
B410589	2/12/92	SILICA, DISSOLVED	8.90 mg/L
B410589	10/7/92	TOTAL SOLIDS	5.00 mg/L
B410689	4/28/92	CARBONATE AS CACO3	4.00 mg/L
B410689	10/8/92	FLUORIDE, SOLUBLE	0.60 mg/L
B410689	4/28/92	ORTHOPHOSPHATE	0.02 mg/L
B410689	1/27/92	SILICA, DISSOLVED	1.00 mg/L
B410689	10/8/92	TOTAL SOLIDS	1.40 mg/L
B410789	4/28/92	CARBONATE AS CACO3	2.00 mg/L
B410789	10/7/92	FLUORIDE, SOLUBLE	0.41 mg/L
B410789	1/31/92	SILICA, DISSOLVED	10.00 mg/L
B410789	10/7/92	TOTAL SOLIDS	6.00 mg/L

Table 3-4. Comparative Statistics for West Spray Field - Analytes with Greater than 50% Quantified Results, 1992 - Groundwater Quality Data from Upgradient and Downgradient Monitoring Wells Compared Using Analysis of Variance (ANOVA)

Analyte	ANOVA Method Used[1]	Probability Value	<0.05	Well Comparison[2]
pH	N	0.0001	*	B410589 - Pool[3]
Carbonate	N	0.6667		
Chloride	NP	0.0001	#	
Fluoride	NP	0.0039	#	
Nitrate/Nitrite	NP	0.0015	#	
Orthophosphate	NP	0.2410		
Silica, Dissolved	LN	0.1960		
Silicon	N	0.0001	*	5086 - Pool
Sulfate	NP	0.0001	#	
Total Dissolved Solids	NP	0.0001	#	
Total Suspended Solids	LN	0.6305		
Aluminum	LN	0.0829		
Barium	NP	0.0149	#	
Calcium	N	0.0001	*	B410789 - Pool B410589 - Pool 5086 - Pool B410689 - Pool B110889 - Pool Pool - B111189
Iron	LN	0.1648		
Lithium	NP	0.0874		
Magnesium	NP	0.0001	#	
Manganese	NP	0.2415		
Molybdenum	N	0.9686		
Potassium	NP	0.0861		
Sodium	NP	0.0003	#	
Strontium	NP	0.0230	#	
Vanadium	NP	0.1899		
Zinc	LN	0.4863		

Table 3-4. Comparative Statistics for West Spray Field - Analytes with Greater than 50% Quantified Results, 1992 - Groundwater Quality Data from Upgradient and Downgradient Monitoring Wells Compared Using Analysis of Variance (ANOVA) (continued)

Analyte	ANOVA Method Used[1]	Probability Value	<0.05	Well Comparison[2]
Americium - 241	NP	0.9391		
Cesium - 137	N	0.6415		
Gross Alpha	N	0.0005	*	B410589 - Pool
Gross Beta	N	0.2767		
Plutonium - 239, 240	NP	0.2446		
Strontium - 89, 90	LN	0.9464		
Tritium	LN	0.0349	***	
Uranium - 233, 234	NP	0.0048	#	
Uranium - 235	N	0.3252		
Methylene Chloride	NP	0.8391		

1 LN = ANOVA method for lognormally distributed data
N = ANOVA method for normally distributed data
NP = ANOVA method for nonparametric (nondistributed) data

2 Monitoring well pair-wise comparisons if a statistically significant difference exists

3 Pool consists of upgradient Wells 5186 and 46192.

* Indicates that the analyte concentrations in the downgradient wells are statistically greater than the analyte concentrations in the upgradient wells. This may indicate downgradient contamination.

** Indicates that the analyte concentrations in the upgradient wells are statistically greater than the downgradient wells. This may indicate a possible upgradient source.

*** Indicates a statistically significant difference in the data set due to a comparison between two downgradient wells and not a comparison between upgradient and downgradient wells.

# Indicates a statistically significant difference between some locations within the data set. The statistical method does not identify the locations, and contaminant distribution must be evaluated to determine if downgradient contamination has occurred.

Table 4-1. Present Landfill Groundwater Monitoring Wells

	Well ID	Screened Unit	Status	Well Type
Uppermost Aquifer (Surficial Materials and Weathered Bedrock)	0586	Qcf	active	CERCLA Char. Well
	0686	Qvf	active	Special Purpose Well
	0786	Qvf	active	RCRA Reg. Well
	1086	Qrf	active	RCRA Reg. Well
	4087	Qvf	active	RCRA Reg. Well
	4287	Qvf	active	CERCLA Char. Well
	5887	Qrf	active	RCRA Reg. Well
	5987	Qrf	inactive	RCRA Reg. Well
	6087	Qrf	active	RCRA Reg. Well
	6187	Qrf	active	RCRA Reg. Well
	6287	Qrf	active	RCRA Reg. Well
	6387	Qrf	damaged	RCRA Reg. Well
	6487	Qrf/Kass(w)	active	RCRA Reg. Well
	6587	Qrf/Kass(w)	active	RCRA Reg. Well
	6687	Qrf	active	RCRA Reg. Well
	6787	Qrf	active	RCRA Reg. Well
	6887	Qrf	active	RCRA Reg. Well
	7087	Qrf	active	RCRA Reg. Well
	7187	Qrf	active	RCRA Reg. Well
	7287	Qrf	active	RCRA Reg. Well
	B106089	Qaf/Qrf	active	RCRA Reg. Well
	B206189	Kacl(w)	active	RCRA Reg. Well
	B206289	Kacl(w)	active	RCRA Reg. Well
	B206389	Qrf/Qaf	active	RCRA Reg. Well
	B206489	Qrf/Kass(w)	active	RCRA Reg. Well
	B206589	Kass(w)	active	RCRA Reg. Well
	B206689	Kacl(w)	active	RCRA Reg. Well
	B206789	Kacl(w)	active	RCRA Reg. Well
	B206889	Kacl(w)	active	RCRA Reg. Well
	B206989	Kacl(w)	active	RCRA Reg. Well
	B207089	Kass(w)	active	RCRA Reg. Well
	B207289	Kacl(w)	active	RCRA Reg. Well
Lowermost Aquifer (Unweathered Bedrock)	0886	Kass(u)	active	RCRA Reg. Well
	0986	Kass(u)	active	RCRA Char. Well
	4187	Kacl(w)Kass(u)	active	RCRA Char. Well
	B207189	Kass(u)	active	RCRA Char. Well

Qaf: Artificial Fill
Qvf: Valley Fill Alluvium
Qrf: Rocky Flats Alluvium
Kacl(w): Weathered Arapahoe Formation Claystone
Kass(w): Weathered Arapahoe Formation Sandstone
Kass(u): Unweathered Arapahoe Formation Sandstone

Table 4-2. Present Landfill - Groundwater Monitoring Wells Not Used in Construction of Potentionmetric Surface Maps for 1992

		Elevation of		Water Elevation			
	Well #	Bottom of Well Screen	Top of Bedrock	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Surficial Material	0786	5919.92	5920.66			5920.52	
	4087	5878.23	5878.49				5876.02
	7087	5952.09	5954.85			5954.02	
	7287	5964.18	5964.68			5963.32	
	B206489	5961.46	5963.96			5963.45	
Bedrock	B206689	5943.03		5942.46			
	B206889	5901.7		5900.51	5899.92	5900.32	5900.38
	B206989	5863.02		5862.16	5861.44	5862.02	5862.71

Table 4-3. Present Landfill - Vertical Hydraulic Gradients Between Surficial Materials and Weathered Bedrock, 1992

Alluvial Well	Screened Unit	Bedrock Well	Screened Unit	Hydraulic Gradient (ft/ft)			
				1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
6487	Qrf/Kass(w)	B206189	Kacl(w)	1.7×10^{-1}	5.5×10^{-1}	3.9×10^{-1}	3.8×10^{-1}
4087	Qvf	B207089	Kacl(w)	4.9×10^{-1}	5.8×10^{-1}	5.1×10^{-1}	4.2×10^{-1}

The vertical gradient was calculated as the quotient of the difference between elevations in water levels divided by the vertical distance between the screened intervals. Specifically, the divisor was the difference between the elevation at the center of the screened interval for the well completed in the surficial materials and the elevation of the screened interval completed in the weathered bedrock.

Qrf: Rocky Flats Alluvium
Qvf: Valley Fill Alluvium
Kacl(w): Weathered Arapahoe Formation Claystone
Kass(w): Weathered Arapahoe Formation Sandstone

Table 4-4. Present Landfill - Average Linear Groundwater Flow Velocities, 1992

	Well Pair	Flow Regime	Hydraulic Gradient	Hydraulic Conductivity (cm/sec)	Assumed Effective Porosity	Average Linear Velocity (ft/yr)
Surficial Material	B106089	High	3.70×10^{-2}	3.81×10^{-4}	0.1	142
	0786	Low	3.47×10^{-2}	3.81×10^{-4}	0.1	133
Bedrock	0986/	High	4.89×10^{-2}	8.90×10^{-7}	0.1	0.4
	0886	Low	2.11×10^{-2}	8.90×10^{-7}	0.1	0.2
	B206189/	High	9.62×10^{-2}	8.90×10^{-7}	0.1	0.9
	0886	Low	9.23×10^{-2}	8.90×10^{-7}	0.1	0.8

High = April and July (for surficial material and bedrock, respectively)
Low = October (for both surficial material and bedrock)

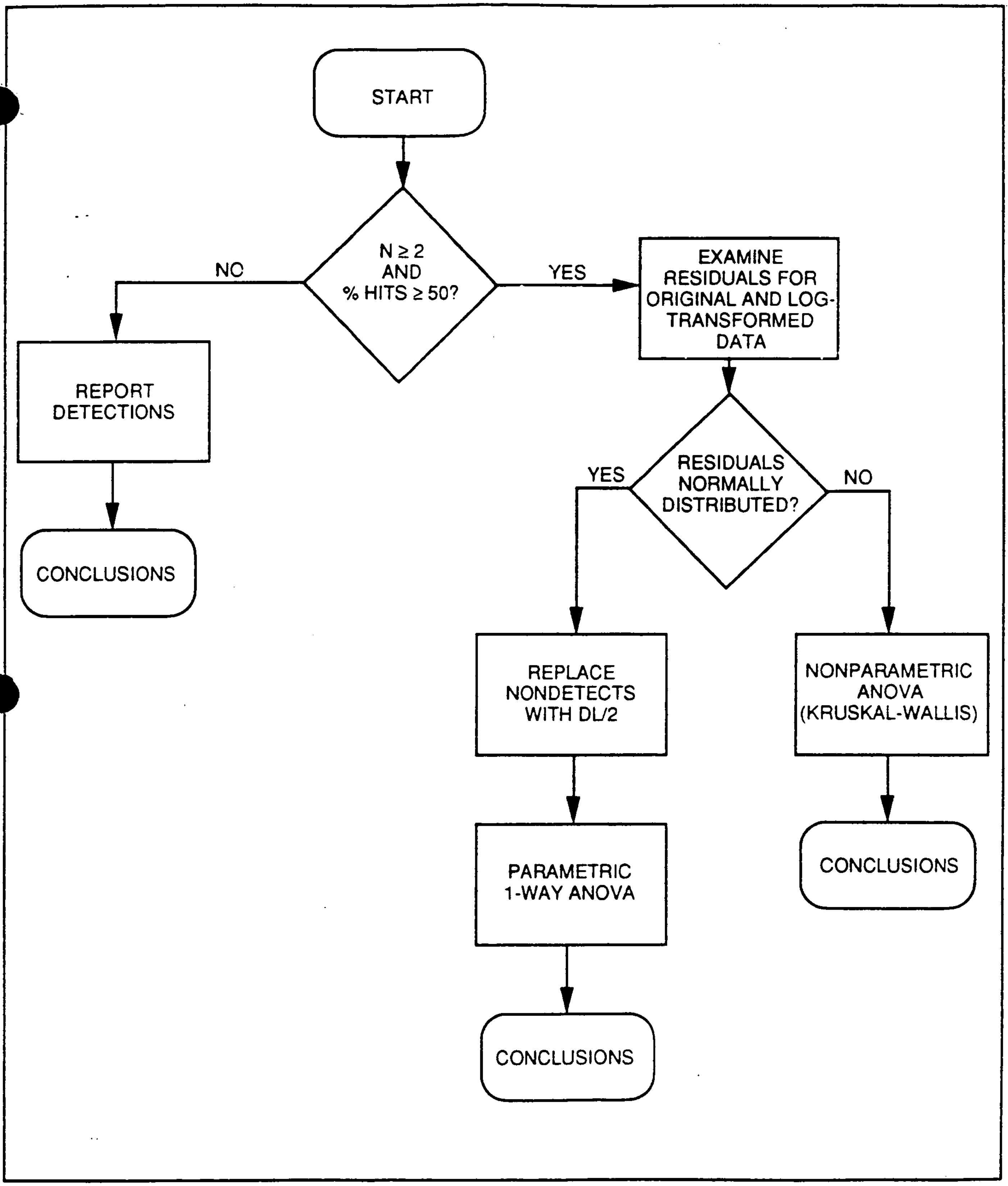
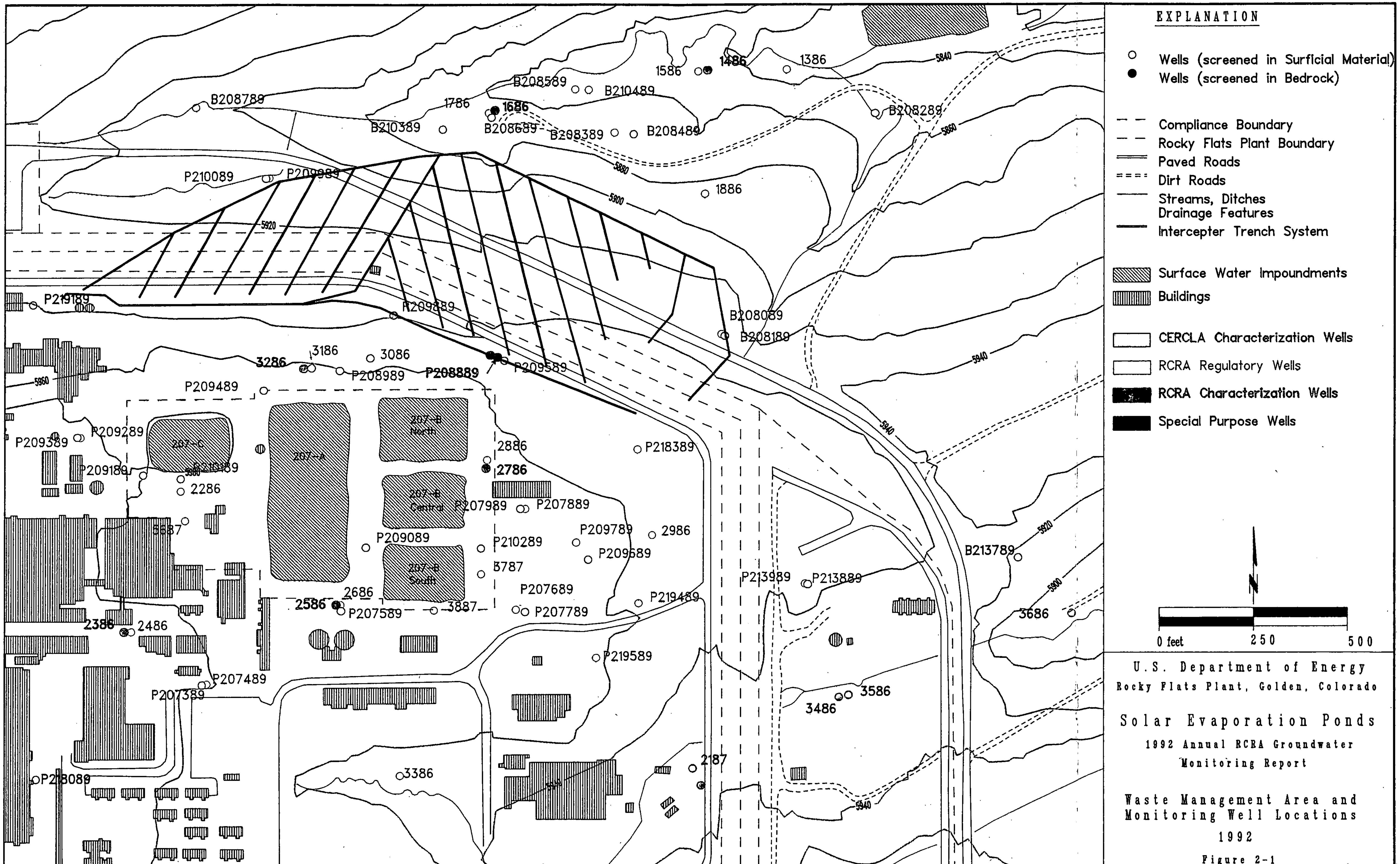


Figure 1-1 Upgradient Well to Downgradient Well Statistical Comparisons Flowchart



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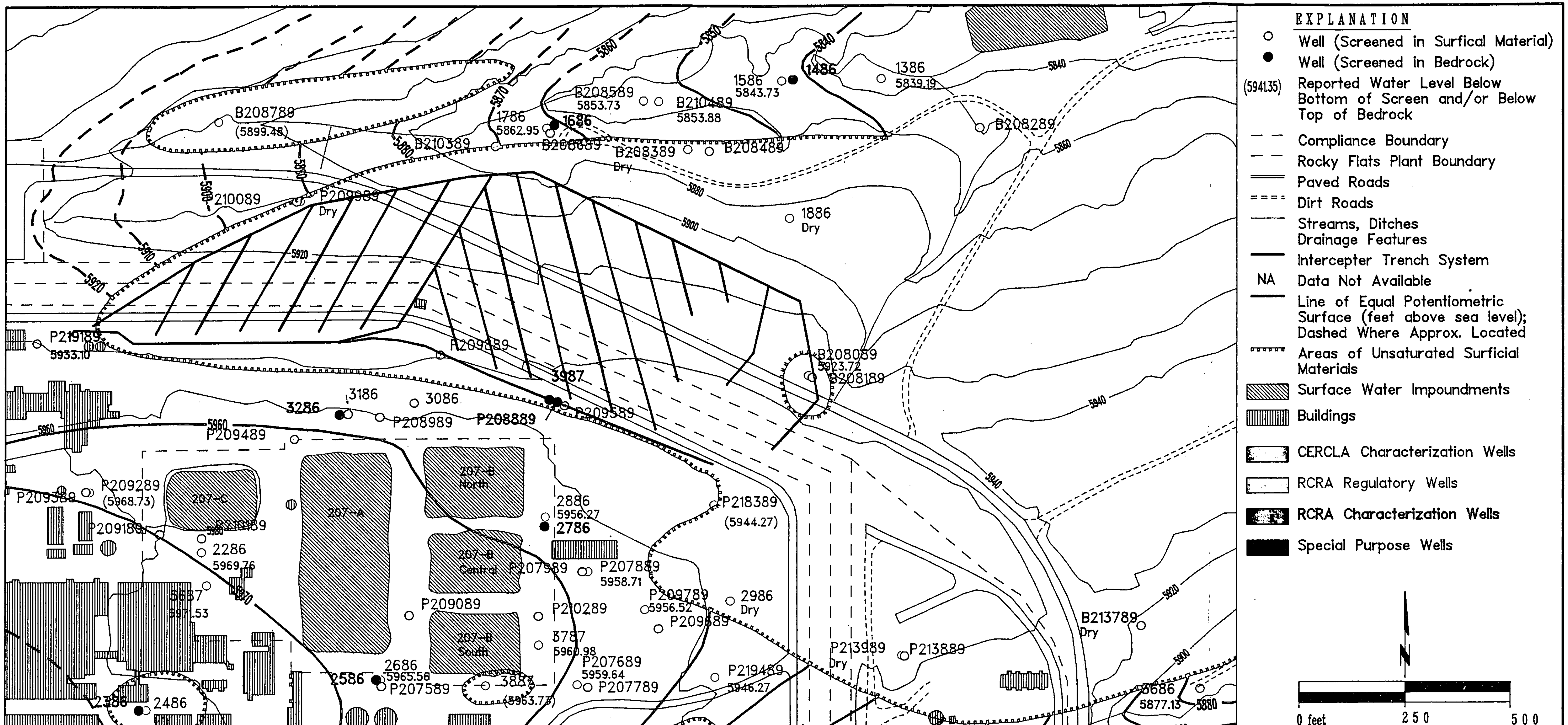
Waste Management Area and Monitoring Well Locations
1992

Figure 2-1



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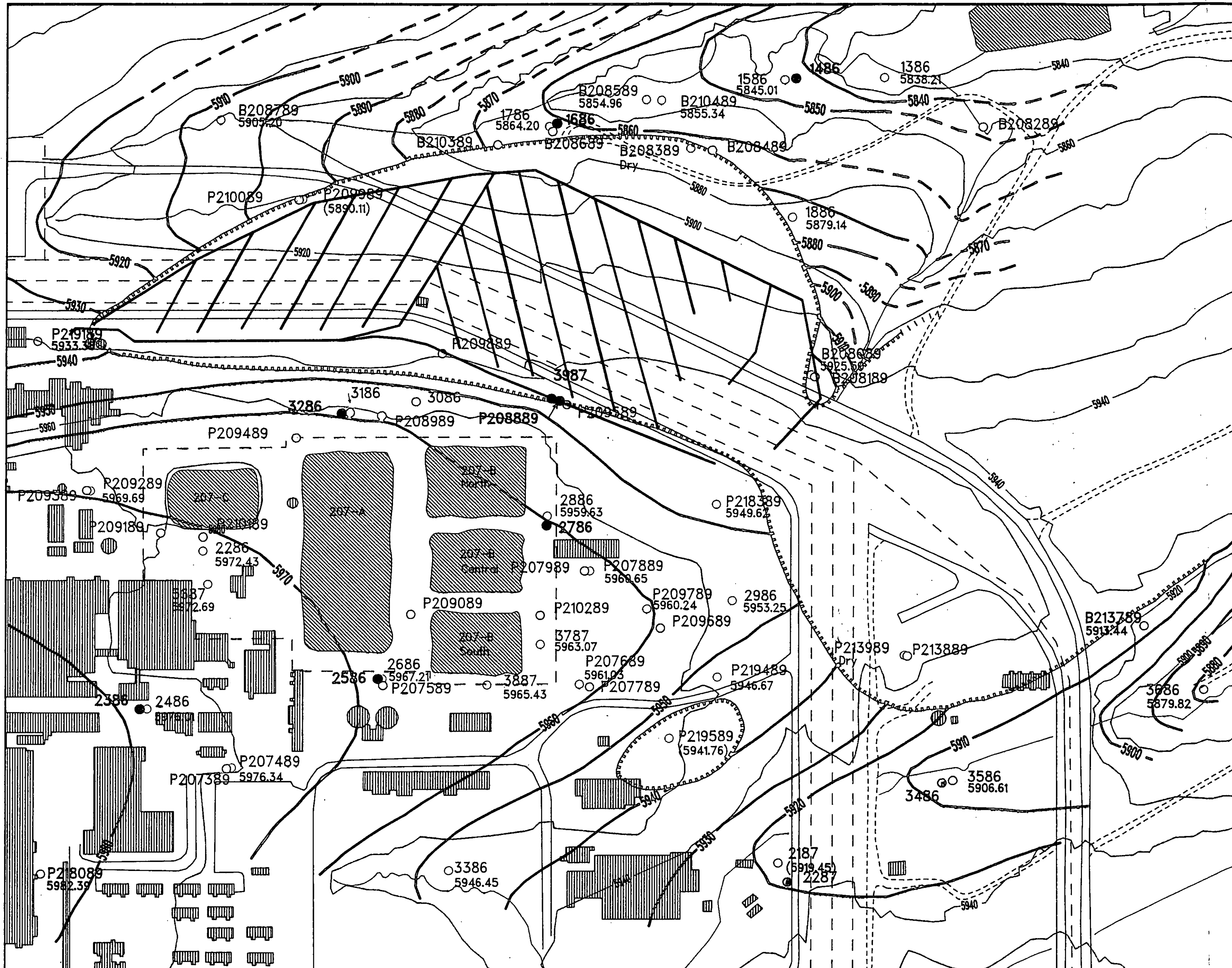
Potentiometric Surface Map Surficial Materials

Figure 2-2

First Quarter January 1992



EXPLANATION

- ○ Well (Screened in Surfical Material)
- ● Well (Screened in Bedrock)
- (5890.11) Reported Water Level Below Bottom of Screen and/or Below Top of Bedrock
- Compliance Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches Drainage Features
- Intercepter Trench System
- NA Data Not Available
- Line of Equal Potentiometric Surface (feet above sea level); Dashed Where Approx. Located
- Areas of Unsaturated Surficial Materials
- Surface Water Impoundments
- Buildings
- CERCLA Characterization Wells
- RCRA Regulatory Wells
- RCRA Characterization Wells
- Special Purpose Wells

0 feet 250 500

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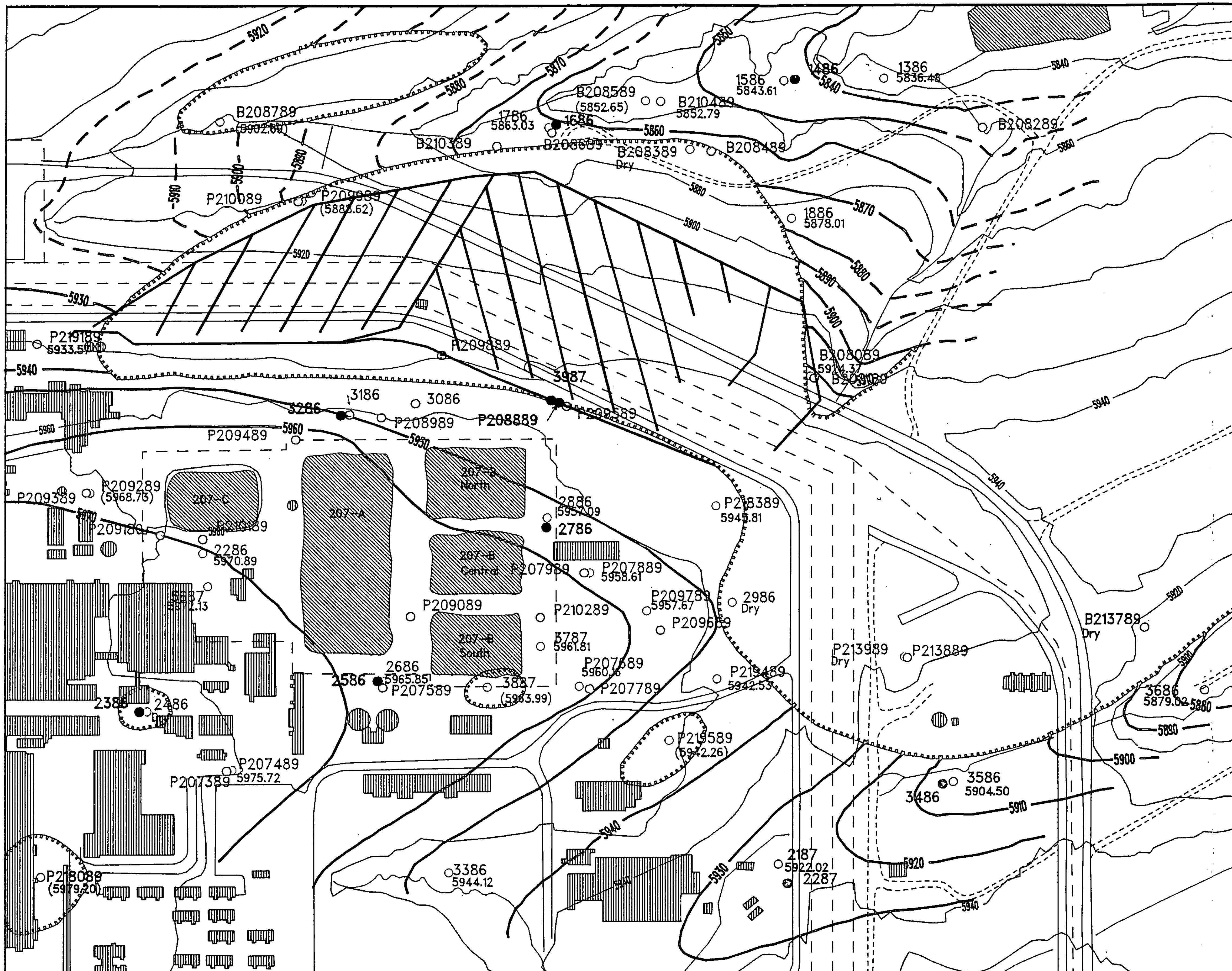
Potentiometric Surface Map

Surficial Materials

Figure 2-3

Second Quarter April 1992



EXPLANATION

- ○ Well (Screened in Surfical Material)
- ● Well (Screened in Bedrock)
- (5963.99) Reported Water Level Below Bottom of Screen and/or Below Top of Bedrock
- Compliance Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches Drainage Features
- Intercepter Trench System
- NA Data Not Available
- Line of Equal Potentiometric Surface (feet above sea level); Dashed Where Approx. Located
- Areas of Unsaturated Surficial Materials
- Surface Water Impoundments
- Buildings
- CERCLA Characterization Wells
- RCRA Regulatory Wells
- **RCRA Characterization Wells**
- Special Purpose Wells

N

0 feet 250 500

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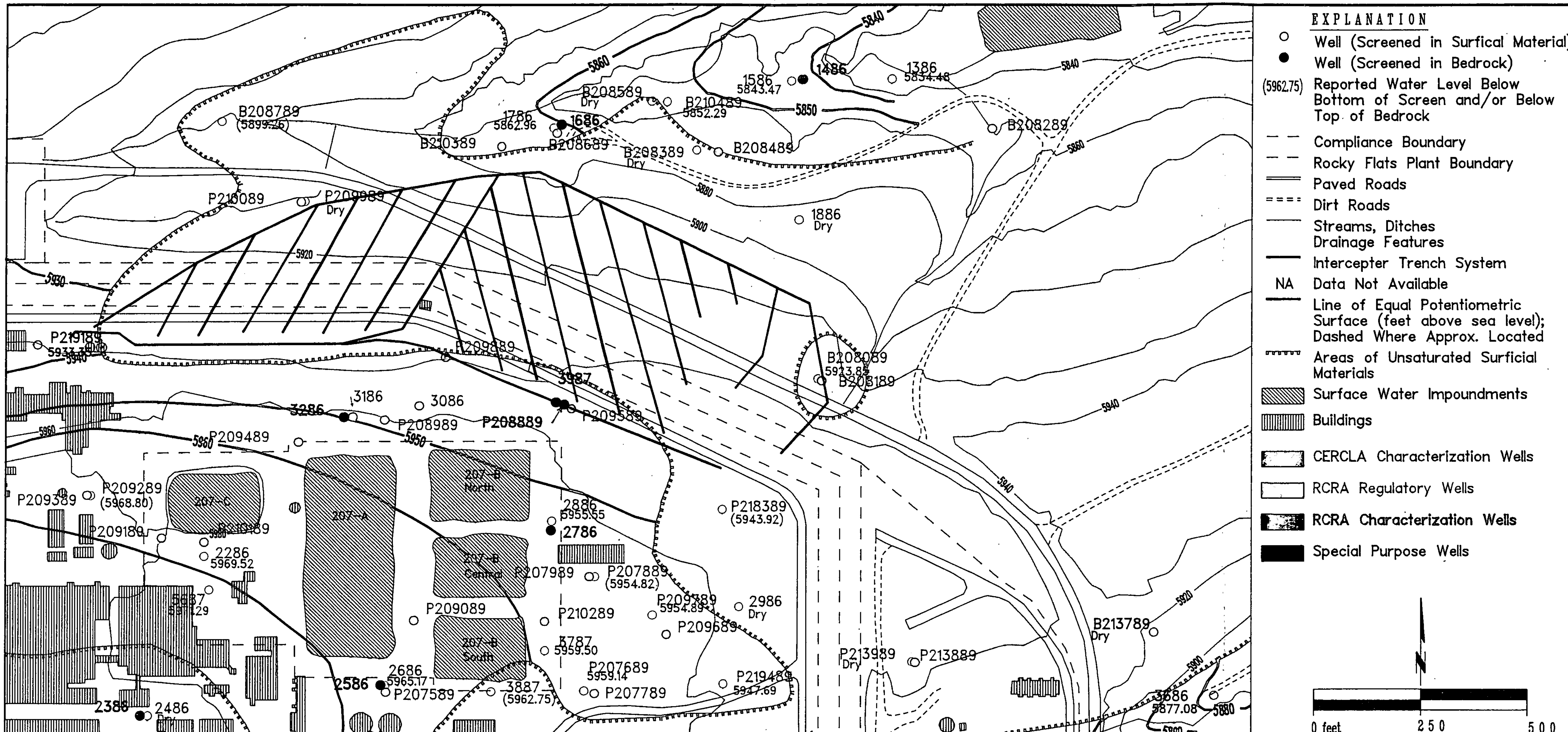
Potentiometric Surface Map Surficial Materials

Figure 2-4

Third Quarter July 1992



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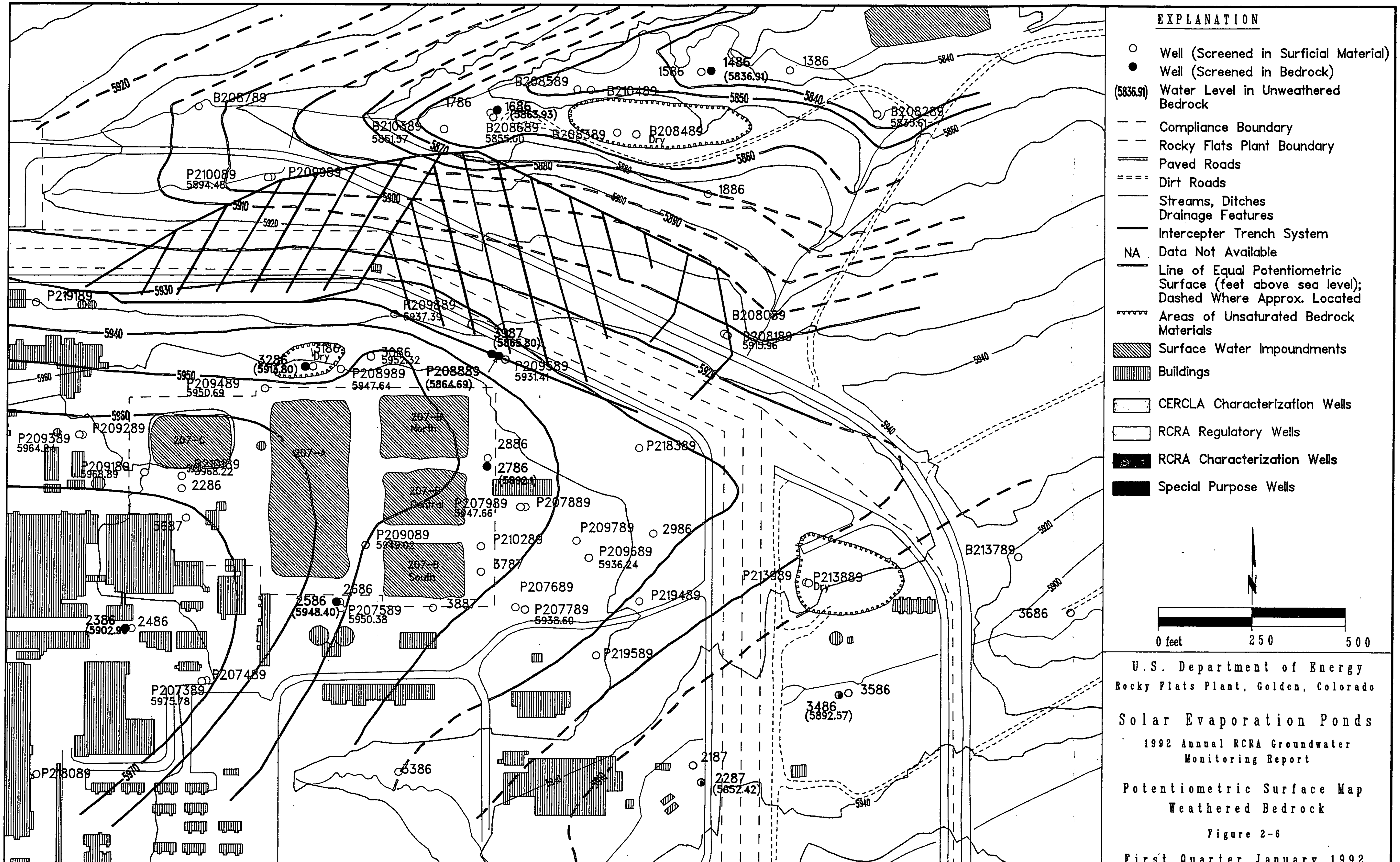
Potentiometric Surface Map Surficial Materials

Figure 2-5

Fourth Quarter October 1992


EXPLANATION
Well (Screened in Surficial Material)
Well (Screened in Bedrock)
(5836.91) Water Level in Unweathered Bedrock
Compliance Boundary
Rocky Flats Plant Boundary
Paved Roads
Dirt Roads
Streams, Ditches Drainage Features
Intercepter Trench System
NA Data Not Available
Line of Equal Potentiometric Surface (feet above sea level); Dashed Where Approx. Located
Areas of Unsaturated Bedrock Materials
Surface Water Impoundments
Buildings
CERCLA Characterization Wells
RCRA Regulatory Wells
RCRA Characterization Wells
Special Purpose Wells
0 feet
250
500
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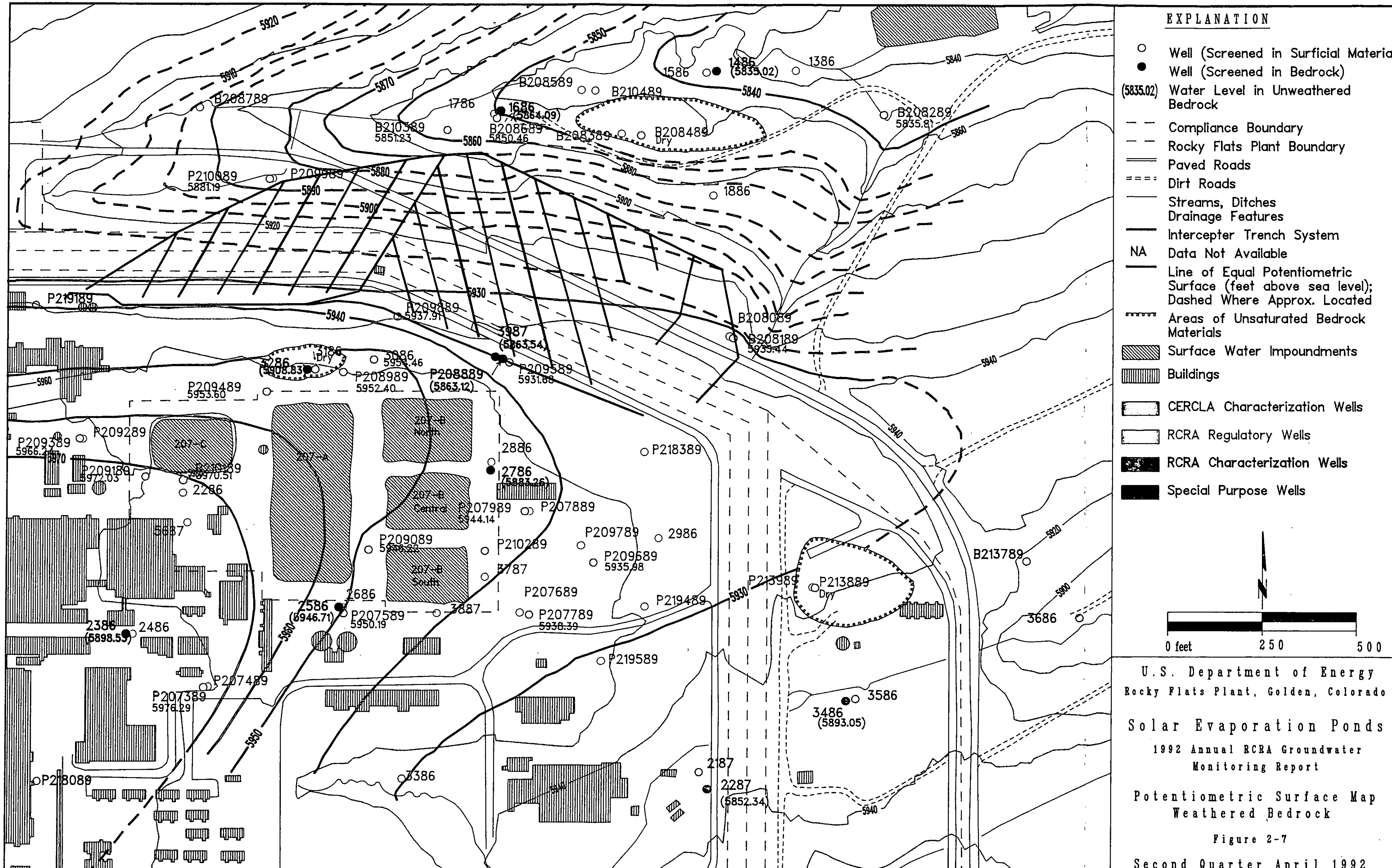
Solar Evaporation Ponds
1992 Annual RCRA Groundwater Monitoring Report
Potentiometric Surface Map
Weathered Bedrock
Figure 2-6
First Quarter January 1992
207-A
207-B North
207-B Center
207-B South
207-C
1486
(5836.91)
1386
1586
B208589
B210489
1786
1686
(5863.93)
B208289
5835.61
B210589
5851.57
B208689
5855.00
B208389
B208489
Dry
P210089
5894.48
P209989
1886
P219189
P209889
5937.39
B208089
B208189
5915.96
3187
(5865.80)
3286
(5913.80)
3186
Dry
3086
5952.32
P208989
5947.64
P208889
(5864.69)
P209589
5931.41
P209489
5950.69
P209389
5964.24
P209289
P209189
5968.89
P210189
5968.22
2286
2886
2786
(5898.1)
P218389
P207989
5947.66
P207889
3887
P209089
5949.02
P210289
P209789
2986
P209689
5936.24
3787
P207689
P213989
P213889
Dry
B213789
P219489
2686
2586
(5948.40)
P207589
5950.38
3887
P207789
5938.60
3686
2386
(5902.97)
2486
P219589
P207489
P207389
5975.78
3586
3486
(5892.57)
P218089
5386
2187
2287
(5852.42)
5840
5850
5860
5870
5880
5890
5900
5910
5920
5930
5940
5950
5960


EXPLANATION
Well (Screened in Surficial Material)
Well (Screened in Bedrock)
(5835.02) Water Level in Unweathered Bedrock
Compliance Boundary
Rocky Flats Plant Boundary
Paved Roads
Dirt Roads
Streams, Ditches Drainage Features
Intercepter Trench System
NA Data Not Available
Line of Equal Potentiometric Surface (feet above sea level); Dashed Where Approx. Located
Areas of Unsaturated Bedrock Materials
Surface Water Impoundments
Buildings
CERCLA Characterization Wells
RCRA Regulatory Wells
RCRA Characterization Wells
Special Purpose Wells
0 feet
250
500
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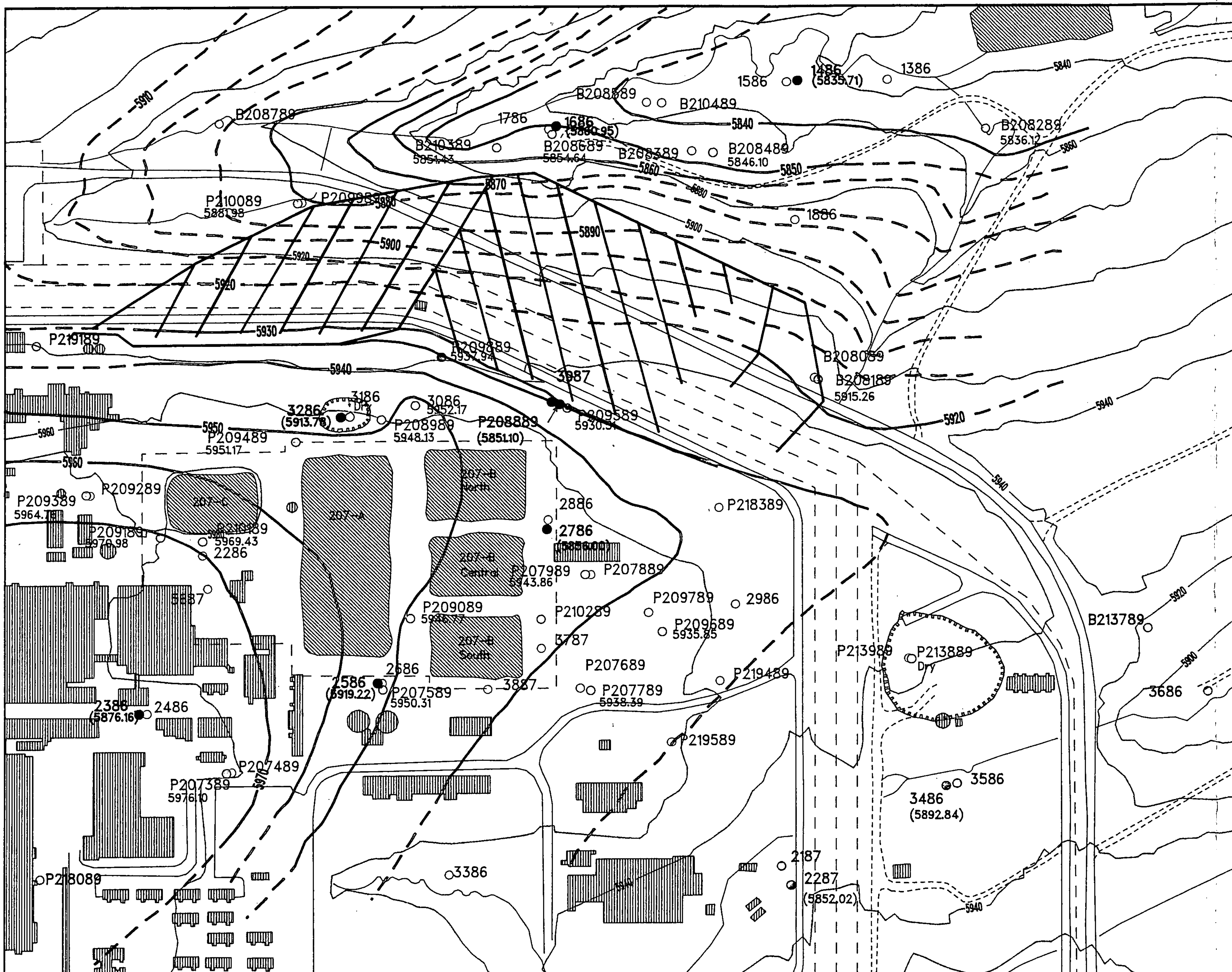
1992 Annual RCRA Groundwater Monitoring Report
Potentiometric Surface Map Weathered Bedrock
Figure 2-7
Second Quarter April 1992
207-A
207-B North
207-B Center
207-B South
207-C



EXPLANATION

- ○ Well (Screened in Surficial Material)
- ● Well (Screened in Bedrock)
- (5835.71) Water Level in Unweathered Bedrock
- Compliance Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches Drainage Features
- Intercepter Trench System
- NA Data Not Available
- Line of Equal Potentiometric Surface (feet above sea level); Dashed Where Approx. Located
- Areas of Unsaturated Bedrock Materials
- Surface Water Impoundments
- Buildings
- CERCLA Characterization Wells
- RCRA Regulatory Wells
- RCRA Characterization Wells
- Special Purpose Wells

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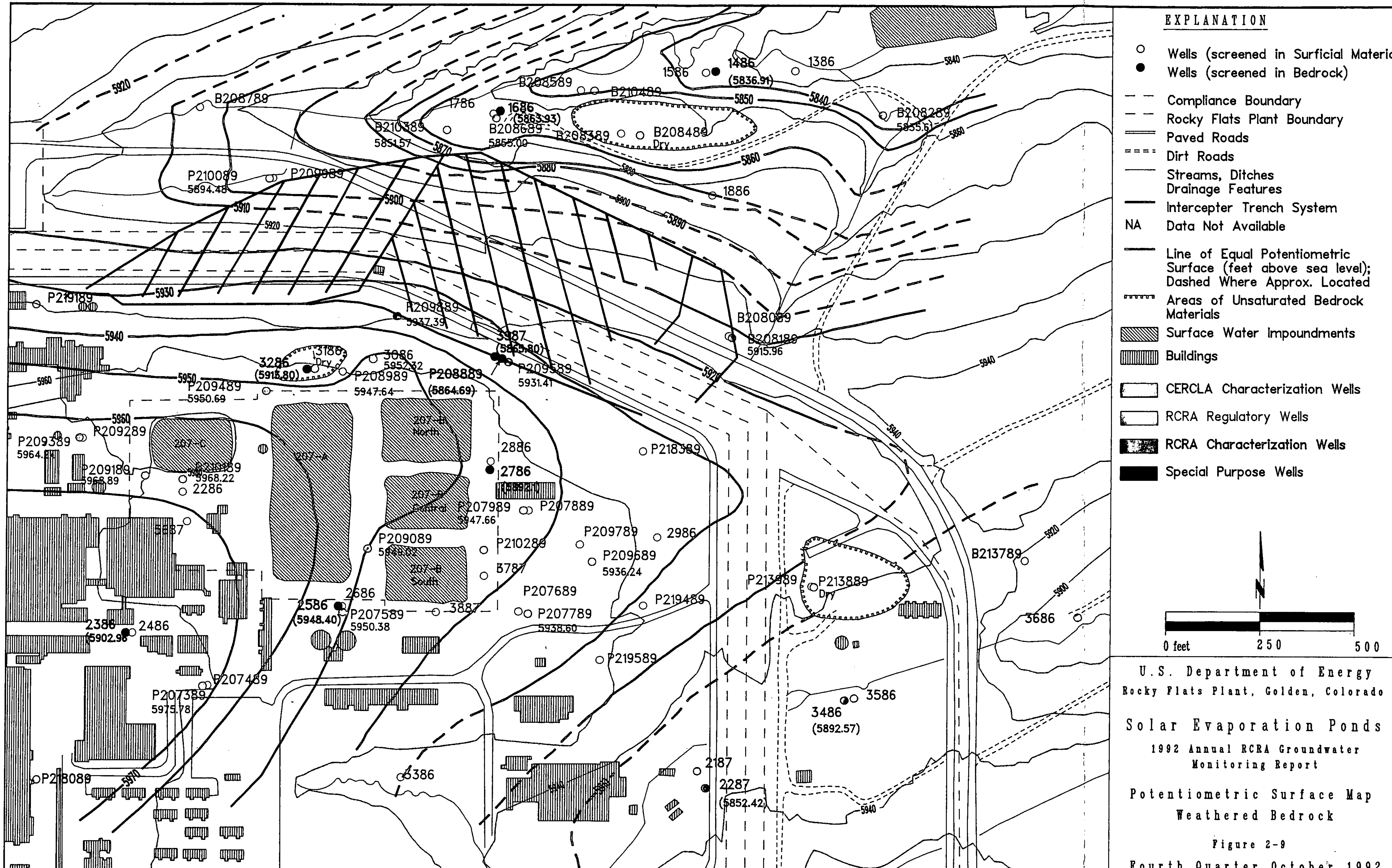
Potentiometric Surface Map Weathered Bedrock

Figure 2-8

Third Quarter July 1992


EXPLANATION
Wells (screened in Surficial Material)
Wells (screened in Bedrock)
Compliance Boundary
Rocky Flats Plant Boundary
Paved Roads
Dirt Roads
Streams, Ditches Drainage Features
Intercepter Trench System
NA Data Not Available
Line of Equal Potentiometric Surface (feet above sea level); Dashed Where Approx. Located
Areas of Unsaturated Bedrock Materials
Surface Water Impoundments
Buildings
CERCLA Characterization Wells
RCRA Regulatory Wells
RCRA Characterization Wells
Special Purpose Wells
0 feet 250 500
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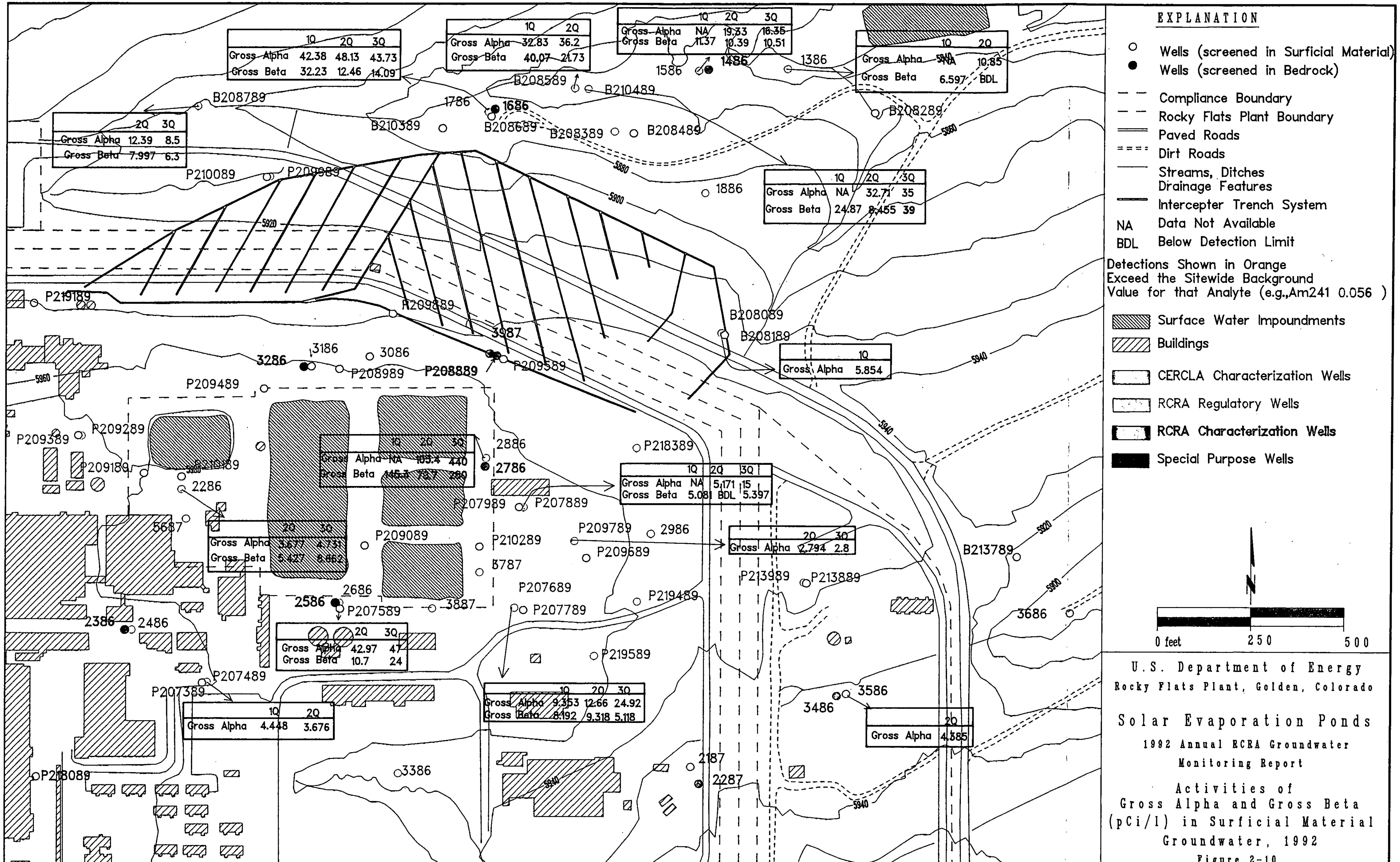
1992 Annual RCRA Groundwater Monitoring Report
Potentiometric Surface Map
Weathered Bedrock
Figure 2-9
Fourth Quarter October 1992


EXPLANATION
Wells (screened in Surficial Material)
Wells (screened in Bedrock)
Compliance Boundary
Rocky Flats Plant Boundary
Paved Roads
Dirt Roads
Streams, Ditches
Drainage Features
Intercepter Trench System
NA Data Not Available
BDL Below Detection Limit
Detections Shown in Orange Exceed the Sitewide Background Value for that Analyte (e.g.,Am241 0.056)
Surface Water Impoundments
Buildings
CERCLA Characterization Wells
RCRA Regulatory Wells
RCRA Characterization Wells
Special Purpose Wells
0 feet
250
500
U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado
Solar Evaporation Ponds
1992 Annual RCRA Groundwater Monitoring Report
Activities of Gross Alpha and Gross Beta (pCi/l) in Surficial Material Groundwater, 1992
Figure 2-10
1Q 2Q 3Q
Gross Alpha 42.38 48.13 43.73
Gross Beta 32.23 12.46 14.09
1Q 2Q
Gross Alpha 32.83 36.2
Gross Beta 40.07 21.73
1Q 2Q 3Q
Gross Alpha NA 19.33 16.35
Gross Beta 11.37 10.39 10.51
1Q 2Q
Gross Alpha NA 10.85
Gross Beta 6.597 BDL
2Q 3Q
Gross Alpha 12.39 8.5
Gross Beta 7.997 6.3
1Q 2Q 3Q
Gross Alpha NA 32.71 35
Gross Beta 24.87 8.455 39
1Q
Gross Alpha 5.854
1Q 2Q 3Q
Gross Alpha NA 103.4 440
Gross Beta 145.3 72.7 260
1Q 2Q 3Q
Gross Alpha NA 5.171 15
Gross Beta 5.081 BDL 5.397
2Q 3Q
Gross Alpha 3.677 4.731
Gross Beta 5.427 8.862
2Q 3Q
Gross Alpha 2.794 2.8
2Q 3Q
Gross Alpha 42.97 47
Gross Beta 10.7 24
1Q 2Q
Gross Alpha 4.448 3.676
1Q 2Q 3Q
Gross Alpha 9.353 12.66 24.92
Gross Beta 8.192 9.318 5.118
2Q
Gross Alpha 4.385
B208789
1786
1686
B208589
B210489
1586
1486
1386
B208289
B210389
B208689
B208389
B208489
P210089
P209989
1886
P219189
P209889
B208089
B208189
3987
3286
3186
3086
P208989
P208889
P209589
P209489
P209389
P209289
P209189
P216189
2286
2886
2786
P218389
P207989
P207889
5687
P209089
P209789
2986
P210289
P209689
B213789
3787
P207689
P213989
P213889
2686
2586
P207589
3887
P207789
P219489
3686
2386
2486
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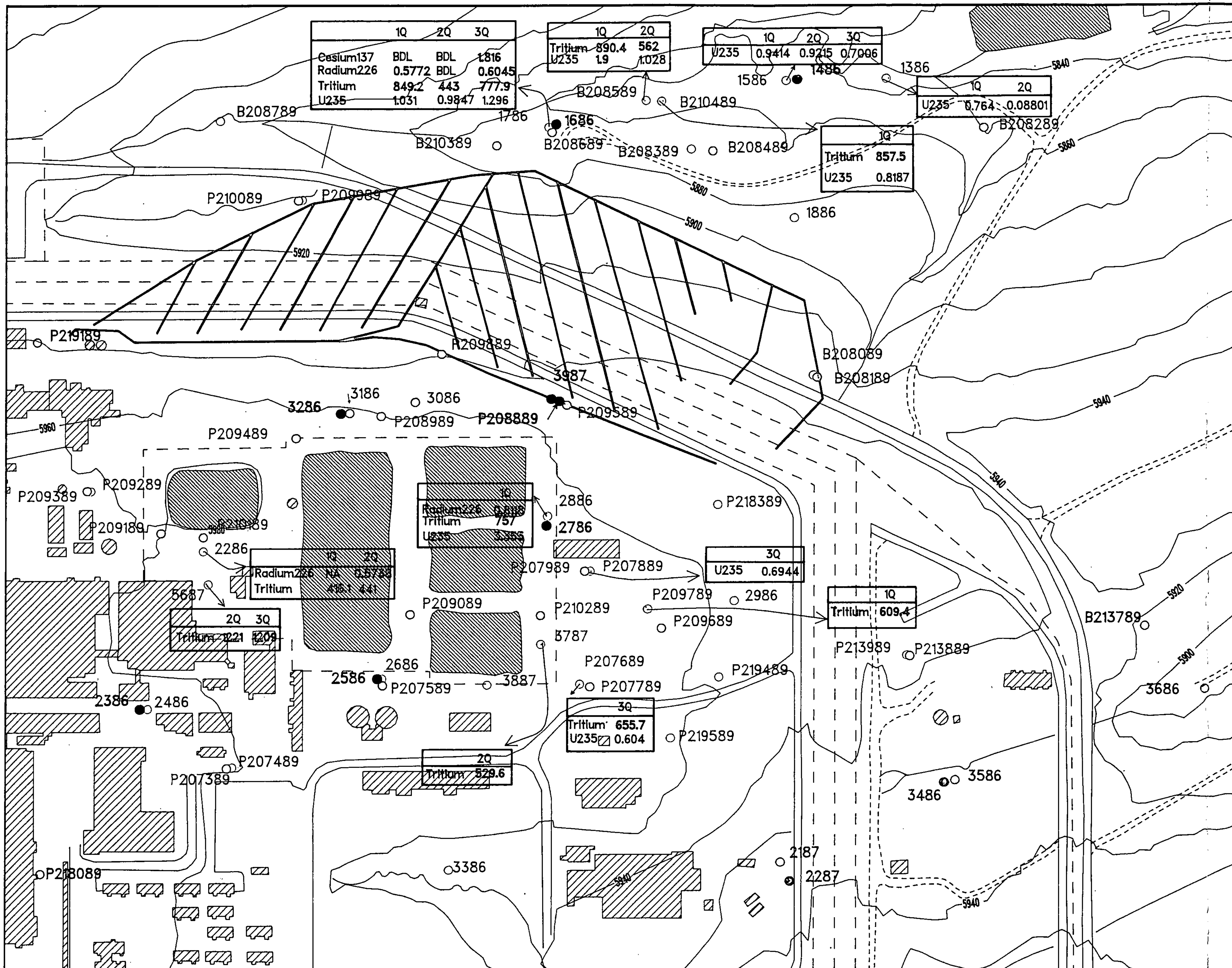
5900
5920
5940
5960



EXPLANATION

- Wells (screened in Surficial Material)
- Wells (screened in Bedrock)
- Compliance Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches Drainage Features
- Intercepter Trench System
- NA Data Not Available
- BDL Below Detection Limit

Detections Shown in Orange Exceed the Sitewide Background Value for that Analyte (e.g.,Am241 **0.056**)

- Surface Water Impoundments
- Buildings
- CERCLA Characterization Wells
- RCRA Regulatory Wells
- RCRA Characterization Wells
- Special Purpose Wells

0 feet 250 500

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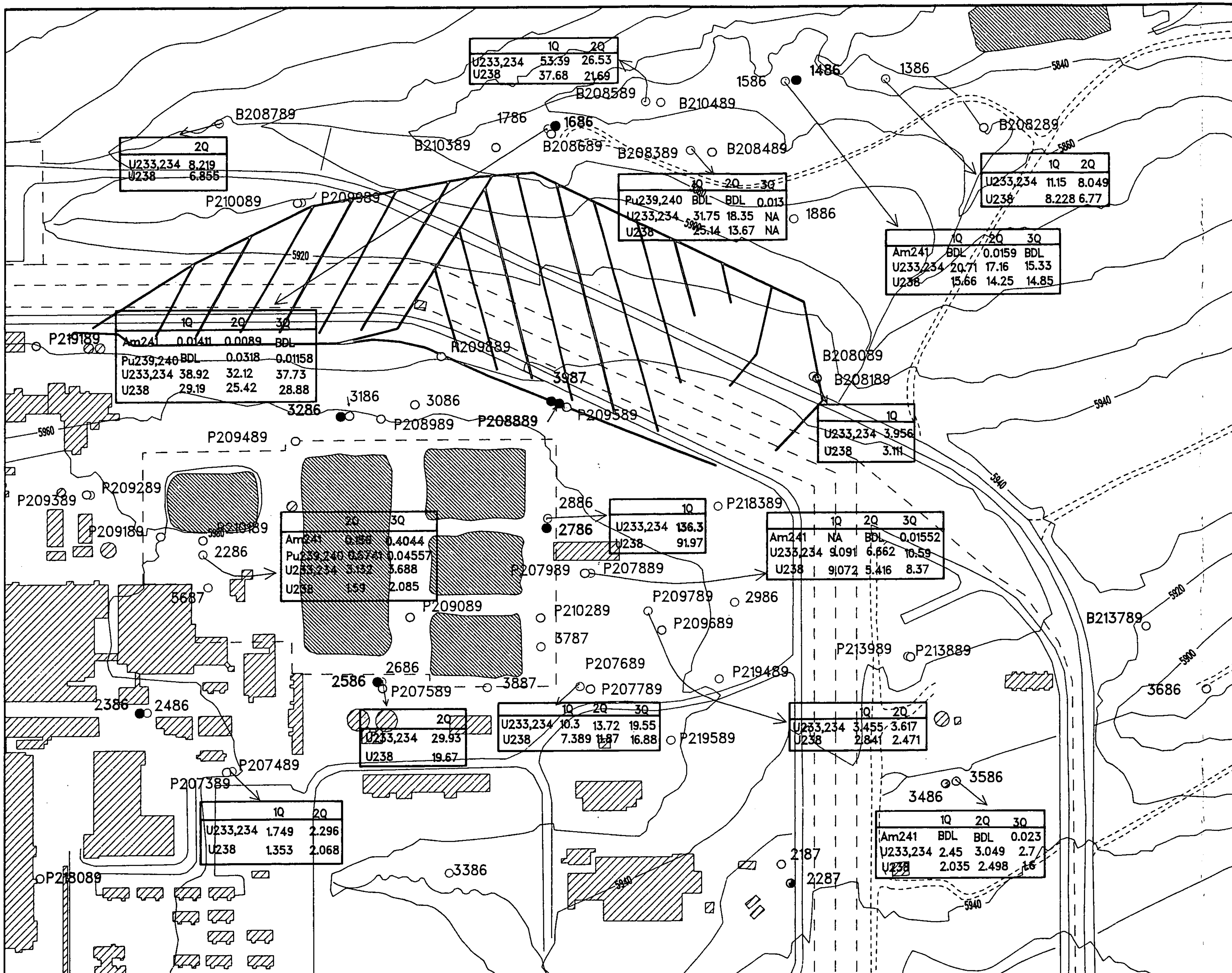
Solar Evaporation Ponds

1992 Annual RCRA Groundwater Monitoring Report

Activities of Ra226, Cs137, Tritium, and U235 (pCi/l) in Surficial Material Groundwater, 1992

Figure 2-11



EXPLANATION

- ○ Wells (screened in Surficial Material)
- ● Wells (screened in Bedrock)
- Compliance Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches Drainage Features
- Intercepter Trench System
- NA Data Not Available
- BDL Below Detection Limit

Detections Shown in Orange Exceed the Sitewide Background Value for that Analyte (e.g.,Am241 **0.056**)

- Surface Water Impoundments
- Buildings
- CERCLA Characterization Wells
- RCRA Regulatory Wells
- RCRA Characterization Wells
- Special Purpose Wells

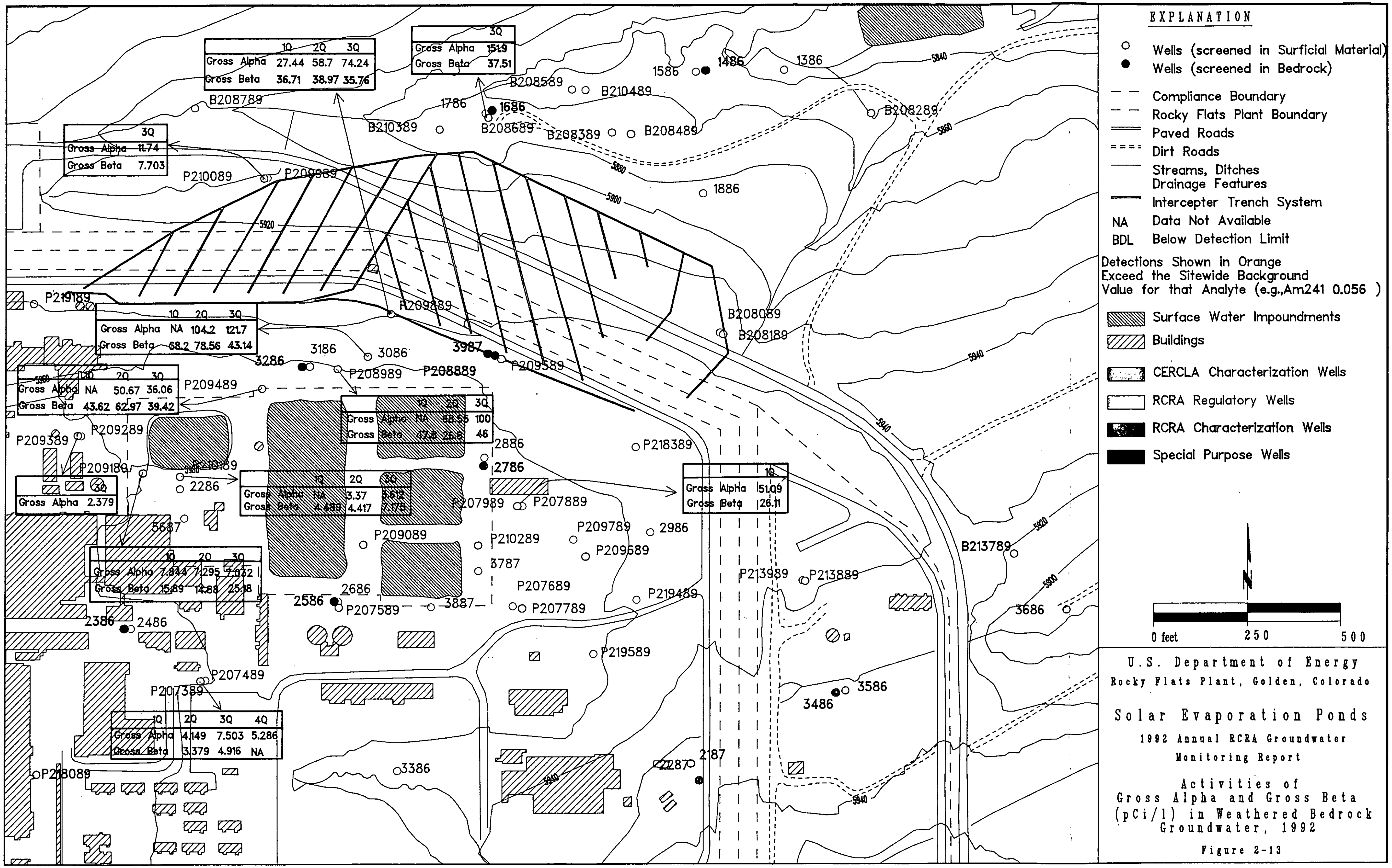
0 feet 250 500

U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

Solar Evaporation Ponds
1992 Annual RCRA Groundwater Monitoring Report

Activities of Am241(total), Pu239&240(total), U233&234, and U238 (pCi/l) in Surficial Material Groundwater, 1992

Figure 2-12


EXPLANATION
Wells (screened in Surficial Material)
Wells (screened in Bedrock)
Compliance Boundary
Rocky Flats Plant Boundary
Paved Roads
Dirt Roads
Streams, Ditches Drainage Features
Intercepter Trench System
NA Data Not Available
BDL Below Detection Limit
Detections Shown in Orange Exceed the Sitewide Background Value for that Analyte (e.g.,Am241 0.056)
Surface Water Impoundments
Buildings
CERCLA Characterization Wells
RCRA Regulatory Wells
RCRA Characterization Wells
Special Purpose Wells
0 feet 250 500
U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado
Solar Evaporation Ponds
1992 Annual RCRA Groundwater Monitoring Report
Activities of Gross Alpha and Gross Beta (pCi/l) in Weathered Bedrock Groundwater, 1992
Figure 2-13
1Q 2Q 3Q
Gross Alpha 27.44 58.7 74.24
Gross Beta 36.71 38.97 35.76
3Q
Gross Alpha 151.9
Gross Beta 37.51
3Q
Gross Alpha 11.74
Gross Beta 7.703
1Q 2Q 3Q
Gross Alpha NA 104.2 121.7
Gross Beta 68.2 78.56 43.14
1Q 2Q 3Q
Gross Alpha NA 50.67 36.06
Gross Beta 43.62 62.97 39.42
1Q 2Q 3Q
Gross Alpha NA 88.55 100
Gross Beta 47.8 26.8 46
3Q
Gross Alpha 2.379
1Q 2Q 3Q
Gross Alpha NA 3.37 3.612
Gross Beta 4.489 4.417 7.175
1Q
Gross Alpha 51.09
Gross Beta 26.11
1Q 2Q 3Q
Gross Alpha 7.844 7.295 7.032
Gross Beta 15.89 14.88 25.18
1Q 2Q 3Q 4Q
Gross Alpha 4.149 7.503 5.286
Gross Beta 3.379 4.916 NA
1586 1486 1386
B208589 B210489 B208789
1786 1686
B210389 B208689 B208389 B208489 B208289
P210089 P209989
1886
P219189
P209889
B208089 B208189
3186 3086
3286 3987
P208989 P208889 P209589
P209489
P209389 P209289
2886
P218389
P209189 P210189
2786
2286
P207989 P207889
5687
P209789 2986
P209089
P210289
P209689
3787
P213989 P213889
B213789
P207689
2686
2586 P207589 3887 P207789 P219489
2386 2486
3686
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P207389
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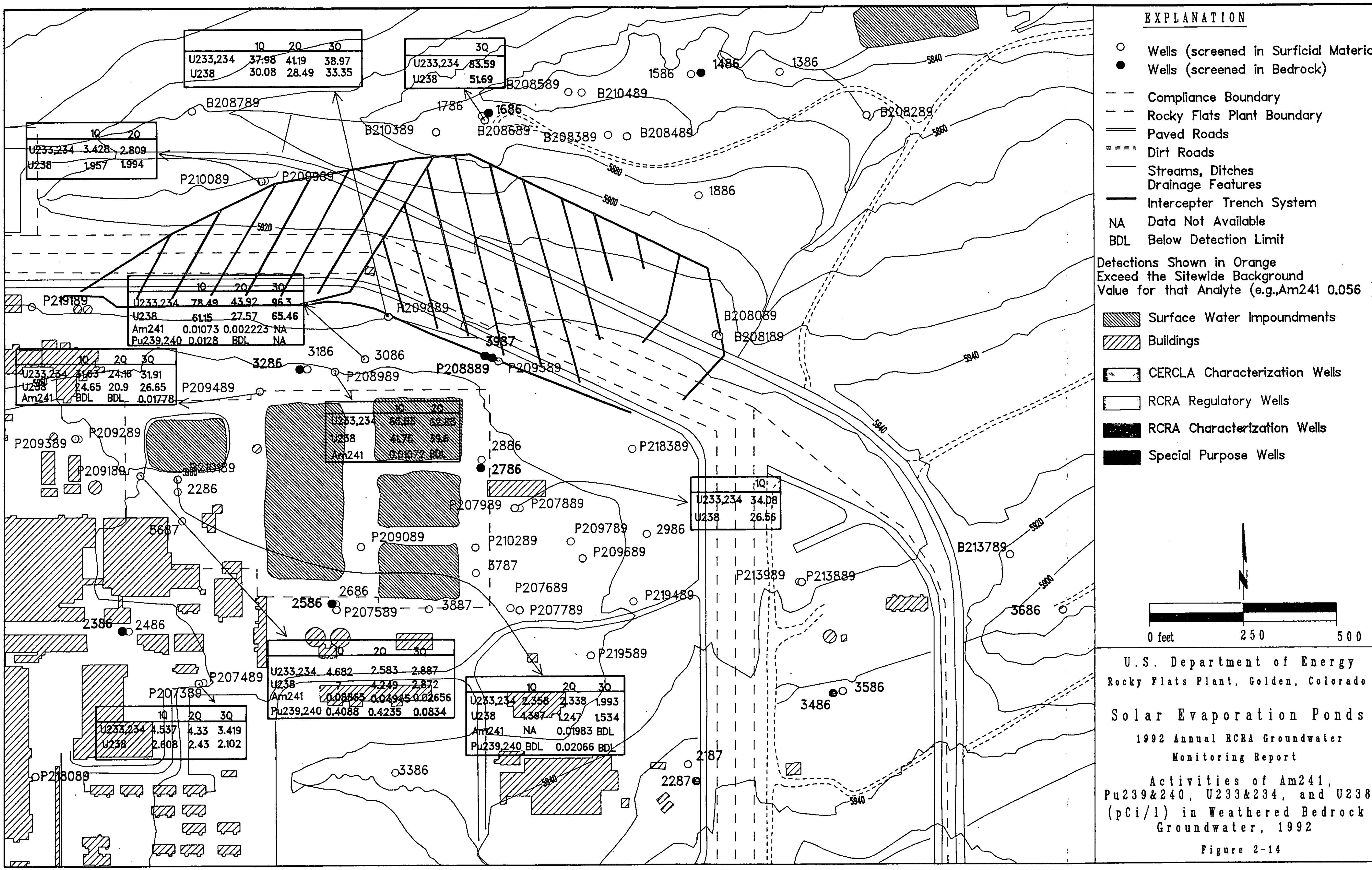
3386
P218089
5840 5860 5880 5900 5920 5940

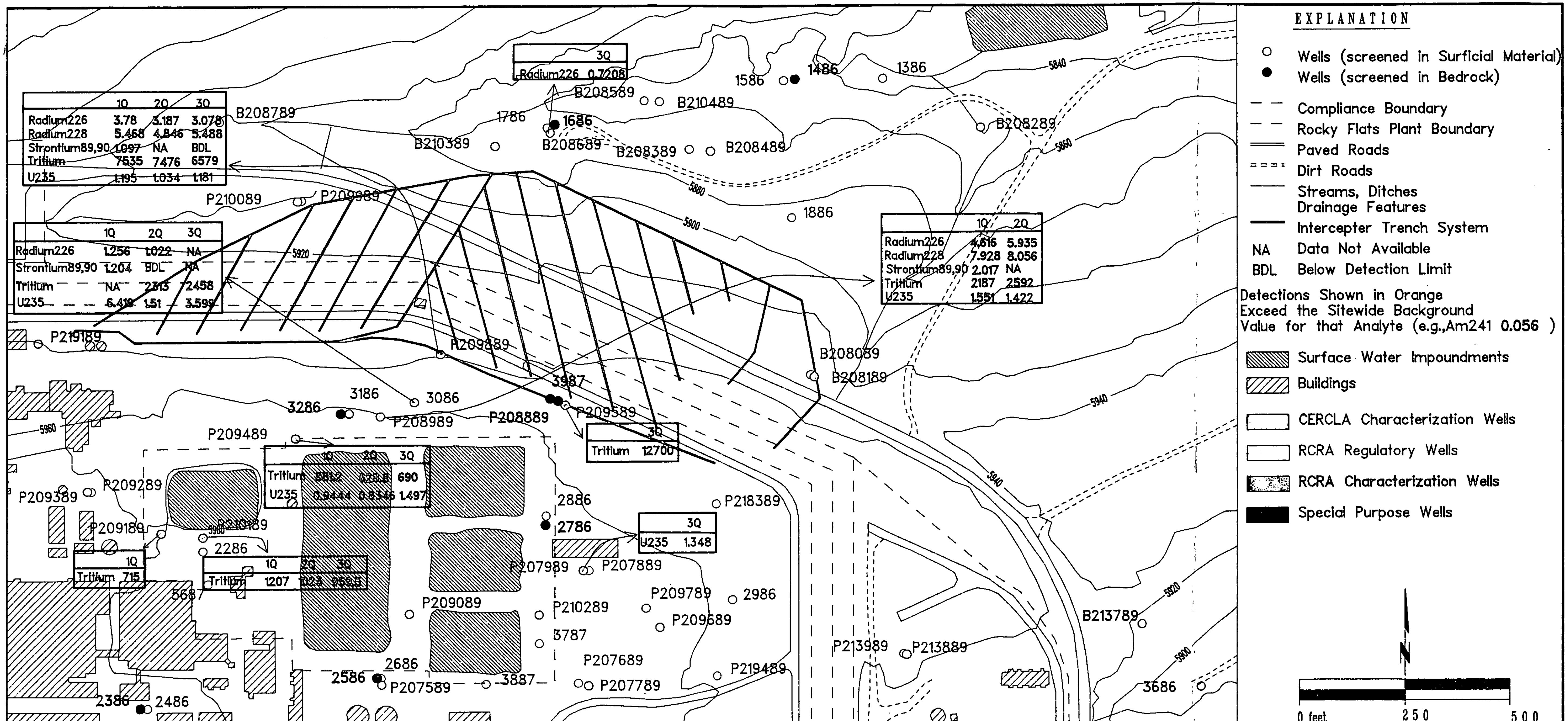


U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

Solar Evaporation Ponds
1992 Annual RCRA Groundwater Monitoring Report

Activities of Am241, Pu239&240, U233&234, and U238 (pCi/l) in Weathered Bedrock Groundwater, 1992

Figure 2-14



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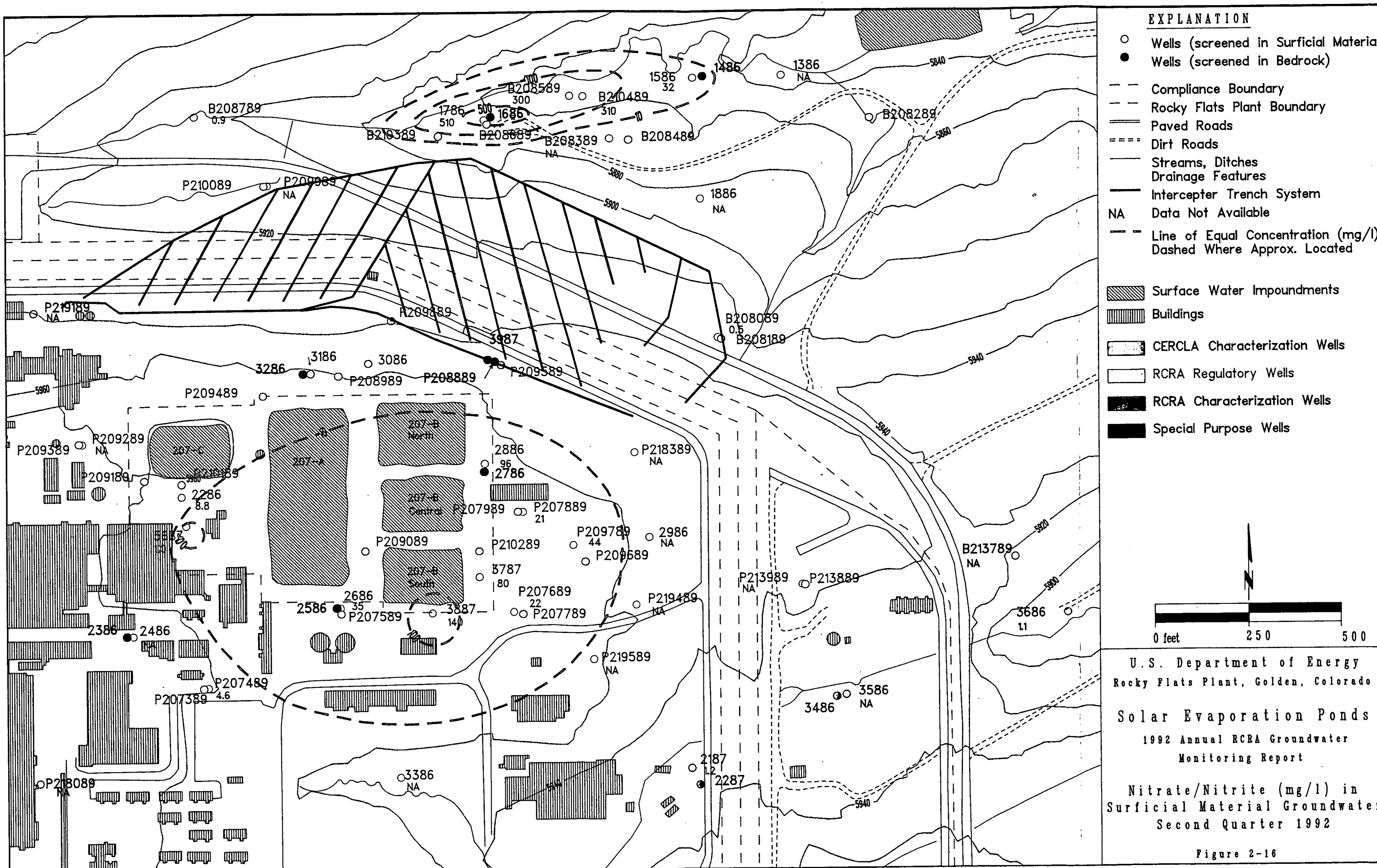
Rocky Flats Plant, Golden, Colorado

Solar Evaporation Ponds

1992 Annual RCRA Groundwater Monitoring Report

Activities of Ra226, Ra228, Sr89&90, Tritium, and U235 (pCi/l) in Weathered Bedrock Groundwater, 1992

Figure 2-15

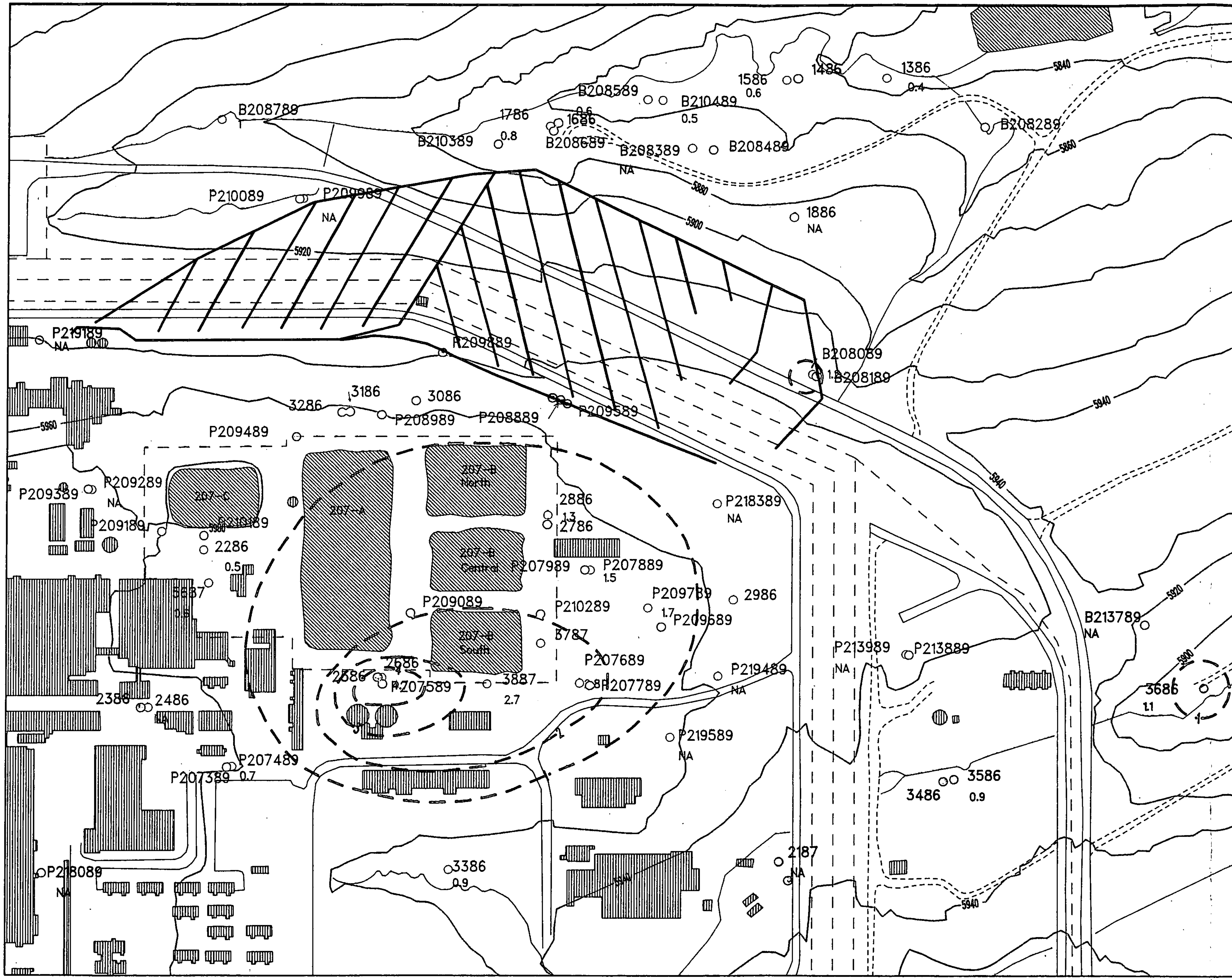


U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

Solar Evaporation Ponds
1992 Annual RCRA Groundwater Monitoring Report

Nitrate/Nitrite (mg/l) in Surficial Material Groundwater Second Quarter 1992

Figure 2-16



EXPLANATION

- Wells (screened in Surficial Material)
- Wells (screened in Bedrock)
- Compliance Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches Drainage Features
- Intercepter Trench System
- NA Data Not Available
- Line of Equal Concentration (mg/l); Dashed Where Approx. Located
- Surface Water Impoundments
- Buildings
- CERCLA Characterization Wells
- RCRA Regulatory Wells
- RCRA Characterization Wells
- Special Purpose Wells

0 feet 250 500

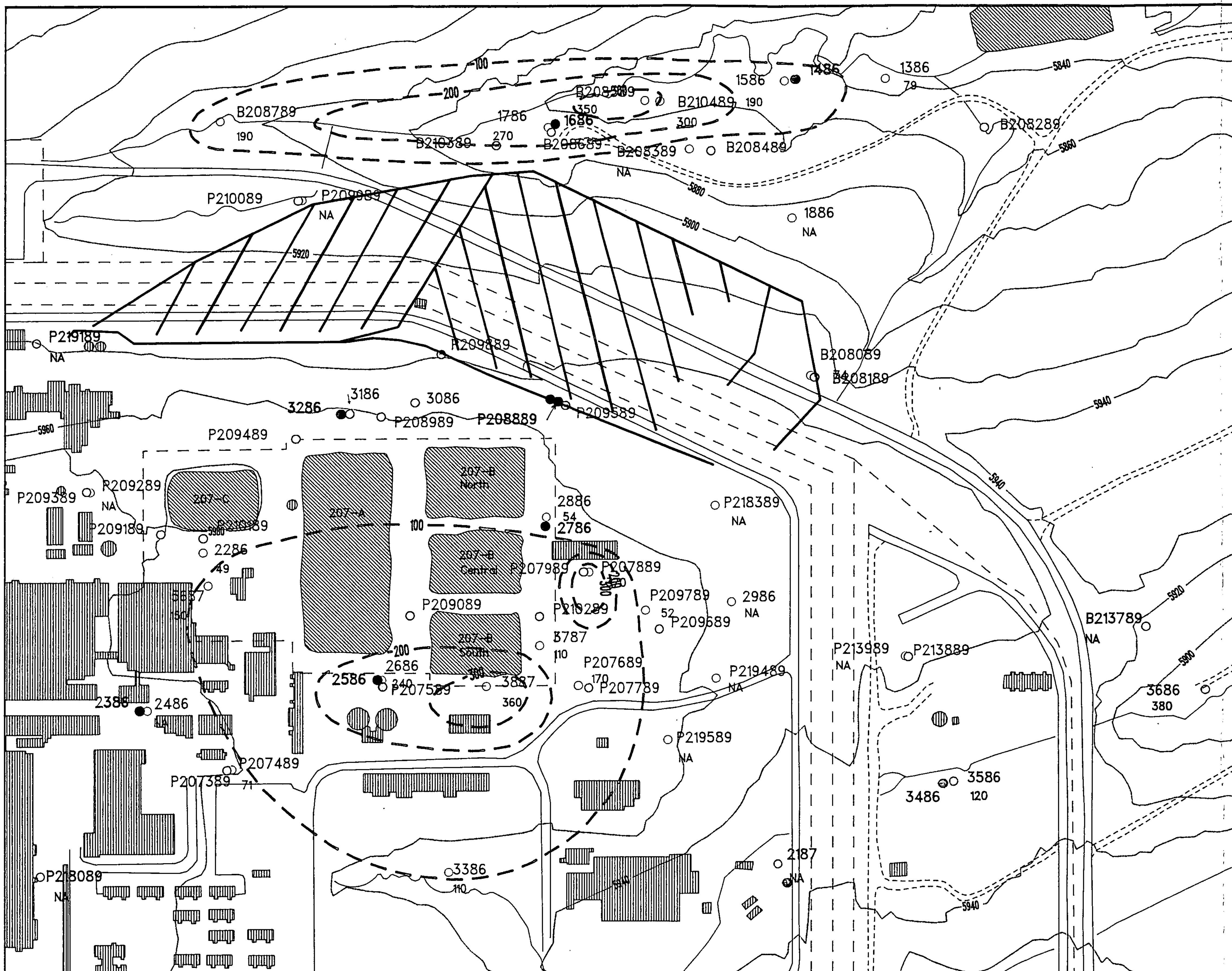
U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

Solar Evaporation Ponds

1992 Annual RCRA Groundwater Monitoring Report

Fluoride (mg/l) in Surficial Material Groundwater Second Quarter 1992

Figure 2-17



EXPLANATION

- ○ Wells (screened in Surficial Material)
- ● Wells (screened in Bedrock)
- Compliance Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches Drainage Features
- Intercepter Trench System
- NA Data Not Available
- Line of Equal Concentration (mg/l); Dashed Where Approx. Located
- Surface Water Impoundments
- Buildings
- CERCLA Characterization Wells
- RCRA Regulatory Wells
- RCRA Characterization Wells
- Special Purpose Wells

0 feet 250 500

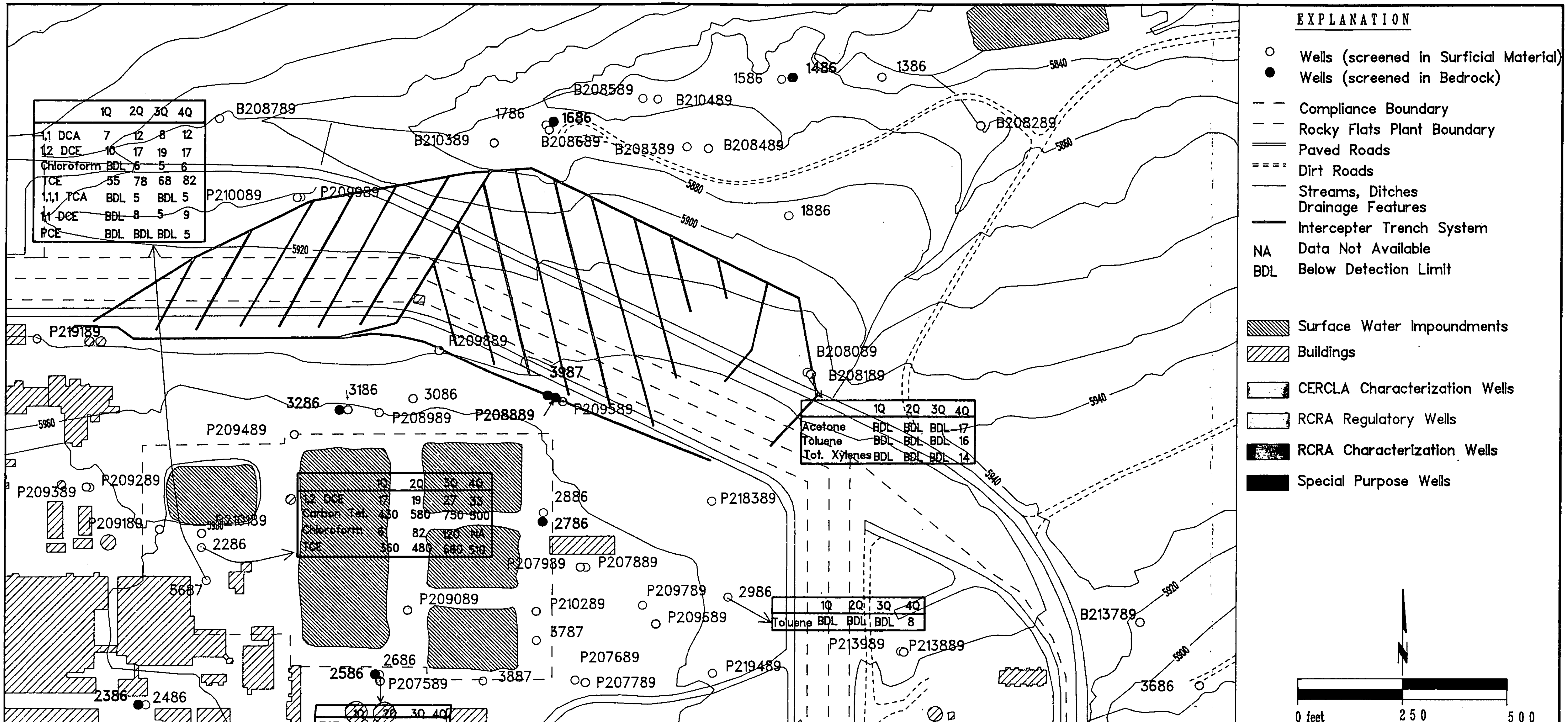
U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

Solar Evaporation Ponds

1992 Annual RCRA Groundwater Monitoring Report

Sulfate (mg/l) in Surficial Material Groundwater Second Quarter 1992

Figure 2-18

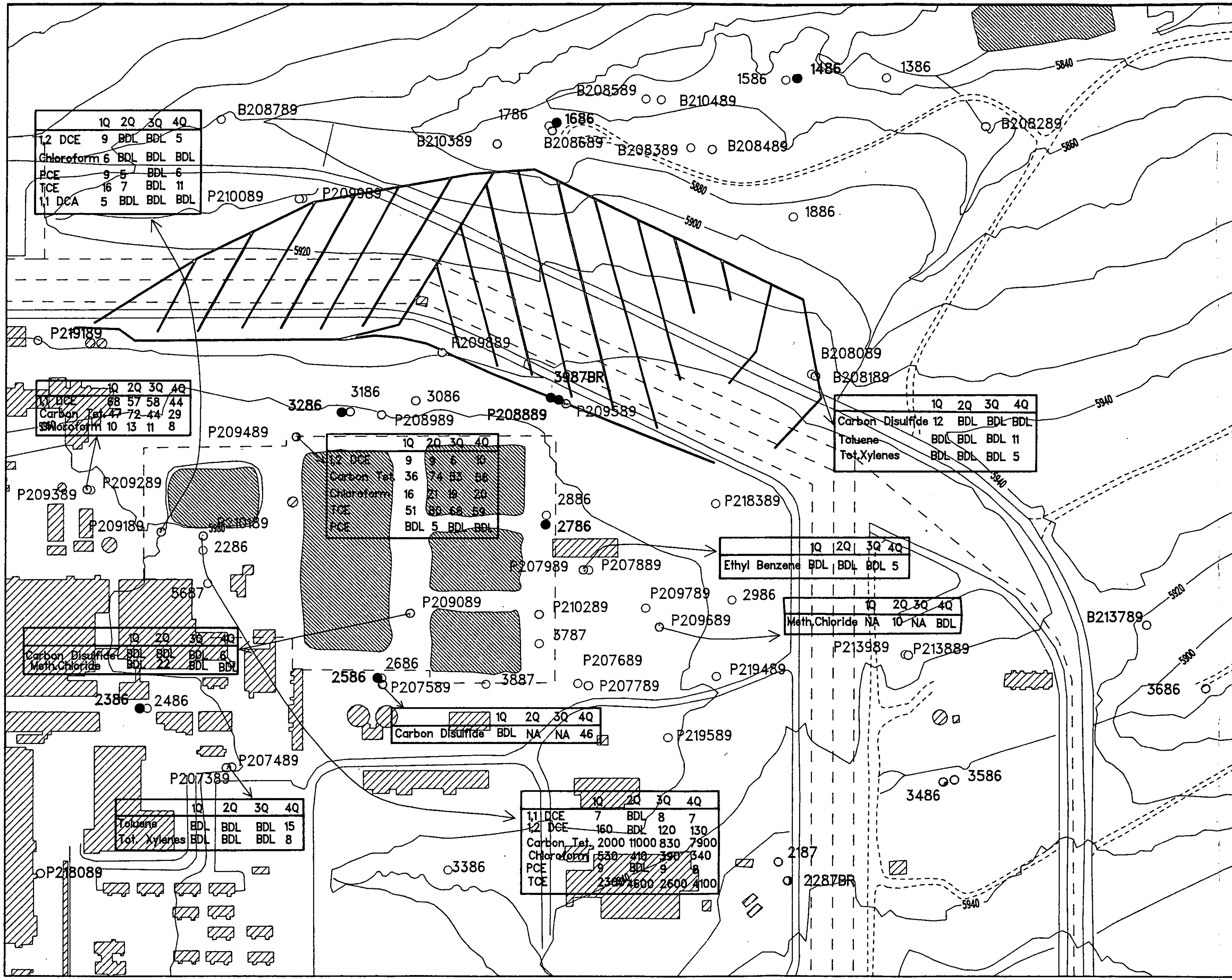


U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

Solar Evaporation Ponds
1992 Annual RCRA Groundwater Monitoring Report

Concentration of Volatile Organic Compounds (ug/l) in Surficial Material Groundwater 1992

Figure 2-19

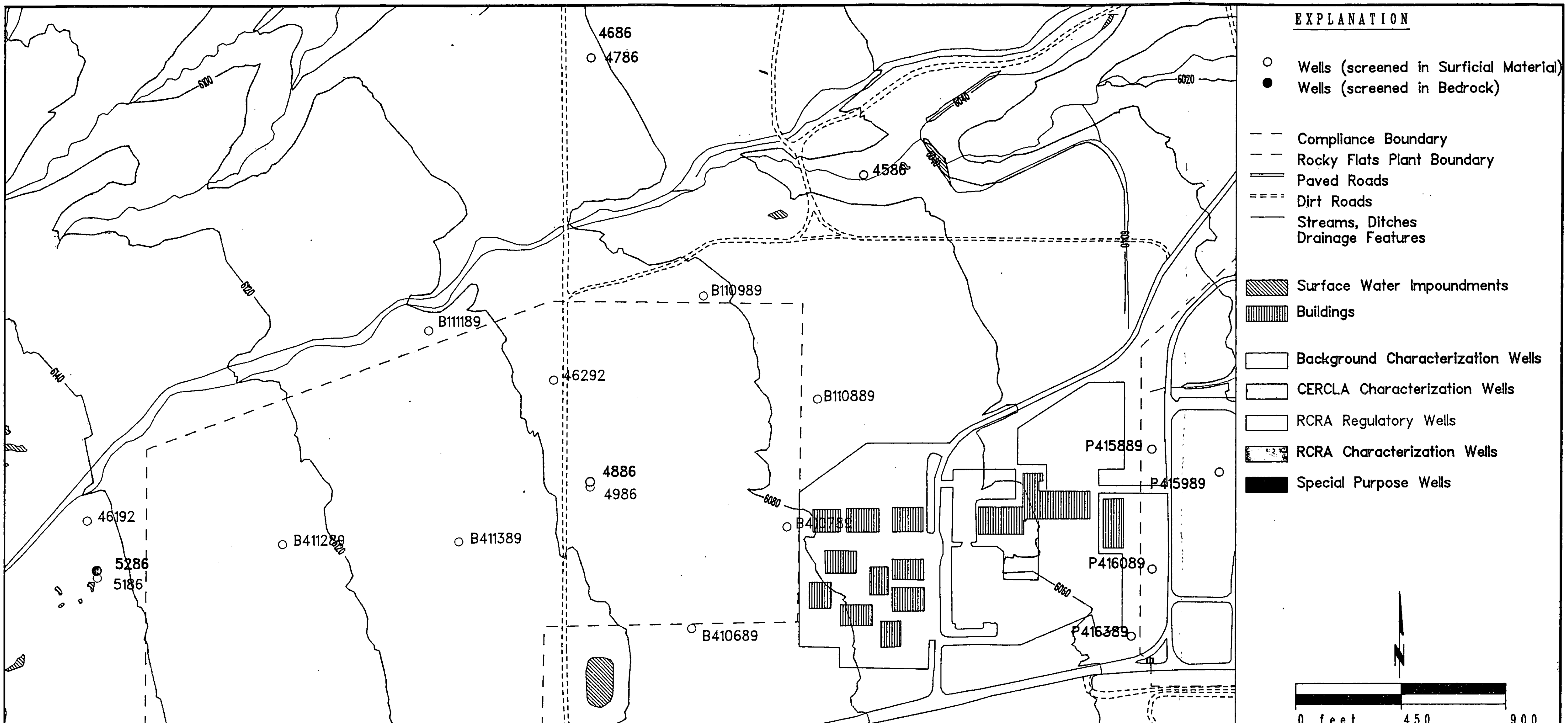


U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

Solar Evaporation Ponds
1992 Annual RCRA Groundwater Monitoring Report

Concentration of Volatile Organic Compounds (ug/l) in Weathered Bedrock 1992

Figure 2-20



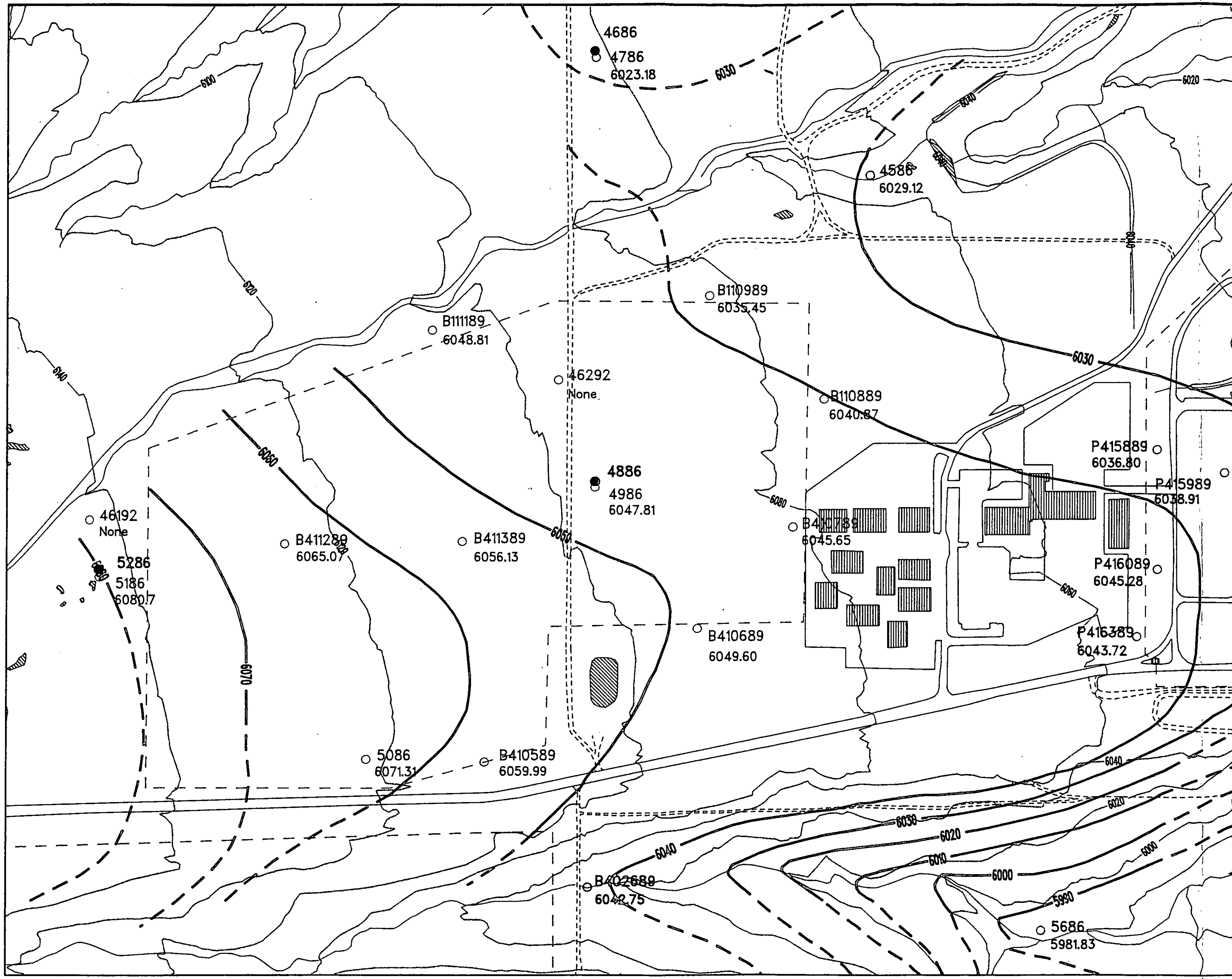
U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

West Spray Field

1992 Annual RCRA Groundwater Monitoring Report

Waste Management Area and Monitoring Well Locations 1992

Figure 3-1



EXPLANATION

- ○ Wells (screened in Surficial Material)
- ● Wells (screened in Bedrock)
- Compliance Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches Drainage Features
- NA Data Not Available
- Line of Equal Potentiometric Surface (feet above sea level); Dashed Where Approx. Located
- Areas of Unsaturated Surficial Materials
- Surface Water Impoundments
- Buildings
- Background Characterization Wells
- CERCLA Characterization Wells
- RCRA Regulatory Wells
- RCRA Characterization Wells
- Special Purpose Wells

N

0 feet 450 900

U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

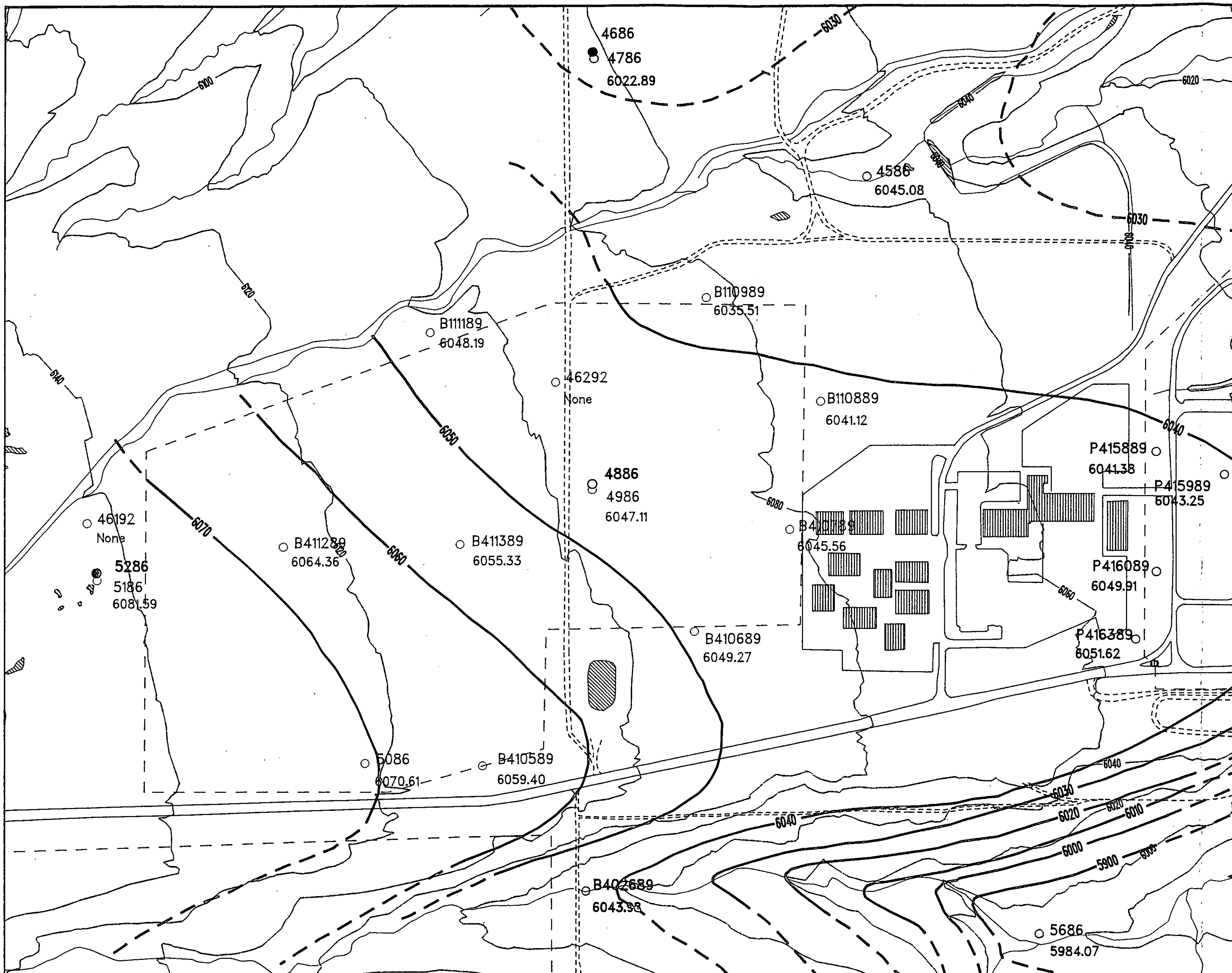
West Spray Field

1992 Annual RCRA Groundwater Monitoring Report

Potentiometric Surface Map
Surficial Materials

Figure 3-2

First Quarter January 1992



EXPLANATION

- ○ Wells (screened in Surficial Material)
- ● Wells (screened in Bedrock)
- Compliance Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches Drainage Features
- NA Data Not Available
- Line of Equal Potentiometric Surface (feet above sea level); Dashed Where Approx. Located
- Areas of Unsaturated Surficial Materials
- Surface Water Impoundments
- Buildings
- Background Characterization Wells
- CERCLA Characterization Wells
- RCRA Regulatory Wells
- RCRA Characterization Wells
- Special Purpose Wells

0 feet 450 900

U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

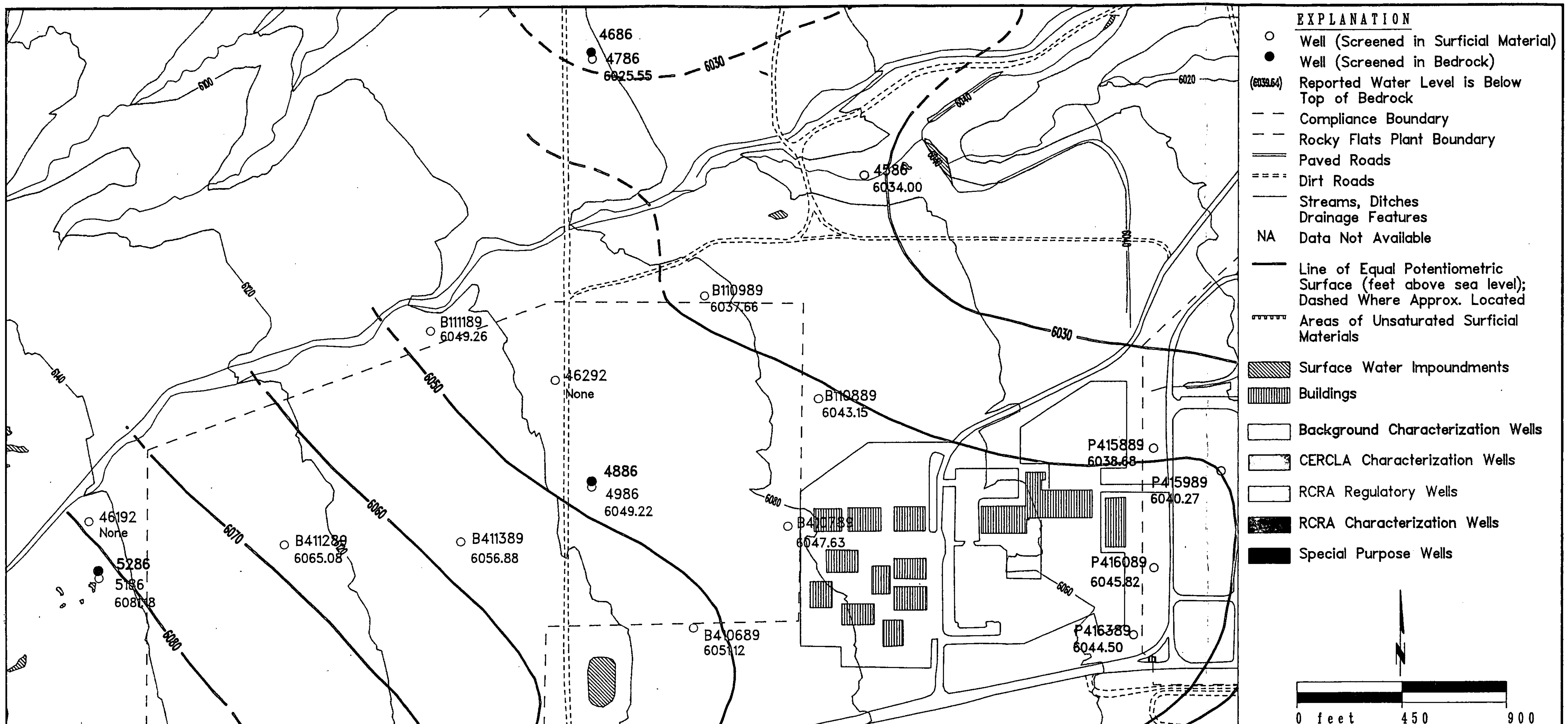
West Spray Field

1992 Annual RCRA Groundwater Monitoring Report

Potentiometric Surface Map
Surficial Materials

Figure 3-3

Second Quarter April 1992

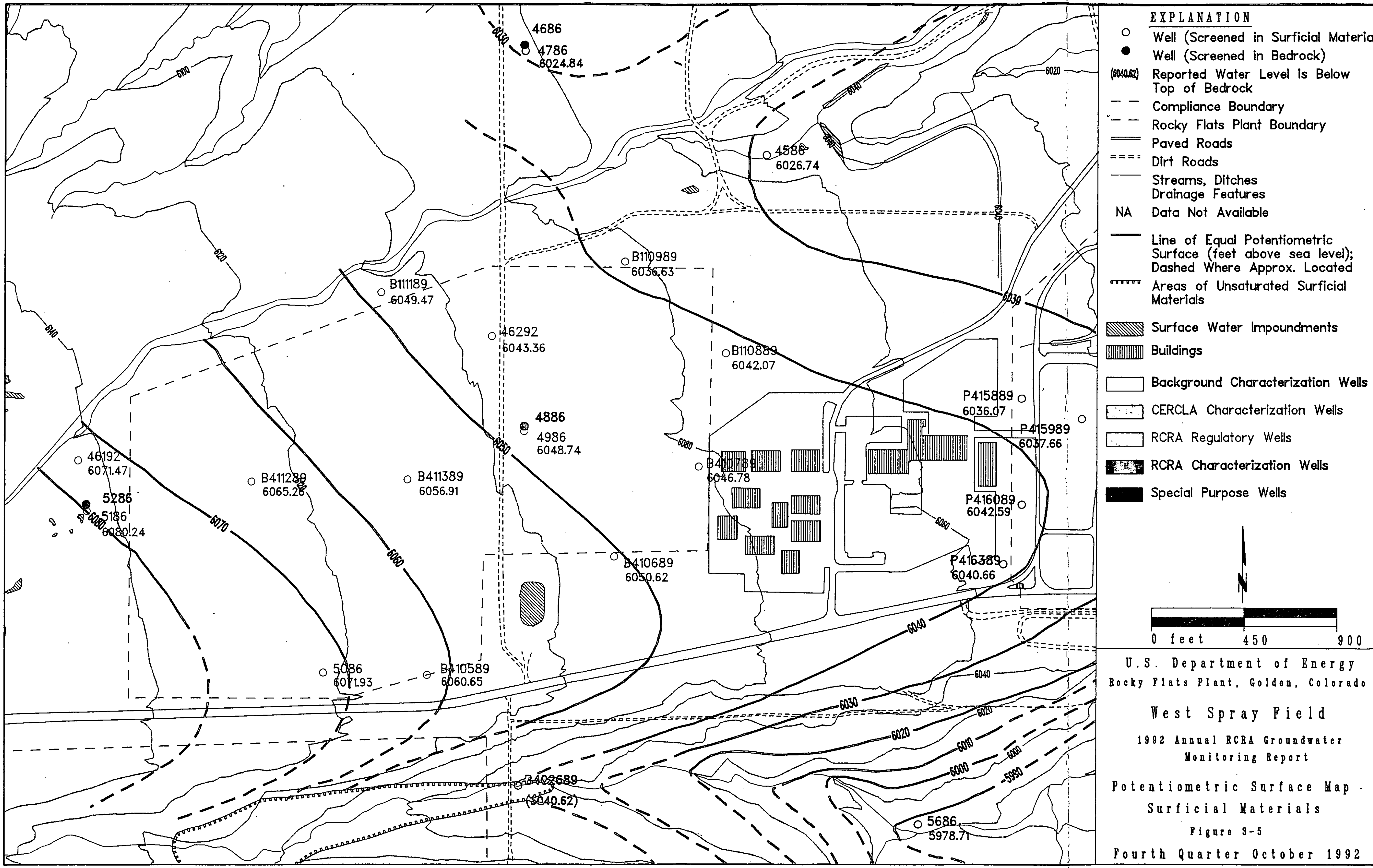


U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

West Spray Field

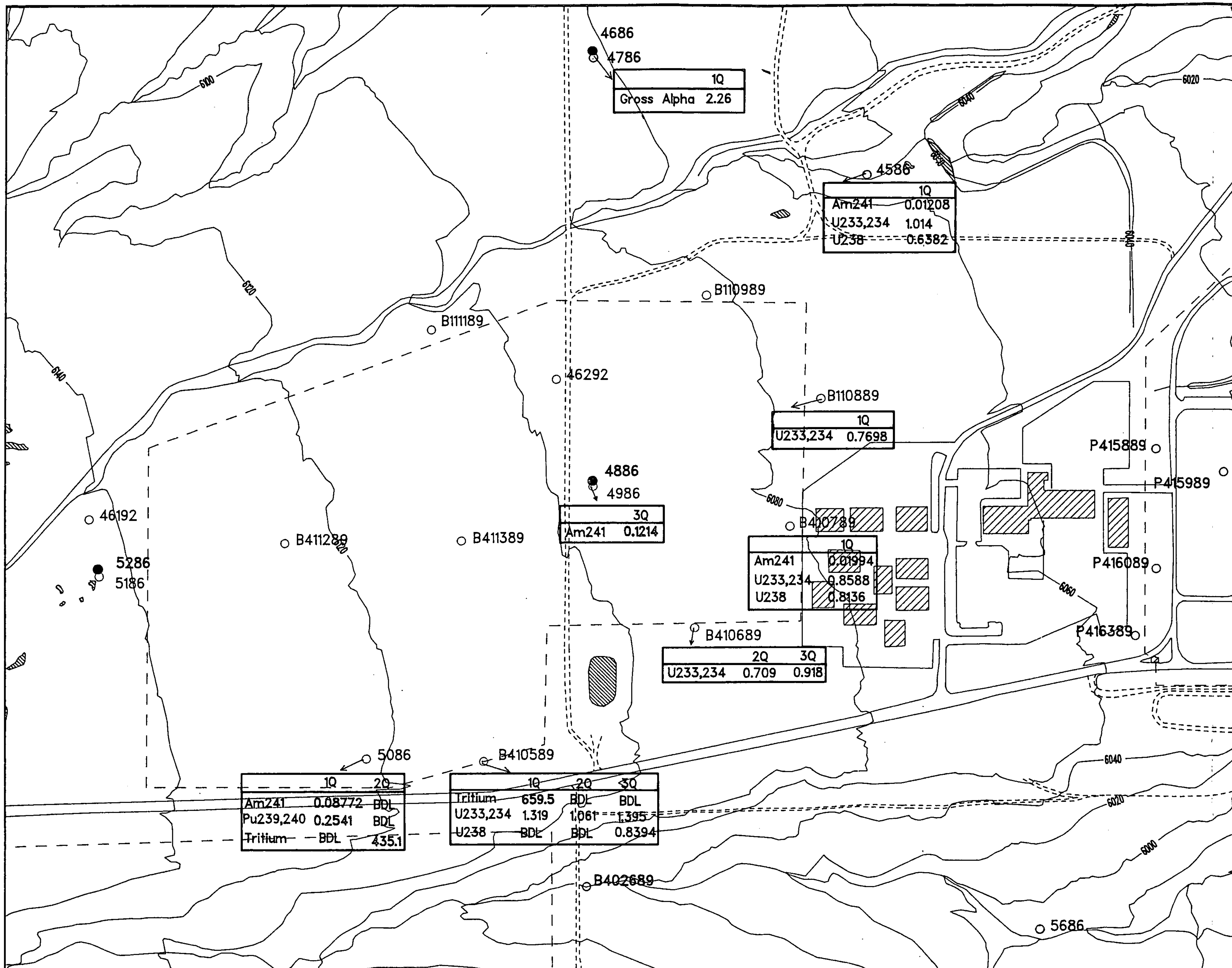
1992 Annual RCRA Groundwater Monitoring Report

Potentiometric Surface Map
Surficial Materials
Figure 3-4
Third Quarter July 1992



EXPLANATION
Well (Screened in Surficial Material)
Well (Screened in Bedrock)
(6040.62) Reported Water Level is Below Top of Bedrock
Compliance Boundary
Rocky Flats Plant Boundary
Paved Roads
Dirt Roads
Streams, Ditches Drainage Features
NA Data Not Available
Line of Equal Potentiometric Surface (feet above sea level); Dashed Where Approx. Located
Areas of Unsaturated Surficial Materials
Surface Water Impoundments
Buildings
Background Characterization Wells
CERCLA Characterization Wells
RCRA Regulatory Wells
RCRA Characterization Wells
Special Purpose Wells
0 feet 450 900
4686
4786
6024.84
4586
6026.74
B110989
6036.63
B111189
6049.47
46292
6043.36
B110889
6042.07
P415889
6036.07
P415989
6037.66
4886
4986
6048.74
46192
6071.47
5286
5186
6080.24
B411289
6065.26
B411389
6056.91
B410789
6046.78
P416089
6042.59
B410689
6050.62
P416389
6040.66
5086
6071.93
B410589
6060.65
B402689
(6040.62)
5686
5978.71

U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado
West Spray Field
1992 Annual RCRA Groundwater Monitoring Report
Potentiometric Surface Map - Surficial Materials
Figure 3-5
Fourth Quarter October 1992



EXPLANATION

- ○ Wells (screened in Surficial Material)
- ● Wells (screened in Bedrock)
- Compliance Boundary
- Operable Unit Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches Drainage Features
- NA Data Not Available
- BDL Below Detection Limit

Detections Shown in Orange Exceed the Sitewide Background Value for that Analyte (e.g.,Am241 0.056)

- Surface Water Impoundments
- Buildings
- Background Characterization Wells
- CERCLA Characterization Wells
- RCRA Regulatory Wells
- RCRA Characterization Wells
- Special Purpose Wells

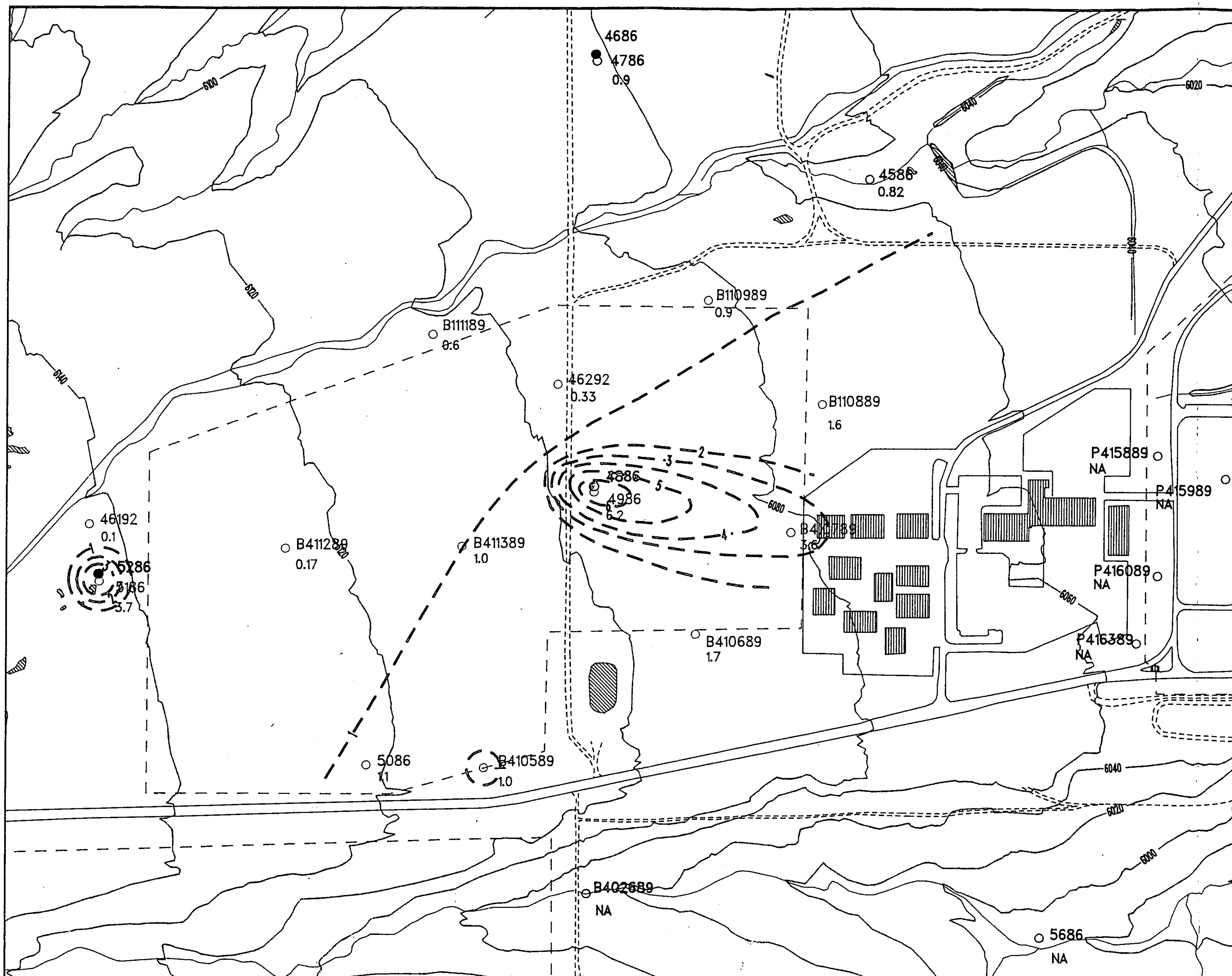
U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

West Spray Field

1992 Annual RCRA Groundwater Monitoring Report

Activities of Radionuclides (pCi/l) in Surficial Material Groundwater 1992

Figure 3-6



EXPLANATION

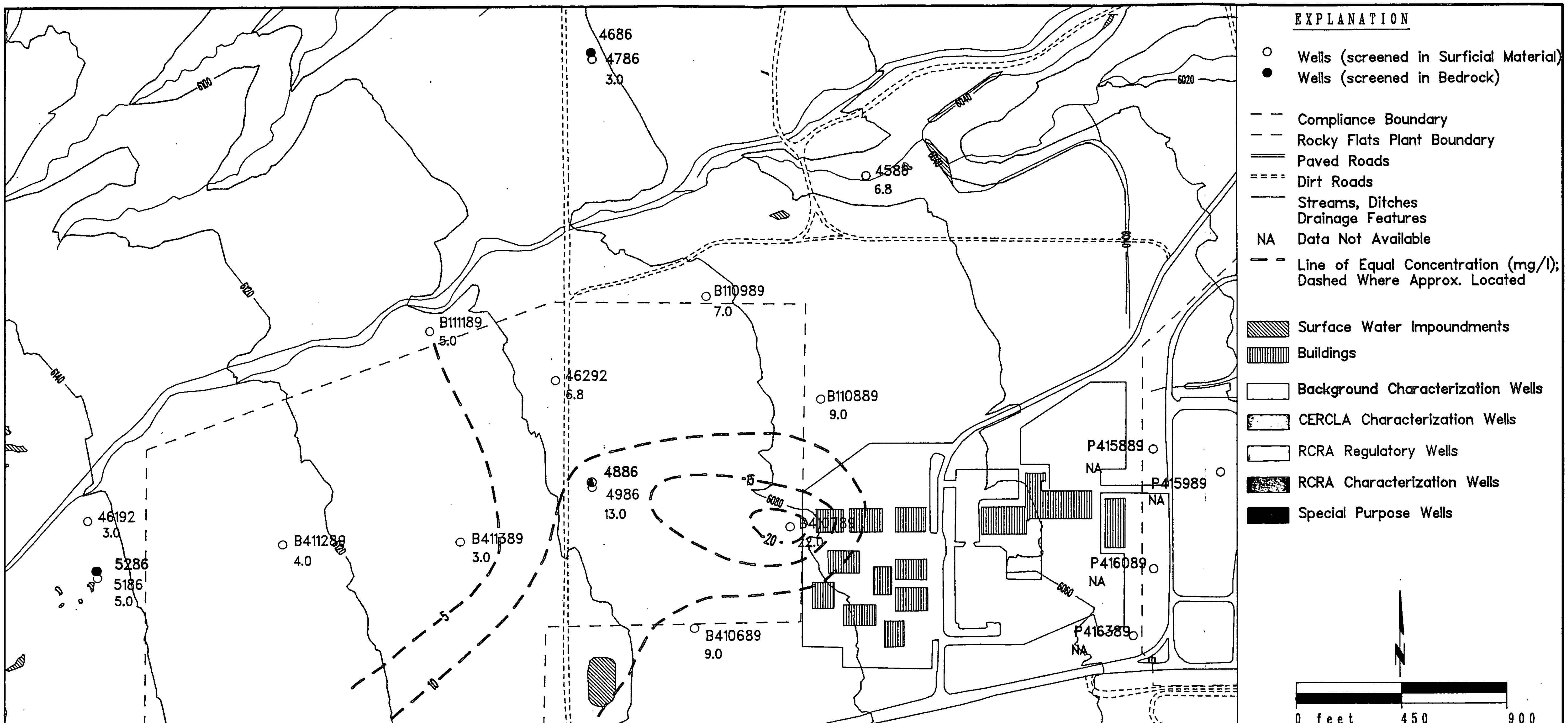
- ○ Wells (screened in Surficial Material)
- ● Wells (screened in Bedrock)
- Compliance Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches Drainage Features
- NA Data Not Available
- Line of Equal Concentration (mg/l); Dashed Where Approx. Located
- Surface Water Impoundments
- Buildings
- Background Characterization Wells
- CERCLA Characterization Wells
- RCRA Regulatory Wells
- RCRA Characterization Wells
- Special Purpose Wells

U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

West Spray Field

1992 Annual RCRA Groundwater Monitoring Report

Nitrate/Nitrite (mg/l) in Surficial Material Groundwater
Third Quarter 1992
Figure 3-7



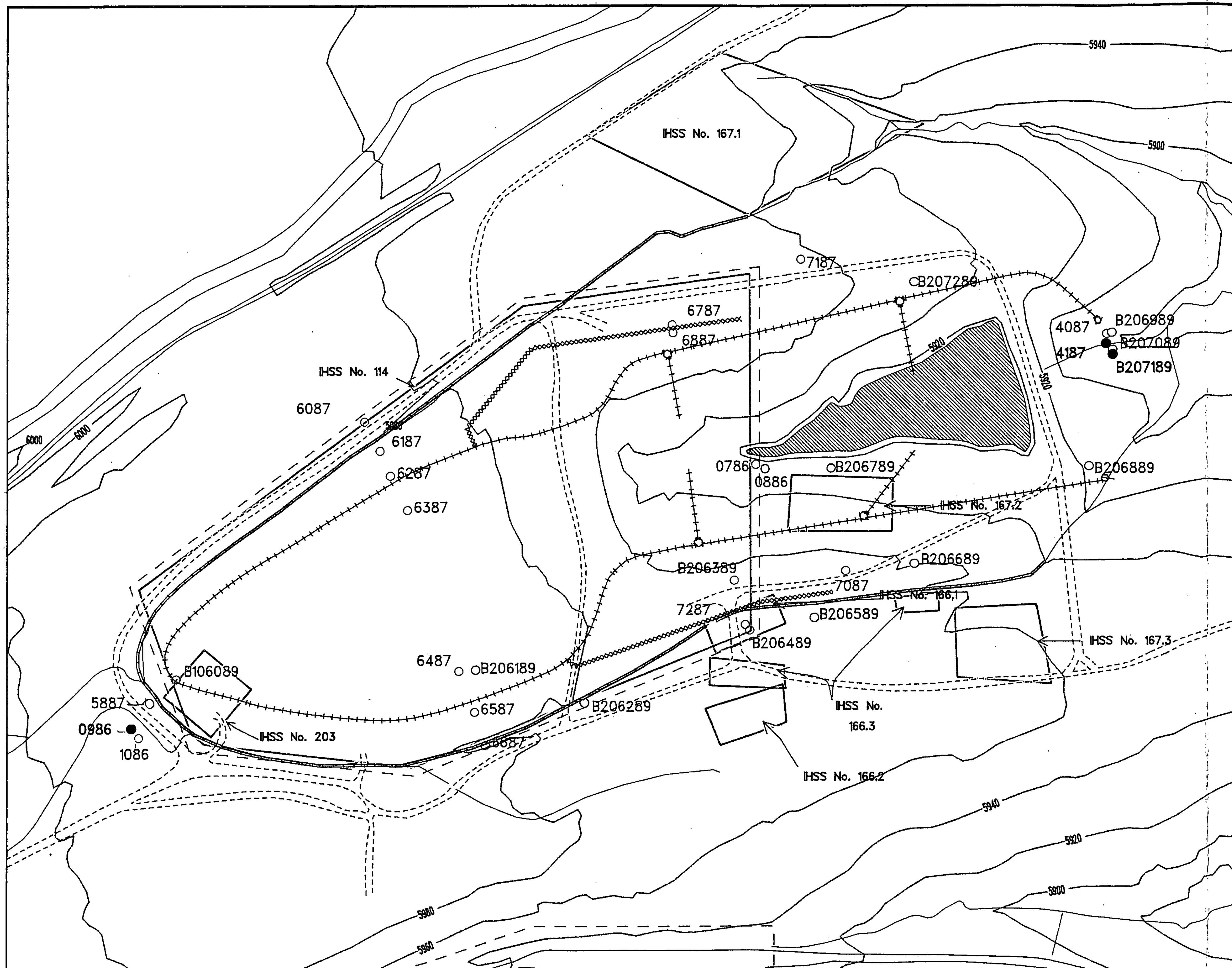
U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

West Spray Field

1992 Annual RCRA Groundwater Monitoring Report

Chloride (mg/l) in Surficial Material Groundwater Third Quarter 1992

Figure 3-8



EXPLANATION

- ○ Wells (screened in Surficial Material)
- ● Wells (screened in Bedrock)
- Compliance Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches Drainage Features
- Surface Water Diversion Ditch
- Slurry Wall
- Groundwater Intercept System
- Surface Water Impoundments
- Buildings
- RCRA Regulatory Wells
- RCRA Characterization Wells

0 feet 250 500

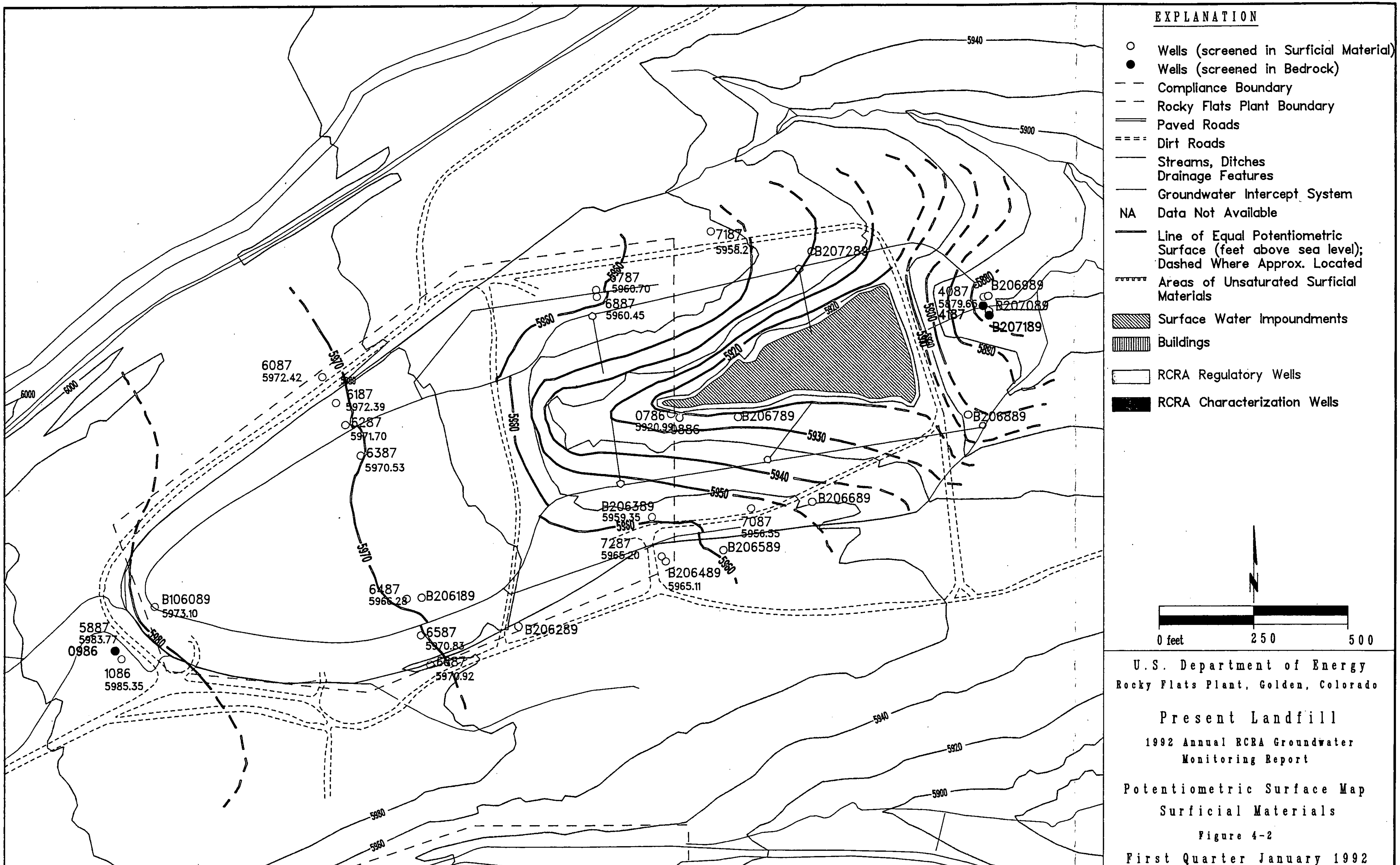
U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

Present Landfill

1992 Annual RCRA Groundwater Monitoring Report

Waste Management Area and Monitoring Well Locations 1992

Figure 4-1



U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

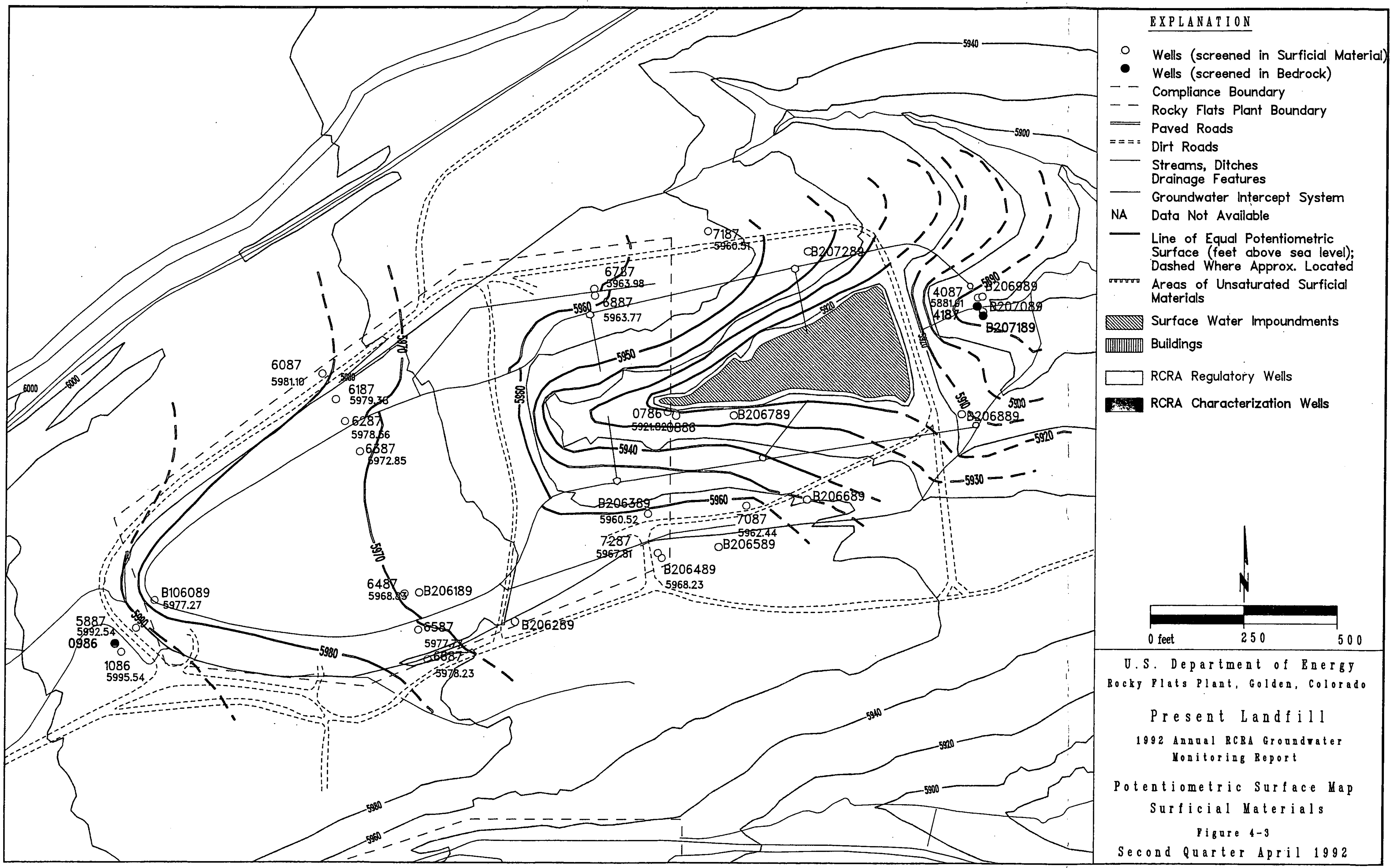
Present Landfill

1992 Annual RCRA Groundwater Monitoring Report

Potentiometric Surface Map
Surficial Materials

Figure 4-2

First Quarter January 1992



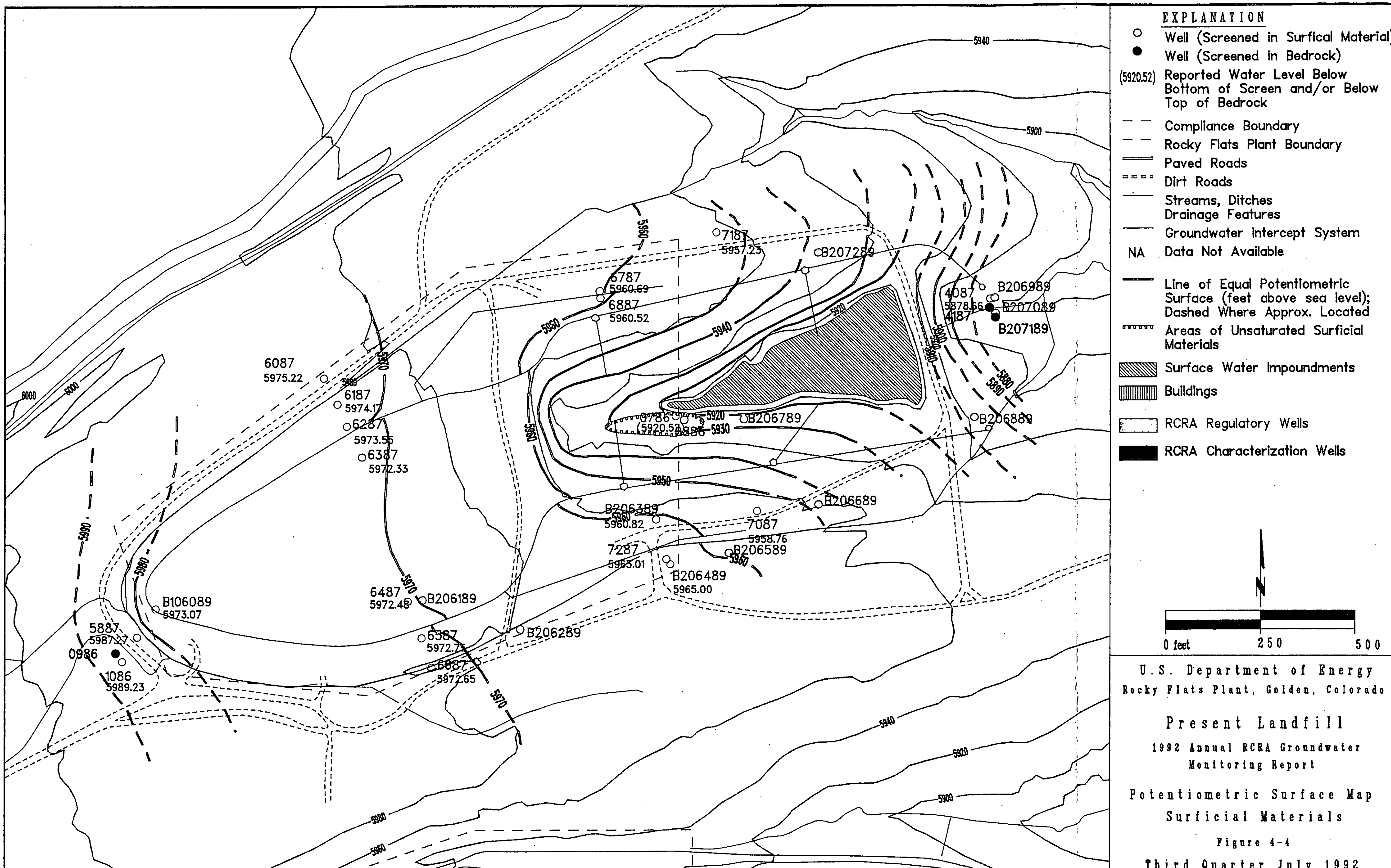
U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

Present Landfill

1992 Annual RCRA Groundwater Monitoring Report

Potentiometric Surface Map
Surficial Materials

Figure 4-3
Second Quarter April 1992



U.S. Department of Energy

Rocky Flats Plant, Golden, Colorado

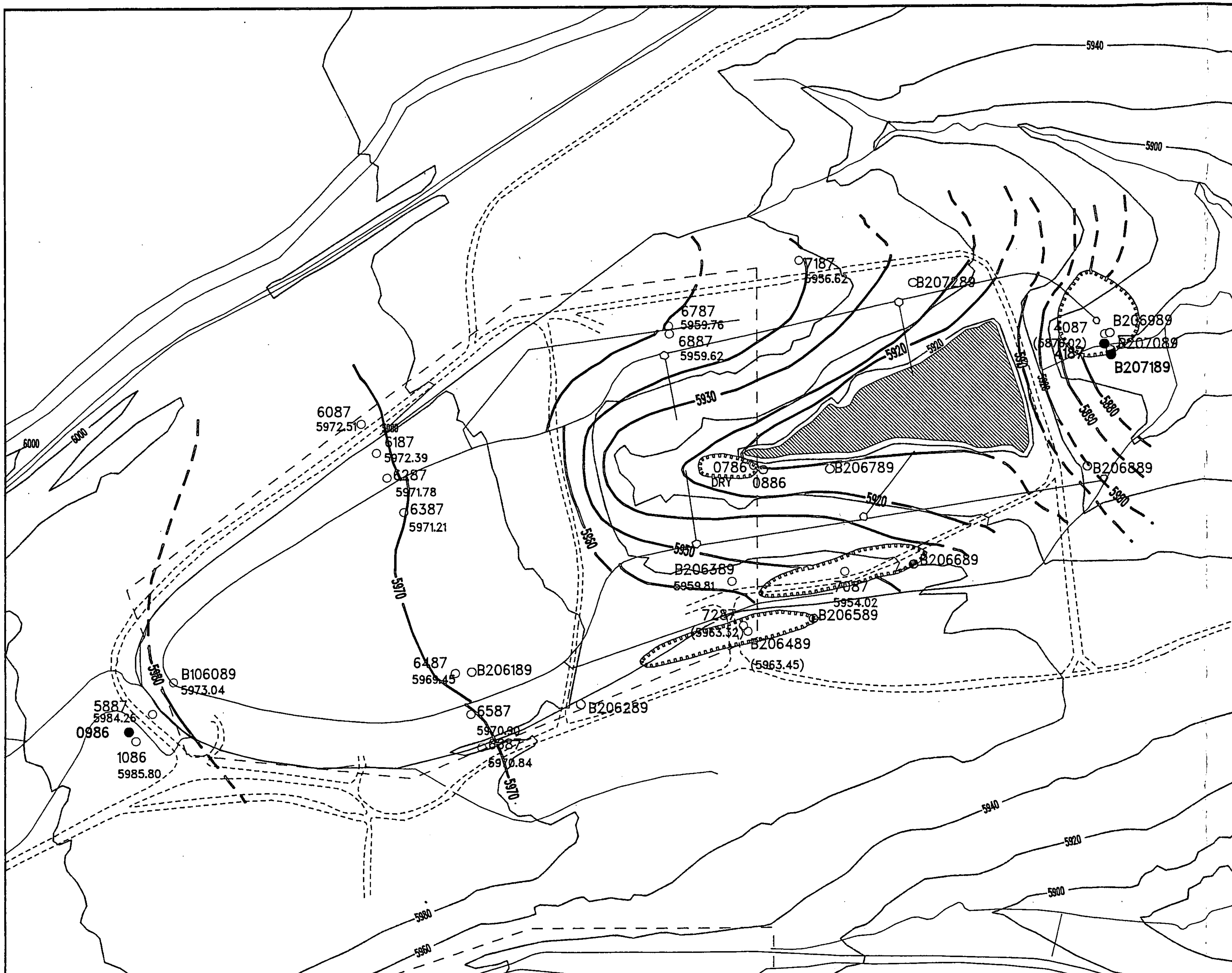
Present Landfill

1992 Annual RCRA Groundwater Monitoring Report

Potentiometric Surface Map Surficial Materials

Figure 4-4

Third Quarter July 1992



EXPLANATION

- ○ Well (Screened in Surfical Material)
- ● Well (Screened in Bedrock)
- (5963.45) Reported Water Level Below Bottom of Screen and/or Below Top of Bedrock
- Compliance Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches Drainage Features
- Groundwater Intercept System
- NA Data Not Available
- Line of Equal Potentiometric Surface (feet above sea level); Dashed Where Approx. Located
- Areas of Unsaturated Surficial Materials
- Surface Water Impoundments
- Buildings
- RCRA Regulatory Wells
- RCRA Characterization Wells

N

0 feet 250 500

U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

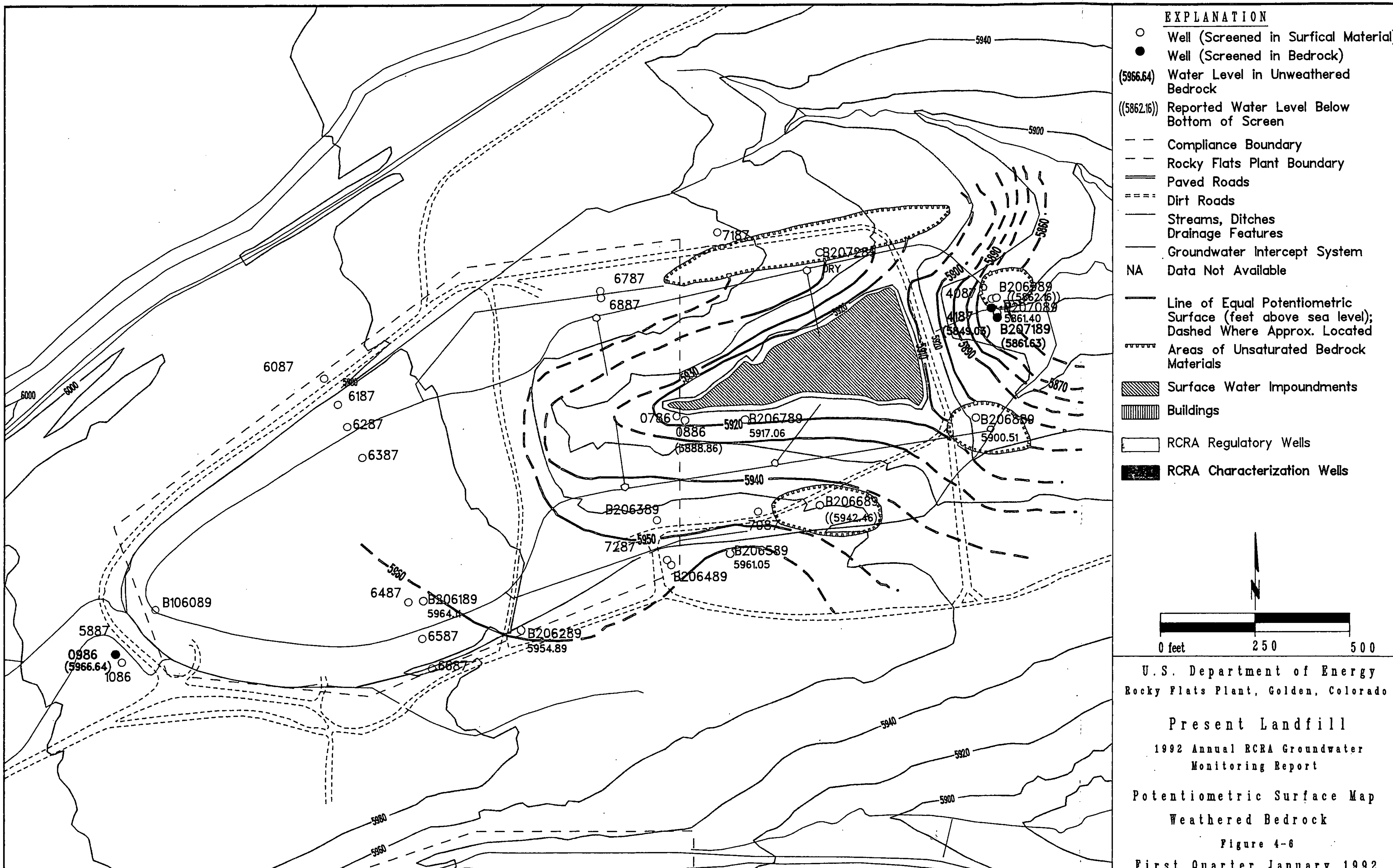
Present Landfill

1992 Annual RCRA Groundwater Monitoring Report

Potentiometric Surface Map
Surficial Materials

Figure 4-5

Fourth Quarter October 1992



U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

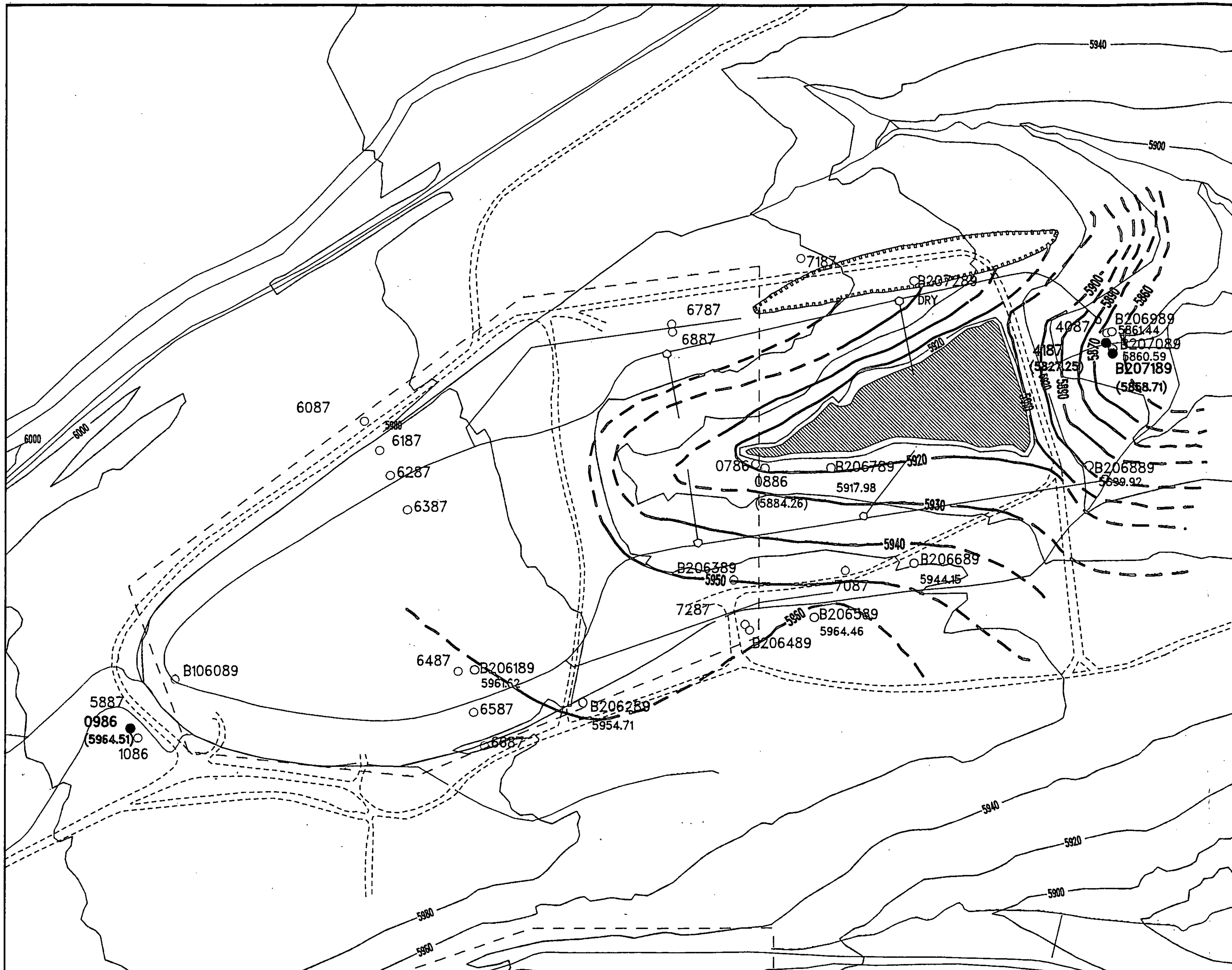
Present Landfill

1992 Annual RCRA Groundwater Monitoring Report

Potentiometric Surface Map
Weathered Bedrock

Figure 4-6

First Quarter January 1992



EXPLANATION

- ○ Well (Screened in Surficial Material)
- ● Well (Screened in Bedrock)
- (5964.51) Water Level in Unweathered Bedrock
- Compliance Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches Drainage Features
- Groundwater Intercept System
- NA Data Not Available
- Line of Equal Potentiometric Surface (feet above sea level); Dashed Where Approx. Located
- Areas of Unsaturated Bedrock Materials
- Surface Water Impoundments
- Buildings
- RCRA Regulatory Wells
- RCRA Characterization Wells

N

0 feet 250 500

U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

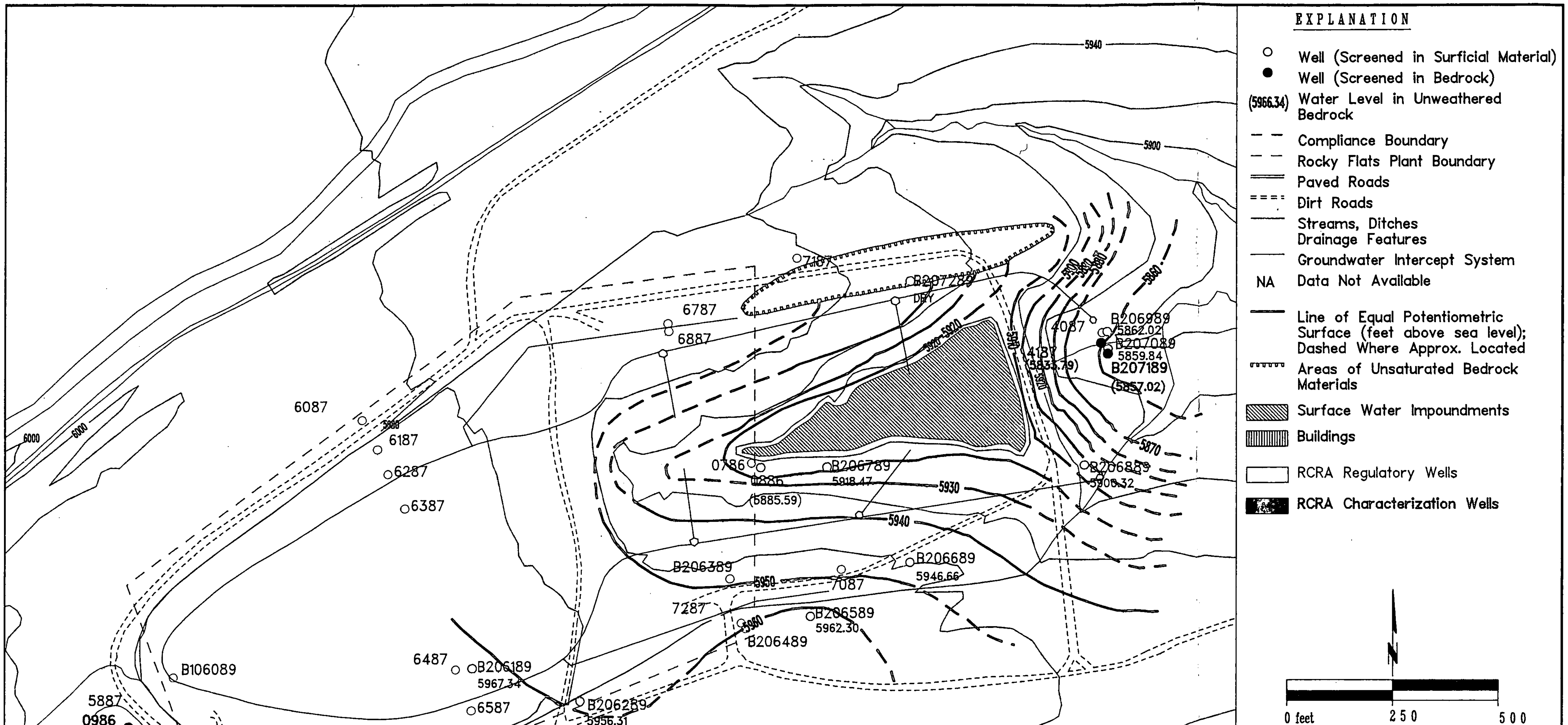
Present Landfill

1992 Annual RCRA Groundwater Monitoring Report

Potentiometric Surface Map Weathered Bedrock

Figure 4-7

Second Quarter April 1992



U.S. Department of Energy

Rocky Flats Plant, Golden, Colorado

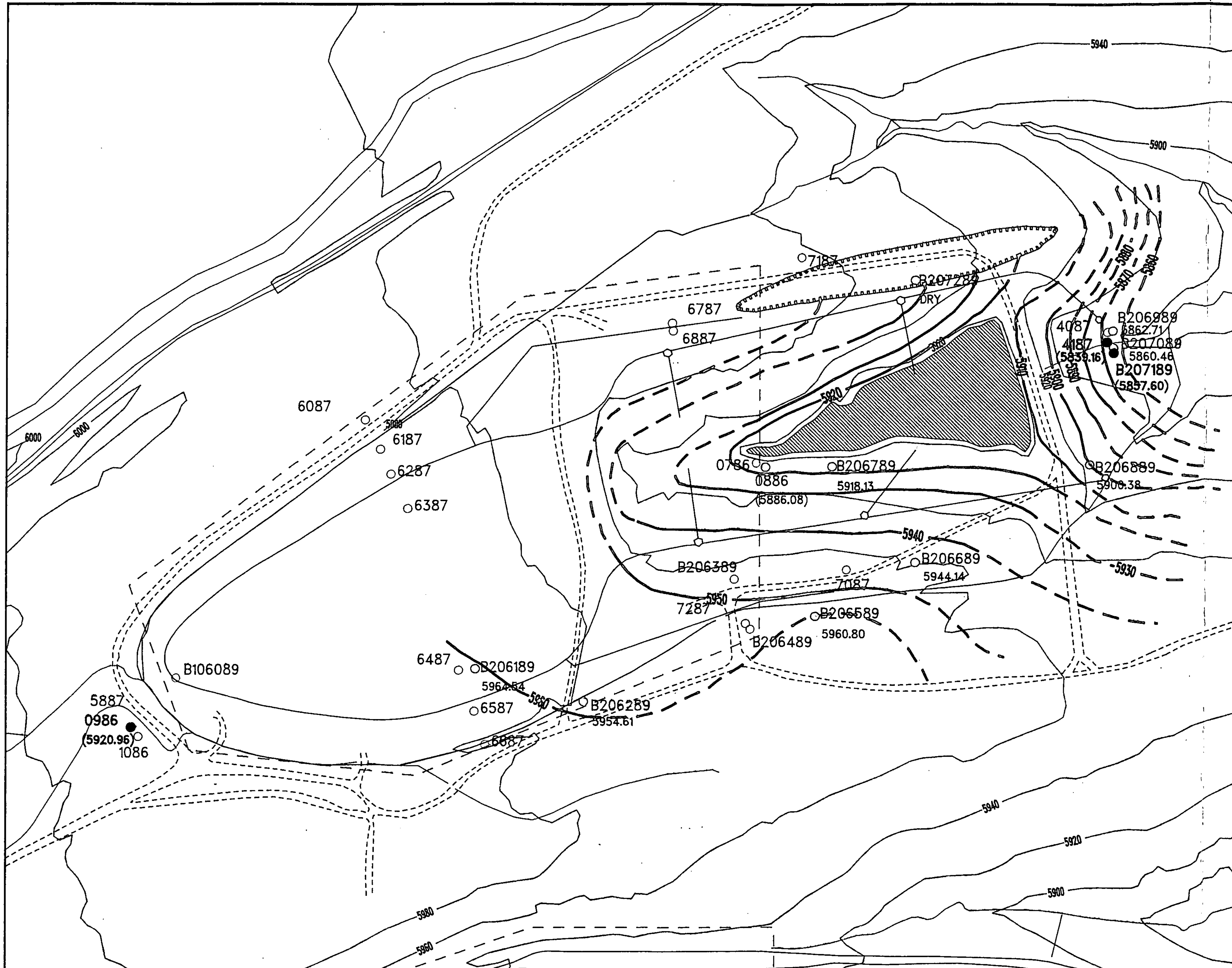
Present Landfill

1992 Annual RCRA Groundwater Monitoring Report

Potentiometric Surface Map Weathered Bedrock

Figure 4-8

Third Quarter July 1992



EXPLANATION

- ○ Well (Screened in Surficial Material)
- ● Well (Screened in Bedrock)
- (5920.96) Water Level in Unweathered Bedrock
- Compliance Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches Drainage Features
- Groundwater Intercept System
- NA Data Not Available
- Line of Equal Potentiometric Surface (feet above sea level); Dashed Where Approx. Located
- Areas of Unsaturated Bedrock Materials
- Surface Water Impoundments
- Buildings
- RCRA Regulatory Wells
- RCRA Characterization Wells

N

0 feet 250 500

U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

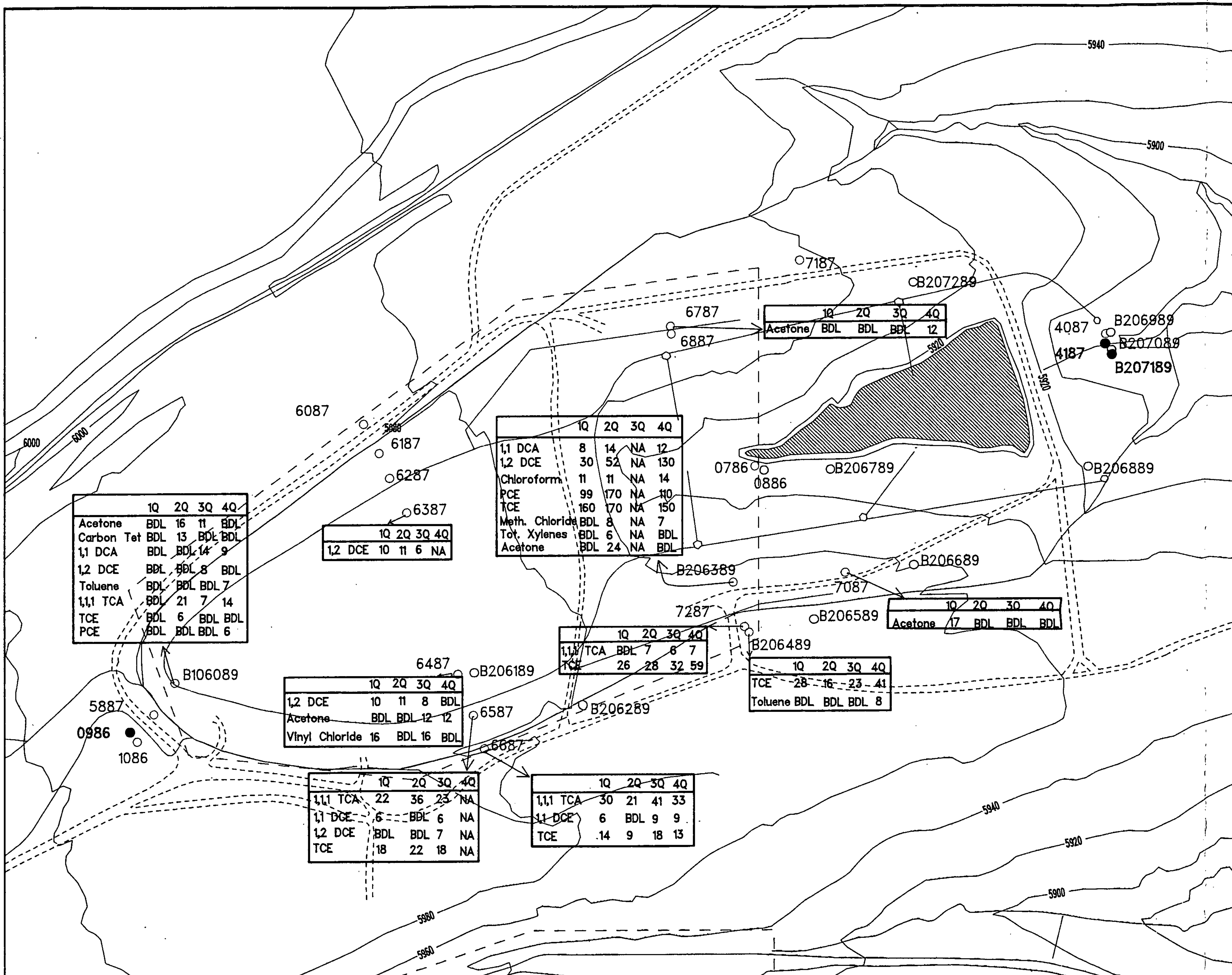
Present Landfill

1992 Annual RCRA Groundwater Monitoring Report

Potentiometric Surface Map
Bedrock Materials

Figure 4-9

Fourth Quarter October 1992



EXPLANATION

- ○ Wells (screened in Surficial Material)
- ● Wells (screened in Bedrock)
- Compliance Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches Drainage Features
- Groundwater Intercept System
- NA Data Not Available
- BDL Below Detection Limit
- Surface Water Impoundments
- Buildings
- RCRA Regulatory Wells
- RCRA Characterization Wells

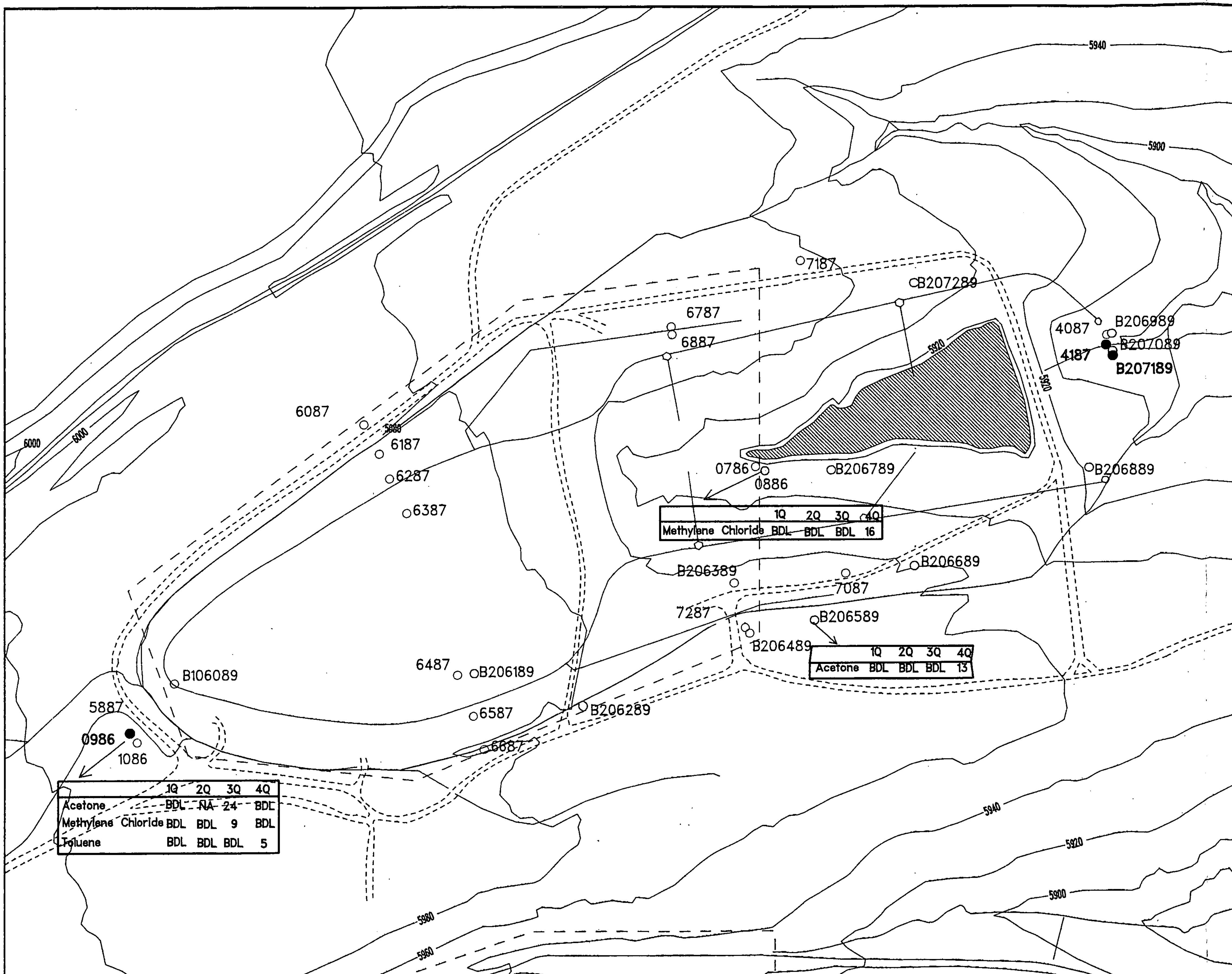
U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

Present Landfill

1992 Annual RCRA Groundwater Monitoring Report

Concentration of Volatile Organic Compounds (ug/l) in Surficial Material Groundwater 1992

Figure 4-10



EXPLANATION

- ○ Wells (screened in Surficial Material)
- ● Wells (screened in Bedrock)
- Compliance Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches, Drainage Features
- Groundwater Intercept System
- NA Data Not Available
- BDL Below Detection Limit
- Surface Water Impoundments
- Buildings
- RCRA Regulatory Wells
- RCRA Characterization Wells

0 feet 250 500

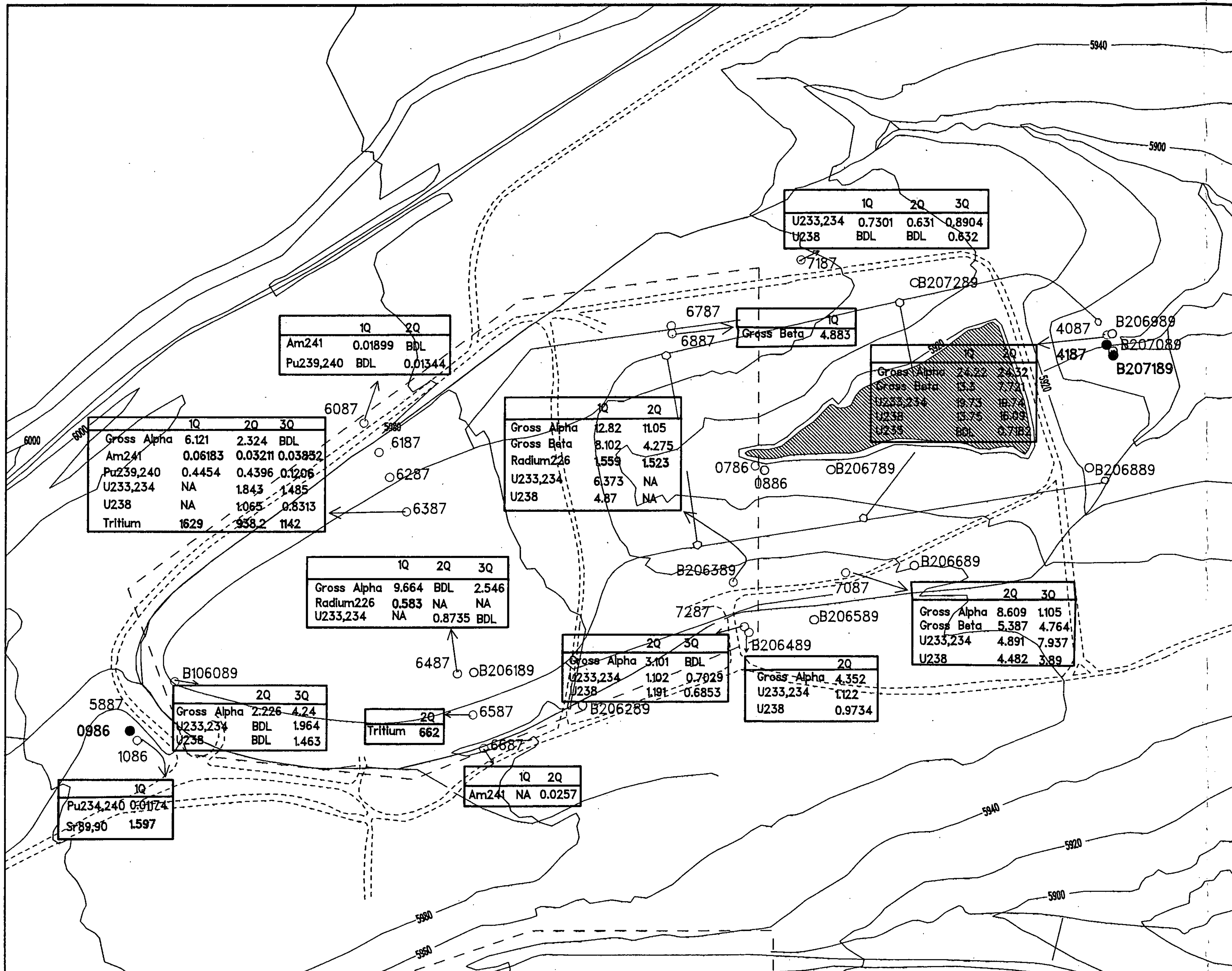
U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

Present Landfill

1992 Annual RCRA Groundwater Monitoring Report

Concentration of Volatile Organic Compounds (ug/l) in Bedrock Groundwater 1992

Figure 4-11



EXPLANATION

- ○ Wells (screened in Surficial Material)
- ● Wells (screened in Bedrock)
- Compliance Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches Drainage Features
- Groundwater Intercept System
- NA Data Not Available
- BDL Below Detection Limit

Detections Shown in Orange Exceed the Sitewide Background Value for that Analyte (e.g.,Am241 **0.056**)

- Surface Water Impoundments
- Buildings
- RCRA Regulatory Wells
- RCRA Characterization Wells

N

0 feet 250 500

U.S. Department of Energy

Rocky Flats Plant, Golden, Colorado

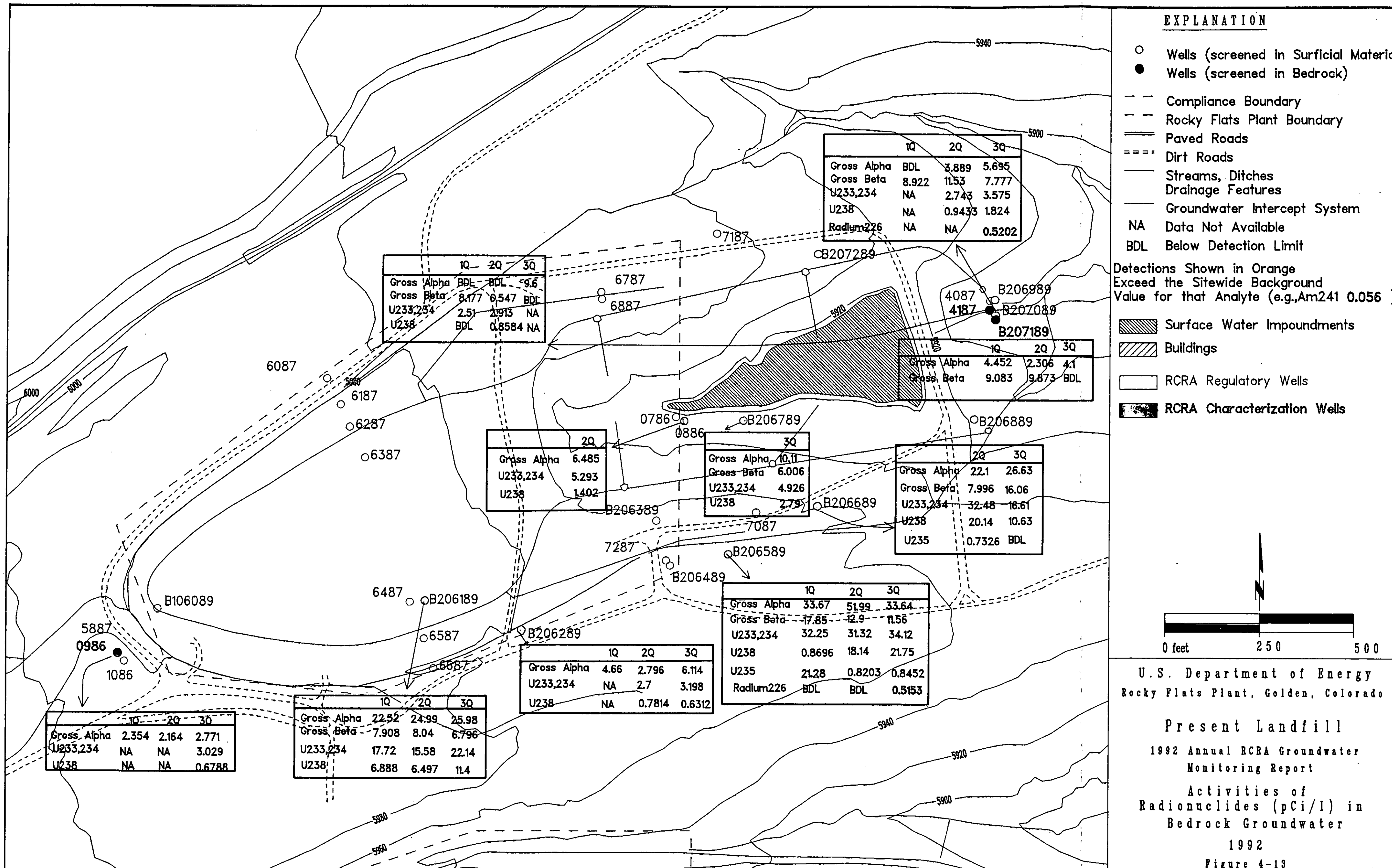
Present Landfill

1992 Annual RCRA Groundwater Monitoring Report

Activities of Radionuclides (pCi/l) in Surficial Material Groundwater

1992

Figure 4-12



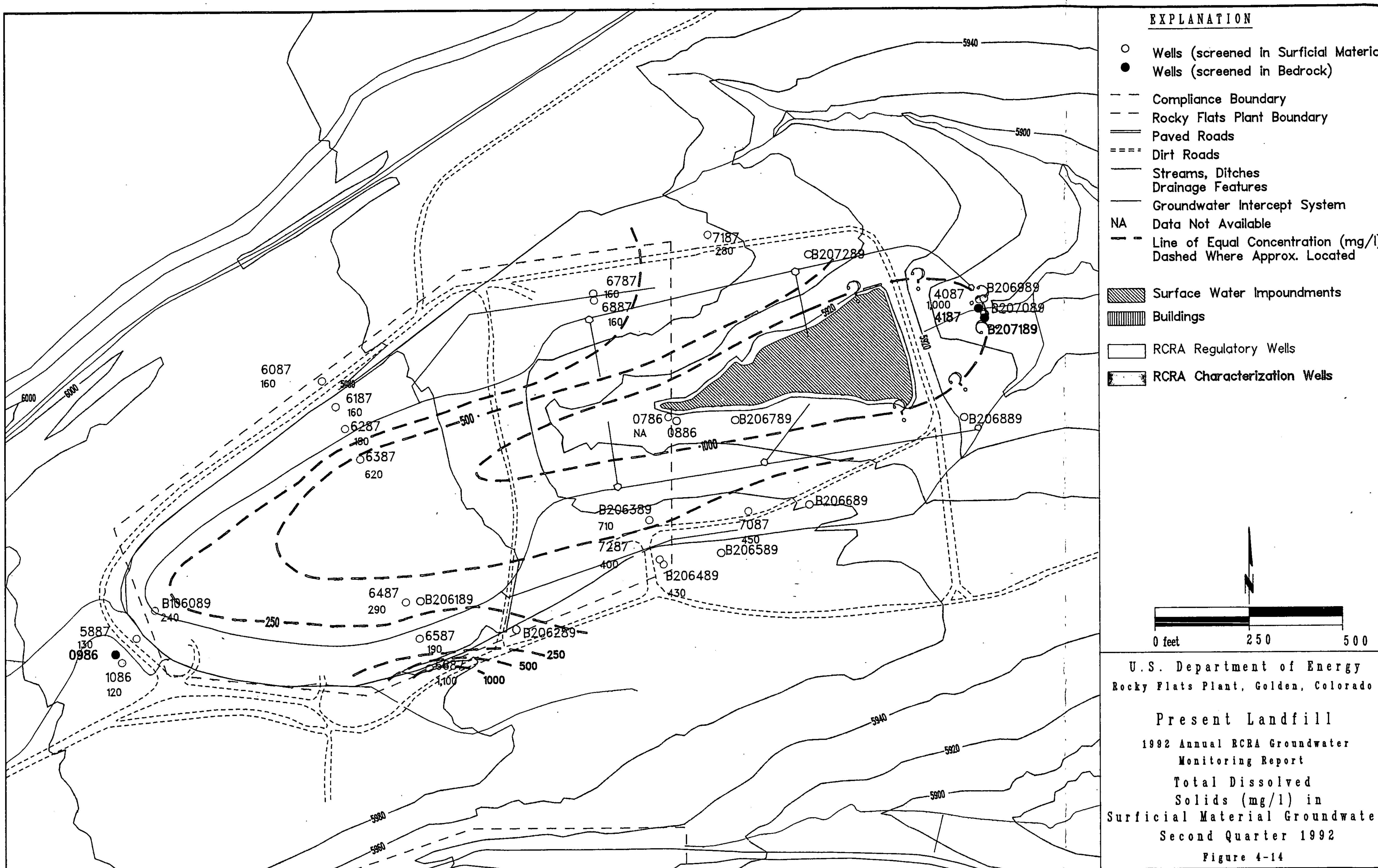
U.S. Department of Energy
Rocky Flats Plant, Golden, Colorado

Present Landfill

1992 Annual RCRA Groundwater Monitoring Report

Activities of Radionuclides (pCi/l) in Bedrock Groundwater
1992

Figure 4-13



U.S. Department of Energy

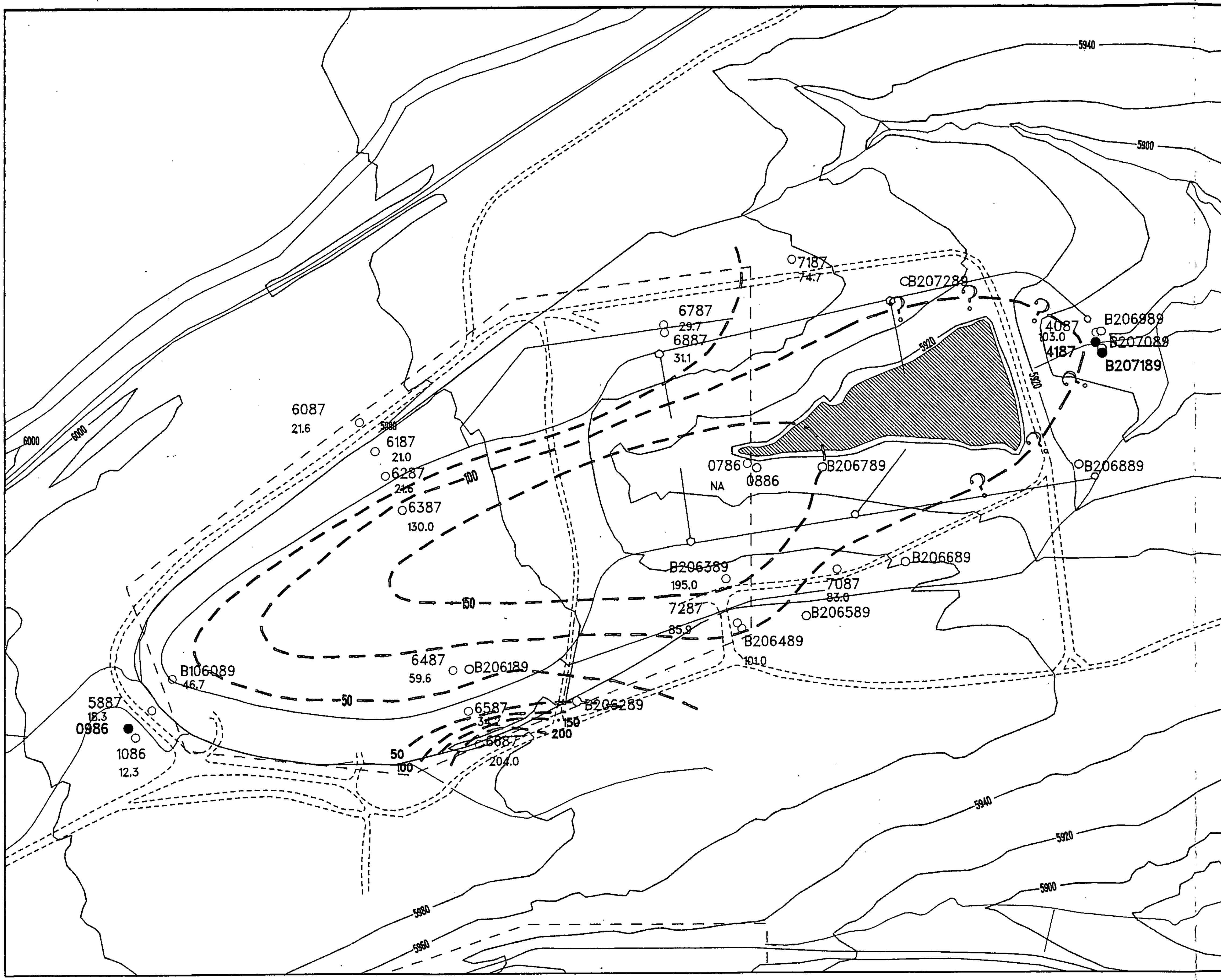
Rocky Flats Plant, Golden, Colorado

Present Landfill

1992 Annual RCRA Groundwater Monitoring Report

Total Dissolved Solids (mg/l) in Surficial Material Groundwater Second Quarter 1992

Figure 4-14



EXPLANATION

- Wells (screened in Surficial Material)
- Wells (screened in Bedrock)
- Compliance Boundary
- Rocky Flats Plant Boundary
- Paved Roads
- Dirt Roads
- Streams, Ditches Drainage Features
- Groundwater Intercept System
- NA Data Not Available
- Line of Equal Concentration (mg/l); Dashed Where Approx. Located
- Surface Water Impoundments
- Buildings
- RCRA Regulatory Wells
- RCRA Characterization Wells

U.S. Department of Energy

Rocky Flats Plant, Golden, Colorado

Present Landfill

1992 Annual RCRA Groundwater Monitoring Report

Calcium (mg/l) in Surficial Material Groundwater Second Quarter 1992

Figure 4-15

APPENDIX A-1

Groundwater Elevation Data Summary for the Solar Evaporation Ponds - Surficial Materials, 1992

A-1 Groundwater Elevation Data Summary for the Solar Evaporation Ponds - Surficial Materials, 1992

Well ID	First Quarter 1992			Second Quarter 1992			Third Quarter 1992			Fourth Quarter 1992		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0487	5897.19	5897.23	5897.64	5901.81	5901.81	5901.65	5899.71	5900.54	5900.72	5900.00	5899.21	5898.68
1386	5839.19	5837.54	5837.45	5838.21	5837.05	5836.89	5836.48	5832.10	5832.97	5834.48	5835.86	5837.06
1586	5843.73	-----	-----	5845.01	-----	-----	5843.61	-----	-----	5843.47	-----	-----
1786	5862.95	5862.92	5864.15	5864.20	5863.13	5863.49	5863.03	5862.82	5863.24	5862.96	5863.13	5863.23
1886	--Dry--	--Dry--	5877.97	5879.14	--Dry--	--Dry--	5878.01	5878.00	5878.00	--Dry--	--Dry--	--Dry--
1987	--Dry--	-----	-----	5962.97	5959.53	-----	5956.86	-----	-----	5956.19	-----	-----
2187	5919.98	5920.61	-----	5919.45	-----	-----	5922.02	-----	-----	5921.85	-----	-----
2286	5969.76	-----	-----	5972.43	-----	-----	5970.89	-----	-----	5969.52	-----	-----
2486	--Dry--	5974.91	--Dry--	5976.01	--Dry--	5974.85	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--	5975.83
2686	5965.56	5965.41	5965.17	5967.21	5966.24	5966.08	5965.85	5965.48	5965.64	5965.17	5964.81	5965.10
2886	5956.27	5955.92	5955.48	5959.63	5958.36	5957.99	5957.09	5956.26	5956.55	5955.55	-----	5957.81
2986	--Dry--	--Dry--	--Dry--	5953.25	5950.79	5950.31	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--
3386	-----	-----	--Dry--	5946.45	-----	-----	5944.12	-----	-----	5943.74	-----	-----
3586	5903.94	-----	-----	5906.61	-----	5905.06	5904.50	5903.87	5903.68	5902.89	5903.54	5903.91
3686	5877.13	-----	-----	5879.82	-----	5879.49	5879.02	5877.30	5877.25	5877.08	--Dry--	--Dry--
3787	5960.98	5960.56	5959.84	5963.07	5962.32	-----	5961.81	5960.60	5960.76	5959.50	5958.96	5959.74
3887	5963.73	-----	-----	5965.43	-----	-----	5963.99	5963.08	-----	5962.75	-----	-----
5687	5971.53	5970.54	5970.69	5972.69	5972.02	5972.02	5972.13	5970.63	5971.35	5971.29	5970.29	5970.44
B208089	5923.72	5923.44	5923.40	5925.50	5924.63	5924.40	5924.37	5924.07	5925.04	5923.85	5923.64	5923.38
B208389	--Dry--	-----	-----	--Dry--	-----	-----	--Dry--	-----	-----	--Dry--	-----	-----
B208589	5853.73	-----	-----	5854.96	-----	-----	5852.65	-----	-----	--Dry--	-----	-----
B208789	5899.48	5895.62	5895.76	5905.20	5902.96	5902.82	5902.69	5895.74	5899.17	5899.26	5895.30	5895.40
B210489	5853.88	5854.14	5853.84	5855.34	5853.75	5853.78	5852.79	5852.09	5852.72	5852.29	5853.14	5853.68
B213789	--Dry--	-----	-----	5913.44	-----	-----	--Dry--	-----	-----	--Dry--	-----	-----
P207489	5975.47	5975.92	5975.88	5976.34	5975.58	-----	5975.72	5974.88	5975.17	5974.11	5974.44	5975.54
P207689	5959.64	-----	-----	5961.03	-----	-----	5960.16	-----	-----	5959.14	-----	-----
P207889	5958.71	-----	-----	5960.65	-----	-----	5958.61	-----	-----	5954.82	-----	-----
P209289	5968.73	--Dry--	--Dry--	5969.69	--Dry--	5969.03	5968.73	--Dry--	5969.05	5968.80	--Dry--	--Dry--
P209789	5956.52	-----	-----	5960.24	-----	-----	5957.67	-----	-----	5954.89	-----	-----
P209989	--Dry--	--Dry--	--Dry--	5890.11	5888.93	--Dry--	5888.62	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--
P213989	--Dry--	-----	-----	--Dry--	-----	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--
P218089	5981.63	5979.33	-----	5982.39	-----	-----	5979.20	-----	-----	5978.06	-----	-----
P218389	5944.27	5943.93	5943.69	5949.62	5946.78	5946.73	5945.81	5944.47	5945.21	5943.92	5943.69	5943.72
P219189	5933.10	-----	-----	5933.38	-----	-----	5933.57	-----	-----	5933.35	-----	-----
P219489	5946.27	-----	-----	5946.67	-----	-----	5942.53	-----	-----	5947.69	-----	-----

A-1 Groundwater Elevation Data Summary for the Solar Evaporation Ponds - Surficial Materials, 1992

Well ID	First Quarter 1992			Second Quarter 1992			Third Quarter 1992			Fourth Quarter 1992		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
P219589	5941.35	-----	-----	5941.76	-----	-----	5942.26	-----	-----	5943.18	-----	-----

Groundwater elevations are measured in feet with respect to mean sea level.
Double readings in same column indicate two readings taken during the same month.
--Dry-- indicates well was dry at time of water level reading.
------- indicates no data was available for indicated month.

APPENDIX A-2

Groundwater Elevation Data Summary for the Solar Evaporation Ponds - Weathered Bedrock, 1992

A-2 Groundwater Elevation Data Summary for the Solar Evaporation Ponds - Weathered Bedrock, 1992

Well ID	First Quarter 1992			Second Quarter 1992			Third Quarter 1992			Fourth Quarter 1992		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1486	5836.91	-----	5836.69	5835.02	-----	-----	5835.71	-----	-----	5835.80	-----	-----
1686	5863.93	-----	-----	5864.09	-----	-----	5860.95	-----	-----	5862.89	-----	-----
2287	5852.42	-----	-----	5852.34	-----	-----	5852.02	-----	-----	5852.23	-----	-----
2386	5902.96	-----	-----	5898.53	-----	5889.44	5876.16	-----	-----	5894.41	-----	-----
2586	5948.40	-----	-----	5946.71	-----	5941.20	5919.22	-----	-----	5946.98	-----	-----
2786	5892.11	-----	-----	5883.26	-----	-----	5836.00	-----	-----	5886.88	-----	-----
3086	5952.32	-----	-----	5954.46	-----	-----	5952.17	-----	-----	5951.03	-----	-----
3186	--Dry--	-----	-----	--Dry--	-----	-----	--Dry--	-----	-----	5947.49	-----	-----
3286	5913.80	-----	5914.49	5908.83	-----	5914.80	5913.78	-----	-----	5914.01	-----	-----
3486	5892.57	-----	-----	5893.05	-----	-----	5892.84	5892.38	-----	5892.45	-----	5892.61
3987	5865.80	-----	-----	5863.54	-----	-----	5863.10	-----	-----	5858.88	-----	-----
B208189	5915.96	-----	-----	5933.44	-----	-----	5915.26	-----	-----	5914.58	-----	-----
B208289	5835.61	-----	-----	5835.81	-----	-----	5836.12	-----	-----	5835.62	-----	-----
B208489	--Dry--	-----	-----	--Dry--	-----	-----	5846.10	-----	-----	--Dry--	-----	-----
B208689	5855.00	5849.56	-----	5850.46	-----	-----	5854.64	-----	-----	5854.80	-----	-----
B210389	5851.57	-----	-----	5851.23	-----	-----	5851.43	-----	-----	5851.44	-----	-----
P207389	5975.78	-----	5976.09	5976.29	-----	-----	5976.10	-----	-----	5974.08	-----	-----
P207589	5950.38	-----	-----	5950.19	-----	-----	5950.31	-----	-----	5950.38	-----	-----
P207789	5938.60	-----	-----	5938.39	-----	-----	5938.39	-----	-----	5938.58	-----	-----
P207989	5947.66	-----	5949.99	5944.14	-----	-----	5943.86	-----	-----	5946.72	-----	-----
P208889	5864.69	-----	-----	5863.12	-----	-----	5851.10	-----	-----	5863.03	-----	-----
P208989	5947.64	-----	-----	5952.40	-----	-----	5948.13	-----	-----	5947.01	-----	-----
P209089	5949.02	-----	5951.25	5946.22	-----	-----	5946.77	-----	-----	5949.12	-----	-----
P209189	5968.89	-----	5967.59	5972.03	-----	-----	5970.98	-----	-----	5968.71	-----	-----
P209389	5964.24	5964.48	-----	5966.24	-----	-----	5964.76	-----	-----	5964.97	-----	-----
P209489	5950.69	-----	-----	5953.60	-----	5973.28	5951.17	-----	-----	5950.73	-----	-----
P209589	5931.41	-----	-----	5931.68	-----	-----	5930.51	-----	-----	5931.29	-----	-----
P209689	5936.24	-----	-----	5935.98	-----	-----	5935.85	-----	-----	5936.06	-----	-----
P209889	5937.39	5937.10	-----	5937.91	-----	-----	5937.94	-----	-----	5937.06	-----	-----
P210089	5894.48	-----	-----	5881.19	-----	-----	5881.98	-----	-----	5881.68	-----	-----
P210189	5968.22	-----	-----	5970.51	-----	-----	5969.43	-----	5969.04	5968.05	-----	-----
P213889	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--

Groundwater elevations are measured in feet with respect to mean sea level.
Double readings in same column indicate two readings taken during the same month.
--Dry-- indicates well was dry at time of water level reading.
------- indicates no data was available for indicated month.

APPENDIX A-3

Groundwater Elevation Data Summary for the West Spray Field - Surficial Materials, 1992

A-3 Groundwater Elevation Data Summary for the West Spray Field - Surficial Materials, 1992

Well ID	First Quarter 1992 Jan	Feb	Mar	Second Quarter 1992 Apr	May	Jun	Third Quarter 1992 Jul	Aug	Sep	Fourth Quarter 1992 Oct	Nov	Dec
4586	6029.12	--Dry--	6026.43	6045.08	6044.82	6040.78	6034.00	6027.91	6027.43	6026.74	6026.62	6025.82
46192	-----	-----	-----	-----	-----	-----	-----	6071.42	6071.37	6071.47	-----	-----
46292	-----	-----	-----	-----	-----	-----	-----	-----	6043.42	6043.36	-----	-----
46392	-----	-----	-----	-----	-----	-----	-----	6033.57	6032.97	6032.62	-----	-----
4786	6023.18	6022.57	6022.69	6022.89	6024.74	6025.33	6025.55	6025.26	6025.06	6024.84	6025.05	6024.22
4986	6047.81	-----	-----	6047.11	-----	-----	6049.22	-----	-----	6048.74	-----	-----
5086	6071.31	6070.64	6070.73	6070.61	6071.16	6071.43	6071.70	6071.80	6072.10	6071.93	6072.44	6072.14
5186	6080.70	--Dry--	6080.96	6081.59	6083.35	6081.76	6081.18	6081.31	6080.69	6080.24	6080.82	6079.48
5686	5981.83	5982.19	-----	5984.07	-----	5982.17	5982.15	-----	5980.26	5978.71	-----	-----
B110889	6040.87	-----	6039.99	6041.12	-----	-----	6043.15	-----	-----	6042.07	-----	-----
B110989	6035.45	6034.57	6034.65	6035.51	6037.64	6037.84	6037.66	6037.29	6037.19	6036.63	6036.28	6035.91
B111189	6048.81	6048.24	6048.34	6048.19	6048.69	6049.00	6049.26	6049.34	6049.63	6049.47	6050.08	6049.69
B402689	6042.75	6043.05	-----	6043.98	6042.33	-----	6039.64	6040.13	-----	6040.62	-----	6042.61
B410589	6059.99	6059.58	-----	6059.40	-----	-----	6060.74	-----	-----	6060.65	-----	-----
B410689	6049.60	6048.85	6049.17	6049.27	6050.75	6051.02	6051.12	6051.00	6051.00	6050.62	6050.32	6049.97
B410789	6045.65	6044.79	6045.21	6045.56	6047.31	6047.49	6047.63	6047.35	6047.29	6046.78	6046.38	6045.97
B411289	6065.07	-----	-----	6064.36	-----	-----	6065.08	-----	-----	6065.26	-----	-----
B411389	6056.13	6055.40	6055.20	6055.33	6056.10	6056.58	6056.88	6056.90	6057.15	6056.91	6057.43	6056.87
P415889	6036.80	6036.52	6035.17	6041.38	6040.16	6038.69	6038.68	6037.27	--Dry--	6036.07	-----	6033.93
P416089	6045.28	6045.30	6041.98	6049.91	6047.52	6046.79	6045.82	6042.24	6045.34	6042.59	6038.87	6042.19
P416389	6043.72	6044.05	6040.93	6051.62	6048.32	6044.27	6044.50	6041.61	6042.78	6040.66	6037.55	6038.97

Groundwater elevations are measured in feet with respect to mean sea level.
Double readings in same column indicate two readings taken during the same month.
--Dry-- indicates well was dry at time of water level reading.
------- indicates no data was available for indicated month.

APPENDIX A-4

Groundwater Elevation Data Summary for the Present Landfill - Surficial Materials, 1992

Groundwater Elevation Data Summary for the Present Landfill - Surficial Materials, 1992

Well ID	First Quarter 1992 Jan	Feb	Mar	Second Quarter 1992 Apr	May	Jun	Third Quarter 1992 Jul	Aug	Sep	Fourth Quarter 1992 Oct	Nov	Dec
0586	5715.19	-----	5723.55	5723.04	-----	-----	5716.63	-----	-----	5715.49	-----	-----
0686	--Dry--	-----	-----	5812.70	-----	-----	5808.66	-----	-----	5805.65	-----	-----
0786	5920.99	5921.00	5893.54	5921.82	-----	-----	5920.52	-----	-----	--Dry--	-----	-----
1086	5985.35	5984.81	5984.42	5995.54	5992.73	5989.72	5989.23	5987.61	5987.02	5985.80	5984.76	5984.04
4087	5879.65	5880.09	5879.72	5881.91	5880.06	5880.60	5878.66	5876.36	5877.05	5876.02	--Dry--	--Dry--
4287	5852.36	5852.54	5852.50	5852.49	5851.45	5852.52	5849.90	--Dry--	5850.32	--Dry--	--Dry--	--Dry--
5887	5983.77	-----	-----	5992.54	-----	-----	5987.27	-----	-----	5984.26	-----	-----
6087	5972.42	-----	5975.54	5981.10	-----	-----	5975.22	-----	-----	5972.51	-----	-----
6187	5972.39	-----	5979.72	5979.38	-----	-----	5974.17	-----	-----	5972.39	-----	-----
6287	5971.70	5971.69	-----	5978.56	-----	-----	5973.55	-----	-----	5971.78	-----	-----
6387	5970.53	5970.41	5970.35	5972.85	5973.18	5972.68	5972.33	5971.67	5971.40	5971.21	-----	-----
6487	5966.28	5966.02	5966.02	5968.83	5971.70	5972.31	5972.48	5971.83	5970.54	5969.45	5968.36	5967.28
6587	5970.83	5970.40	-----	5977.77	-----	-----	5972.75	-----	-----	5970.90	-----	-----
6687	5970.92	5970.41	-----	5978.23	-----	-----	5972.65	-----	-----	5970.84	-----	-----
6787	5960.70	5961.00	5960.54	5963.98	5961.58	5961.33	5960.69	5959.92	5960.02	5959.76	5959.74	5959.96
6887	5960.45	-----	-----	5963.77	5961.22	-----	5960.52	-----	-----	5959.62	-----	-----
7087	5956.55	5957.58	5952.01	5962.44	5960.53	5959.71	5958.76	5952.85	5953.70	5954.02	5951.13	5951.63
7187	5958.27	-----	-----	5960.51	-----	-----	5957.23	-----	-----	5956.62	-----	-----
7287	5965.20	5965.70	-----	5967.81	-----	-----	5965.01	-----	-----	5963.32	-----	-----
B106089	5973.10	5973.06	5973.02	5977.27	5975.10	5973.30	5973.07	5973.06	5973.07	5973.04	5973.01	5973.03
B206389	5959.35	5959.47	-----	5960.52	-----	-----	5960.82	-----	-----	5959.81	-----	-----
B206489	5965.11	5963.56	-----	5968.23	-----	-----	5965.00	-----	-----	5963.45	-----	-----

Groundwater elevations are measured in feet with respect to mean sea level.
Double readings in same column indicate two readings taken during the same month.
--Dry-- indicates well was dry at time of water level reading.
------- indicates no data was available for indicated month.

APPENDIX A-5

Groundwater Elevation Data Summary for the Present Landfill - Weathered Bedrock, 1992

Groundwater Elevation Data Summary for the Present Landfill - Weathered Bedrock, 1992

Well ID	First Quarter 1992 Jan	Feb	Mar	Second Quarter 1992 Apr	May	Jun	Third Quarter 1992 Jul	Aug	Sep	Fourth Quarter 1992 Oct	Nov	Dec
0886	5888.86	5895.74	-----	5884.26	-----	-----	5885.59	-----	-----	5886.08	-----	-----
0986	5966.64	5967.79	-----	5964.51	-----	-----	5966.34	-----	5968.02	5920.96	-----	-----
4187	5849.03	5848.64	-----	5827.25	-----	-----	5833.79	-----	-----	5839.16	-----	-----
B206189	5964.11	5965.31	-----	5961.62	-----	-----	5967.34	-----	-----	5964.54	-----	-----
B206289	5954.89	5958.94	-----	5954.71	-----	-----	5956.31	-----	-----	5954.61	-----	-----
B206589	5961.05	5961.41	-----	5964.46	-----	-----	5962.30	-----	-----	5960.80	-----	-----
B206689	5942.46	5944.23	-----	5944.15	-----	-----	5946.66	-----	-----	5944.14	-----	-----
B206789	5917.06	5917.94	-----	5917.98	-----	-----	5918.47	-----	-----	5918.13	-----	-----
B206889	5900.51	5901.01	-----	5899.92	-----	-----	5900.32	-----	-----	5900.38	-----	-----
B206989	5862.16	5862.65	-----	5861.44	-----	-----	5862.02	-----	-----	5862.71	-----	-----
B207089	5861.40	5862.33	-----	5860.59	-----	-----	5859.84	-----	-----	5860.46	-----	-----
B207189	5861.63	-----	-----	5858.71	-----	-----	5857.02	-----	-----	5857.60	-----	-----
B207289	--Dry--	5881.16	-----	--Dry--	-----	-----	--Dry--	-----	-----	--Dry--	-----	-----

Groundwater elevations are measured in feet with respect to mean sea level.
Double readings in same column indicate two readings taken during the same month.
--Dry-- indicates well was dry at time of water level reading.
------- indicates no data was available for indicated month.

APPENDIX B

Groundwater Quality Data Set, 1992

Analytical data for the 1992 Annual RCRA Groundwater Monitoring Report are included in ASCII format on one 3-1/2 inch disk. Files have been archived using self-extracting software. To retrieve the analytical data, run the executable file, RCRA.EXE, on the user's C drive and the archived ASCII files will be created in the current directory. The names and contents of the archived files are:

Solar Evaporation Ponds (SEP)

SEP92VOA.DAT	Volatile Organic Compounds, 1992
SEP92RAD.DAT	Radionuclides, 1992
SEP92MET.DAT	Metals, 1992
SEP92WAT.DAT	Inorganic Analytes, 1992

West Spray Field (WSF)

WSF92VOA.DAT	Volatile Organic Compounds, 1992
WSF92RAD.DAT	Radionuclides, 1992
WSF92MET.DAT	Metals, 1992
WSF92WAT.DAT	Inorganic Analytes, 1992

Present Landfill (PL)

PL92VOA.DAT	Volatile Organic Compounds, 1992
PL92RAD.DAT	Radionuclides, 1992
PL92MET.DAT	Metals, 1992
PL92WAT.DAT	Inorganic Analytes, 1992

APPENDIX C

Upgradient Versus Downgradient Comparative Statistics

Comparative statistics for the 1992 Annual RCRA Groundwater Monitoring Report are included in ASCII format on one 3-1/2 inch disk. Files have been archived using self-extracting software. To retrieve the statistical information, run the executable file, STAT92.EXE, on the user's C drive and the archived ASCII files will be created in the current directory. The names and contents of the archived files are:

ANOVA_N.OUT	Analysis of variance results for normally distributed data.
ANOVA_L.OUT	Analysis of variance results for lognormally distributed data.
NONPAR.OUT	Analysis of variance results for nonparametric (nondistributed) data.

APPENDIX D-1

Solar Evaporation Ponds - Field Parameters, 1992

GROUNDWATER QUALITY FIELD PARAMETERS
SOLAR EVAPORATION PONDS

WELL ID	SAMPLE NUMBER	SAMPLE DATE	PH	SPEC COND	UNIT
1386	GW02237IT	14-JAN-92	7.61		US/CM
1386	GW02659IT	15-APR-92	7.29		US/CM
1386	GW03232IT	30-JUL-92	7.49	1.20	MS/CM
1386	GW03621IT	13-OCT-92	7.49	1.10	MS/CM
1486	GW02618IT	25-MAR-92	7.38		US/CM
1486	GW02675IT	15-APR-92	7.51		US/CM
1486	GW03184IT	17-JUL-92	6.80	1.83	MS/CM
1486	GW03626IT	13-OCT-92	7.84	1.78	MS/CM
1586	GW02240IT	15-JAN-92	7.34		US/CM
1586	GW02676IT	13-APR-92	7.36		US/CM
1586	GW02676ITLR	13-APR-92			US/CM
1586	GW03182IT	16-JUL-92	7.00	1.63	MS/CM
1586	GW03182ITLR	16-JUL-92			MS/CM
1586	GW03627IT	07-OCT-92	7.21	1.63	MS/CM
1586	GW03627ITLR	07-OCT-92			MS/CM
1686	GW02209IT	14-JAN-92	7.72		US/CM
1686	GW02639IT	08-APR-92	6.93		US/CM
1686	GW03189IT	22-JUL-92	7.45	2.06	MS/CM
1686	GW03629IT	13-OCT-92	7.42	1.92	MS/CM
1786	GW02210IT	09-JAN-92	6.72		US/CM
1786	GW02210ITLR	09-JAN-92			US/CM
1786	GW02640IT	07-APR-92	7.05		US/CM
1786	GW02640ITLR	07-APR-92			US/CM
1786	GW03190IT	27-JUL-92	7.03	5.46	MS/CM
1786	GW03190ITLR	27-JUL-92			MS/CM
1786	GW03630IT	07-OCT-92	7.07	5.37	MS/CM
1786	GW03630ITLR	07-OCT-92			MS/CM
1886	GW02220IT	13-JAN-92			US/CM
1886	GW02660IT	10-APR-92	7.39		US/CM
1886	GW03191IT	22-JUL-92			MS/CM
1886	GW03631IT	02-OCT-92			MS/CM
2187	GW02256IT	19-MAR-92	8.22		US/CM
2187	GW02256IT	19-MAR-92			US/CM
2187	GW02520IT	27-FEB-92	6.83		US/CM
2187	GW02647IT	16-APR-92	6.69		US/CM
2187	GW03210IT	24-JUL-92	7.00	2.49	MS/CM
2187	GW03566IT	13-OCT-92	6.89	2.94	MS/CM
2286	GW02205IT	10-JAN-92	7.47		US/CM
2286	GW02627IT	13-APR-92	7.43		US/CM
2286	GW03155IT	22-JUL-92	7.10	0.82	MS/CM
2286	GW03526IT	07-OCT-92	7.34	0.92	MS/CM
2287	GW02276IT	29-JAN-92	1.76		US/CM
2287	GW02648IT	16-APR-92	7.92		US/CM
2287	GW03211IT	24-JUL-92	8.86	1.15	MS/CM
2287	GW03567IT	13-OCT-92	8.52	1.45	MS/CM
2386	GW02224IT	13-JAN-92	7.31		US/CM
2386	GW03017IT	09-JUN-92	7.57	1.41	MS/CM
2386	GW03156IT	28-JUL-92	7.59	1.38	MS/CM
2386	GW03527IT	07-OCT-92	7.82	1.49	MS/CM
2486	GW02223IT	13-JAN-92			US/CM
2486	GW02651IT	10-APR-92	8.43		US/CM
2486	GW03168IT	01-JUL-92			US/CM
2486	GW03528IT	07-OCT-92			MS/CM
2586	GW02267IT	23-JAN-92	7.26		US/CM
2586	GW02267IT	23-JAN-92	7.26		US/CM
2586	GW03018IT	09-JUN-92	7.10	2.66	MS/CM
2586	GW03158IT	22-JUL-92	7.18	2.68	MS/CM
2586	GW03529IT	13-OCT-92	7.90	2.68	MS/CM
2686	GW02269IT	30-JAN-92	7.03		US/CM
2686	GW02653IT	14-APR-92	7.29		US/CM
2686	GW03159IT	21-JUL-92	7.18	2.35	MS/CM
2686	GW03530IT	12-OCT-92	7.86	2.25	MS/CM
2786	GW02232IT	27-JAN-92	7.94		US/CM
2786	GW02662IT	14-APR-92	7.93		US/CM
2786	GW03193IT	22-JUL-92	7.83	1.34	MS/CM
2786	GW03541IT	16-OCT-92	7.95	1.36	MS/CM
2886	GW02231IT	28-JAN-92	7.09		US/CM
2886	GW02661IT	14-APR-92	7.17		US/CM
2886	GW03192IT	21-JUL-92	6.85	6.76	MS/CM
2886	GW03542IT	14-OCT-92	6.82	12.96	MS/CM
2986	GW02214IT	09-JAN-92			US/CM
2986	GW02835IT	30-APR-92	7.56	0.55	MS/CM

GROUNDWATER QUALITY FIELD PARAMETERS
SOLAR EVAPORATION PONDS

WELL ID	SAMPLE NUMBER	SAMPLE DATE	PH	SPEC COND	UNIT
2986	GW03169IT	01-JUL-92			US/CM
2986	GW03543IT	07-OCT-92			MS/CM
3086	GW02225IT	29-JAN-92	7.29		US/CM
3086	GW02836IT	30-APR-92	7.14	6.44	MS/CM
3086	GW03084IT	08-JUL-92	7.00	5.78	MS/CM
3086	GW03552IT	09-OCT-92	7.26	6.44	MS/CM
3186	GW02285IT	08-JAN-92			US/CM
3186	GW02724IT	20-APR-92			US/CM
3186	GW03085IT	07-JUL-92			US/CM
3186	GW03170IT	01-JUL-92			US/CM
3186	GW03553IT	05-OCT-92			MS/CM
3286	GW02353IT	05-MAR-92	7.98		US/CM
3286	GW02723IT	17-APR-92	8.04		US/CM
3286	GW03086IT	08-JUL-92	7.92	0.88	MS/CM
3286	GW03554IT	09-OCT-92	7.92	0.93	MS/CM
3386	GW02553IT	03-MAR-92			US/CM
3386	GW02674IT	14-APR-92	7.50		US/CM
3386	GW03212IT	23-JUL-92			MS/CM
3386	GW03568IT	05-OCT-92			MS/CM
3486	GW02199IT	10-JAN-92	7.48		US/CM
3486	GW02199ITLR	10-JAN-92			US/CM
3486	GW02633IT	07-APR-92	7.13		US/CM
3486	GW03216IT	05-AUG-92	7.00	2.20	MS/CM
3486	GW03827IT	11-DEC-92	7.76	2.25	MS/CM
3586	GW02195IT	10-JAN-92	7.06		US/CM
3586	GW02631IT	07-APR-92	7.06		US/CM
3586	GW03217IT	05-AUG-92	6.89	1.49	MS/CM
3586	GW03828IT	10-DEC-92	7.28	1.51	MS/CM
3686	GW02196IT	09-JAN-92			US/CM
3686	GW02196IT	09-JAN-92			US/CM
3686	GW02632IT	08-APR-92	7.01		US/CM
3686	GW03234IT	24-JUL-92	7.05	2.85	MS/CM
3686	GW03642IT	12-OCT-92			NS/CM
3787	GW02234IT	22-JAN-92	7.79		US/CM
3787	GW02521IT	27-FEB-92	6.42		US/CM
3787	GW02673IT	14-APR-92	7.77		US/CM
3787	GW03194IT	22-JUL-92	7.81	1.72	MS/CM
3787	GW03544IT	19-OCT-92	7.89	1.88	MS/CM
3887	GW02235IT	22-JAN-92	6.82		US/CM
3887	GW02235IT	22-JAN-92	6.82		US/CM
3887	GW02751IT	21-APR-92	7.13		US/CM
3887	GW03196IT	11-AUG-92	6.55	2.30	MS/CM
3887	GW03545IT	19-OCT-92			MS/CM
3987	GW02213IT	10-JAN-92	8.01		US/CM
3987	GW02624IT	10-APR-92	7.99		US/CM
3987	GW03138IT	30-JUL-92	7.50	1.89	MS/CM
3987	GW03557IT	06-OCT-92	7.66	2.11	MS/CM
5687	GW02203IT	10-JAN-92	7.50		US/CM
5687	GW02626IT	07-APR-92	7.56		US/CM
5687	GW03160IT	23-JUL-92	7.28	1.91	MS/CM
5687	GW03531IT	07-OCT-92	7.43	1.84	MS/CM
B208089	GW02197IT	10-JAN-92	7.28		US/CM
B208089	GW02635IT	10-APR-92	7.47		US/CM
B208089	GW03133IT	15-JUL-92	6.45	0.79	MS/CM
B208089	GW03632IT	06-OCT-92	6.95	1.01	MS/CM
B208189	GW02198IT	10-JAN-92	7.40		US/CM
B208189	GW02636IT	10-APR-92	8.03		US/CM
B208189	GW03134IT	15-JUL-92	7.09	0.81	MS/CM
B208189	GW03633IT	06-OCT-92	7.18	0.80	MS/CM
B208289	GW02216IT	14-JAN-92	7.30		US/CM
B208289	GW02658IT	10-APR-92	6.94		US/CM
B208289	GW03231IT	28-JUL-92	7.75	3.26	MS/CM
B208289	GW03640IT	05-OCT-92	7.84	3.45	MS/CM
B208389	GW02217IT	03-JAN-92			US/CM
B208389	GW02698IT	02-APR-92			MS/CM
B208389	GW03174IT	02-JUL-92			US/CM
B208389	GW03634IT	02-OCT-92			MS/CM
B208489	GW02218IT	03-JAN-92			US/CM
B208489	GW02699IT	02-APR-92			MS/CM
B208489	GW03136IT	14-JUL-92			MS/CM
B208489	GW03635IT	02-OCT-92			MS/CM
B208589	GW02227IT	14-JAN-92	7.79		US/CM

GROUNDWATER QUALITY FIELD PARAMETERS
SOLAR EVAPORATION PONDS

WELL ID	SAMPLE NUMBER	SAMPLE DATE	PH	SPEC COND	UNIT
B208589	GW02654IT	10-APR-92	7.84		US/CM
B208589	GW03137IT	20-JUL-92	7.63	6.19	MS/CM
B208589	GW03636IT	02-OCT-92			MS/CM
B208689	GW02226IT	22-JAN-92	7.19		US/CM
B208689	GW02496IT	21-FEB-92	7.08		US/CM
B208689	GW02644IT	08-APR-92	7.07		US/CM
B208689	GW03187IT	22-JUL-92	7.35	4.46	MS/CM
B208689	GW03637IT	13-OCT-92	7.43	4.06	MS/CM
B208789	GW02208IT	14-JAN-92	7.12		US/CM
B208789	GW02638IT	09-APR-92	7.45		US/CM
B208789	GW03132IT	21-JUL-92	7.23	1.51	MS/CM
B208789	GW03623IT	06-OCT-92	6.96	1.41	MS/CM
B210389	GW02219IT	14-JAN-92	7.29		US/CM
B210389	GW02643IT	07-APR-92	7.23		US/CM
B210389	GW03188IT	22-JUL-92	7.51	4.00	MS/CM
B210389	GW03638IT	05-OCT-92	7.18	3.96	MS/CM
B210489	GW02228IT	13-JAN-92	7.10		US/CM
B210489	GW02655IT	10-APR-92	7.13		US/CM
B210489	GW02655ITLR	10-APR-92			US/CM
B210489	GW03185IT	20-JUL-92	7.25	5.74	MS/CM
B210489	GW03185ITLR	20-JUL-92			MS/CM
B210489	GW03639IT	08-OCT-92	7.21	5.77	MS/CM
P207389	GW02258IT	05-MAR-92	7.63		US/CM
P207389	GW02645IT	29-APR-92	7.72		US/CM
P207389	GW03105IT	24-JUL-92	7.79	0.79	MS/CM
P207389	GW03532IT	06-OCT-92	7.57	0.94	MS/CM
P207489	GW02259IT	05-MAR-92	7.50		US/CM
P207489	GW02646IT	29-APR-92	7.67		US/CM
P207489	GW03106IT	24-JUL-92	7.69	0.78	MS/CM
P207489	GW03533IT	06-OCT-92	7.72	0.91	MS/CM
P207589	GW02268IT	29-JAN-92	7.83		US/CM
P207589	GW02649IT	14-APR-92	7.91		US/CM
P207589	GW03107IT	13-JUL-92	8.03	1.11	MS/CM
P207589	GW03534IT	13-OCT-92	8.48	1.13	MS/CM
P207689	GW02252IT	15-JAN-92	7.51		US/CM
P207689	GW02252ITLR	15-JAN-92			US/CM
P207689	GW02664IT	15-APR-92	7.20		US/CM
P207689	GW02664ITLR	15-APR-92			US/CM
P207689	GW03140IT	13-JUL-92	7.15	2.33	MS/CM
P207689	GW03546IT	09-OCT-92	7.80	1.94	MS/CM
P207689	GW03546ITLR	09-OCT-92			MS/CM
P207789	GW02253IT	21-JAN-92	7.87		US/CM
P207789	GW02253IT	21-JAN-92	7.87		US/CM
P207789	GW02713IT	15-APR-92	8.16		US/CM
P207789	GW03141IT	13-JUL-92	7.51	1.70	MS/CM
P207789	GW03547IT	08-OCT-92	8.74	1.90	MS/CM
P207889	GW02249IT	22-JAN-92	7.75		US/CM
P207889	GW02249IT	22-JAN-92	7.75		US/CM
P207889	GW02641IT	08-APR-92	7.84		US/CM
P207889	GW03142IT	14-JUL-92	7.14	1.62	MS/CM
P207889	GW03548IT	12-OCT-92	8.07	1.86	MS/CM
P207989	GW02248IT	06-MAR-92	7.48		US/CM
P207989	GW02642IT	07-APR-92	8.14		US/CM
P207989	GW03143IT	17-JUL-92	7.78	1.80	MS/CM
P207989	GW03549IT	08-OCT-92	7.98	1.78	MS/CM
P208889	GW02211IT	10-JAN-92	9.58		US/CM
P208889	GW02621IT	10-APR-92	9.32		US/CM
P208889	GW03087IT	10-JUL-92	7.32	1.73	MS/CM
P208889	GW03558IT	06-OCT-92	8.66	2.06	MS/CM
P208989	GW02264IT	30-JAN-92	7.16		US/CM
P208989	GW02752IT	21-APR-92	7.20		US/CM
P208989	GW03082IT	17-JUL-92	6.99	12.59	MS/CM
P208989	GW03555IT	09-OCT-92	7.09	13.50	MS/CM
P209089	GW02270IT	19-MAR-92	7.12		US/CM
P209089	GW02786IT	28-APR-92	8.19		US/CM
P209089	GW03108IT	17-JUL-92	7.79	0.82	MS/CM
P209089	GW03535IT	09-OCT-92	8.39	0.96	MS/CM
P209189	GW02519IT	03-MAR-92	7.18		US/CM
P209189	GW02623IT	10-APR-92	7.30		US/CM
P209189	GW03109IT	28-JUL-92	7.05	0.75	MS/CM
P209189	GW03536IT	14-OCT-92	7.16	0.94	MS/CM
P209289	GW02221IT	13-JAN-92	7.35		US/CM

GROUNDWATER QUALITY FIELD PARAMETERS
SOLAR EVAPORATION PONDS

WELL ID	SAMPLE NUMBER	SAMPLE DATE	PH	SPEC COND	UNIT
P209289	GW02517IT	26-FEB-92	7.75		US/CM
P209289	GW02767IT	22-APR-92	7.88		US/CM
P209289	GW03110IT	13-JUL-92	7.96	1.09	MS/CM
P209289	GW03537IT	07-OCT-92	7.85	1.13	MS/CM
P209389	GW02222IT	22-JAN-92	7.27		US/CM
P209389	GW02515IT	27-FEB-92	6.90		US/CM
P209389	GW02785IT	24-APR-92	6.95		US/CM
P209389	GW03111IT	14-JUL-92	7.14	0.72	MS/CM
P209389	GW03538IT	08-OCT-92	7.53	0.78	MS/CM
P209489	GW02260IT	30-JAN-92	9.65		US/CM
P209489	GW02787IT	24-APR-92	7.00		US/CM
P209489	GW03112IT	14-JUL-92	6.81	2.51	MS/CM
P209489	GW03539IT	15-OCT-92	6.85	2.79	MS/CM
P209589	GW02212IT	10-JAN-92	7.14		US/CM
P209589	GW02622IT	10-APR-92	7.05		US/CM
P209589	GW03088IT	09-JUL-92	6.06	TOO HIGH	MS/CM
P209589	GW03559IT	06-OCT-92	6.98	TOO HIGH	MS/CM
P209689	GW02250IT	21-JAN-92	7.76		US/CM
P209689	GW02250IT	21-JAN-92	7.76		US/CM
P209689	GW02788IT	28-APR-92	8.01		US/CM
P209689	GW03144IT	20-JUL-92	8.17	1.24	MS/CM
P209689	GW03550IT	13-OCT-92	8.49	1.29	MS/CM
P209789	GW02239IT	20-JAN-92	8.46		US/CM
P209789	GW02239IT	20-JAN-92	8.46		US/CM
P209789	GW02989IT	24-APR-92	7.58		US/CM
P209789	GW02989ITLR	24-APR-92			US/CM
P209789	GW03186IT	20-JUL-92	7.76	1.03	MS/CM
P209789	GW03551IT	16-OCT-92	7.75	1.52	MS/CM
P209889	GW02266IT	22-JAN-92	8.0		US/CM
P209889	GW02516IT	28-FEB-92	7.24		US/CM
P209889	GW02753IT	21-APR-92	7.38		US/CM
P209889	GW03083IT	09-JUL-92	6.43	18.66	MS/CM
P209889	GW03556IT	09-OCT-92	7.24	TOO HIGH	MS/CM
P209989	GW02207IT	03-JAN-92			US/CM
P209989	GW02842IT	30-APR-92	7.49	1.74	MS/CM
P209989	GW03213IT	27-JUL-92			MS/CM
P209989	GW03624IT	02-OCT-92			MS/CM
P210089	GW02206IT	10-JAN-92	7.14		US/CM
P210089	GW02637IT	08-APR-92	7.53		US/CM
P210089	GW03214IT	28-JUL-92	6.52	4.23	MS/CM
P210089	GW03625IT	06-OCT-92	7.07	4.60	MS/CM
P210189	GW02257IT	20-JAN-92	7.12		US/CM
P210189	GW02257IT	20-JAN-92	7.12		US/CM
P210189	GW02665IT	15-APR-92	7.10		US/CM
P210189	GW02665ITLR	15-APR-92			US/CM
P210189	GW03154IT	11-SEP-92	7.15	1.04	MS/CM
P210189	GW03154ITLR	11-SEP-92			MS/CM
P210189	GW03540IT	15-OCT-92	7.39	0.98	MS/CM

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West Spray Field - Field Parameters, 1992

WELL ID	SAMPLE NUMBER	SAMPLE DATE	PH	SPEC COND	UNIT
4586	GW02339IT	27-JAN-92	6.44		US/CM
4586	GW02339ITMS	27-JAN-92	6.44		US/CM
4586	GW02339ITMSD	27-JAN-92	6.44		US/CM
4586	GW02340IT	27-JAN-92			US/CM
4586	GW02341IT	27-JAN-92			US/CM
4586	GW02810IT	15-MAY-92	6.36	0.11	MS/CM
4586	GW02810ITMS	15-MAY-92			US/CM
4586	GW02810ITMSD	15-MAY-92			US/CM
4586	GW02811IT	15-MAY-92			US/CM
4586	GW02812IT	15-MAY-92	6.36	0.11	MS/CM
4586	GW03298IT	04-AUG-92	6.84	0.12	MS/CM
4586	GW03298ITMS	04-AUG-92			MS/CM
4586	GW03298ITMSD	04-AUG-92			MS/CM
4586	GW03299IT	04-AUG-92			MS/CM
4586	GW03300IT	04-AUG-92			MS/CM
4586	GW03645IT	19-OCT-92	7.05	0.21	MS/CM
46192	GW03498IT	18-SEP-92	6.65	0.17	MS/CM
46192	GW03654IT	21-OCT-92	7.24	0.18	MS/CM
46292	GW03499IT	22-SEP-92	6.77	0.20	MS/CM
46292	GW03499ITMS	22-SEP-92			MS/CM
46292	GW03499ITMSD	22-SEP-92			MS/CM
46292	GW03500IT	22-SEP-92			MS/CM
46292	GW03501IT	22-SEP-92			MS/CM
46292	GW03649IT	22-OCT-92	6.90	0.20	MS/CM
46292	GW03649ITMS	22-OCT-92			US/CM
46292	GW03649ITMSD	22-OCT-92			
46292	GW03650IT	22-OCT-92			US/CM
46292	GW03651IT	22-OCT-92			US/CM
46392	GW03502IT	18-SEP-92	6.96	0.28	MS/CM
46392	GW03648IT	20-OCT-92	7.84	0.33	MS/CM
4686	GW02480IT	25-FEB-92	7.66		US/CM
4686	GW02979IT	03-JUN-92	7.85	0.38	MS/CM
4686	GW03222IT	21-JUL-92	7.47	0.41	MS/CM
4686	GW03643IT	20-OCT-92	7.74	0.41	MS/CM
4786	GW02481IT	11-FEB-92	7.25		US/CM
4786	GW02868IT	14-MAY-92	7.20	0.19	MS/CM
4786	GW03221IT	20-JUL-92	7.25	0.16	MS/CM
4786	GW03644IT	15-OCT-92	7.43	0.17	MS/CM
4886	GW02295IT	17-JAN-92	8.63		US/CM
4886	GW02803IT	30-APR-92			US/CM
4886	GW03118IT	28-JUL-92	8.03	0.37	MS/CM
4886	GW03659IT	16-OCT-92	8.85	0.32	MS/CM
4986	GW02296IT	22-JAN-92	6.95		US/CM
4986	GW02296IT	22-JAN-92	6.95		US/CM
4986	GW02804IT	29-APR-92	6.47		US/CM
4986	GW02804ITLR	29-APR-92			US/CM
4986	GW03117IT	15-JUL-92	6.70	0.24	MS/CM
4986	GW03660IT	13-OCT-92	6.96	0.23	MS/CM
5086	GW02471IT	11-FEB-92	7.00		US/CM
5086	GW02744IT	17-APR-92	6.78		US/CM
5086	GW03116IT	14-JUL-92	6.90	0.23	MS/CM
5086	GW03663IT	13-OCT-92	7.02	0.24	MS/CM
5086	GW03663ITMS	13-OCT-92			MS/CM
5086	GW03663ITMSD	13-OCT-92			MS/CM
5086	GW03664IT	13-OCT-92			MS/CM
5086	GW03665IT	13-OCT-92			MS/CM
5186	GW02320IT	30-JAN-92	7.30		US/CM
5186	GW02796IT	24-APR-92	6.36		US/CM
5186	GW02796ITMS	24-APR-92			US/CM
5186	GW02796ITMSD	24-APR-92			US/CM
5186	GW02797IT	24-APR-92			US/CM
5186	GW02798IT	24-APR-92			US/CM
5186	GW03121IT	16-JUL-92	6.63	0.17	MS/CM
5186	GW03655IT	14-OCT-92	7.05	0.17	MS/CM
5286	GW02319IT	21-JAN-92	10.51		US/CM
5286	GW02319IT	21-JAN-92	10.51		US/CM
5286	GW02816IT	07-MAY-92	10.29	0.29	MS/CM
5286	GW03120IT	16-JUL-92	10.25	0.30	MS/CM
5286	GW03656IT	14-OCT-92	10.33	0.28	MS/CM
B110889	GW02335IT	31-JAN-92	7.28		US/CM
B110889	GW02561IT	12-MAR-92	7.25		US/CM
B110889	GW02801IT	28-APR-92	6.98		US/CM

GROUNDWATER QUALITY FIELD PARAMETERS
WEST SPRAY FIELD

WELL ID	SAMPLE NUMBER	SAMPLE DATE	PH	SPEC COND	UNIT
B110889	GW03161IT	20-JUL-92	7.06	0.24	MS/CM
B110889	GW03652IT	09-OCT-92	7.18	0.26	MS/CM
B110989	GW02336IT	29-JAN-92	7.02		US/CM
B110989	GW02799IT	29-APR-92	6.86		US/CM
B110989	GW03162IT	17-JUL-92	6.88	0.18	MS/CM
B110989	GW03647IT	12-OCT-92	7.03	0.19	MS/CM
B111189	GW02317IT	31-JAN-92	7.06		US/CM
B111189	GW02562IT	12-MAR-92	6.80		US/CM
B111189	GW02818IT	30-APR-92	7.22	0.15	MS/CM
B111189	GW03223IT	21-JUL-92	7.05	0.14	MS/CM
B111189	GW03223ITLR	21-JUL-92			MS/CM
B111189	GW03646IT	12-OCT-92	7.03	0.15	MS/CM
B410589	GW02332IT	12-FEB-92	7.65		US/CM
B410589	GW02332ITLR	12-FEB-92			US/CM
B410589	GW02817IT	29-APR-92	7.63		US/CM
B410589	GW03228IT	29-JUL-92	7.65	0.31	MS/CM
B410589	GW03228ITMS	29-JUL-92			MS/CM
B410589	GW03228ITMSD	29-JUL-92			MS/CM
B410589	GW03229IT	29-JUL-92			MS/CM
B410589	GW03230IT	29-JUL-92			MS/CM
B410589	GW03666IT	07-OCT-92	7.65	0.32	MS/CM
B410689	GW02331IT	27-JAN-92	7.52		US/CM
B410689	GW02802IT	28-APR-92	7.11		US/CM
B410689	GW03113IT	22-JUL-92	7.40	0.24	MS/CM
B410689	GW03113ITMS	22-JUL-92			MS/CM
B410689	GW03113ITMSD	22-JUL-92			MS/CM
B410689	GW03114IT	22-JUL-92			MS/CM
B410689	GW03115IT	22-JUL-92			MS/CM
B410689	GW03661IT	08-OCT-92	7.27	0.26	MS/CM
B410789	GW02333IT	31-JAN-92	7.48		US/CM
B410789	GW02333ITLR	31-JAN-92			US/CM
B410789	GW02800IT	28-APR-92	6.99		US/CM
B410789	GW03297IT	30-JUL-92	7.30	0.32	MS/CM
B410789	GW03297ITLR	30-JUL-92			MS/CM
B410789	GW03662IT	07-OCT-92	7.04	0.36	MS/CM
B410789	GW03662ITLR	07-OCT-92			MS/CM
B411289	GW02315IT	31-JAN-92	7.50		US/CM
B411289	GW02315ITLR	31-JAN-92			US/CM
B411289	GW02746IT	20-APR-92	6.54		US/CM
B411289	GW02746ITLR	20-APR-92			US/CM
B411289	GW03163IT	22-JUL-92	6.59	0.17	MS/CM
B411289	GW03657IT	09-OCT-92	6.73	0.17	MS/CM
B411289	GW03657ITLR	09-OCT-92			MS/CM
B411389	GW02316IT	30-JAN-92	7.38		US/CM
B411389	GW02747IT	17-APR-92	6.88		US/CM
B411389	GW03119IT	16-JUL-92	6.85	0.13	MS/CM
B411389	GW03658IT	08-OCT-92	7.13	0.15	MS/CM

APPENDIX D-3

Present Landfill - Field Parameters, 1992

GROUNDWATER QUALITY FIELD PARAMETERS
PRESENT LANDFILL

WELL ID	SAMPLE NUMBER	SAMPLE DATE	PH	SPEC COND	UNIT
0586	GW02243IT	17-MAR-92	7.47		US/CM
0586	GW02243IT	17-MAR-92	7.83		US/CM
0586	GW02670IT	23-APR-92	7.47		US/CM
0586	GW03151IT	22-JUL-92	7.31	5.94	MS/CM
0586	GW03615IT	07-OCT-92	7.44	5.49	MS/CM
0686	GW02244IT	16-JAN-92			US/CM
0686	GW02671IT	15-APR-92	7.81		US/CM
0686	GW03150IT	16-JUL-92	7.56	4.75	MS/CM
0686	GW03614IT	08-OCT-92			MS/CM
0786	GW02301IT	06-FEB-92	6.78		US/CM
0786	GW02778IT	27-APR-92			US/CM
0786	GW03207IT	30-JUL-92			MS/CM
0786	GW03591IT	01-OCT-92			MS/CM
0886	GW02299IT	06-FEB-92	9.17		US/CM
0886	GW02777IT	28-APR-92	8.57		US/CM
0886	GW03208IT	24-JUL-92	9.33	0.45	MS/CM
0886	GW03592IT	16-OCT-92	9.51	0.48	MS/CM
0986	GW02469IT	19-FEB-92	8.07		US/CM
0986	GW02725IT	16-APR-92	7.19		US/CM
0986	GW03203IT	22-SEP-92	7.40	0.40	MS/CM
0986	GW03587IT	16-OCT-92	7.97	0.40	MS/CM
1086	GW02284IT	16-JAN-92	6.90		US/CM
1086	GW02284ITLR	16-JAN-92			US/CM
1086	GW02726IT	16-APR-92	5.74		US/CM
1086	GW03205IT	21-JUL-92	6.61	0.14	MS/CM
1086	GW03588IT	08-OCT-92	7.71	0.15	MS/CM
4087	GW02313IT	21-FEB-92	7.43		US/CM
4087	GW02790IT	28-APR-92	7.81		US/CM
4087	GW03103IT	10-JUL-92	7.83	2.60	MS/CM
4087	GW03578IT	01-OCT-92			MS/CM
4187	GW02307IT	20-FEB-92	7.32		US/CM
4187	GW02771IT	28-APR-92	7.25		US/CM
4187	GW03104IT	17-JUL-92	7.49	3.22	MS/CM
4187	GW03579IT	13-OCT-92	7.52	3.13	MS/CM
4287	GW02246IT	16-JAN-92	7.56		US/CM
4287	GW02672IT	21-APR-92	7.45		US/CM
4287	GW03149IT	14-JUL-92			MS/CM
4287	GW03613IT	02-OCT-92			MS/CM
5887	GW02283IT	16-JAN-92	7.07		US/CM
5887	GW02745IT	22-APR-92	6.44		US/CM
5887	GW03206IT	23-JUL-92	6.55	0.20	MS/CM
5887	GW03589IT	07-OCT-92	7.12	0.19	MS/CM
6087	GW02500IT	06-MAR-92	6.36		US/CM
6087	GW02500ITMS	06-MAR-92			US/CM
6087	GW02500ITMSD	06-MAR-92			US/CM
6087	GW02501IT	06-MAR-92			US/CM
6087	GW02502IT	06-MAR-92			US/CM
6087	GW02678IT	17-APR-92	6.38		US/CM
6087	GW02678ITMS	17-APR-92			US/CM
6087	GW02678ITMSD	17-APR-92			US/CM
6087	GW02679IT	17-APR-92			US/CM
6087	GW02680IT	17-APR-92			US/CM
6087	GW03145IT	20-JUL-92	6.59	0.29	MS/CM
6087	GW03145ITMS	20-JUL-92			MS/CM
6087	GW03145ITMSD	20-JUL-92			MS/CM
6087	GW03146IT	20-JUL-92			MS/CM
6087	GW03147IT	20-JUL-92			MS/CM
6087	GW03593IT	15-OCT-92	6.64	0.21	MS/CM
6087	GW03593ITMS	15-OCT-92			MS/CM
6087	GW03593ITMSD	15-OCT-92			MS/CM
6087	GW03594IT	15-OCT-92			MS/CM
6087	GW03595IT	15-OCT-92			MS/CM
6187	GW02262IT	17-MAR-92	6.72		US/CM
6187	GW02262IT	17-MAR-92	6.23		US/CM
6187	GW02758IT	23-APR-92	6.54		US/CM
6187	GW02758ITLR	23-APR-92			US/CM
6187	GW03129IT	17-JUL-92	7.20	0.18	MS/CM
6187	GW03129ITMS	17-JUL-92			MS/CM
6187	GW03129ITMSD	17-JUL-92			MS/CM
6187	GW03130IT	17-JUL-92			MS/CM
6187	GW03131IT	17-JUL-92			MS/CM
6187	GW03596IT	14-OCT-92	6.19	0.21	MS/CM

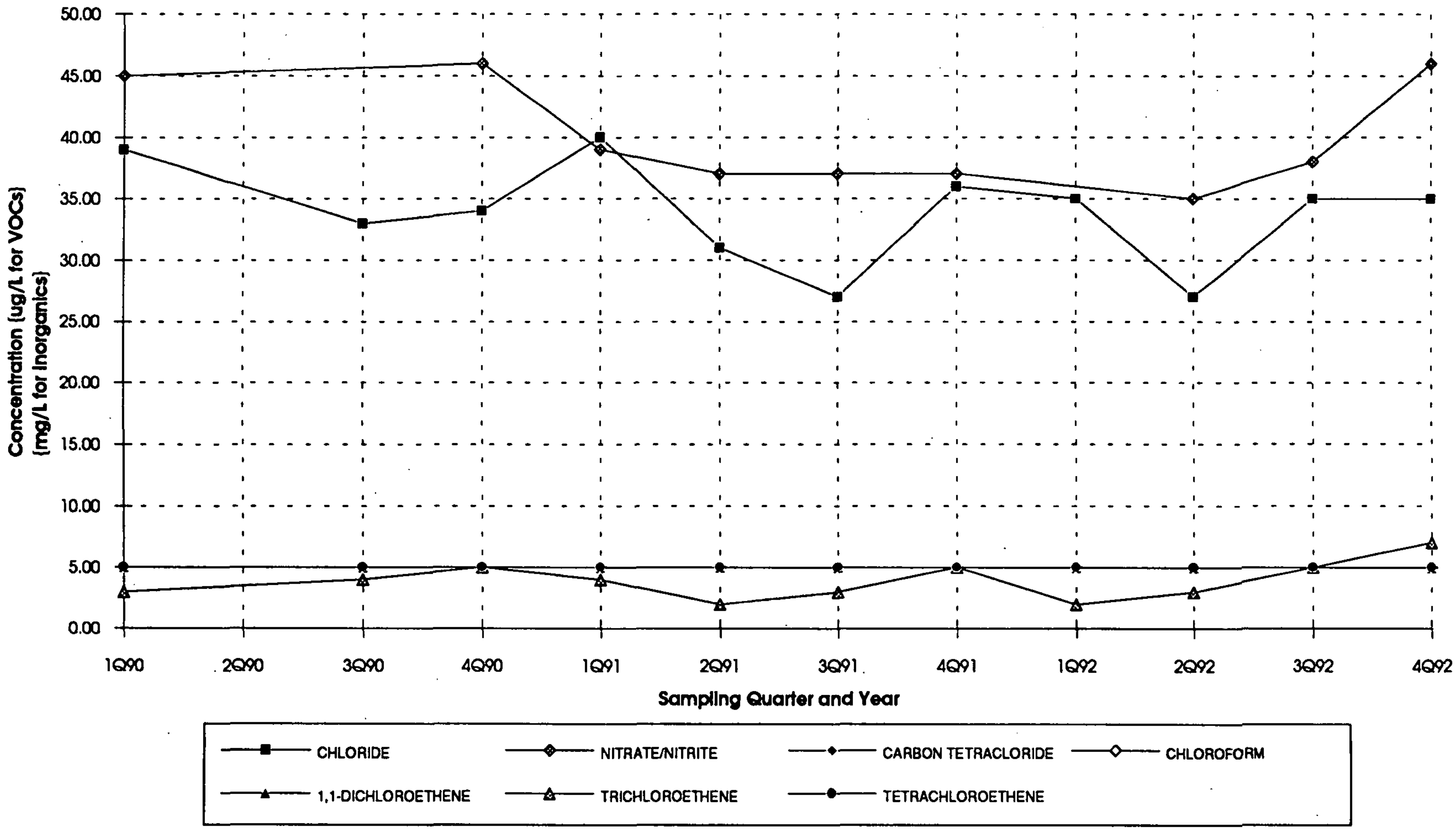
GROUNDWATER QUALITY FIELD PARAMETERS
PRESENT LANDFILL

WELL ID	SAMPLE NUMBER	SAMPLE DATE	PH	SPEC COND	UNIT
6187	GW03596ITLR	14-OCT-92			MS/CM
6287	GW02263IT	18-FEB-92	6.26		US/CM
6287	GW02759IT	21-APR-92	6.11		US/CM
6287	GW03247IT	30-JUL-92	6.13	0.20	MS/CM
6287	GW03597IT	05-OCT-92	6.29	0.19	MS/CM
6387	GW02472IT	20-FEB-92	6.39		US/CM
6387	GW02472ITMS	20-FEB-92			US/CM
6387	GW02472ITMSD	20-FEB-92			US/CM
6387	GW02473IT	20-FEB-92			US/CM
6387	GW02474IT	20-FEB-92			US/CM
6387	GW02780IT	24-APR-92	6.46		US/CM
6387	GW02780ITMS	24-APR-92			US/CM
6387	GW02780ITMSD	24-APR-92			US/CM
6387	GW02781IT	24-APR-92			US/CM
6387	GW02782IT	24-APR-92			US/CM
6387	GW03199IT	30-JUL-92	6.31	0.90	MS/CM
6487	GW02408IT	19-FEB-92	6.25		US/CM
6487	GW02754IT	21-APR-92	6.39		US/CM
6487	GW03248IT	29-JUL-92	6.59	0.61	MS/CM
6487	GW03601IT	06-OCT-92	7.05	1.06	MS/CM
6587	GW02409IT	18-FEB-92	6.60		US/CM
6587	GW02755IT	21-APR-92	6.77		US/CM
6587	GW03249IT	27-JUL-92	6.65	0.32	MS/CM
6587	GW03602IT	06-OCT-92	7.41	0.30	MS/CM
6687	GW02470IT	21-FEB-92	6.86		US/CM
6687	GW02779IT	28-APR-92	6.46		US/CM
6687	GW03250IT	28-JUL-92	6.73	0.67	MS/CM
6687	GW03603IT	08-OCT-92	7.83	0.41	MS/CM
6787	GW02291IT	20-FEB-92	6.87		US/CM
6787	GW02684IT	27-APR-92	6.22		US/CM
6787	GW03097IT	13-JUL-92	6.44	0.26	MS/CM
6787	GW03574IT	05-OCT-92	6.50	0.26	MS/CM
6887	GW02292IT	07-FEB-92			US/CM
6887	GW02293IT	07-FEB-92			US/CM
6887	GW02294IT	07-FEB-92	6.53		US/CM
6887	GW02294ITMS	07-FEB-92			US/CM
6887	GW02294ITMSD	07-FEB-92			US/CM
6887	GW02748IT	11-MAY-92	6.43	0.25	MS/CM
6887	GW02748ITMS	11-MAY-92			US/CM
6887	GW02748ITMSD	11-MAY-92			US/CM
6887	GW02749IT	11-MAY-92			US/CM
6887	GW02750IT	11-MAY-92			US/CM
6887	GW03098IT	14-JUL-92	6.32	0.26	MS/CM
6887	GW03098ITLR	14-JUL-92			MS/CM
6887	GW03575IT	20-OCT-92	6.37	0.26	MS/CM
6887	GW03575ITMS	20-OCT-92			US/CM
6887	GW03575ITMSD	20-OCT-92			US/CM
6887	GW03576IT	20-OCT-92			US/CM
6887	GW03577IT	20-OCT-92			
7087	GW02303IT	21-FEB-92	7.67		US/CM
7087	GW02776IT	28-APR-92	7.53		US/CM
7087	GW03094IT	23-JUL-92	7.74	0.82	MS/CM
7087	GW03608IT	06-OCT-92	7.13	0.82	MS/CM
7187	GW02279IT	16-JAN-92	7.71		US/CM
7187	GW02279ITMS	16-JAN-92			US/CM
7187	GW02279ITMSD	16-JAN-92			US/CM
7187	GW02280IT	16-JAN-92			US/CM
7187	GW02281IT	16-JAN-92			US/CM
7187	GW02681IT	20-APR-92	7.63		US/CM
7187	GW02681ITMS	20-APR-92			US/CM
7187	GW02681ITMSD	20-APR-92			US/CM
7187	GW02682IT	20-APR-92			US/CM
7187	GW02683IT	20-APR-92			US/CM
7187	GW03148IT	22-JUL-92	7.52	0.44	MS/CM
7187	GW03148ITLR	22-JUL-92			MS/CM
7187	GW03580IT	09-OCT-92	6.76	0.44	MS/CM
7187	GW03580ITMS	09-OCT-92			MS/CM
7187	GW03580ITMSD	09-OCT-92			MS/CM
7187	GW03581IT	09-OCT-92			MS/CM
7187	GW03582IT	09-OCT-92			MS/CM
7287	GW02309IT	20-FEB-92	7.48		US/CM
7287	GW02783IT	23-APR-92	6.97		US/CM

GROUNDWATER QUALITY FIELD PARAMETERS
PRESENT LANDFILL

WELL ID	SAMPLE NUMBER	SAMPLE DATE	PH	SPEC COND	UNIT
7287	GW03089IT	07-JUL-92	7.00	0.54	MS/CM
7287	GW03604IT	07-OCT-92	8.28	0.49	MS/CM
B106089	GW02410IT	06-FEB-92	6.54		US/CM
B106089	GW02775IT	27-APR-92	6.37		US/CM
B106089	GW03204IT	28-JUL-92	6.59	0.86	MS/CM
B106089	GW03590IT	06-OCT-92	6.22	0.70	MS/CM
B206189	GW02411IT	06-FEB-92	7.45		US/CM
B206189	GW02756IT	22-APR-92	7.30		US/CM
B206189	GW03209IT	24-JUL-92	7.11	1.44	MS/CM
B206189	GW03605IT	15-OCT-92	7.16	1.57	MS/CM
B206289	GW02418IT	07-FEB-92	8.50		US/CM
B206289	GW02774IT	23-APR-92	7.50		US/CM
B206289	GW03244IT	28-JUL-92	7.74	0.63	MS/CM
B206289	GW03606IT	06-OCT-92	7.38	0.63	MS/CM
B206389	GW02300IT	07-FEB-92	7.36		US/CM
B206389	GW02791IT	28-APR-92	6.89		US/CM
B206389	GW03628IT	13-OCT-92	6.72	1.18	MS/CM
B206489	GW02310IT	20-FEB-92	7.62		US/CM
B206489	GW02720IT	16-APR-92	7.17		US/CM
B206489	GW03246IT	30-JUL-92	7.51	0.69	MS/CM
B206489	GW03607IT	06-OCT-92	7.21	0.64	MS/CM
B206589	GW02311IT	07-FEB-92	8.45		US/CM
B206589	GW02721IT	21-APR-92	7.37		US/CM
B206589	GW03091IT	14-JUL-92	6.74	0.93	MS/CM
B206589	GW03609IT	06-OCT-92	7.06	0.98	MS/CM
B206689	GW02312IT	22-FEB-92	7.91		US/CM
B206689	GW02722IT	23-APR-92	8.03		US/CM
B206689	GW03092IT	16-JUL-92	7.78	0.77	MS/CM
B206689	GW03610IT	06-OCT-92	7.58	0.84	MS/CM
B206789	GW02298IT	06-FEB-92	8.08		US/CM
B206789	GW02773IT	28-APR-92	7.75		US/CM
B206789	GW03093IT	23-JUL-92	7.89	1.60	MS/CM
B206789	GW03611IT	14-OCT-92	7.74	1.60	MS/CM
B206889	GW02308IT	22-FEB-92	7.44		US/CM
B206889	GW02772IT	29-APR-92	7.81		US/CM
B206889	GW03288IT	29-JUL-92	7.58	4.51	MS/CM
B206889	GW03612IT	13-OCT-92	7.50	4.30	MS/CM
B206989	GW02304IT	21-FEB-92	7.16		US/CM
B206989	GW02768IT	28-APR-92	7.53		US/CM
B206989	GW03099IT	10-JUL-92	7.79	5.44	MS/CM
B206989	GW03583IT	13-OCT-92	7.69	5.49	MS/CM
B207089	GW02306IT	20-FEB-92	7.40		US/CM
B207089	GW02769IT	28-APR-92	7.00		US/CM
B207089	GW03100IT	10-JUL-92	7.39	3.08	MS/CM
B207089	GW03584IT	14-OCT-92	7.36	2.95	MS/CM
B207189	GW02305IT	20-FEB-92	8.58		US/CM
B207189	GW02770IT	29-APR-92	8.14		US/CM
B207189	GW03101IT	17-JUL-92	8.11	2.87	MS/CM
B207289	GW02286IT	06-JAN-92			US/CM
B207289	GW02697IT	01-APR-92			MS/CM
B207289	GW03173IT	02-JUL-92			US/CM
B207289	GW03586IT	01-OCT-92			MS/CM

SOLAR EVAPORATION PONDS
2686 Combined



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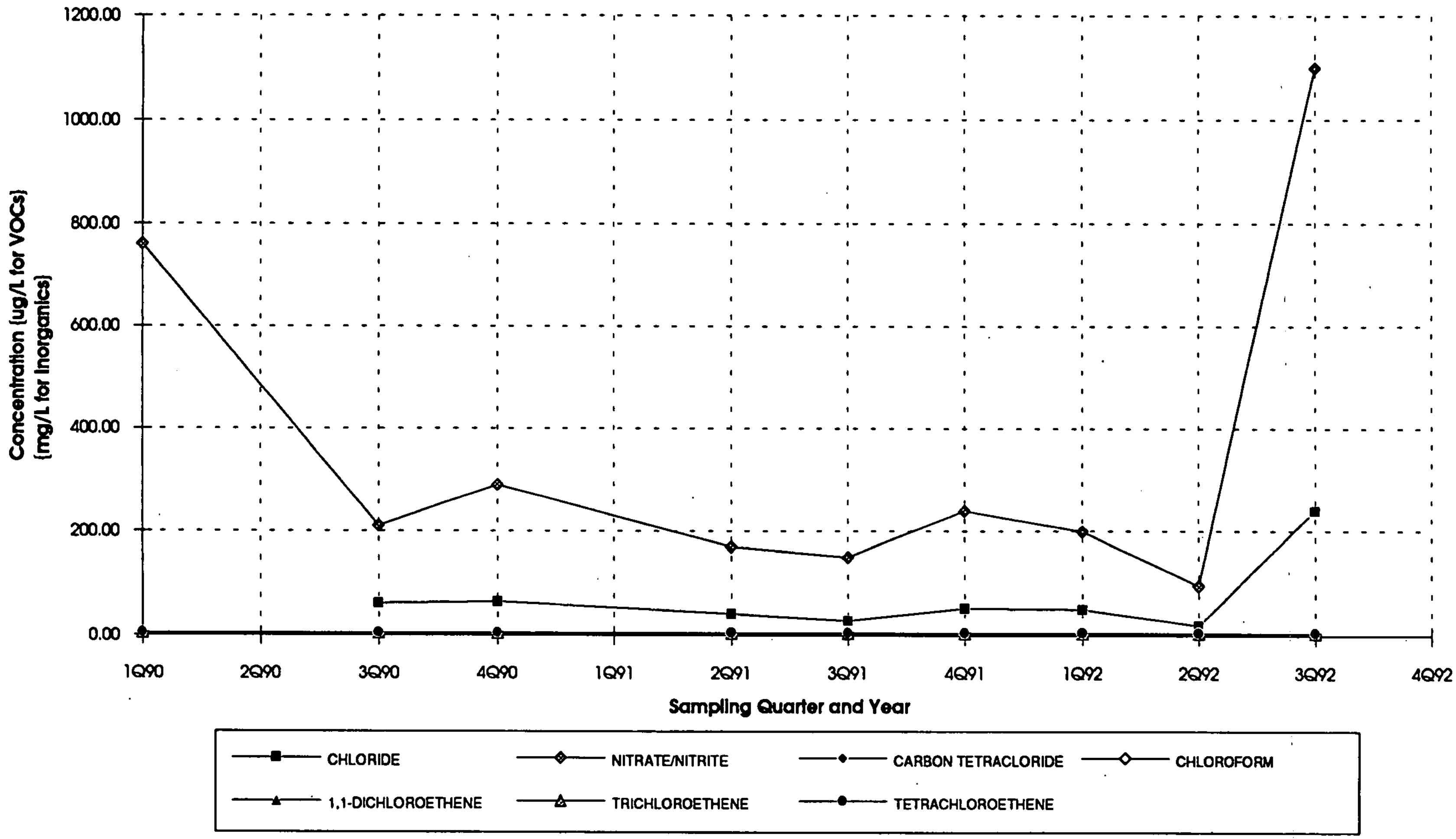
SOLAR EVAPORATION PONDS
2886 Combined



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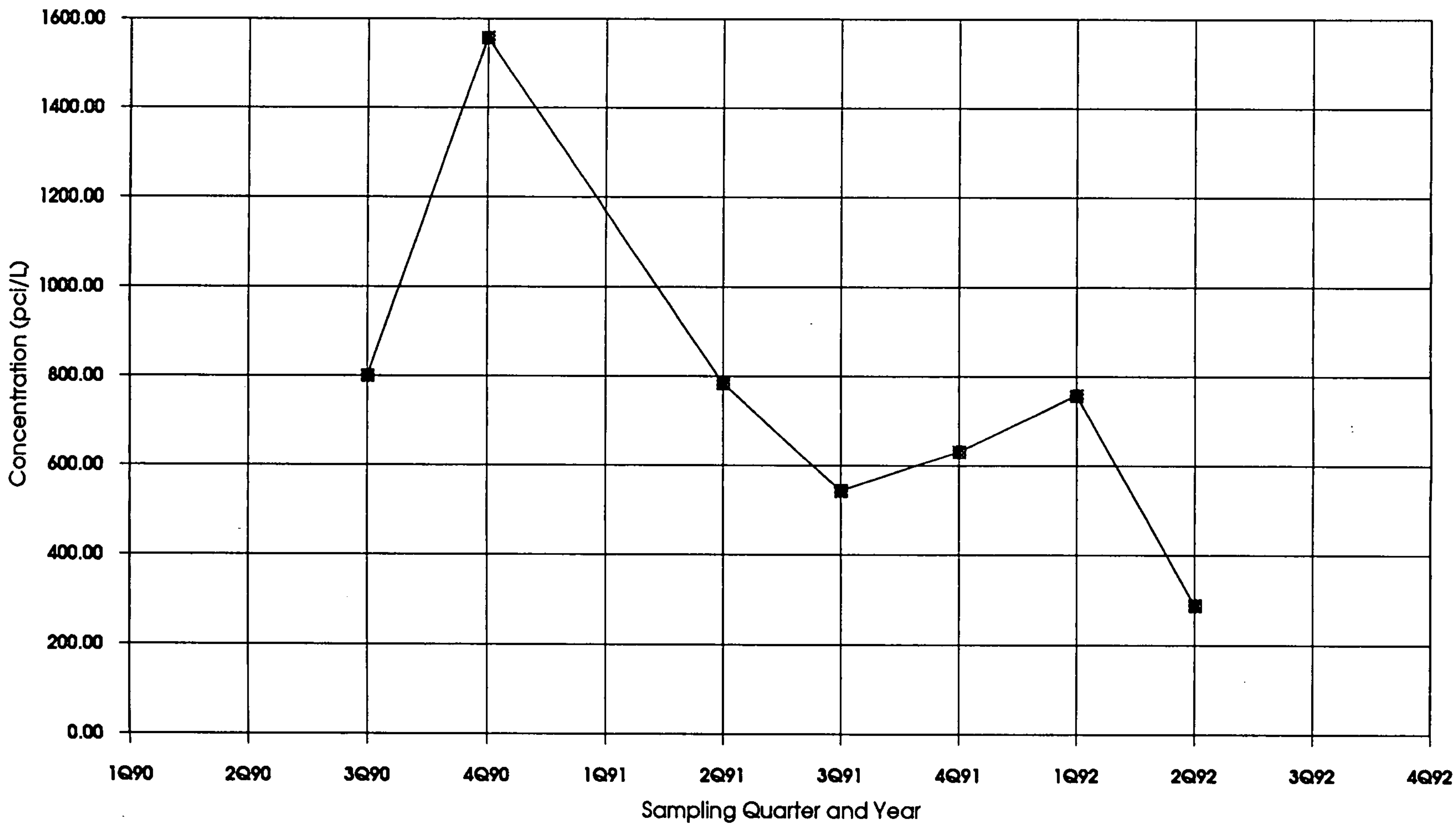
SOLAR EVAPORATION PONDS
Time Series Plot - 2886 - Tritium



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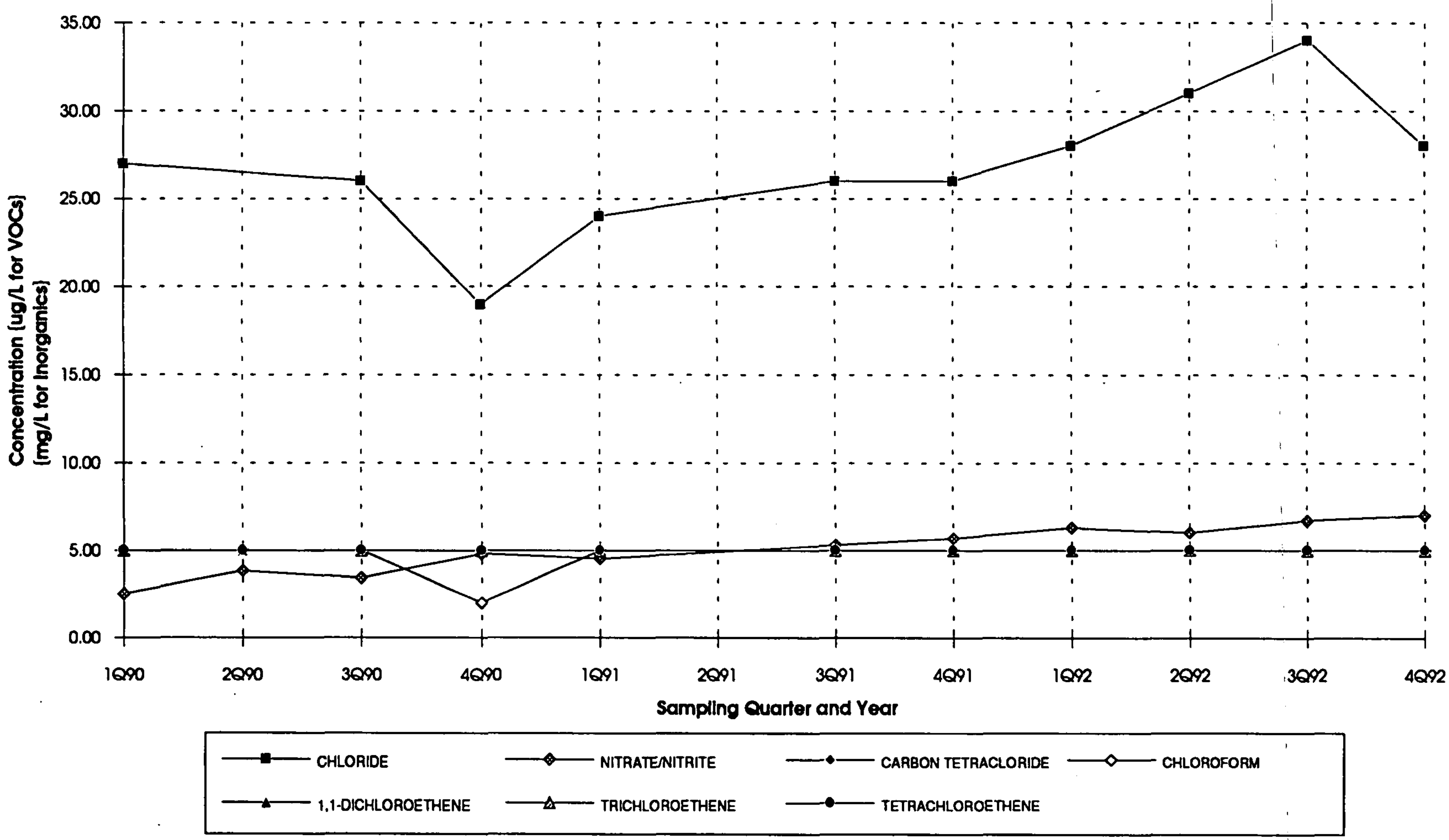
SOLAR EVAPORATION PONDS
P207389 Combined



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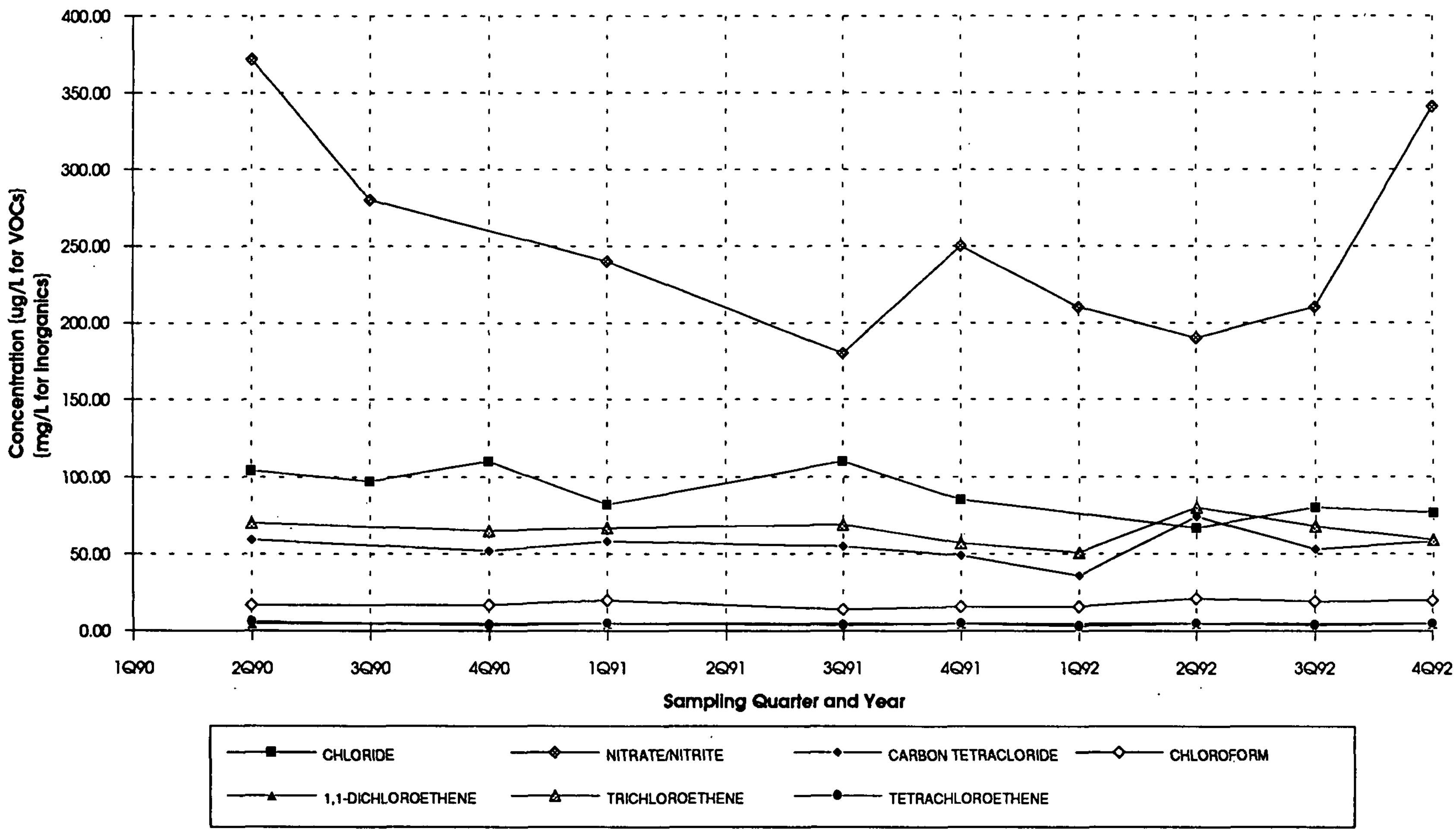
SOLAR EVAPORATION PONDS
P207489 Combined



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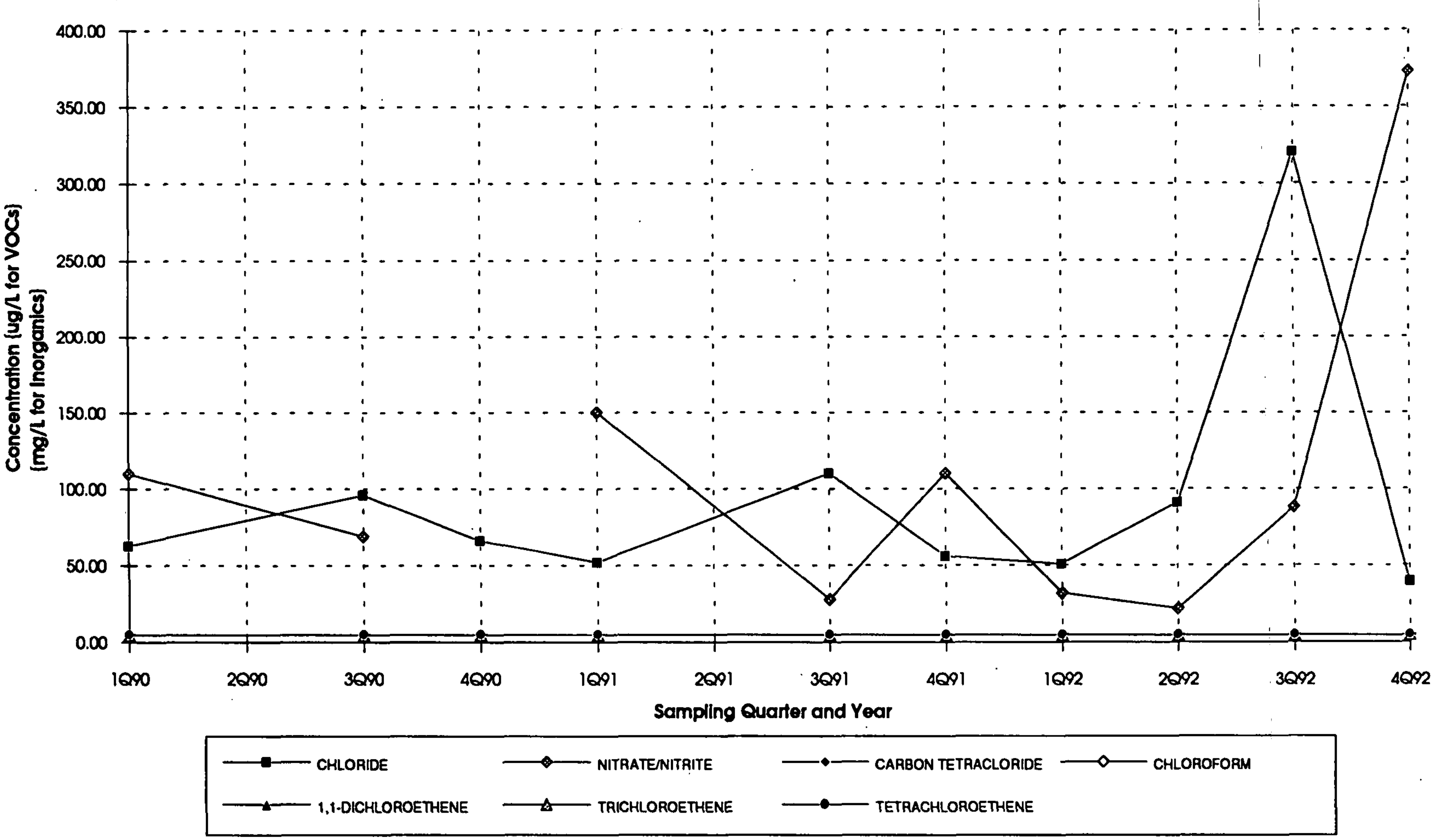
SOLAR EVAPORATION PONDS
P207689 Combined



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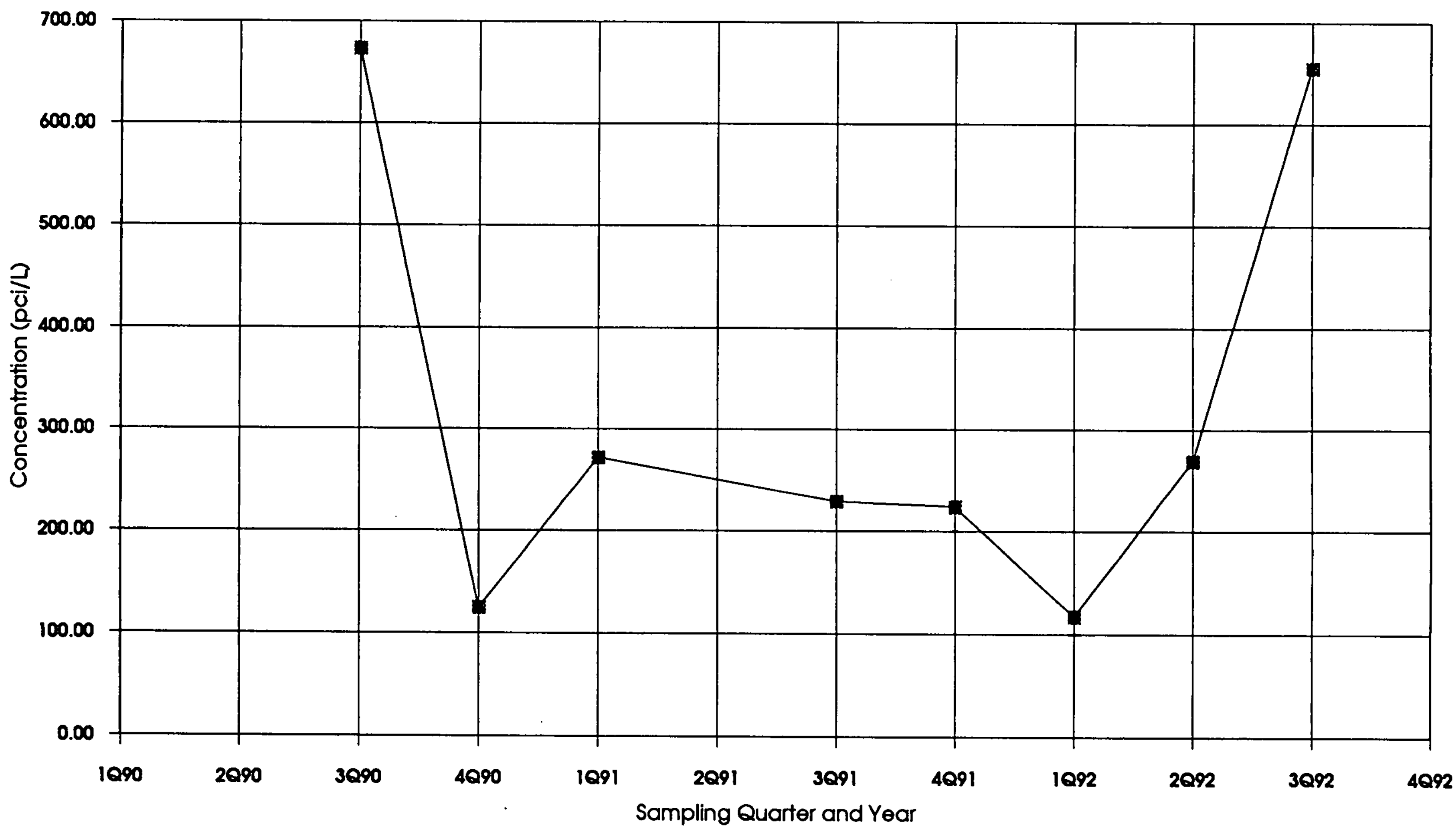
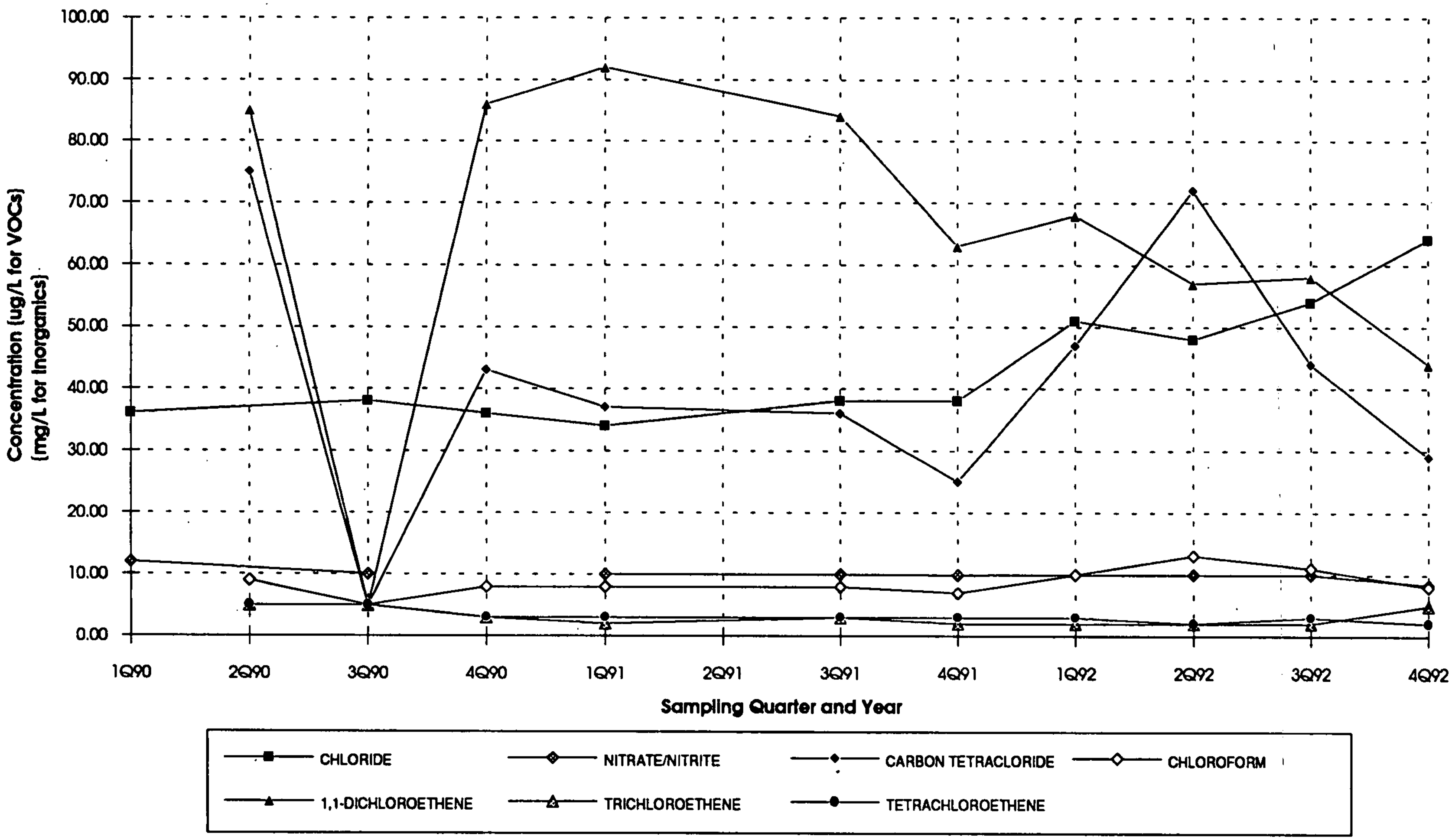
SOLAR EVAPORATION PONDS
Time Series Plot - P207689 - Tritium



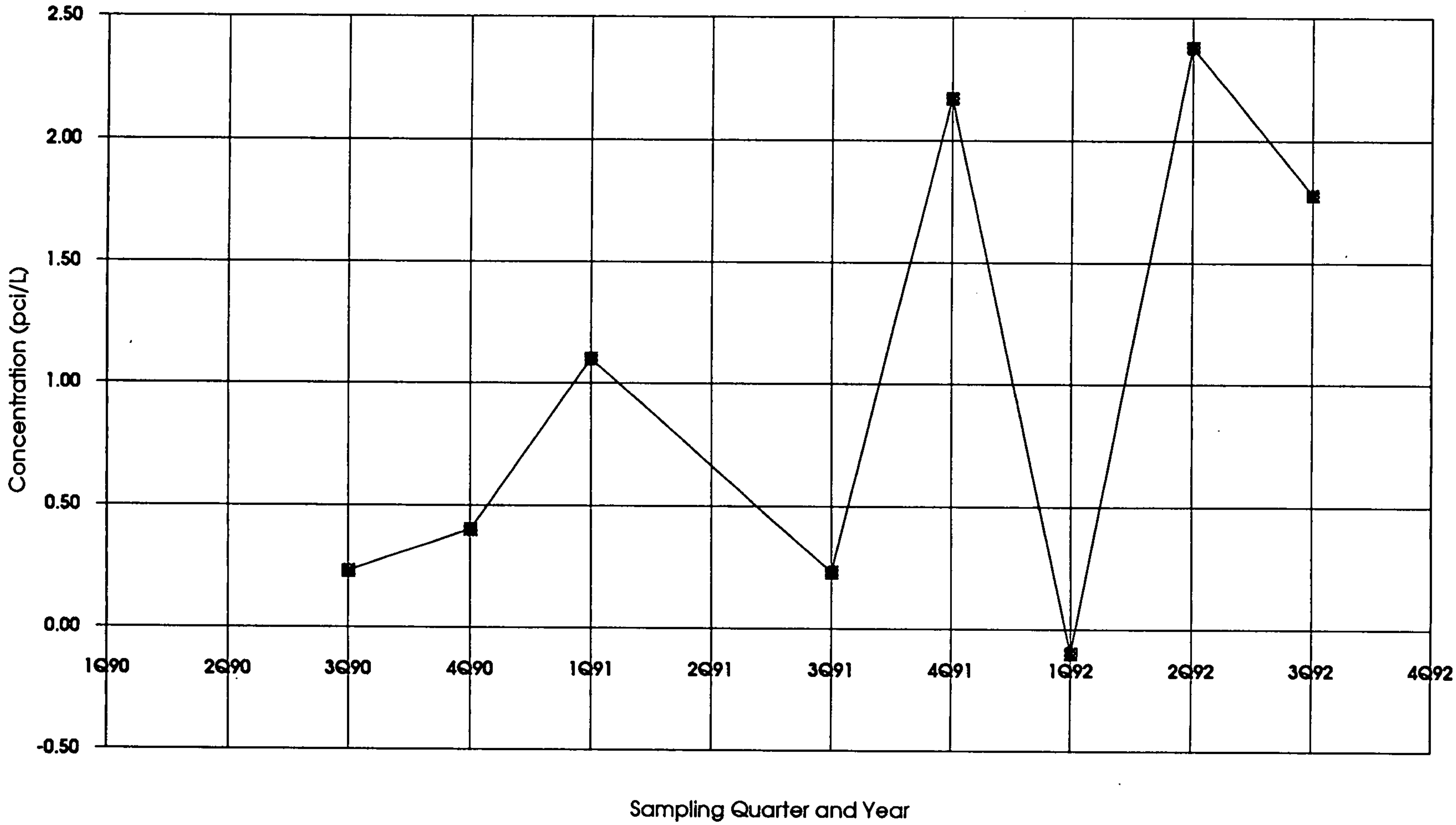
P37\D:\DOCS\ES\TTP7689.XLC\2/18/93

SOLAR EVAPORATION PONDS
P209389 Combined



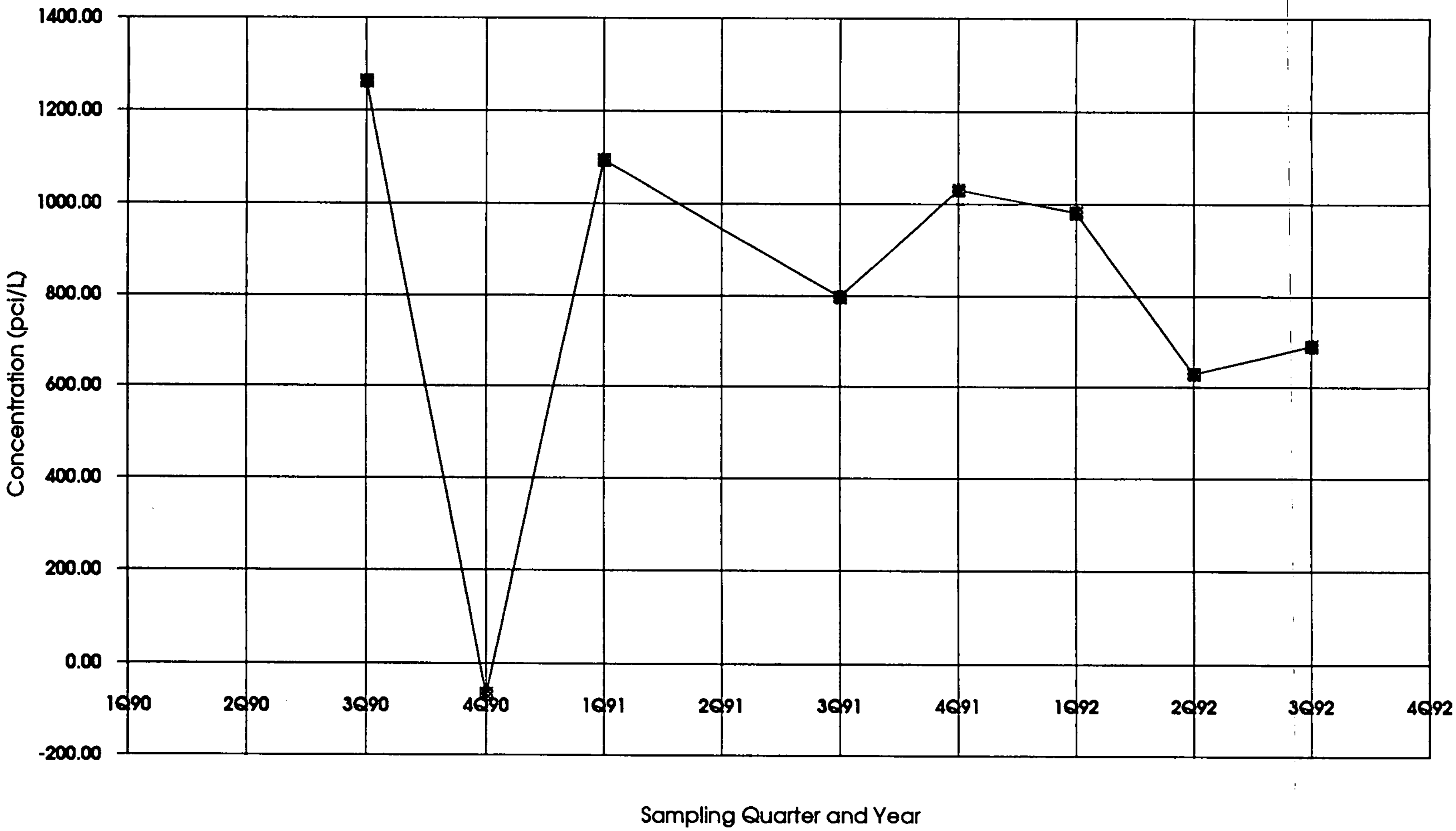
P37\D:\DOCS\ES\COMB\SCP9389.XLC\2/19/93

SOLAR EVAPORATION PONDS
Time Series Plot - P209389 - Gross Alpha - Dissolved



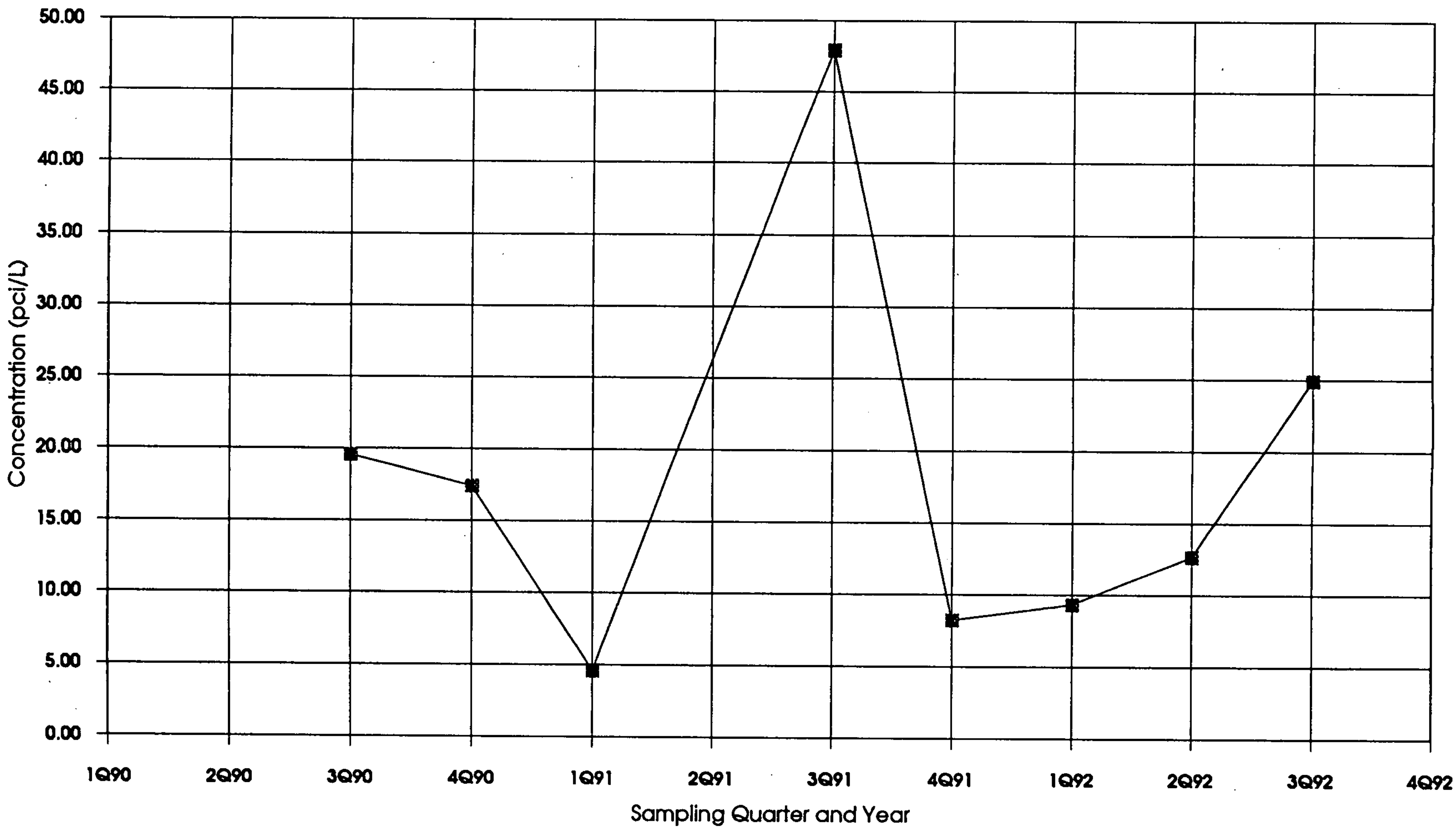
P37\D:\DOCS\ES\GRP9389.XLC\2/18/93

SOLAR EVAPORATION PONDS
Time Series Plot - P209489 - Tritium

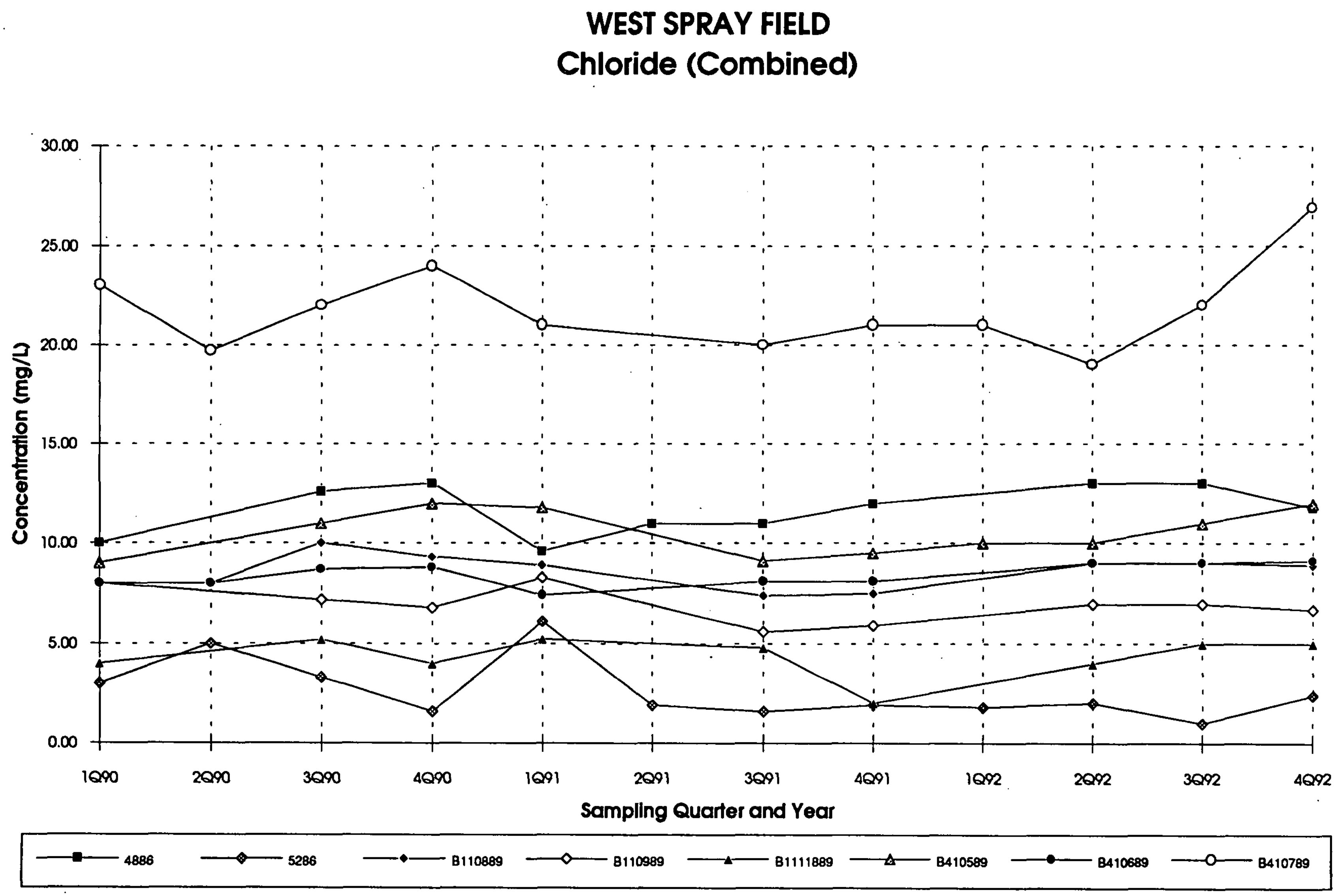


P37\D:\DOCS\ES\TTP9489.XLC\2/18/93

SOLAR EVAPORATION PONDS
Time Series Plot - P207689 - Gross Alpha - Dissolved

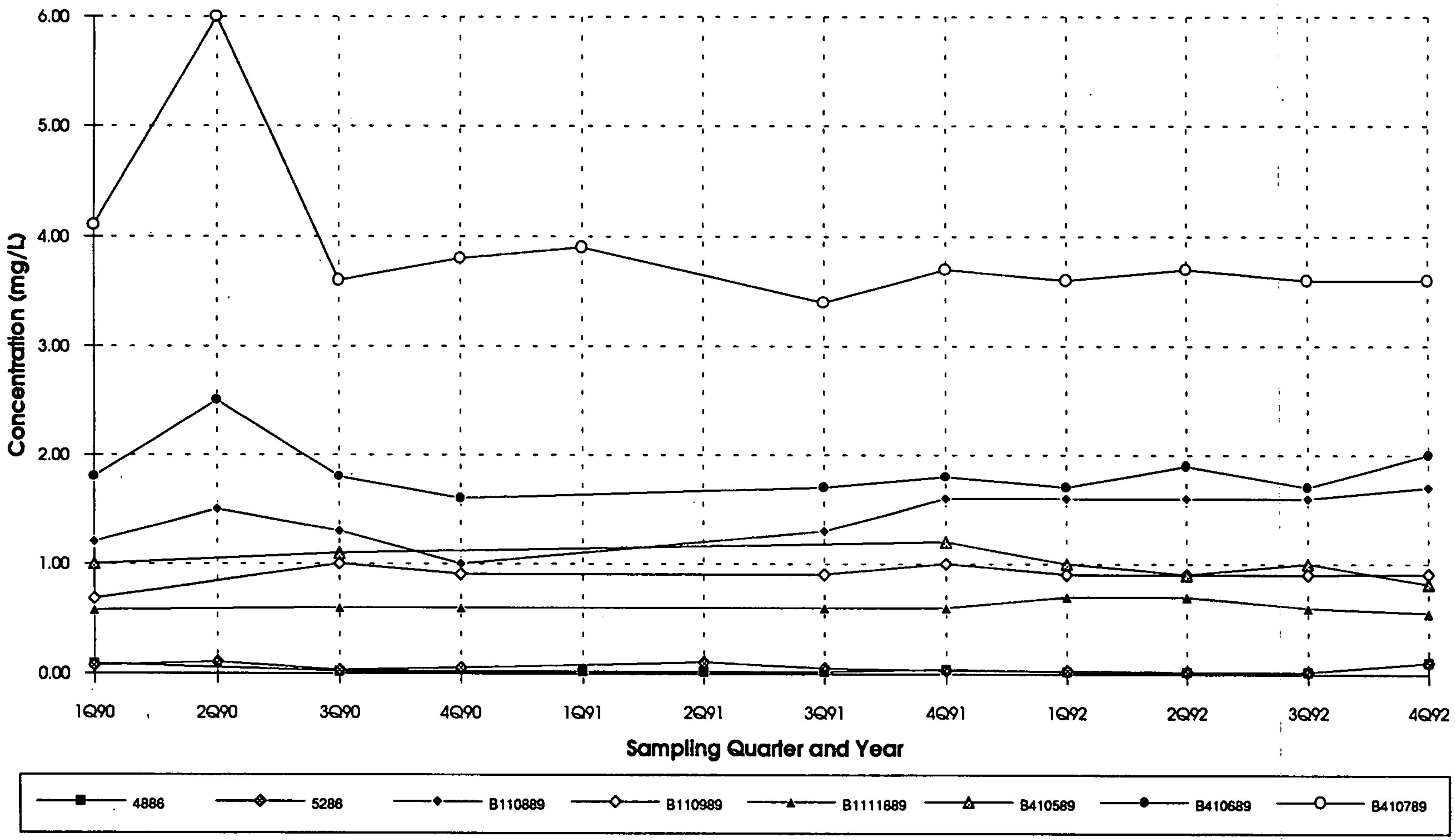


P37\D:\DOCS\ES\GRP7689.XLC\2/18/93

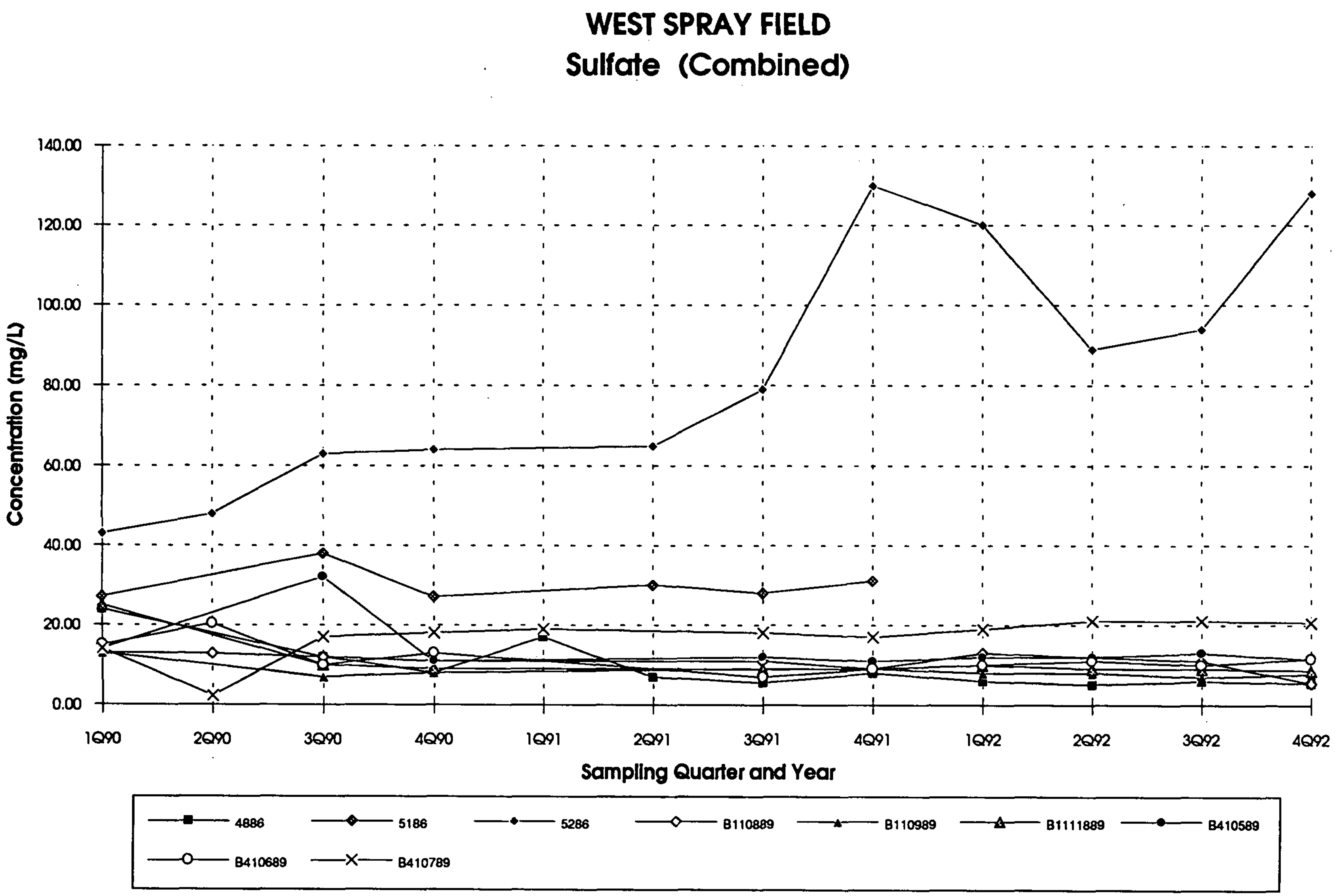


P37\D:\DOCS\ES\COMB\WCCHLOR.XLC\2/20/93

WEST SPRAY FIELD
Nitrate\Nitrite (Combined)

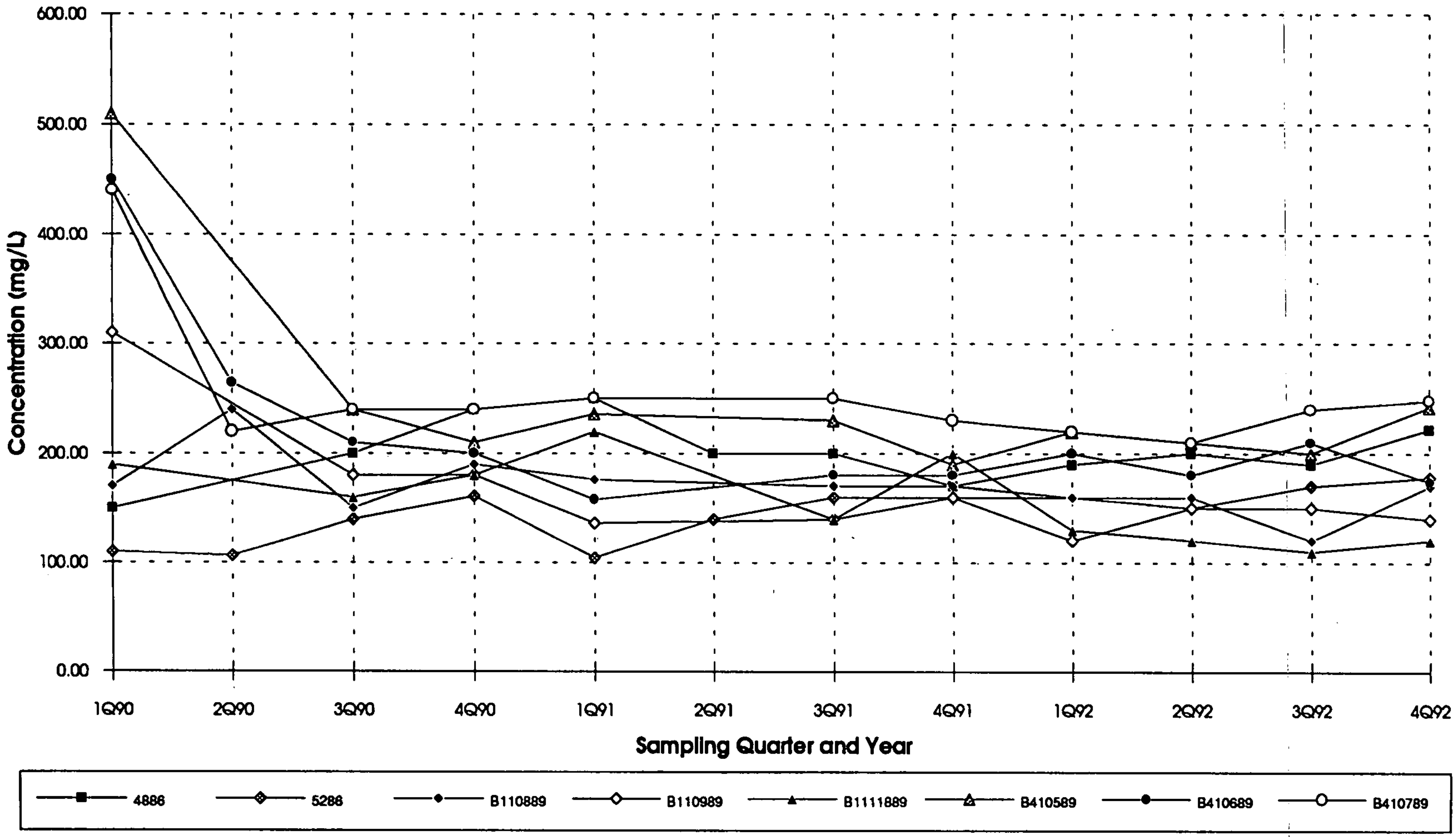


P37\D:\DOCS\ES\COMB\WCNIT.XLC\2/20/93



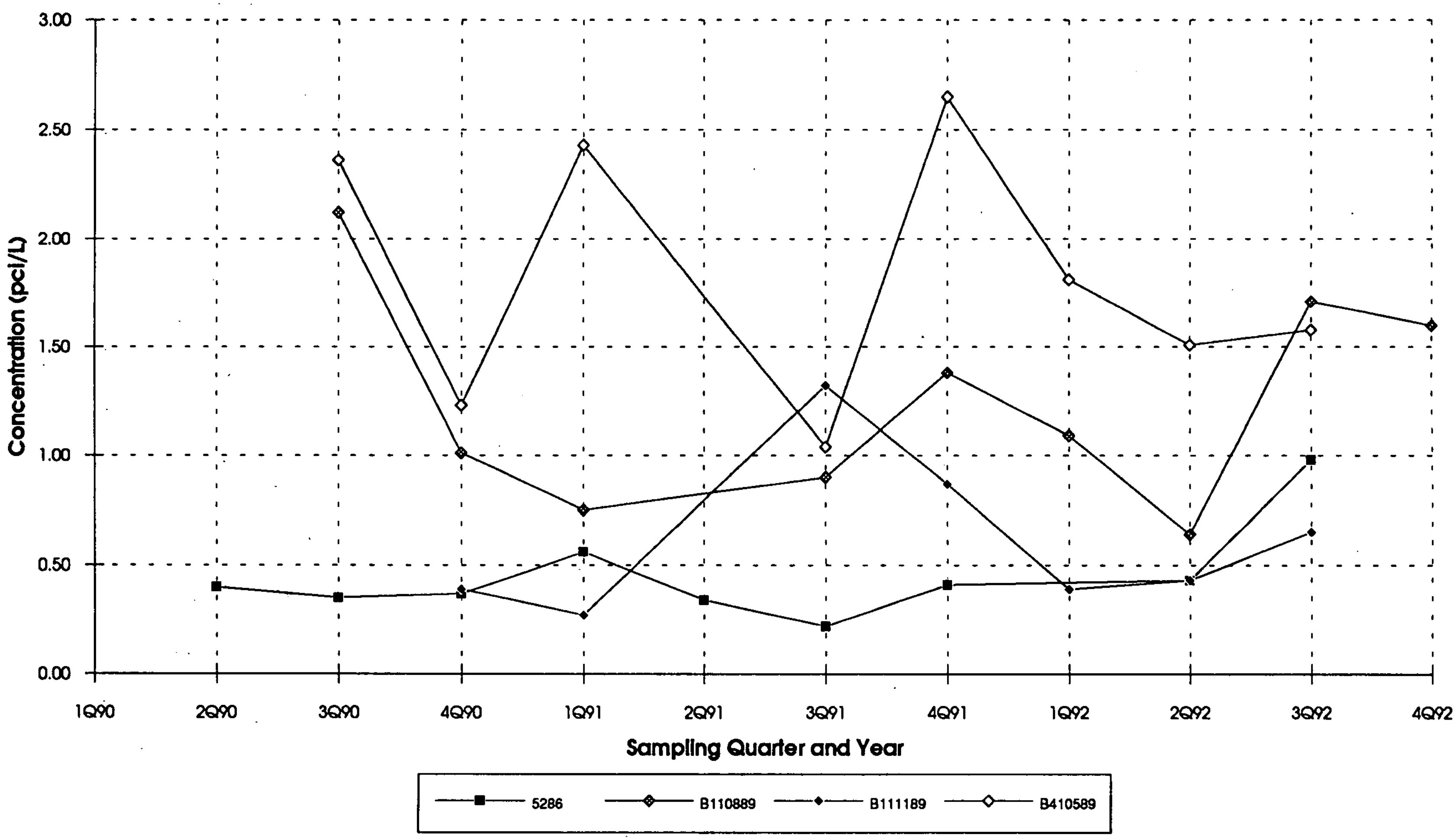
P37\D:\DOCS\ES\COMB\WCSULF.XLC\2/20/93

WEST SPRAY FIELD
Total Dissolved Solids (Combined)



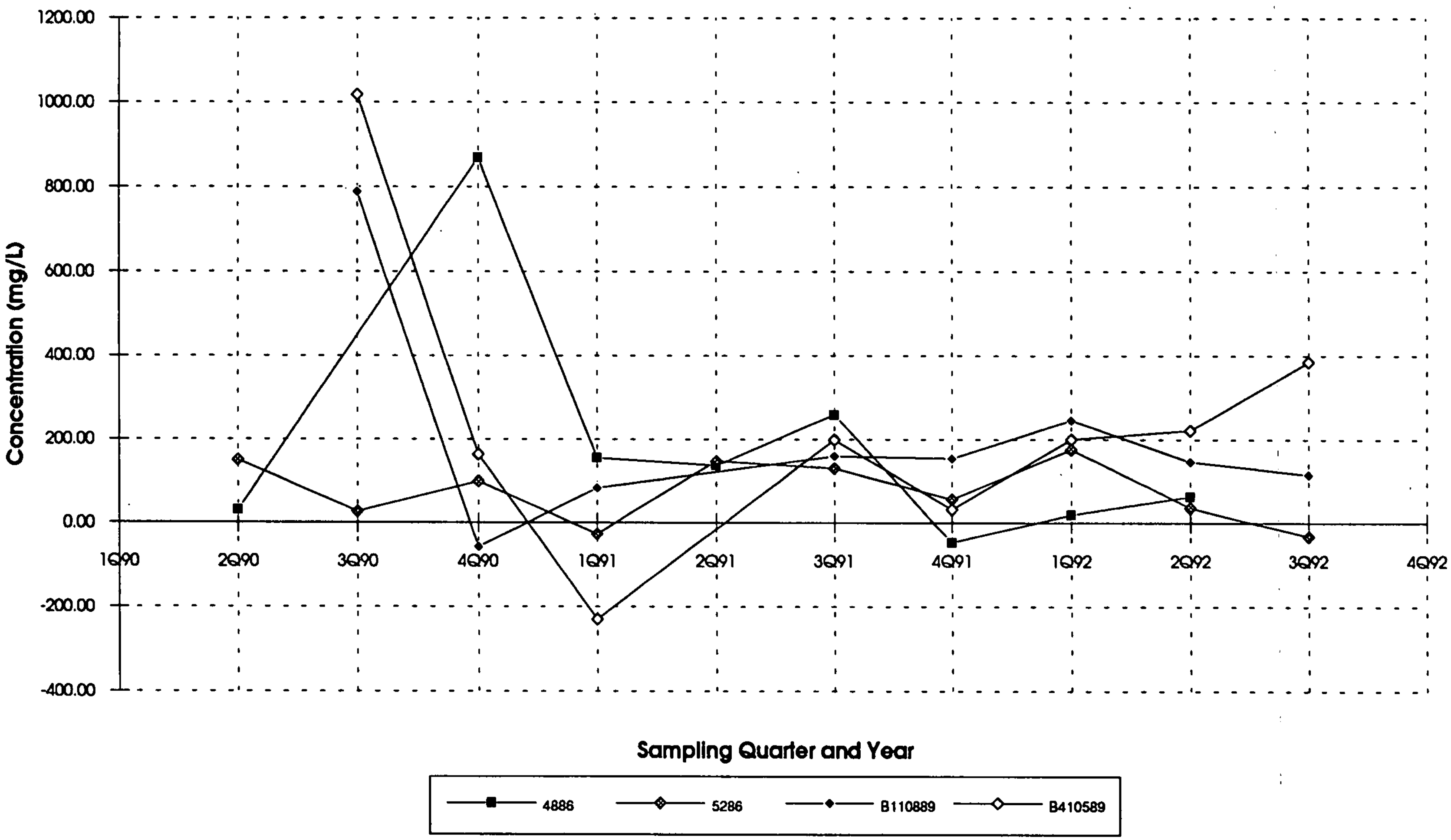
P37\D:\DOCS\ES\COMB\WCTDS.XLC\2/20/93

WEST SPRAY FIELD
Gross Alpha - Dissolved (Combined)



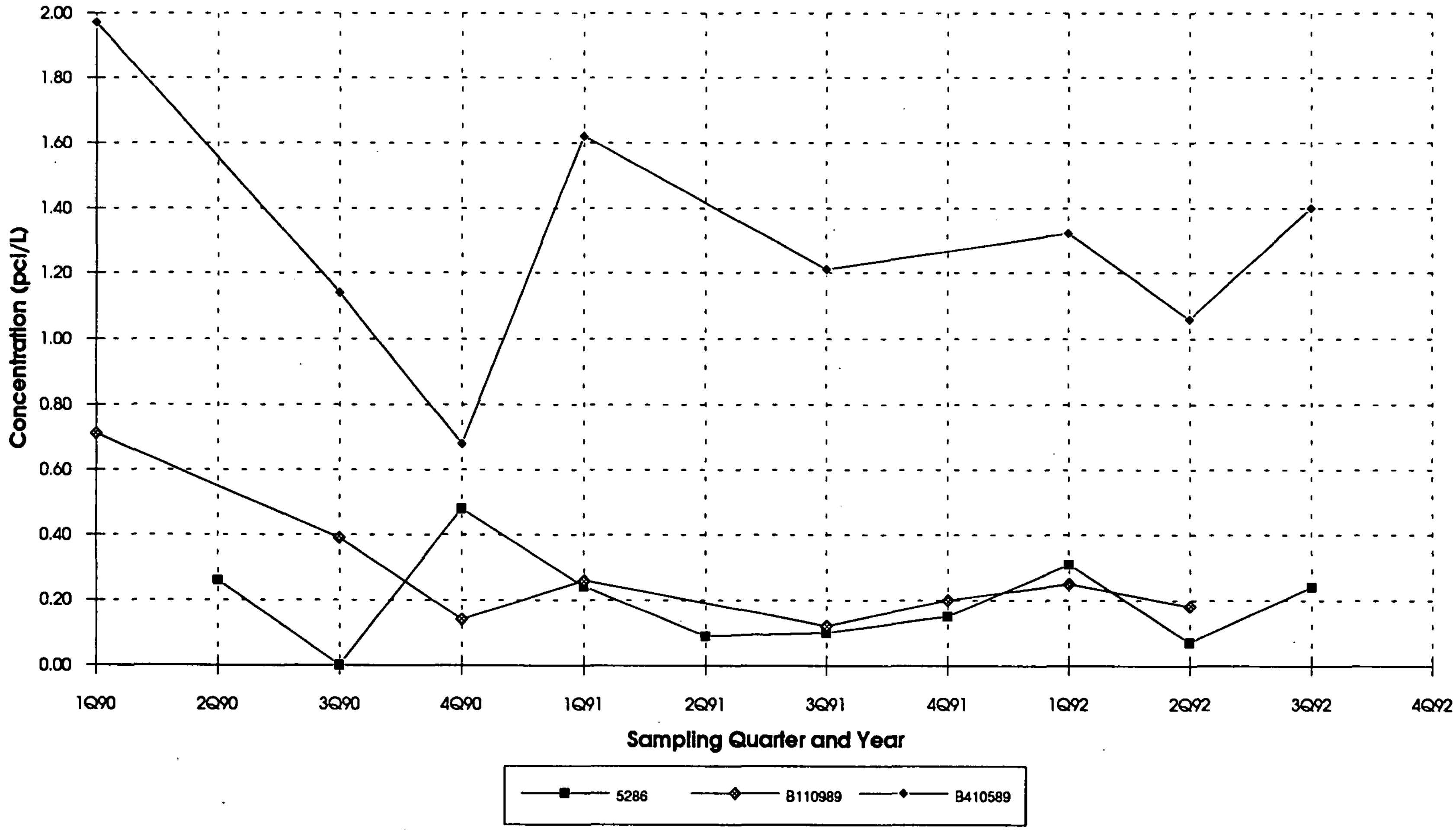
P37\D:\DOCS\ES\COMB\WCGROSS.XLC\2/20/93

WEST SPRAY FIELD
Tritium (Combined)

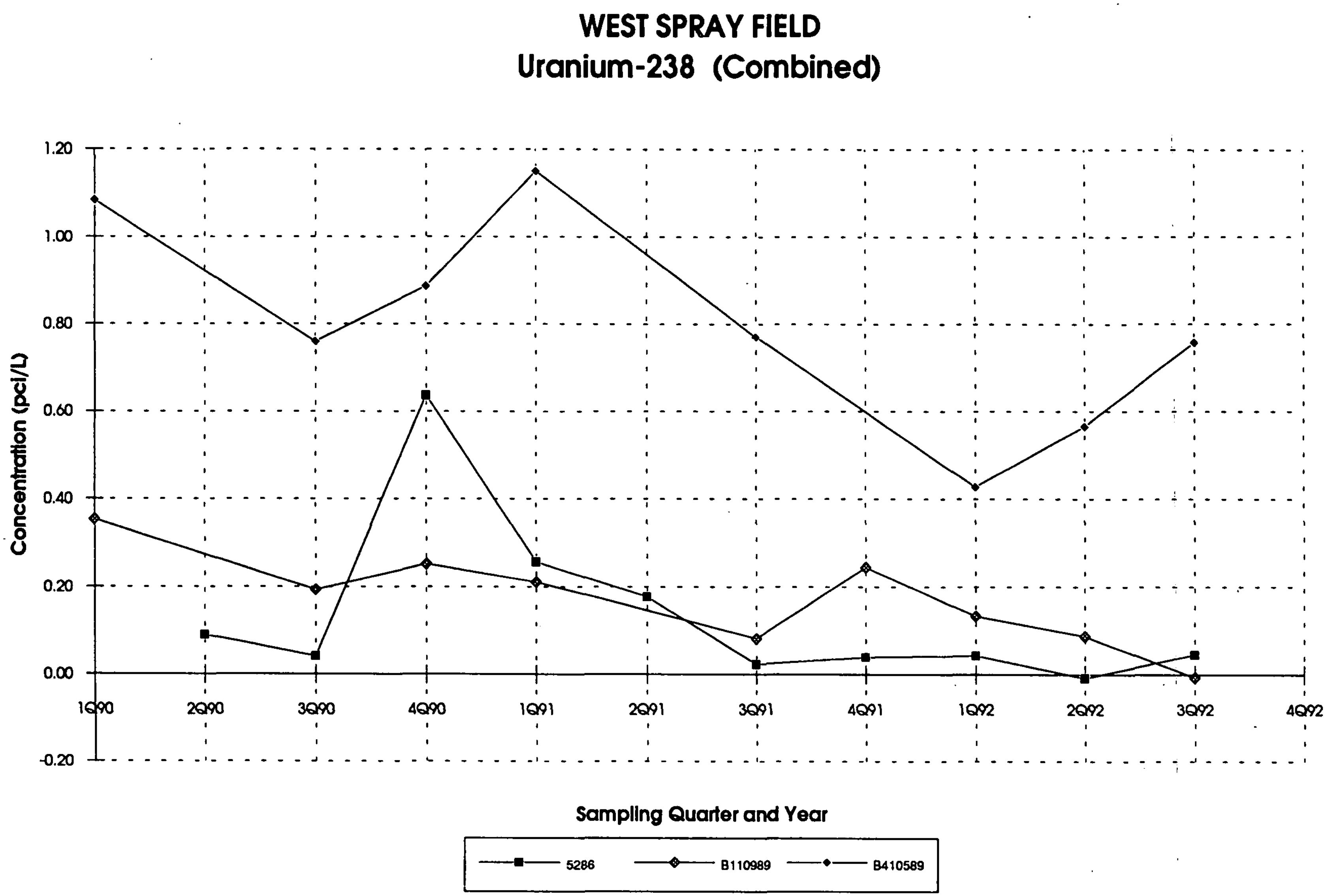


P37\D:\DOCS\ES\COMB\WCTRIT.XLC\2/20/93

WEST SPRAY FIELD
Uranium-233,-234 (Combined)

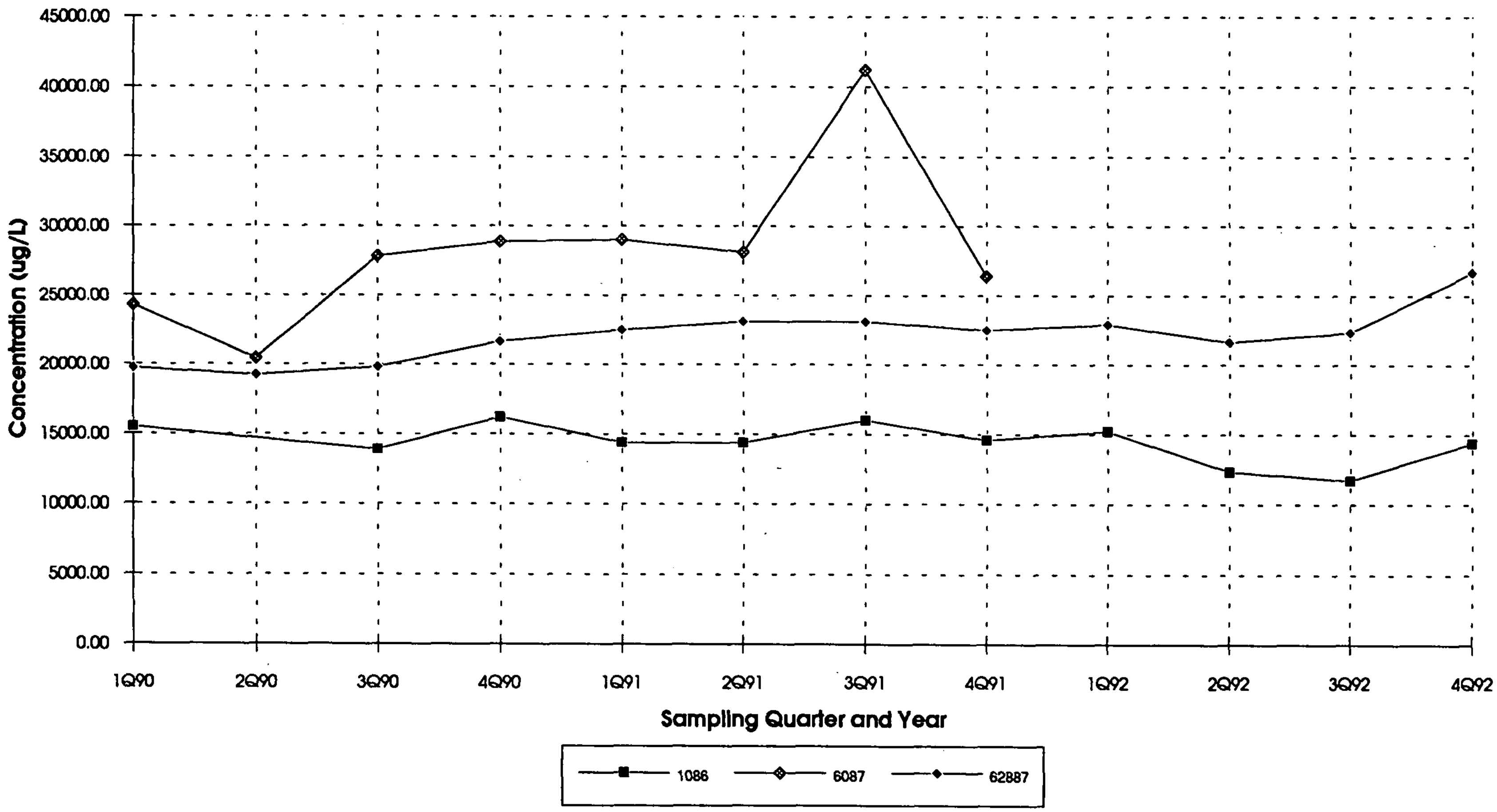


P37\D:\DOCS\ES\COMB\WCURAN.XLC\2/20/93



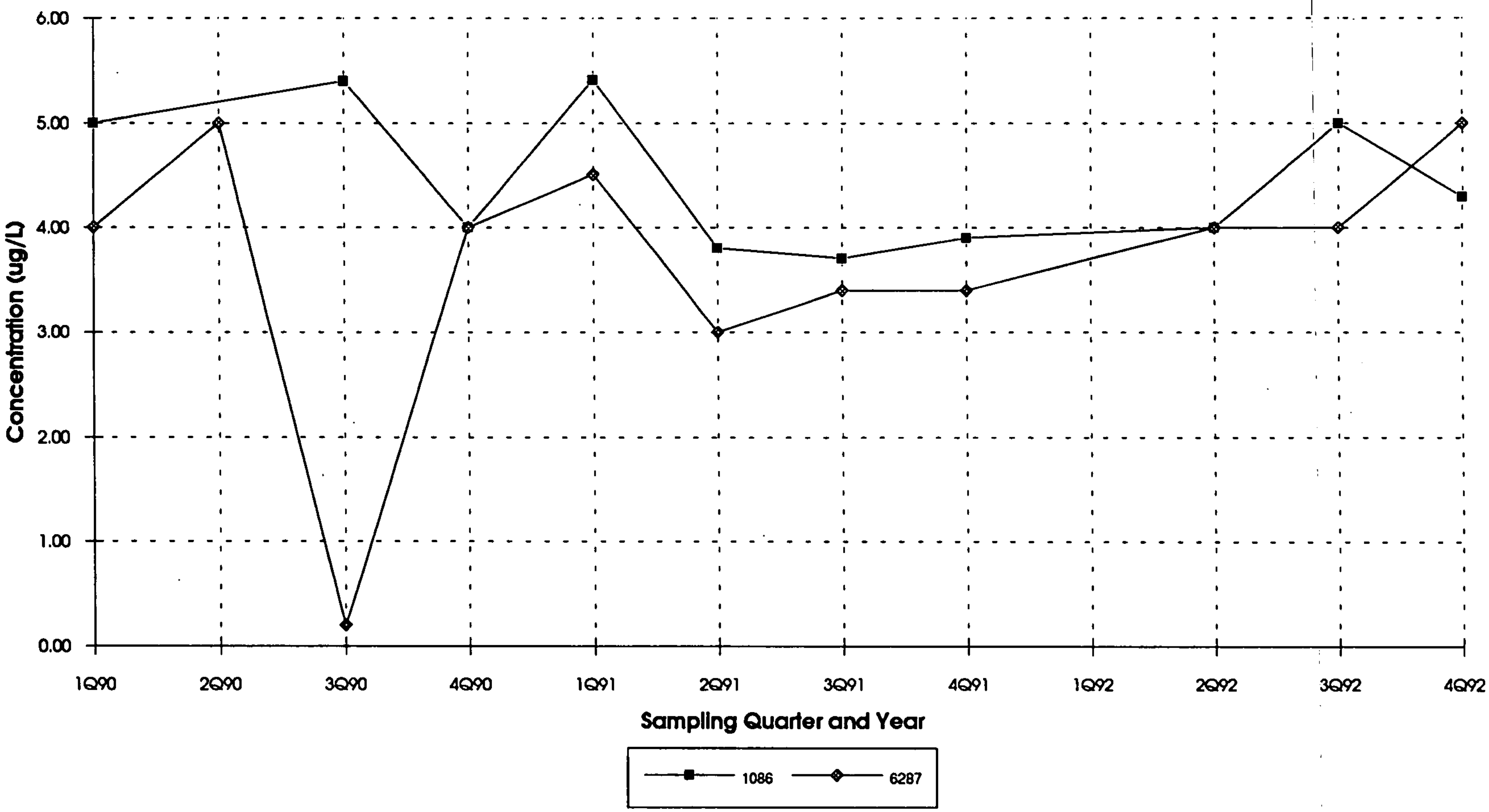
P37\D:\DOCS\FS\COMB\WCU238.XLC\2/20/93

PRESENT LANDFILL
Upgradiant Wells
Calcium (Combined)



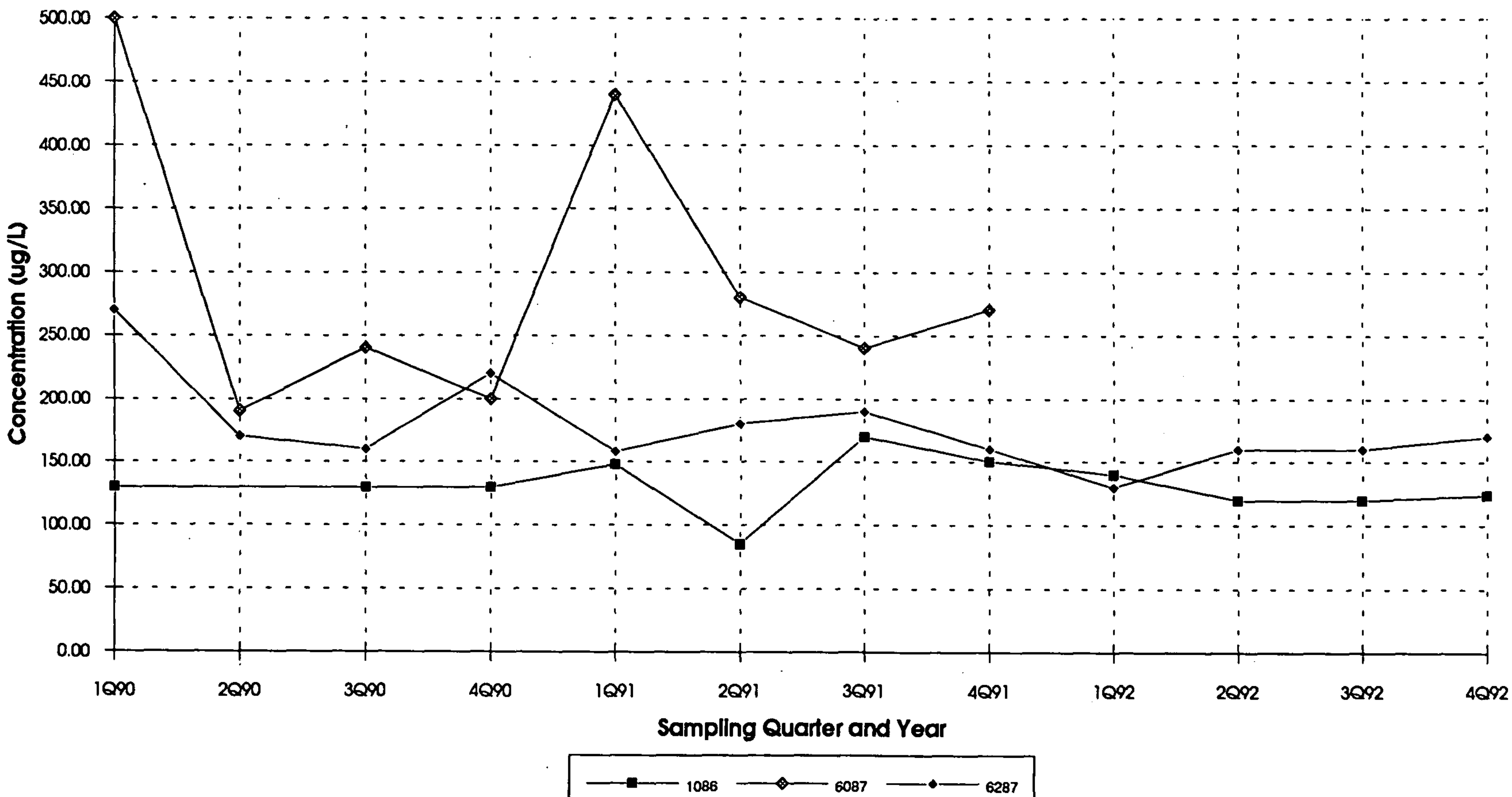
P37\D:\DOCS\ES\COMB\PCUCAL.XLC\2/20/93

PRESENT LANDFILL
Upgradiant Wells
Chloride (Combined)



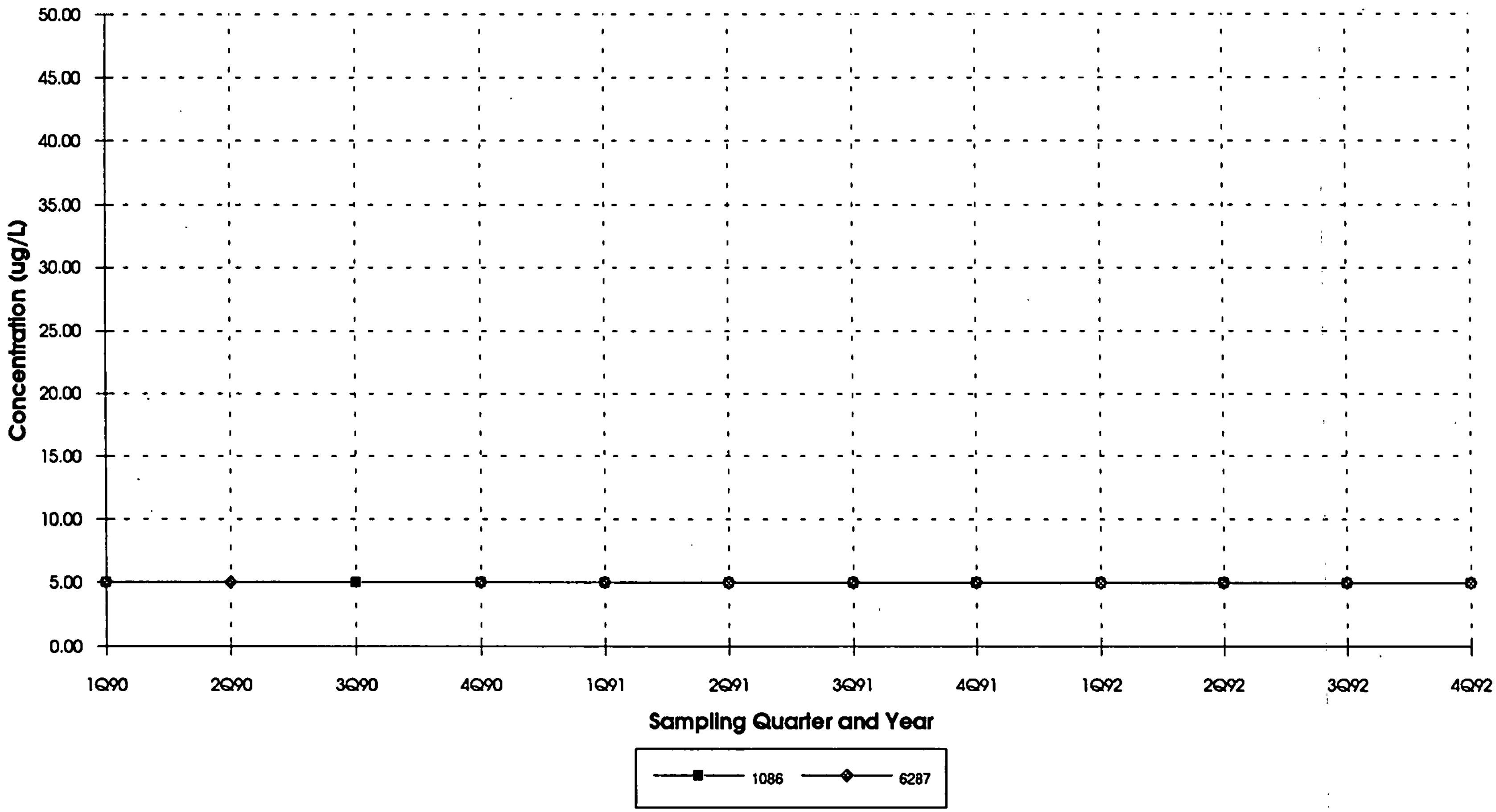
P37\D:\DOCS\ES\COMB\PCUCHLOR.XLC\2/20/93

PRESENT LANDFILL
Upgradiant Wells
Total Dissolved Solids (Combined)

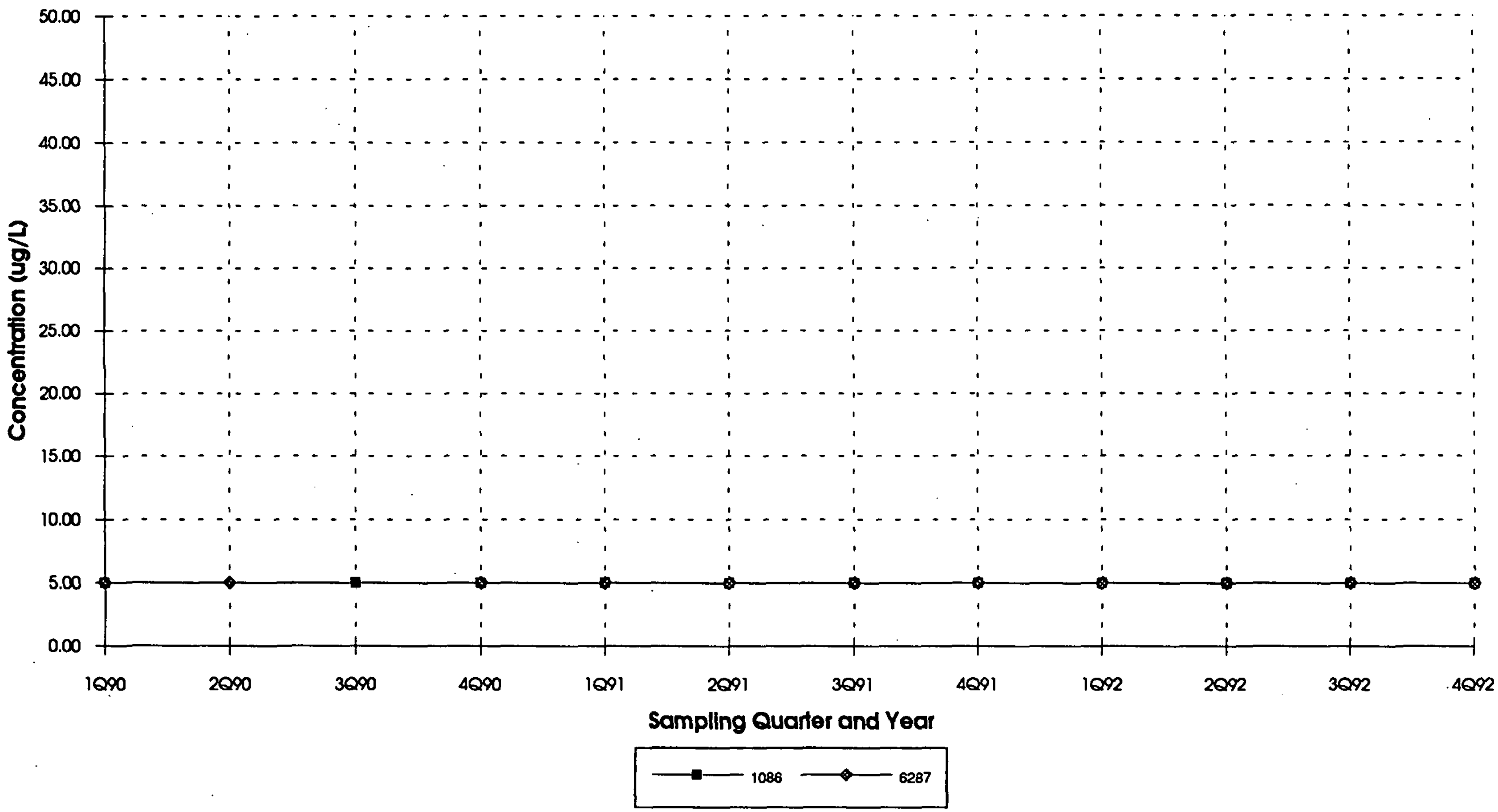


P37\D:\DOCS\ES\COMB\PCUTDS.XLC\2/20/93

PRESENT LANDFILL
Upgradiant Wells
1,2-Dichloroethene (Combined)

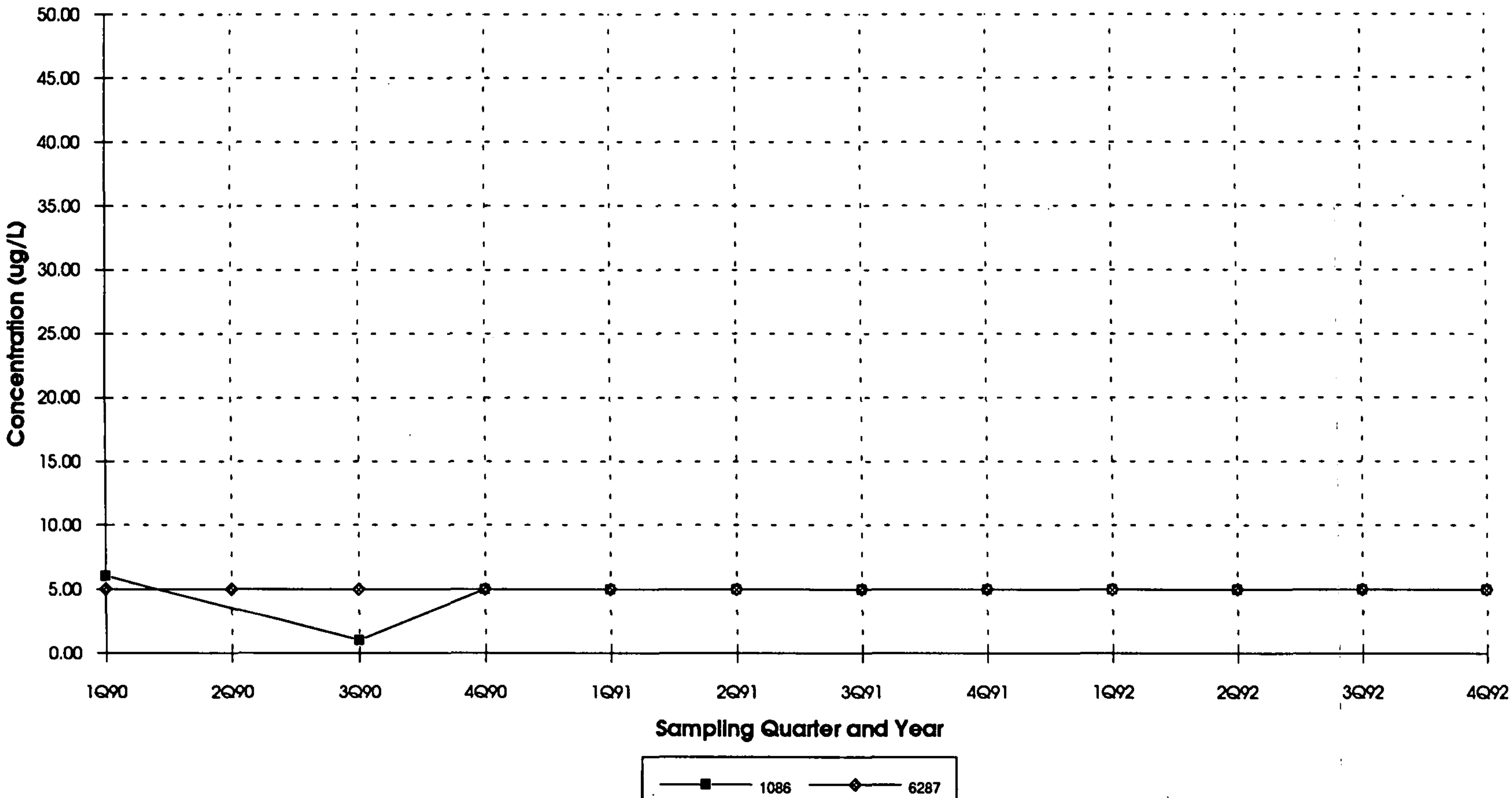


PRESENT LANDFILL
Upgradiant Wells
Trichloroethene (Combined)

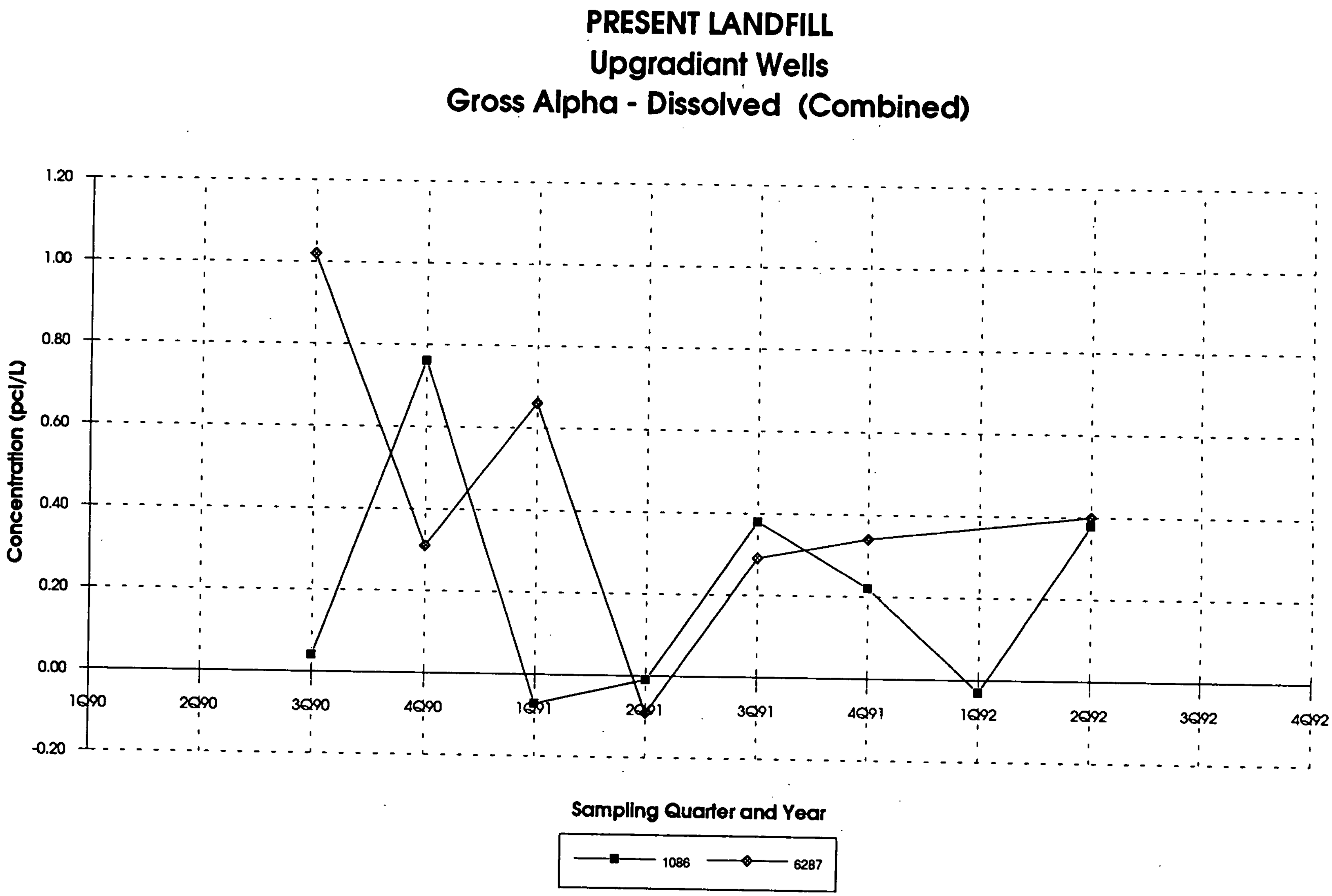


P37\D:\DOCS\ES\COMB\PCUTRI.XLC\2/20/93

PRESENT LANDFILL
Upgradiant Wells
Tetrachloroethene (Combined)

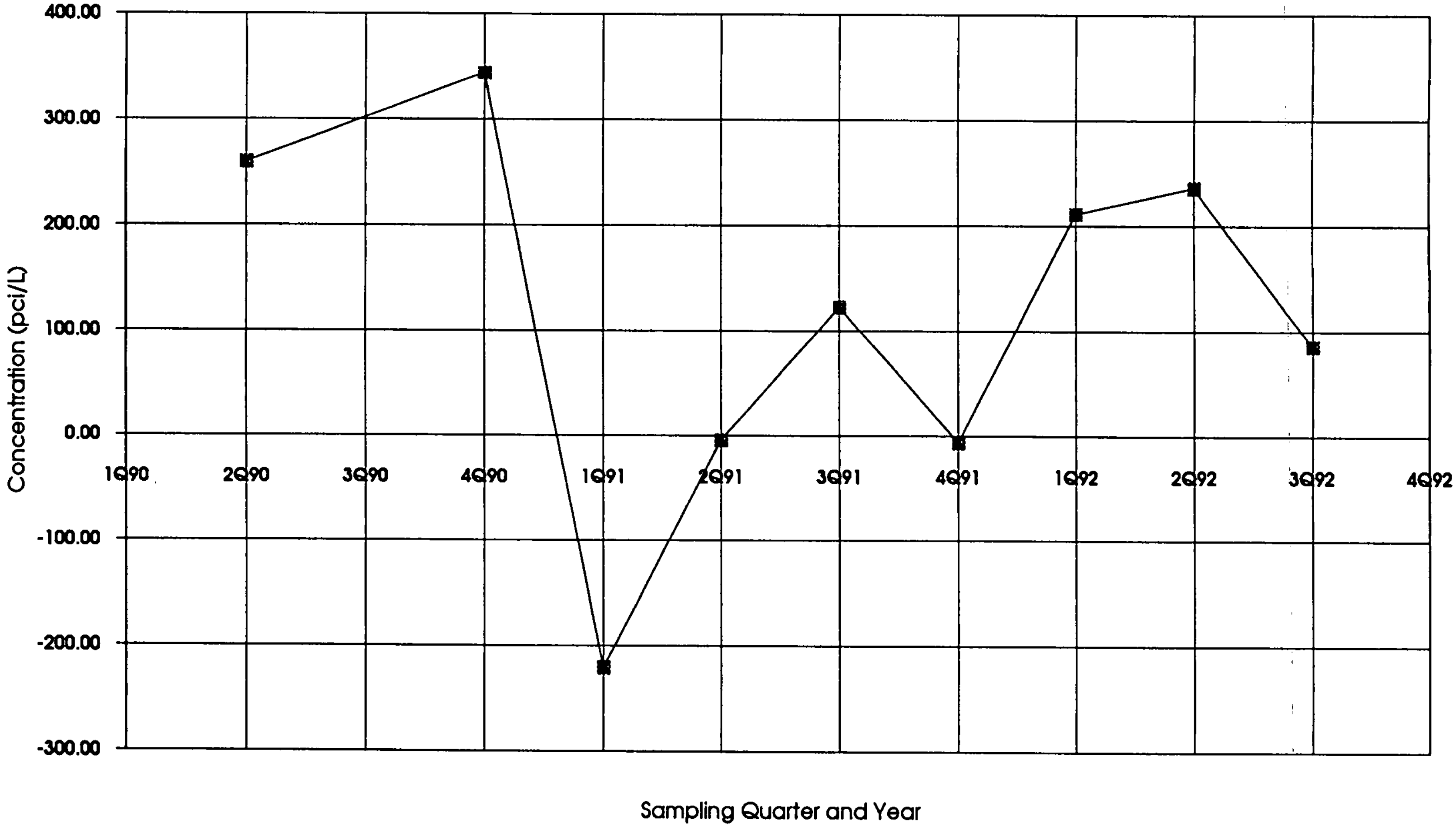


P37\D:\DOCS\ES\COMB\PCUPCE.XLC\2/20/93



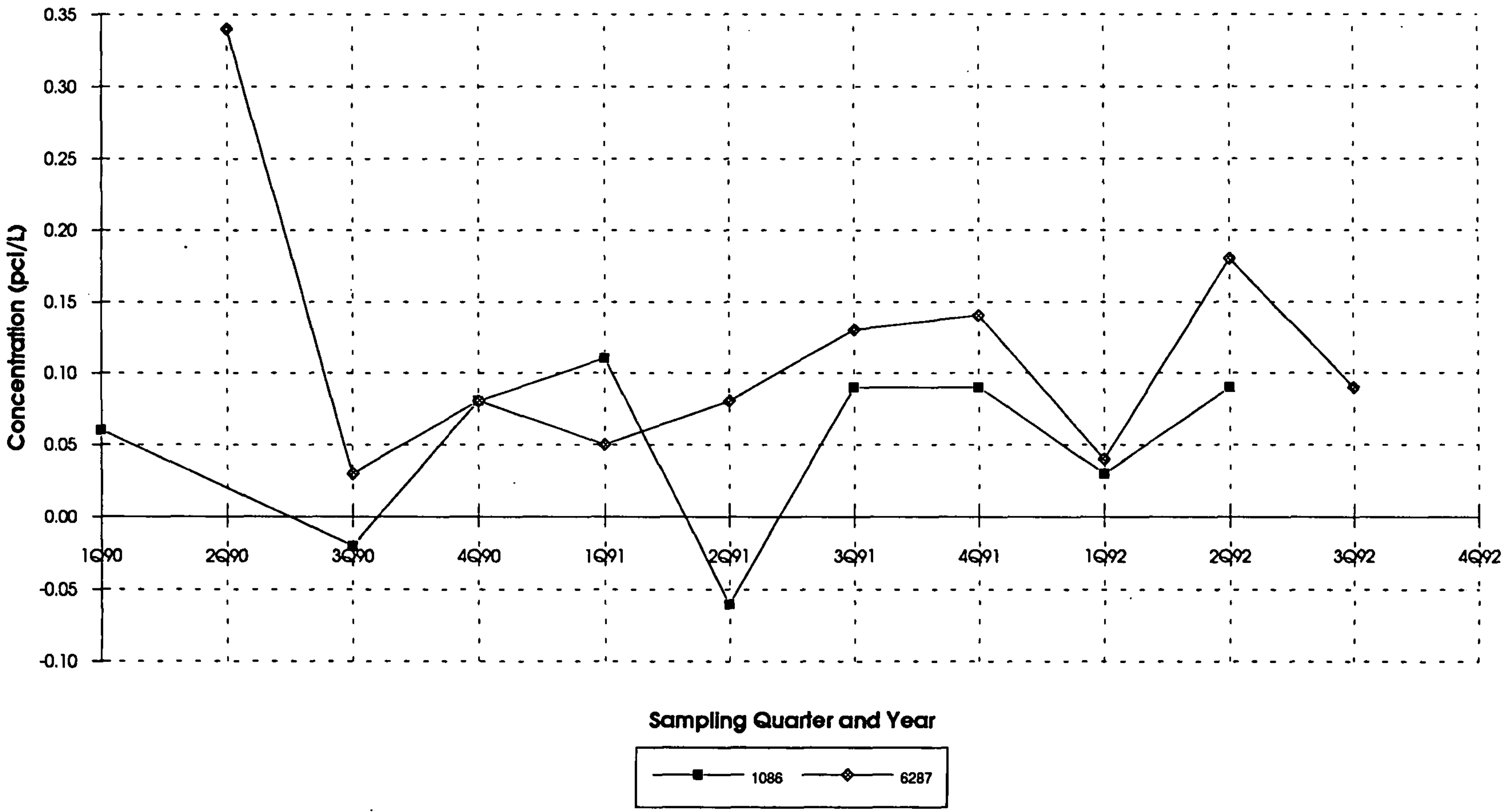
P37\D:\DOCS\ES\COMB\PCUGROSS.XLC\2/20/93

PRESENT LANDFILL
Time Series Plot - 6287 - Tritium



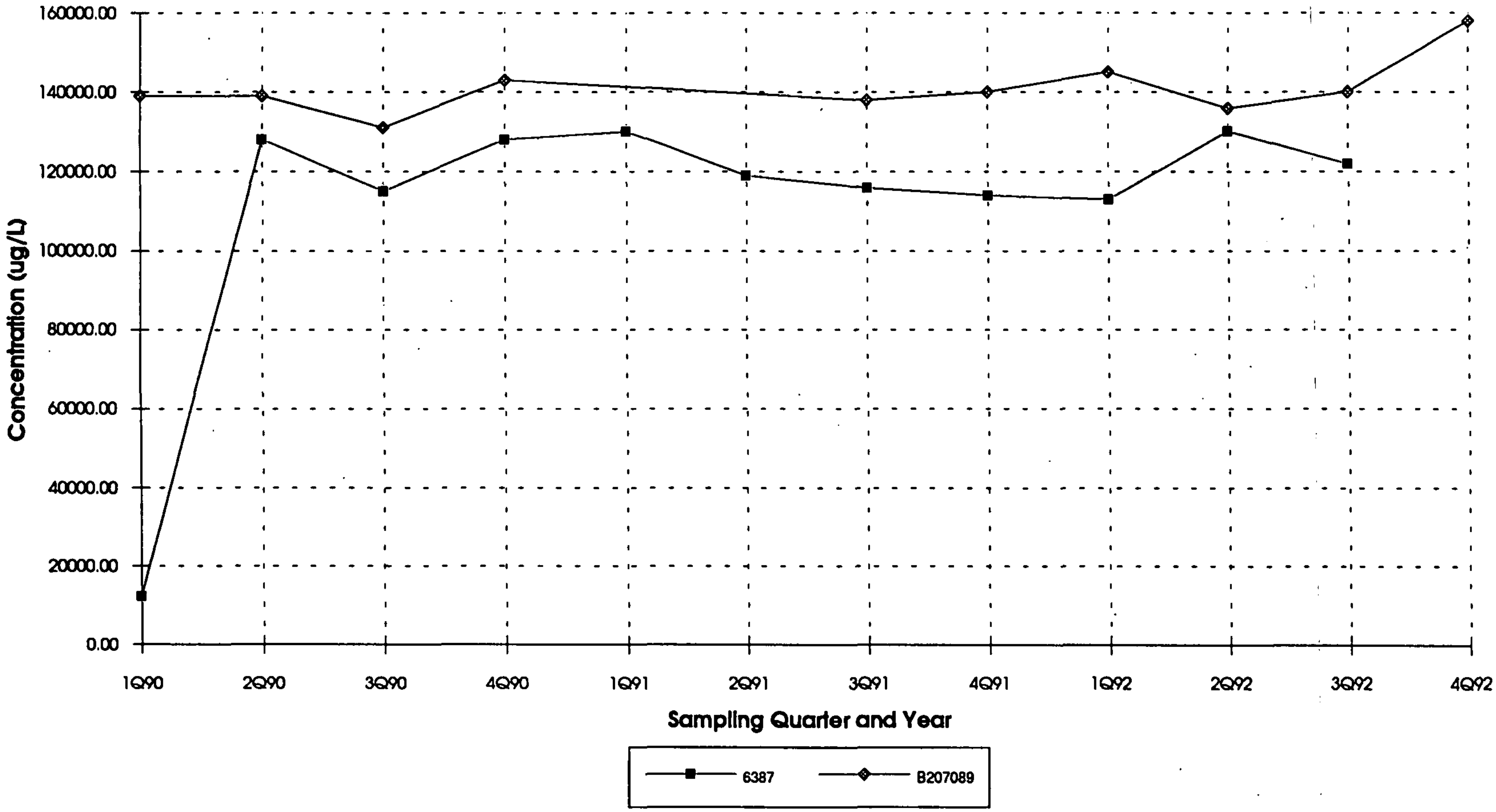
P37\D:\DOCS\ES\TRT6287.XLC\2/16/93

PRESENT LANDFILL
Upgradiant Wells
Uranium-233,-234 (Combined)



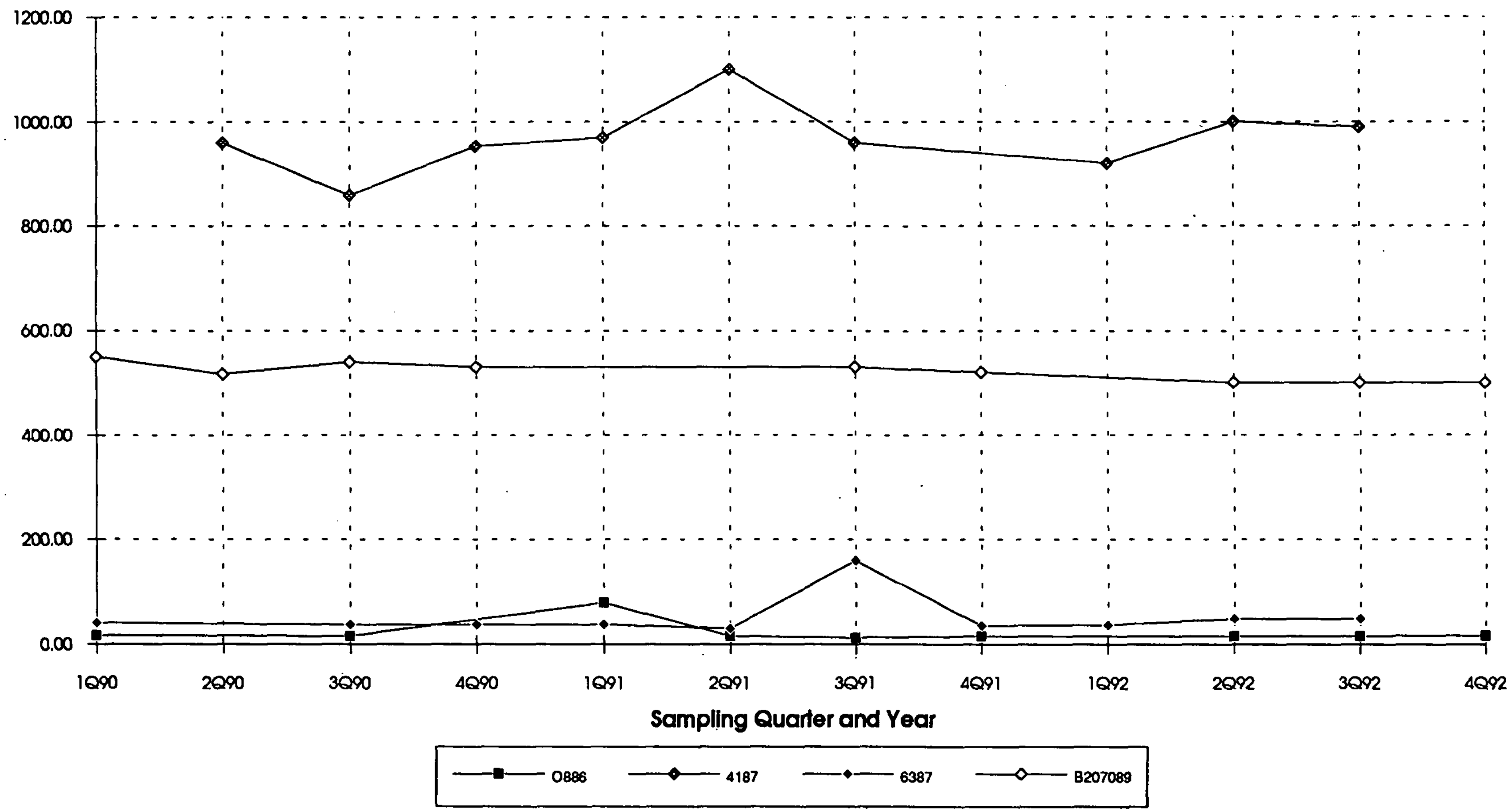
P37\D:\DOCS\ES\COMB\PCUURAN.XLC\2/20/93

PRESENT LANDFILL
Internal & Downgradiant Wells
Calcium (Combined)



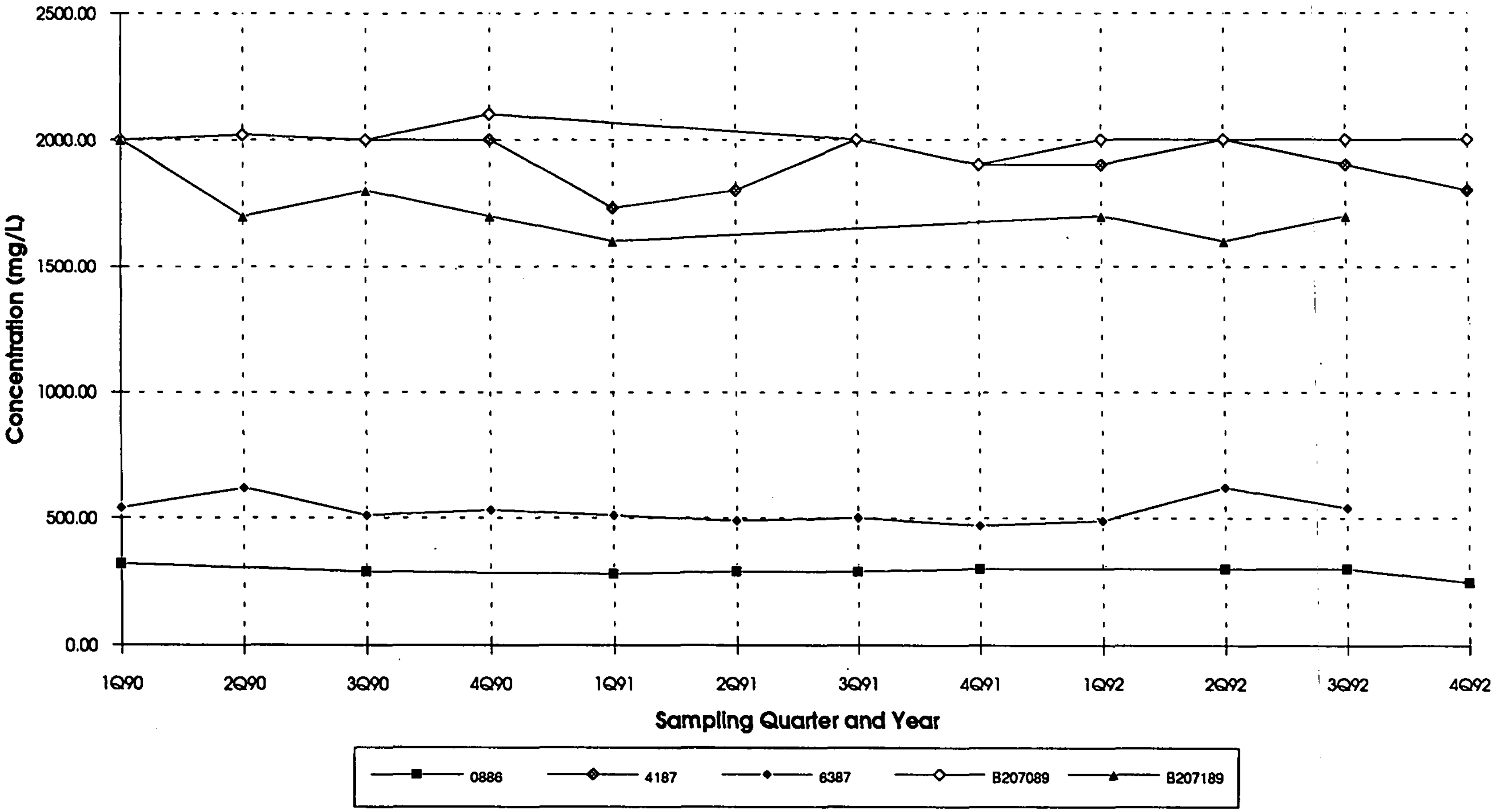
P37\D:\DOCS\ES\COMB\PCICAL.XLC\2/20/93

PRESENT LANDFILL
Internal & Downgradiant Wells
Chloride (Combined)



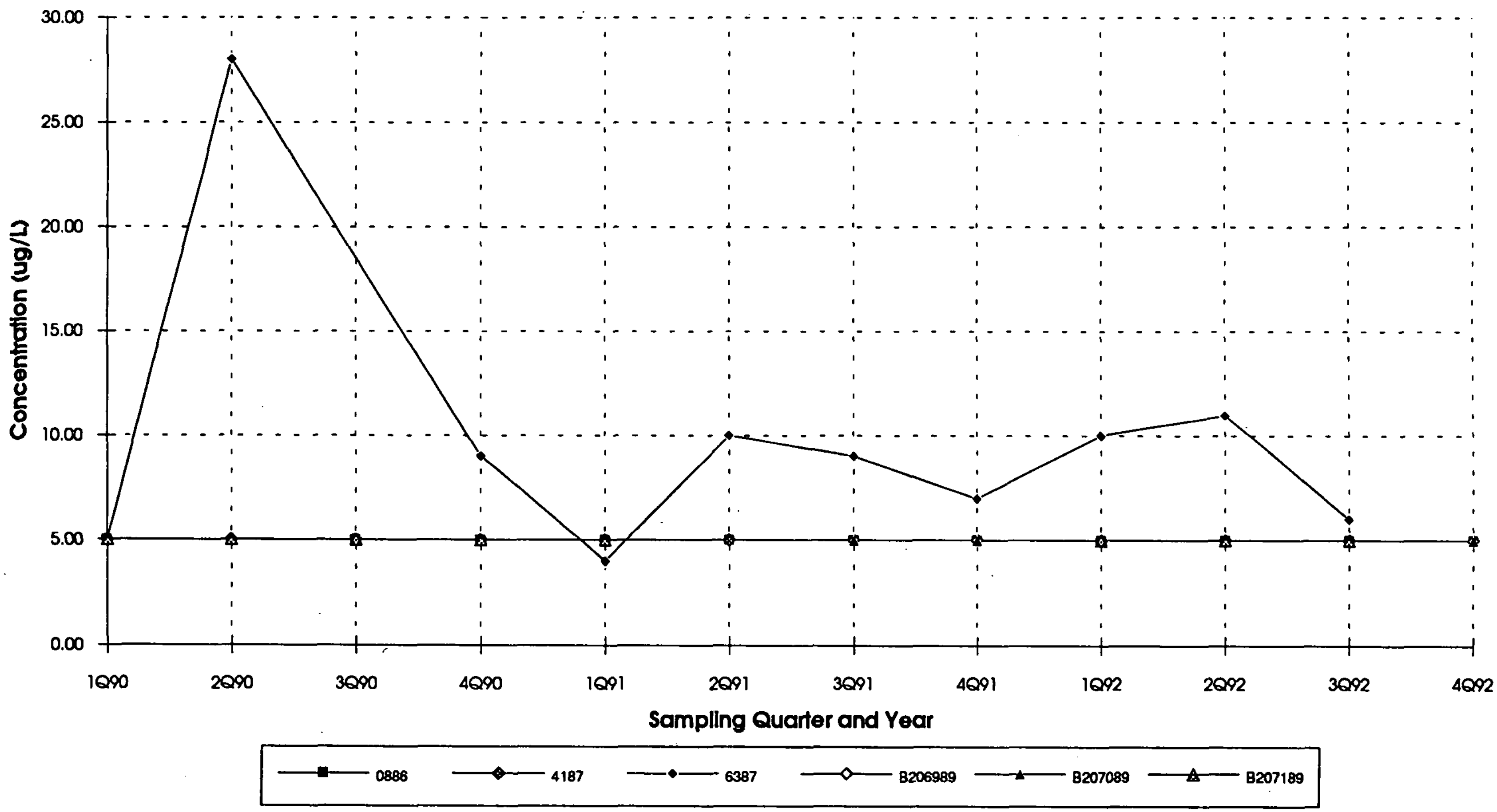
P37\D:\DOCS\ES\COMB\PCICHLOR.XLC\2/20/93

PRESENT LANDFILL
Internal & Downgradiant Wells
Total Dissolved Solids (Combined)



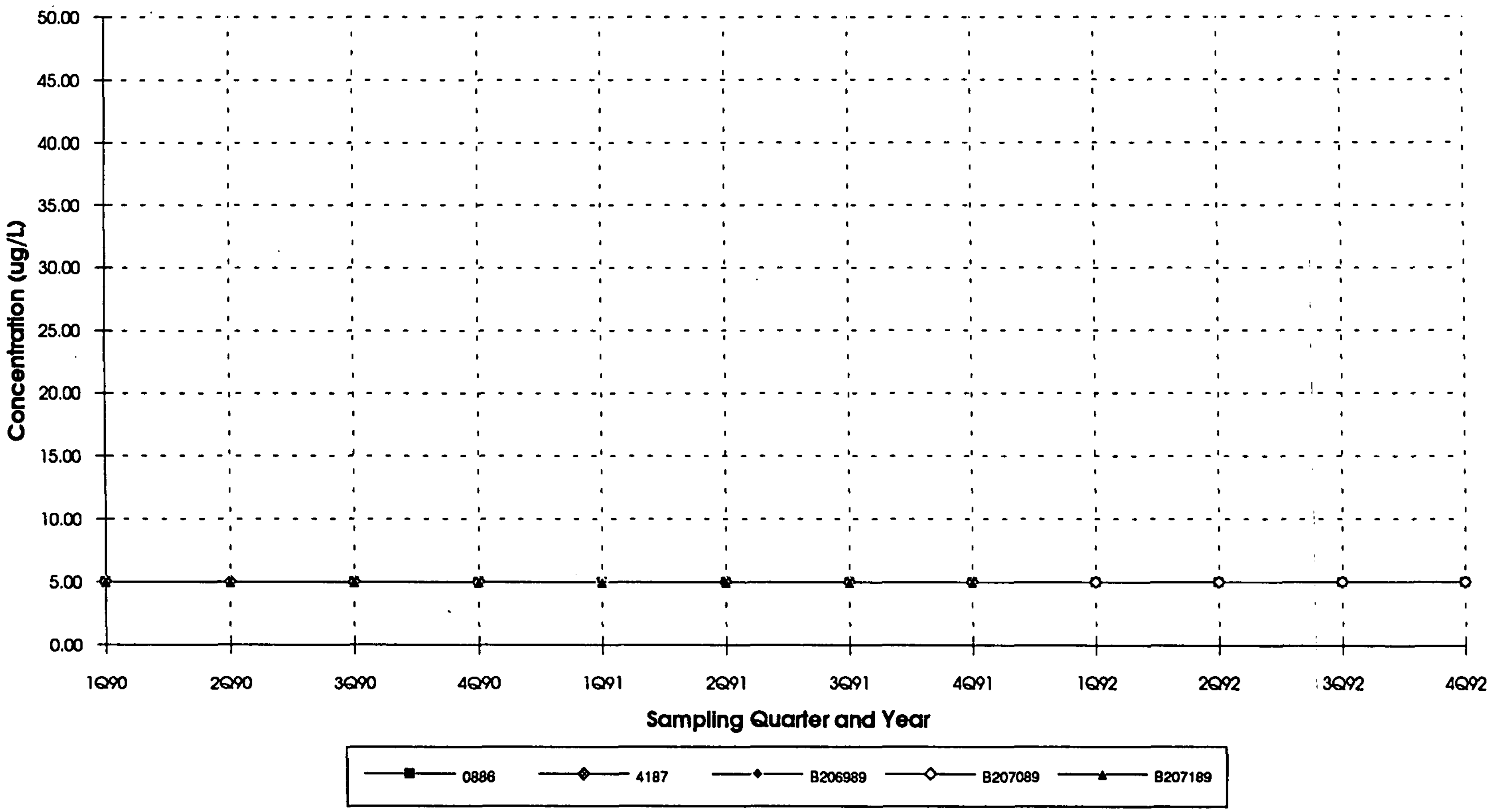
P37\D:\DOCS\ES\COMB\PCITDS.XLC\2/20/93

PRESENT LANDFILL
Internal & Downgradiant Wells
1,2-Dichloroethene (Combined)



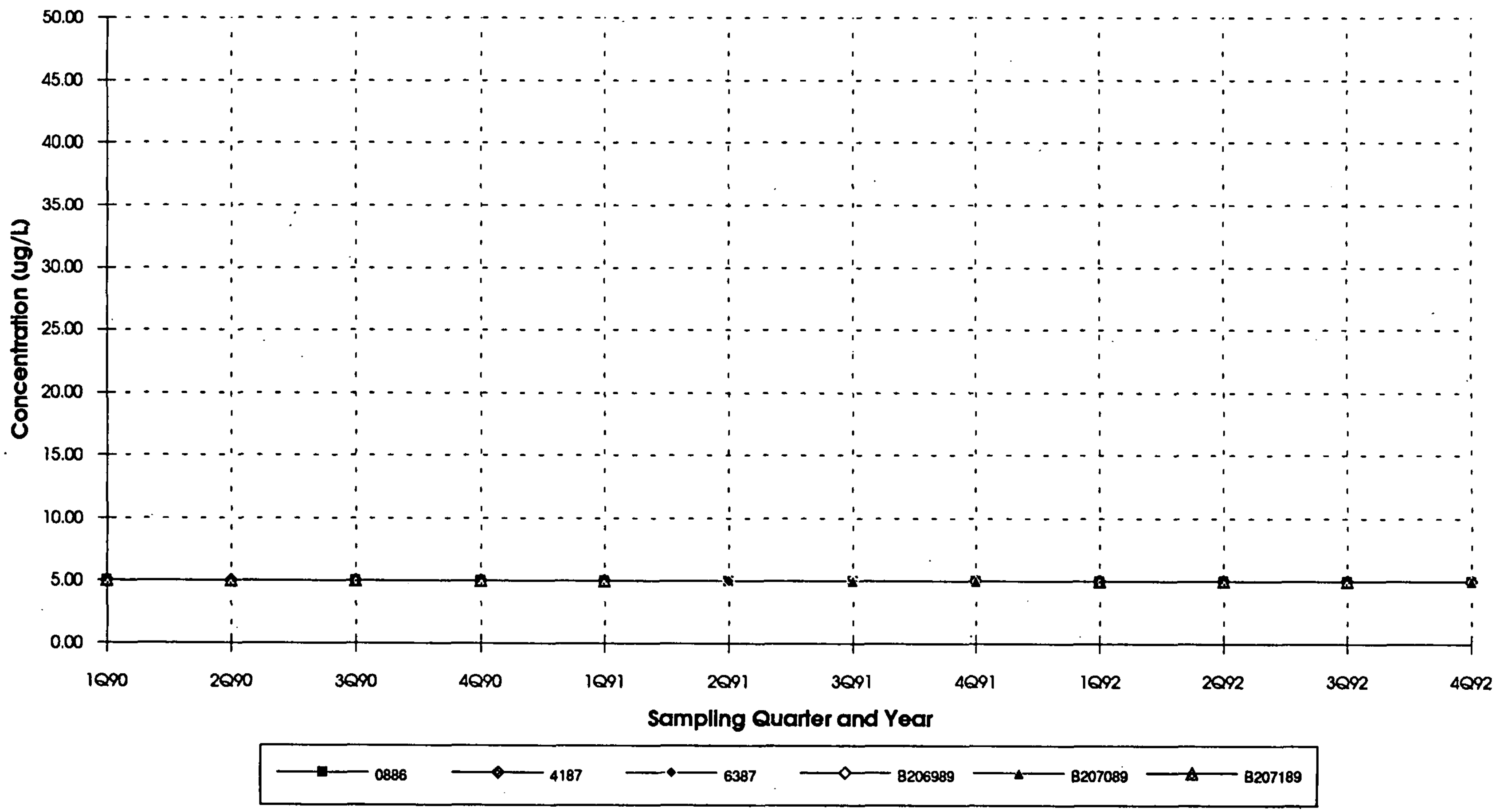
P37\D:\DOCS\ES\COMB\PCIDCE.XLC\2/20/93

PRESENT LANDFILL
Internal & Downgradiant Wells
Trichloroethene (Combined)



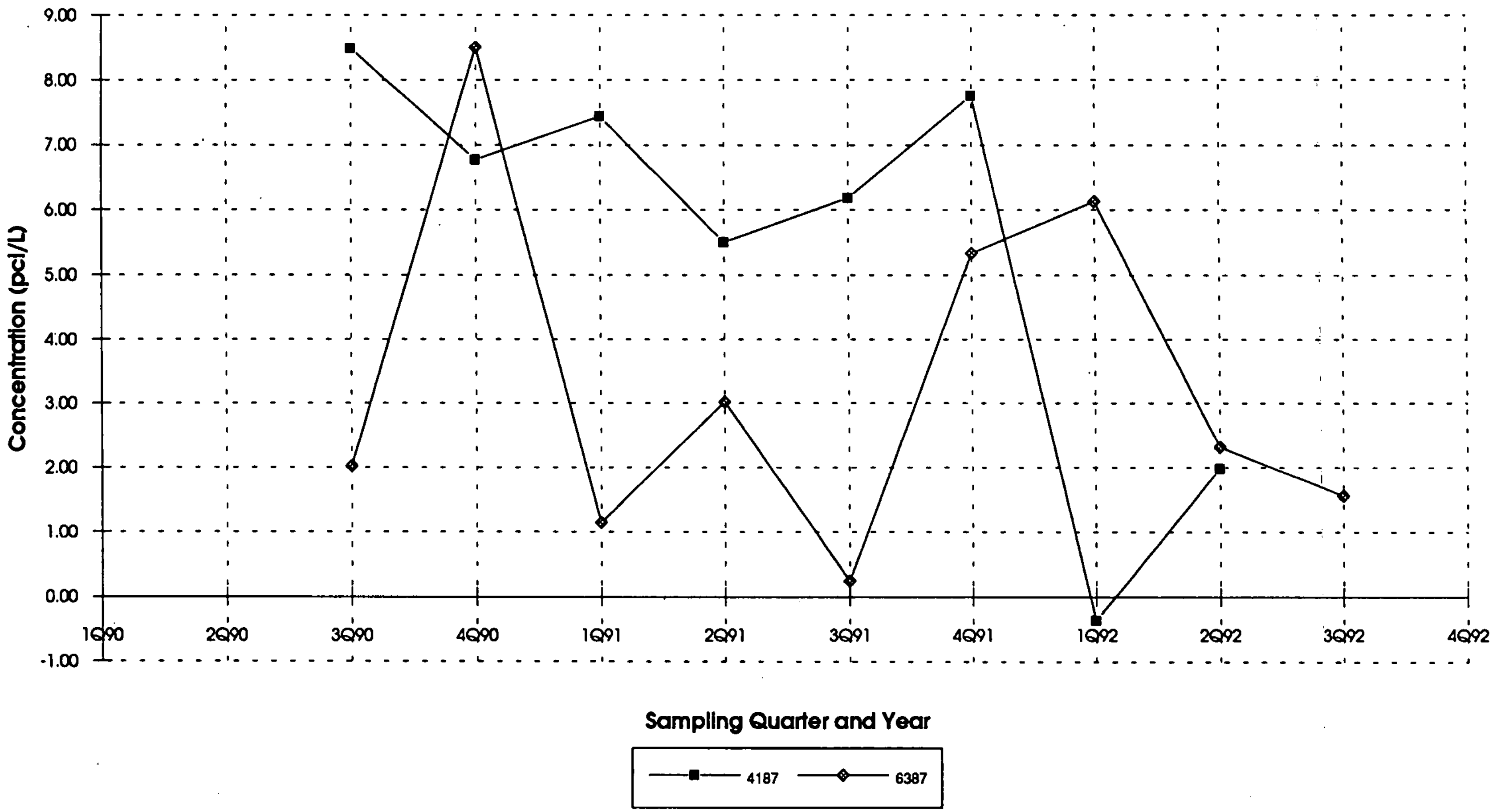
P37\D:\DOCS\ES\COMB\PCITRI.XLC\2/20/93

PRESENT LANDFILL
Internal & Downgradiant Wells
Tetrachloroethene (Combined)



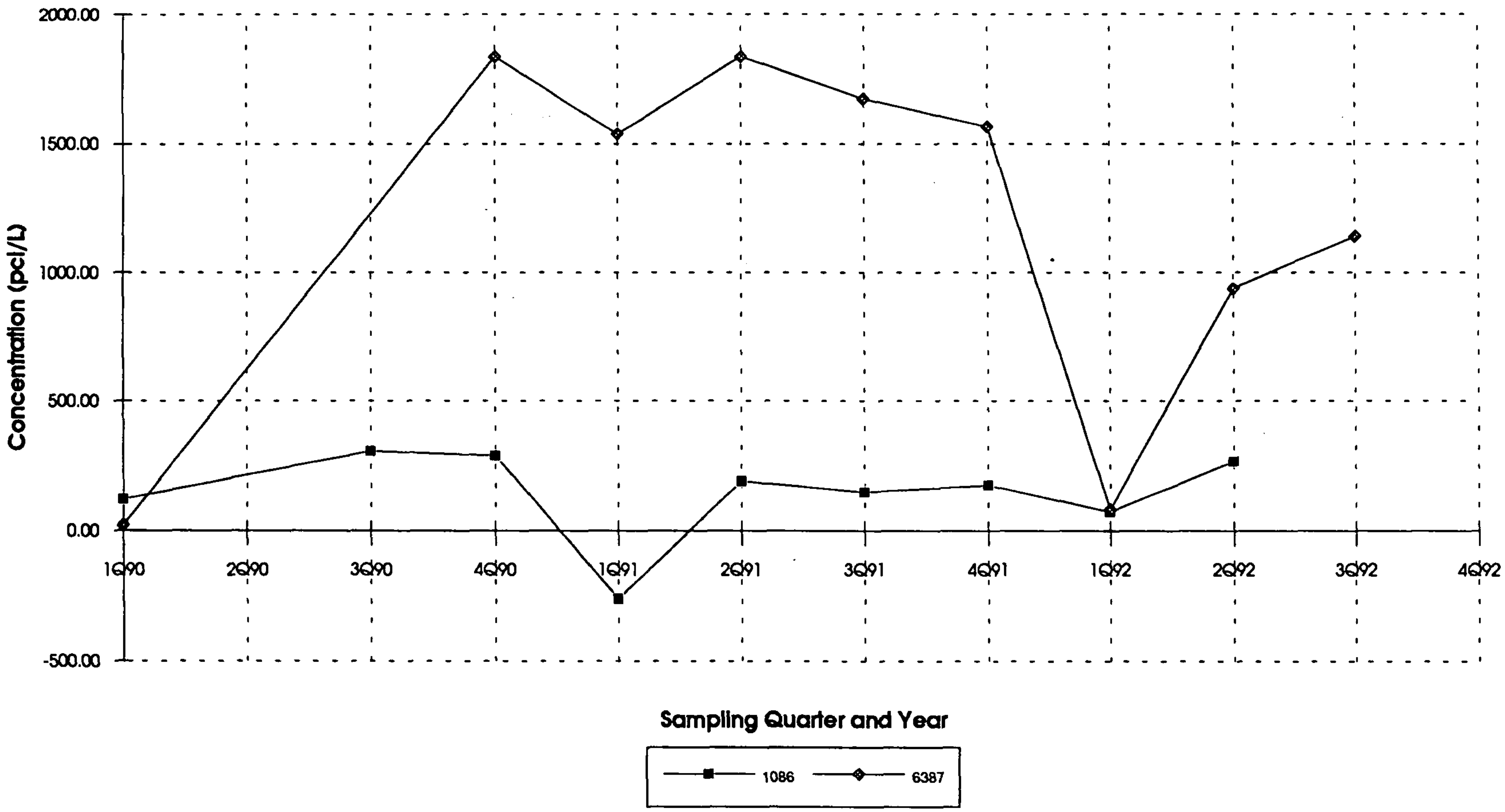
P37\D:\DOCS\ES\COMB\PCIPCE.XLC\2/20/93

PRESENT LANDFILL
Internal & Downgradiant Wells
Gross Alpha - Dissolved (Combined)



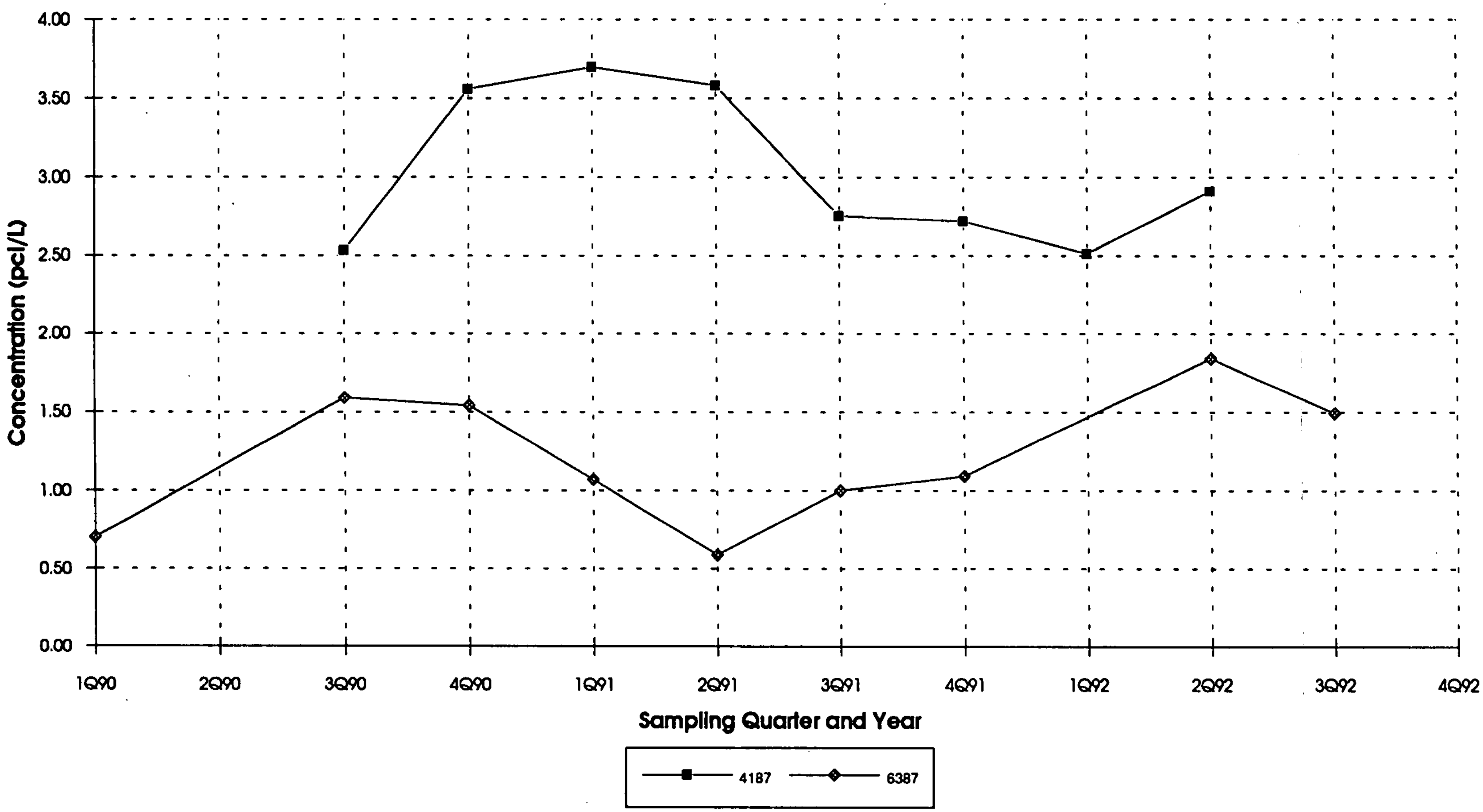
P37\D:\DG...\ES\COMB\PCIGROSS.XLC\2/20/93

PRESENT LANDFILL
Internal & Downgradiant Wells
Tritium (Combined)



P37\D:\DOCS\ES\COMB\PCITRIT.XLC\2/20/93

PRESENT LANDFILL
Internal & Downgradiant Wells
Uranium-233, -234 (Combined)

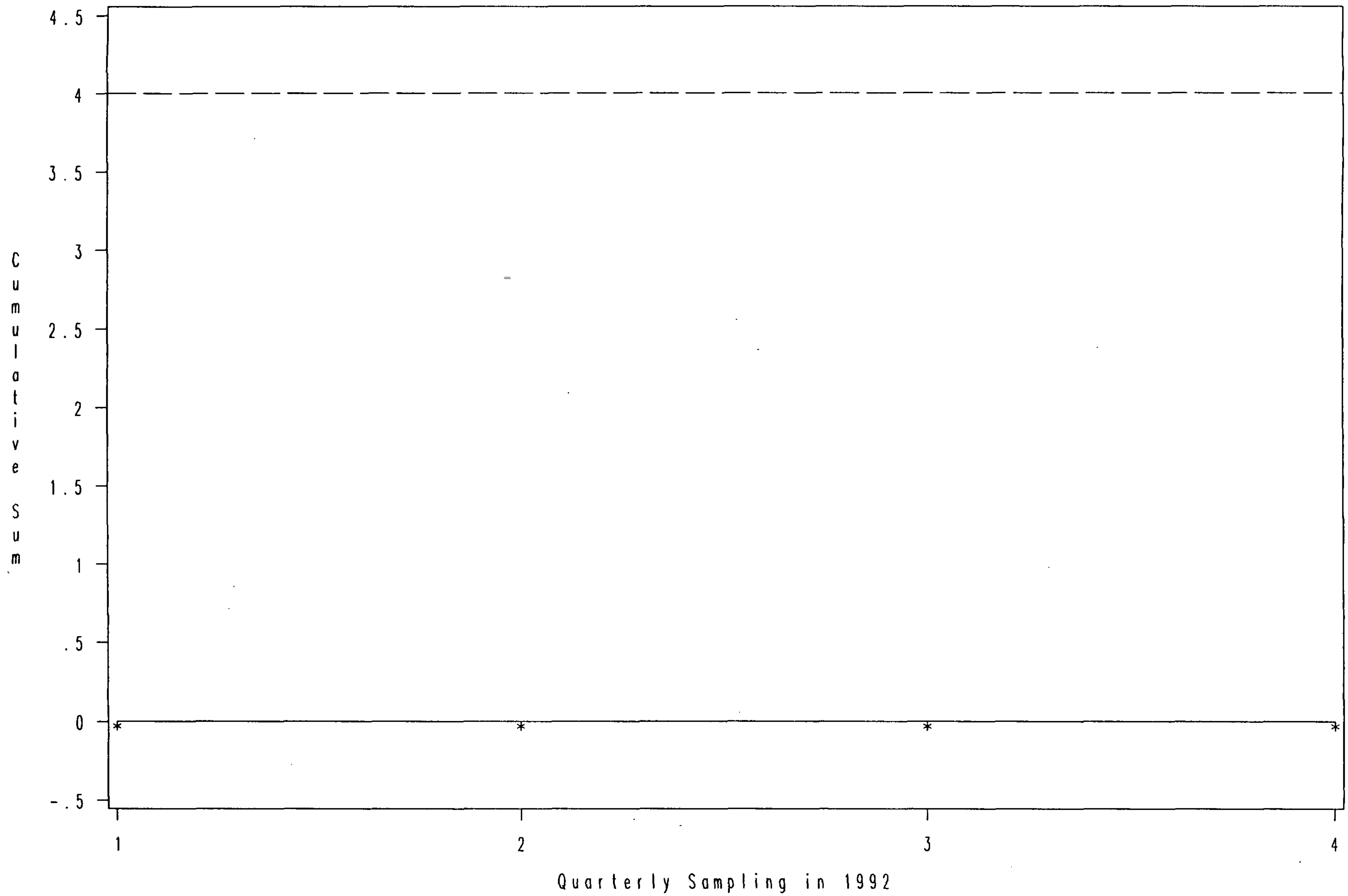


P37\D:\DOCS\ES\COMB\PCIURAN.XLC\2/20/93

APPENDIX F

Cumulative Sum (CUSUM) Control Charts for Groundwater Monitoring Wells 5887 and 0986

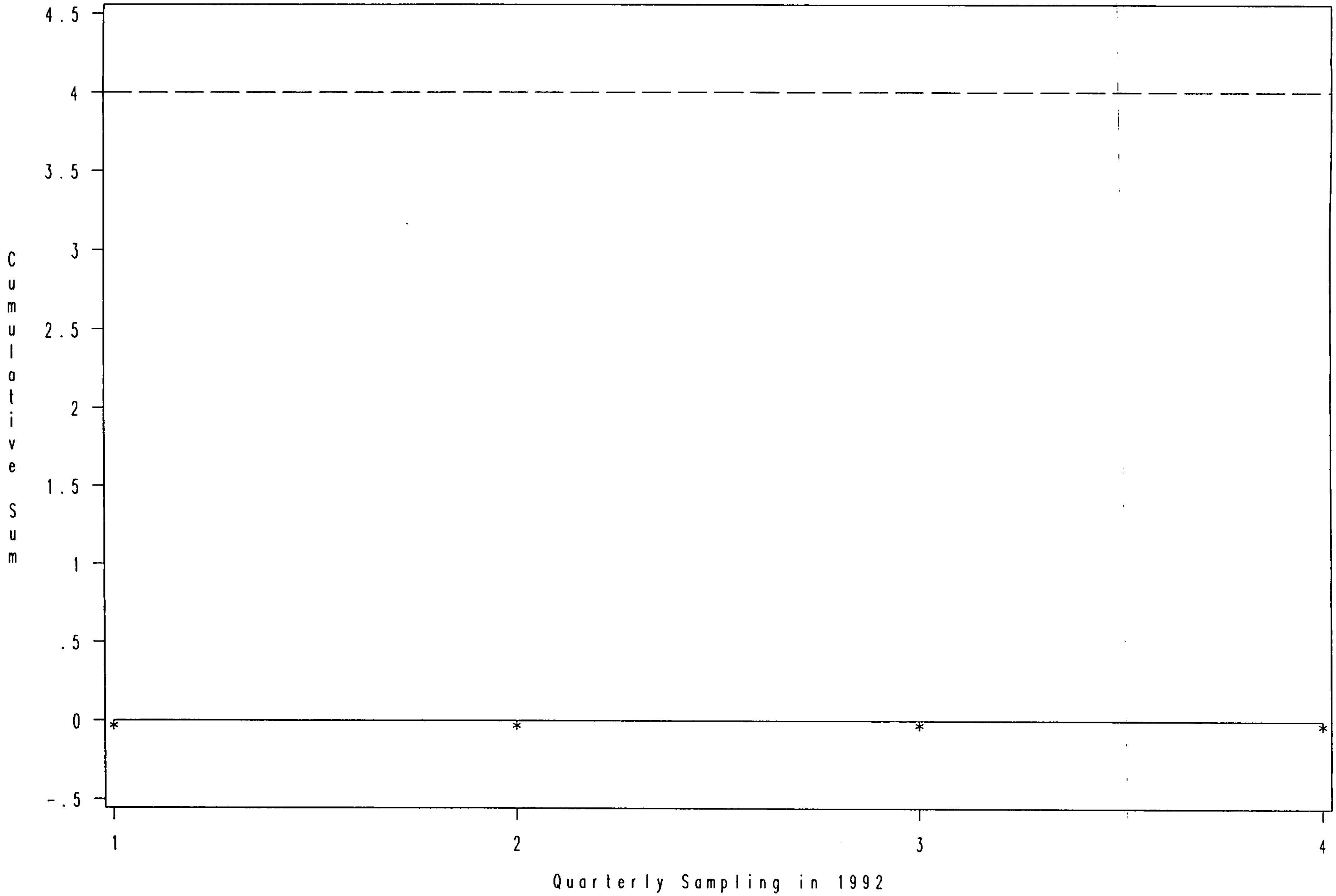
5887 – C●RBONATE



Subgroup Sizes: * n=1
Parameters: μ_o=4.263638 δ=2 h=4

Log Transformed

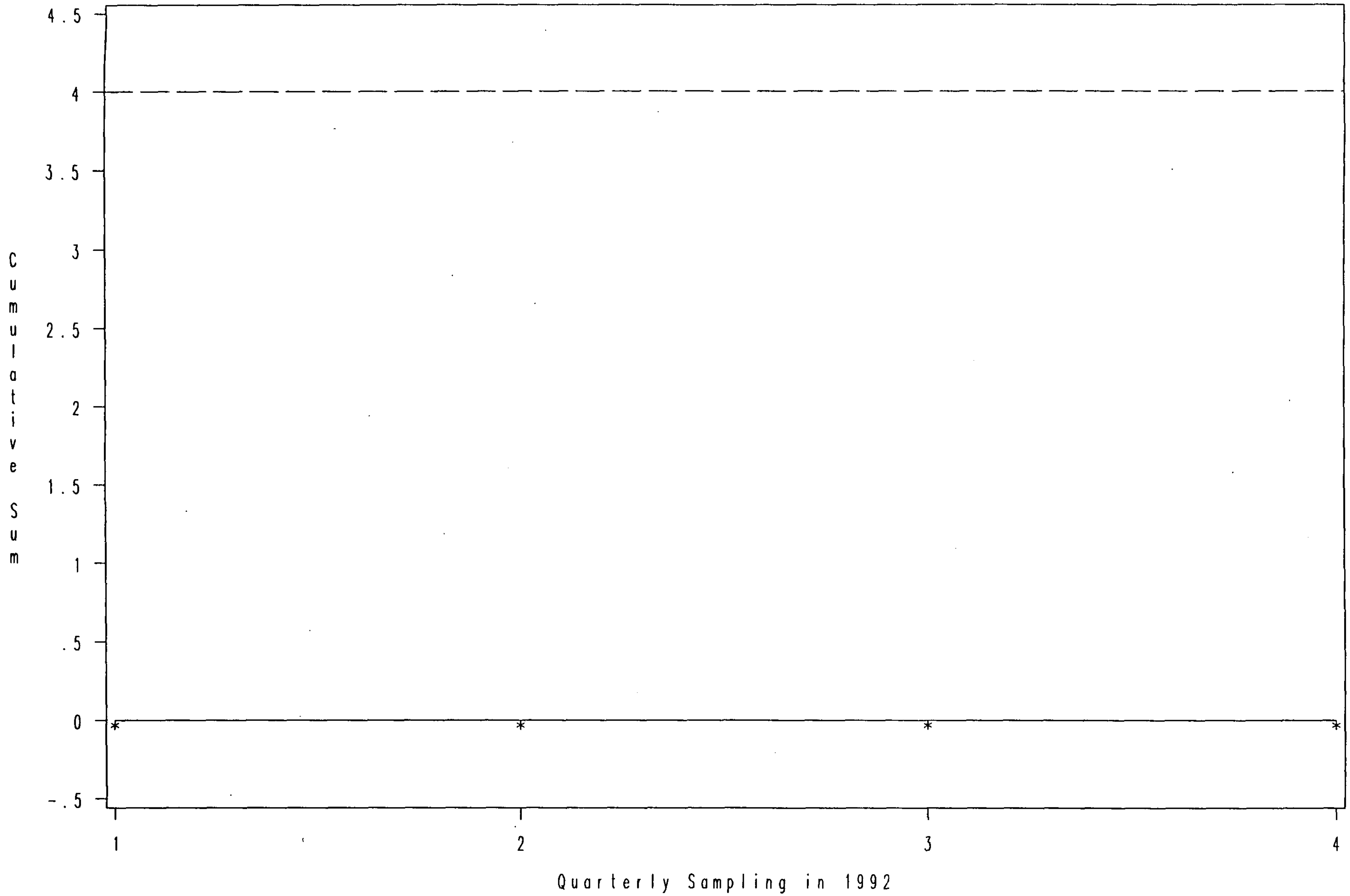
5887 - SULFATE



Subgroup Sizes: * n=1
Parameters: μ_o=3.453452 δ=2 h=4

Log Transformed

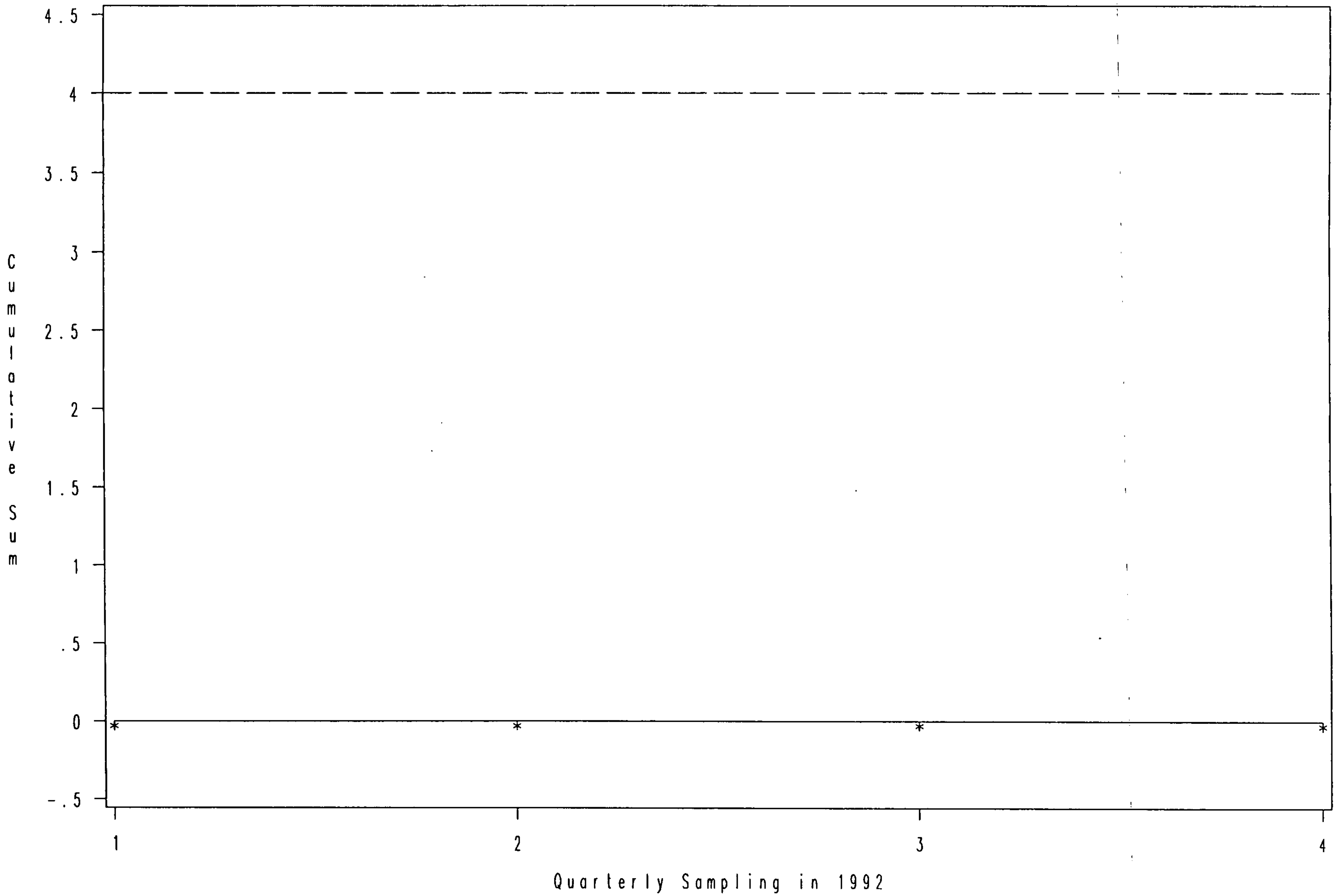
5887 – TOTAL DISSOLVED SOLIDS



Subgroup Sizes: * n=1
Parameters: μ_0=5.184715 δ=2 h=4

Log Transformed

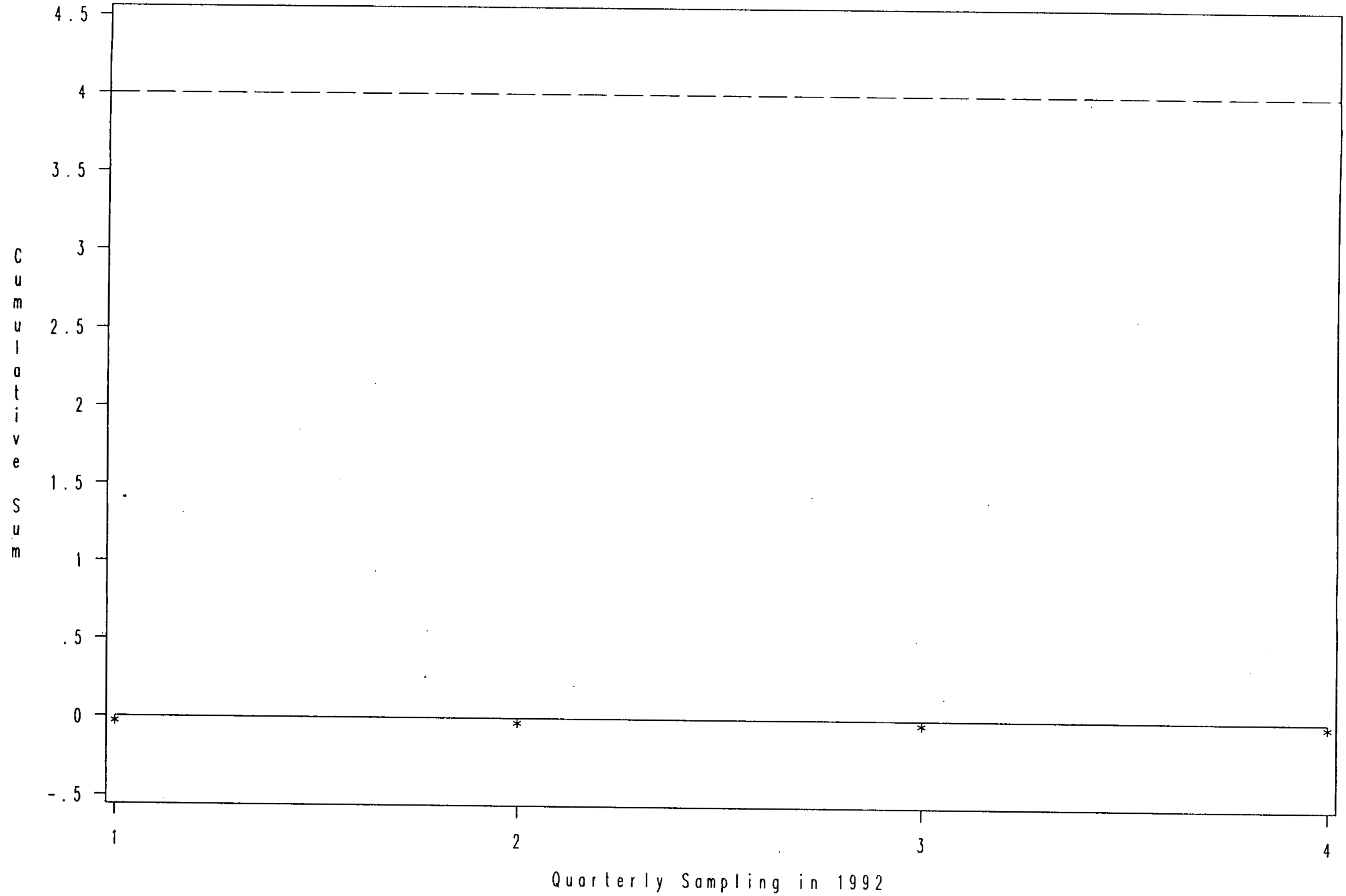
5887 – NITRATE/NITRITE



Subgroup Sizes: * n=1
Parameters: μ_0=3.579286 δ=2 h=4

Untransformed

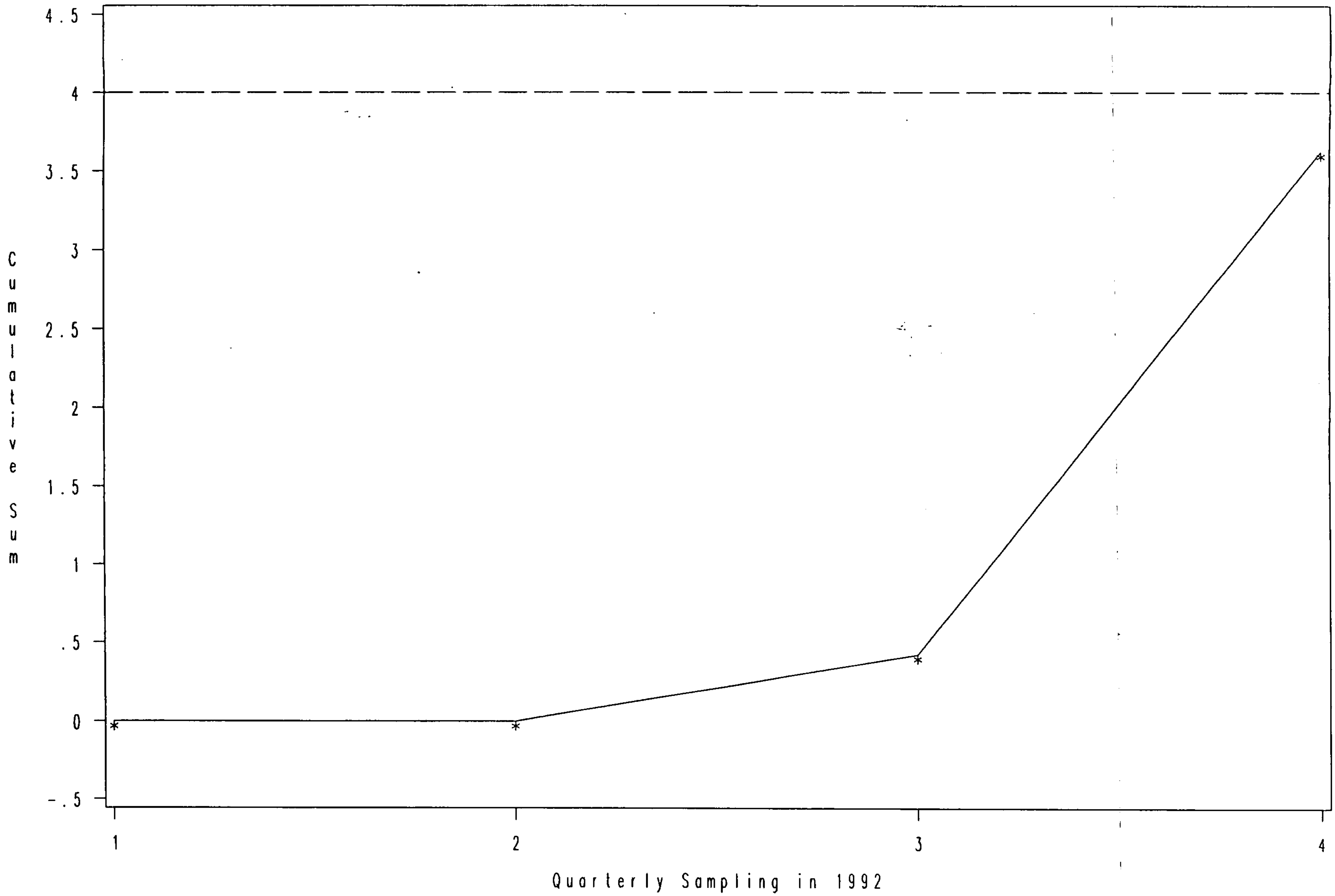
0986 – CARBONATE



Subgroup Sizes: * n=1
Parameters: μ_o=5.286564 δ=2 h=4

Log Transformed

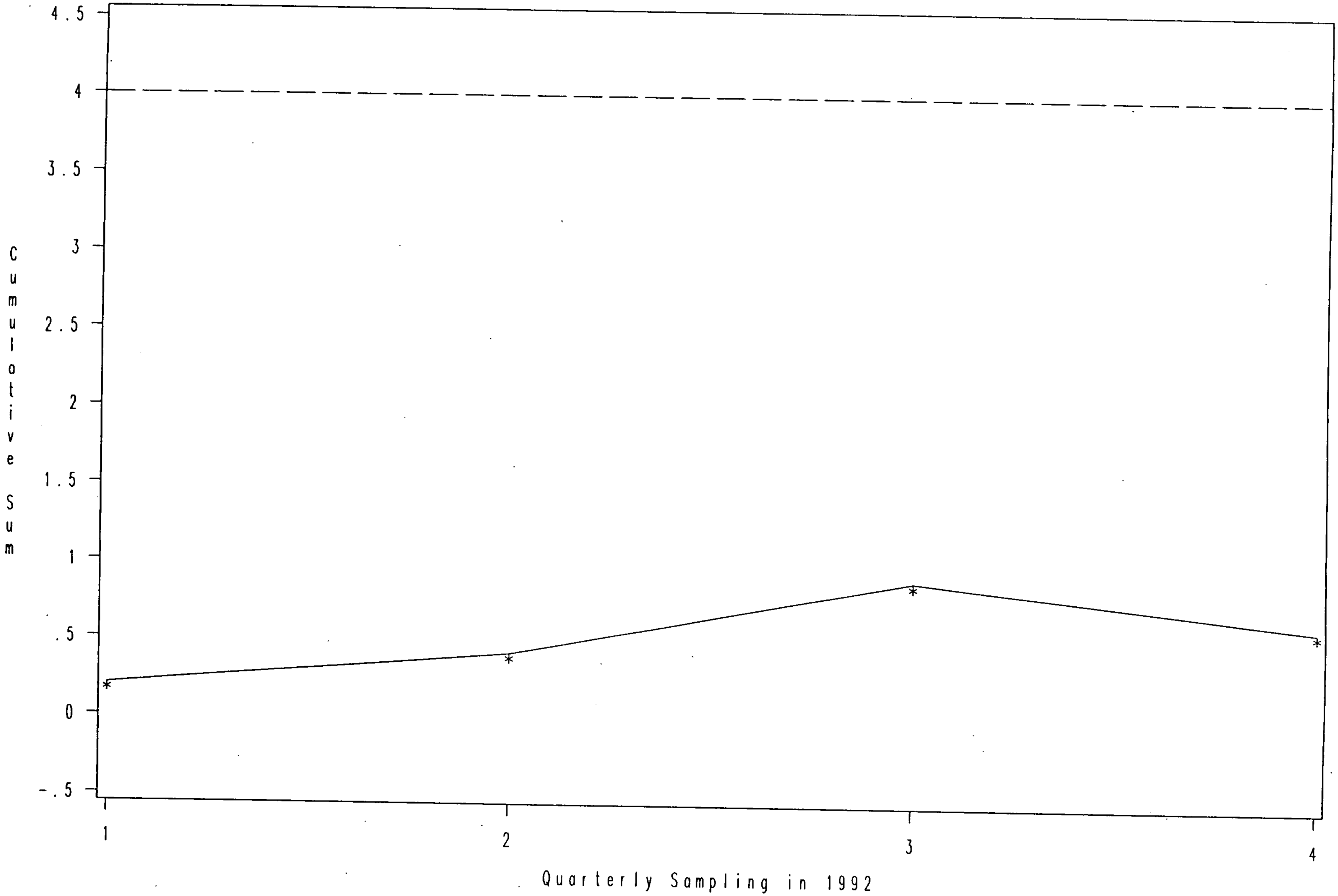
0986 – TOTAL DISSOLVED SOLIDS



Subgroup Sizes: * n=1
Parameters: μ_0=5.518645 δ=2 h=4

Log Tr[illegible]formed

0986 – CHLORIDE



Subgroup Sizes: * n=1
Parameters: μ_o=10.286 δ=2 h=4

Untransformed

165/165

APPENDIX A-2

Groundwater Elevation Data Summary for the Solar Evaporation Ponds - Weathered Bedrock, 1992

APPENDIX A-1

Groundwater Elevation Data Summary for the Solar Evaporation Ponds - Surficial Materials, 1992

A-1 Groundwater Elevation Data Summary for the Solar Evaporation Ponds - Surficial Materials, 1992

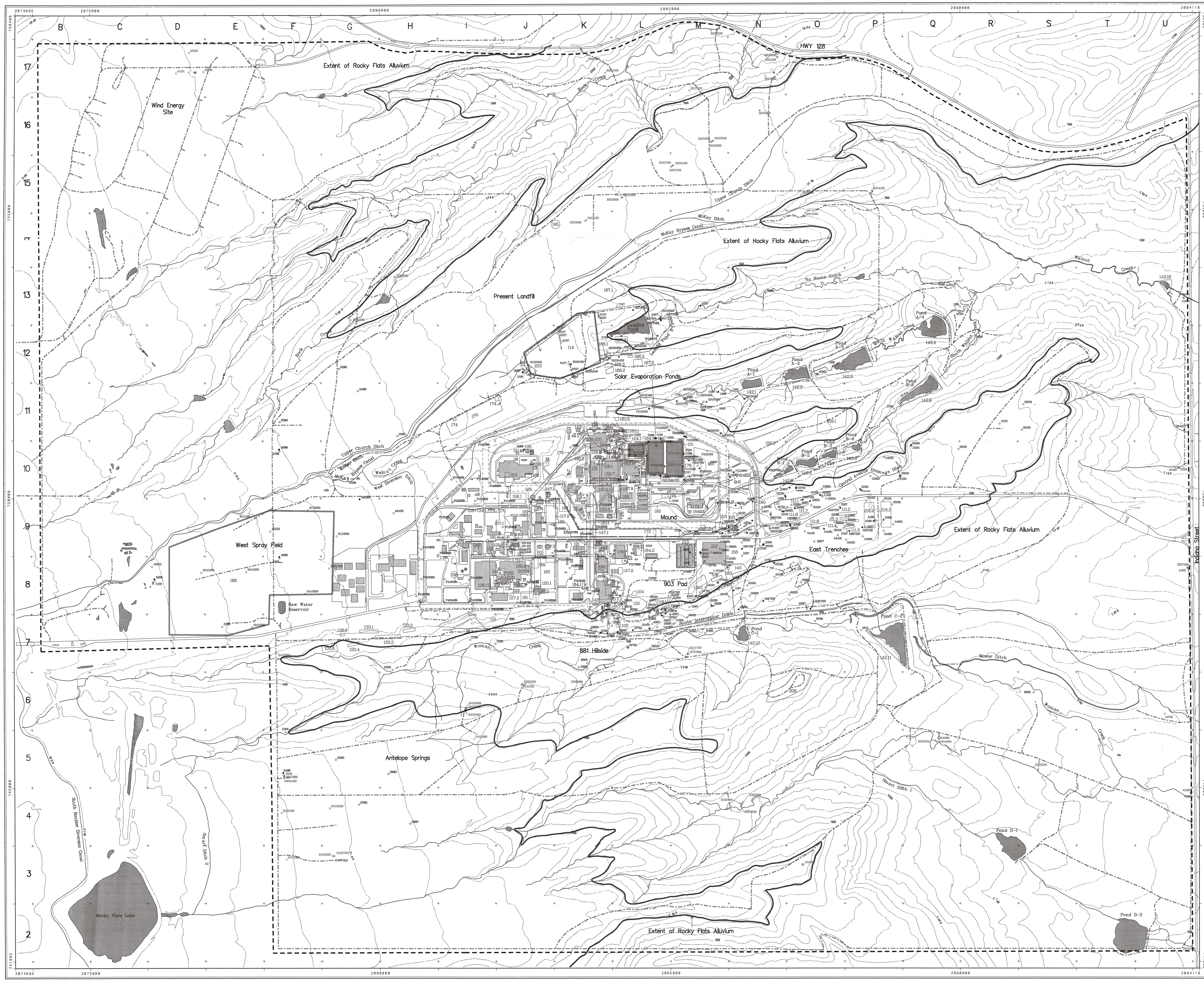
Well ID	First Quarter 1992 Jan	Feb	Mar	Second Quarter 1992 Apr	May	Jun	Third Quarter 1992 Jul	Aug	Sep	Fourth Quarter 1992 Oct	Nov	Dec
0487	5897.19	5897.23	5897.64	5901.81	5901.81	5901.65	5899.71	5900.54	5900.72	5900.00	5899.21	5898.68
1386	5839.19	5837.54	5837.45	5838.21	5837.05	5836.89	5836.48	5832.10	5832.97	5834.48	5835.86	5837.06
1586	5843.73	-----	-----	5845.01	-----	-----	5843.61	-----	-----	5843.47	-----	-----
1786	5862.95	5862.92	5864.15	5864.20	5863.13	5863.49	5863.03	5862.82	5863.24	5862.96	5863.13	5863.23
1886	--Dry--	--Dry--	5877.97	5879.14	--Dry--	--Dry--	5878.01	5878.00	5878.00	--Dry--	--Dry--	--Dry--
1987	--Dry--	-----	-----	5962.97	5959.53	-----	5956.86	-----	-----	5956.19	-----	-----
2187	5919.98	5920.61	-----	5919.45	-----	-----	5922.02	-----	-----	5921.85	-----	-----
2286	5969.76	-----	-----	5972.43	-----	-----	5970.89	-----	-----	5969.52	-----	-----
2486	--Dry--	5974.91	--Dry--	5976.01	--Dry--	5974.85	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--	5975.83
2686	5965.56	5965.41	5965.17	5967.21	5966.24	5966.08	5965.85	5965.48	5965.64	5965.17	5964.81	5965.10
2886	5956.27	5955.92	5955.48	5959.63	5958.36	5957.99	5957.09	5956.26	5956.55	5955.55	-----	5957.81
2986	--Dry--	--Dry--	--Dry--	5953.25	5950.79	5950.31	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--
3386	-----	-----	--Dry--	5946.45	-----	-----	5944.12	-----	-----	5943.74	-----	-----
3586	5903.94	-----	-----	5906.61	-----	5905.06	5904.50	5903.87	5903.68	5902.89	5903.54	5903.91
3686	5877.13	-----	-----	5879.82	-----	5879.49	5879.02	5877.30	5877.25	5877.08	--Dry--	--Dry--
3787	5960.98	5960.56	5959.84	5963.07	5962.32	-----	5961.81	5960.60	5960.76	5959.50	5958.96	5959.74
3887	5963.73	-----	-----	5965.43	-----	-----	5963.99	5963.08	-----	5962.75	-----	-----
5687	5971.53	5970.54	5970.69	5972.69	5972.02	5972.02	5972.13	5970.63	5971.35	5971.29	5970.29	5970.44
B208089	5923.72	5923.44	5923.40	5925.50	5924.63	5924.40	5924.37	5924.07	5925.04	5923.85	5923.64	5923.38
B208389	--Dry--	-----	-----	--Dry--	-----	-----	--Dry--	-----	-----	--Dry--	-----	-----
B208589	5853.73	-----	-----	5854.96	-----	-----	5852.65	-----	-----	--Dry--	-----	-----
B208789	5899.48	5895.62	5895.76	5905.20	5902.96	5902.82	5902.69	5895.74	5899.17	5899.26	5895.30	5895.40
B210489	5853.88	5854.14	5853.84	5855.34	5853.75	5853.78	5852.79	5852.09	5852.72	5852.29	5853.14	5853.68
B213789	--Dry--	-----	-----	5913.44	-----	-----	--Dry--	-----	-----	--Dry--	-----	-----
P207489	5975.47	5975.92	5975.88	5976.34	5975.58	-----	5975.72	5974.88	5975.17	5974.11	5974.44	5975.54
P207689	5959.64	-----	-----	5961.03	-----	-----	5960.16	-----	-----	5959.14	-----	-----
P207889	5958.71	-----	-----	5960.65	-----	-----	5958.61	-----	-----	5954.82	-----	-----
P209289	5968.73	--Dry--	--Dry--	5969.69	--Dry--	5969.03	5968.73	--Dry--	5969.05	5968.80	--Dry--	--Dry--
P209789	5956.52	-----	-----	5960.24	-----	-----	5957.67	-----	-----	5954.89	-----	-----
P209989	--Dry--	--Dry--	--Dry--	5890.11	5888.93	--Dry--	5888.62	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--
P213989	--Dry--	-----	-----	--Dry--	-----	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--	--Dry--
P218089	5981.63	5979.33	-----	5982.39	-----	-----	5979.20	-----	-----	5978.06	-----	-----
P218389	5944.27	5943.93	5943.69	5949.62	5946.78	5946.73	5945.81	5944.47	5945.21	5943.92	5943.69	5943.72
P219189	5933.10	-----	-----	5933.38	-----	-----	5933.57	-----	-----	5933.35	-----	-----
P219489	5946.27	-----	-----	5946.67	-----	-----	5942.53	-----	-----	5947.69	-----	-----

A-1 Groundwater Elevation Data Summary for the Solar Evaporation Ponds - Surficial Materials, 1992

Well ID	First Quarter 1992			Second Quarter 1992			Third Quarter 1992			Fourth Quarter 1992		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
P219589	5941.35	-----	-----	5941.76	-----	-----	5942.26	-----	-----	5943.18	-----	-----

Groundwater elevations are measured in feet with respect to mean sea level.
Double readings in same column indicate two readings taken during the same month.
--Dry-- indicates well was dry at time of water level reading.
------- indicates no data was available for indicated month.

SW-A-005531



U.S. Department of Energy

Rocky Flats Plant

1992 Annual RCRA Groundwater Monitoring Report for Regulated Units at Rocky Flats Plant

Location of Monitoring Wells and RCRA Waste Management Areas

- Paved roads
- Unimproved dirt roads
- Streams, ditches, and other drainage features
- Individual Hazardous Substance Sites
- RCRA Waste Management Areas
- Limit of Rocky Flats alluvium
- Rocky Flats Plant boundary
- Ponds/lakes
- Buildings or structures

WELL TYPES

- Background Characterization Wells
- Boundary Wells
- CERCLA Characterization Wells
- RCRA Regulatory Wells
- RCRA Characterization Wells
- Special Purpose Wells
- Bedrock
- Alluvium
- Alluvium/Bedrock

N

Mapscale = 1 : 6000
1 inch = 500 feet

500 0 1000 2000

State Plane Coordinate Projection
Zone 3476

Prepared By:

EG&G ROCKY FLATS

Rocky Flats Plant
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Plate 1

Date 3-1-93