Study Objectives

The primary objectives of the Plant 83 Plume Delineation Program are to

- Evaluate the horizontal and vertical extent of the intermediate/deep VOC plume and the aquifer hydrogeologic characteristics.
- Develop an understanding of the three dimensional flow field in the intermediate/deep aquifer in order to evaluate plume migration, remedial (pumping) options, and defend selection of a desired remedial alternative.

Secondary objectives include

- Select monitor well locations and screened intervals to further delineate the plume
- Develop a conceptual and numerical model to evaluate remedial alternatives and use in the remedial design
- Develop a conceptual and numerical model that is consistent with continued use for evaluating remedial system performance

The plume delineation program will be conducted in phases to ensure that the level of effort is commensurate with the level actually required. This avoids beginning with an overly complex work plan that may not effectively and economically achieve the objectives. We will rely on available data and the progress towards the objectives to determine the level of effort required for each forthcoming stage of the work. Deliverables and tasks that focus and guide plume delineation will be clearly defined before commencing each phase.

Phase I is a data evaluation, hydrogeologic analysis, and model input parameter development task. It includes the following activities: compiling and evaluating available site-related data, formulating a conceptual model of site hydrogeology, analyzing data on plume migration to guide additional data gathering activities, and developing input parameters to provide a basis for flow field design. Identification of data gaps and the activities required to fill those gaps is critical to the data evaluation phase. In Phase II, H*GCL will implement the field activities required to fill the data gaps identified in Phase I. The iteration between Phase I and Phase II will be repeated as new data is collected and

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analyzed, and data gaps are identified. Phase III involves predictive analyses for plume migration and plume definition, development of a three dimensional model of ground water flow for the site and nearby municipal wells, development of a remedial alternative and, if required, contaminant transport modeling/source analysis. The process of numerical model selection, grid development, and input parameter data validation and preparation will be initiated as part of the Phase I activities. These activities will be conducted interactively with the Phase II field investigation to assure optimum cost-effectiveness of well installations for plume definition and monitoring.

Phase I

Phase I involves compiling, analyzing, and interpreting available site-related hydrogeologic data. Phase I analyses and interpretations will be used to identify significant data gaps and to define additional field data gathering activities. Also, Phase I results will be used for plume delineation and remedial alternative assessment and for development of a three dimensional ground water flow model that integrates the extensive amount of hydrogeologic data available for the site. The following are the standard hydrogeologic analyses for achieving the program's primary objectives of plume delineation and an understanding of the flow field required for plume delineation, and for developing, defending, and evaluating the performance of a remedial system:

1. **Data Evaluation** — H*GCL will catalog, compile, and evaluate available site-related data for use in hydrogeologic analyses. Data sources include previous investigations and reports such as the USGS, Geraghty & Miller, CH2M Hill, Fred C. Hart, and H*GCL reports and in-house data and analyses. Available data will be validated and potential uncertainty ranges identified in order to assure that the flow field model accurately reflects site conditions and provides the optimum tool for developing, defending and evaluating remedial design alternatives. Minimum site-related data that are required to complete the Phase I analyses are as follows:

   - **Aquifer parameters** — hydraulic conductivity, aquifer thickness, transmissivity, storage coefficient, porosity, and related aquifer test data
   - **Lithology/stratigraphy** — well lithologic logs, well completion information, cross-sections, geophysical logs, survey data, and grain-size distribution
   - **Recharge** — AMAFCA channel gauging data; Rio Grande influence
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- All available current plume data – constituents, concentrations over time and distance, horizontal and vertical extents, and data QA/QC

- Ground water flow – hydraulic heads and gradients, past and present ground water velocity direction and magnitude, and hydrologic boundary conditions

- Municipal and private water supply/irrigation well data – locations, screened intervals, pumping histories of well fields

- Aqueous geochemistry (ions and metals) data – concentration over time and distance

H*GCL will review existing USGS and private (e.g., Geraghty and Miller) ground water flow models and reports on the Albuquerque Basin. This review will allow us to understand how others have conceptualized and modeled the basin and to determine how the Plant 83 program area fits into the regional flow system. As part of Phase I, geologic cross-sections through the site will be prepared as well as ground water elevation and plume concentration contour maps. To adequately predict aquifer behavior, hydrostratigraphic units and their associated hydrogeologic properties will be defined. Hydrostratigraphic units contain geologic units of similar hydrogeologic properties and are critical for conceptualizing the site’s hydrogeologic system, plume delineation, and remedial design efforts. Slug testing and pressure profiling in WB-01, WB-02, and other monitor wells will provide needed aquifer properties in the deeper zones. Phase I work will result in an understanding of the site’s hydrogeologic characteristics, the definition of a three dimensional flow field, a compilation of data requirements to complete plume delineation, and the development of a conceptual hydrogeologic model which will be translated into a numerical representation of the three dimensional flow field.

2. Ground Water Elevation Maps – Advection, or ground water flow, is the primary mechanism for contaminant transport at this site. For this reason, it is critical that the flow field for the site be well understood, as it will dictate the lateral and vertical extent of the plume and how the plume will respond to various remedial (pumping) strategies. Since advection far outweighs the role of other contaminant transport mechanisms (such as diffusion) at the site, a three dimensional flow field numerical representation combined with a particle tracking algorithm will result in the most useful tool for evaluating, defending, designing, and monitoring performance of remedial strategies. Therefore, H*GCL will update shallow, intermediate, and deep ground water elevation contour maps to reflect current
conditions that will be useful in selecting monitor well locations. To provide a realistic picture of the ground water flow conditions, the locations and pumping rates of nearby municipal and private pumping wells that have an influence on the local site groundwater flow will be included. Historical ground water flow conditions will be evaluated qualitatively to determine what influence they may have had on plume migration and its present-day configuration. Historical gradient reversals and changes may have been a major influence on current plume location. This information will be developed qualitatively as a flow field over time using applicable analytical and modeling tools. Contaminant dispersion increases with increased relative change in ground water velocities. Ground water flow velocities in each hydrostratigraphic unit will be estimated using appropriate values of hydraulic gradient, hydraulic conductivity and effective porosity. These estimates and presumed interaction between hydrostratigraphic units will be used to help predict advection/dispersion rates and travel times.

3. **Contaminant Trend Analysis** – Using available data, H*GCL will evaluate plume concentrations over time and distance for key wells and contaminants within the shallow, intermediate, and deep zones. Contaminant concentrations will be contoured on geologic cross-sections and planar base maps. Trends in plume migration directions and rates can be estimated and used together with ground water elevation maps to select locations and screened intervals for additional monitor wells.

4. **Recharge Influences** – The significance of recharge from the Rio Grande, AMAFCA channel, and area drains on the shallow, intermediate and deep zones will be evaluated. Water levels in well(s) near the AMAFCA channel (e.g., D-02 and WB-02) will be evaluated. The influence of recharge from the AMAFCA channel on Phase I analyses is scale-dependent. In an analysis of the intermediate zone, recharge may affect a significant portion of the zone and would have to be considered. On the other hand, recharge effects may not propagate to the deep zone to any significance and, therefore, would not need to be considered. This evaluation is dependent upon unpredictable weather events and requires long-term monitoring of seasonal water level fluctuations.

QA/QC by Canonie will be conducted periodically throughout, and at the end of Phase I. H*GCL and Canonie will meet during and at the end of Phase I to review results and recommendations and to agree on appropriate site conceptual model flow field parameters and design evaluation parameters. After QA/QC by Canonie and review and approval by
GEAE, field activities proposed to further delineate the plume and fill data gaps will begin. The following Phase I deliverables either have been, or will be, complete in May 1992.

- Results of hydrogeologic analyses using data compiled in Phase I as shown on supporting geologic cross-sections, ground water elevation and plume contour maps, and figures and tables.

- Identification of data gaps and proposed ways to fill the data gaps.

- Description of modeling objectives and flow field modeling work plan.

- A working site conceptual hydrogeologic model based on interpretations of the above results.

- Collection and validation of municipal well pumping data.

- Proposed location and screen intervals for the next Westbay monitor well. This well will further define the lateral and vertical extent of the plume.

- Preliminary locations for additional monitor wells and screen intervals to further delineate the plume in both vertical and horizontal directions.

Additional Phase I activities including input parameters, numerical three dimensional flow field development, and on-going hydrogeologic/lithologic analyses will be continuing in an iterative fashion throughout Phases II and III.

**Phase II**

Phase II includes drilling and installing the proposed monitor well(s) and conducting the proposed field activities to fill data gaps as indicated in Phase I. Monitor well installation plans are to drill Westbay wells within the plume near the east and south boundaries, and then to step in with single-completion wells. Other specific field activities include water level measurements and water quality sampling in monitor wells. A water level and sampling schedule will be completed and reviewed by the end of May.

As newly-acquired data is collected and reduced, it will be evaluated with previous Phase I data. Interpretations, the site conceptual hydrogeologic model, the numerical flow field, and proposed monitor well locations and screened intervals will be updated to incorporate the
newly-acquired data and results of hydrogeologic analyses. As before, if data gaps exist, we will identify and propose ways to fill them. The process of collecting and reducing data, then evaluating and updating interpretations and developing the site conceptual hydrogeologic model may need to be repeated several times before the primary goal of plume delineation is achieved.

Phase II QA/QC by Canonie will be completed prior to major field activities or testing, such as monitor well installation or slug testing. Since the completion of Phase II depends on the outcome of field activities, a specific deadline for Phase II deliverables is dependent on the development of the investigation. They will coincide with the completion of proposed field activities and iterative analyses with Phase I data. A brief summary of field activities, data collected, and analyses performed will be provided in a monthly report. The deliverables for Phase II will typically include the following:

- Summary of field activities, methods employed, data collected, and QA/QC results
- Updated Phase I deliverables
- Analytical data, including water measurements, contaminant concentrations and other water quality data in monitor wells
- Aquifer characteristics, including interpretation of slug test data and grain-size distribution in Westbay wells
- Stratigraphic data including lithologic and borehole geophysical logs in Westbay wells and new monitor wells with single completions

**Phase III**

Phase III involves flow field analysis, predictive analyses of remedial designs and three dimensional flow/particle tracking ground water modeling to assist in plume delineation, remedial design, defense of remedial alternative selection, and system performance evaluation. Ground water modeling will be conducted based on the outcome of the Phase I and Phase II iterative process. Any numerical ground water modeling beyond flow and particle tracking (such as contaminant transport modeling), if deemed necessary, will be conducted with clearly defined goals designed to effectively achieve the program's objectives. This will avoid the development of a contaminant transport model whose complexity exceeds...
the accuracy of available data and the primary objectives of the program. H*GCL will apply the standard model application protocol of code selection, model design, calibration, verification, prediction, results, and (if possible) post-audit. It is possible that detailed contaminant transport modeling (including such factors as retardation, degradation, etc.) may not be necessary to achieve the program's primary objectives of plume delineation, but would be necessary to satisfy potential alternative objectives. Alternative objectives include the identification of other plumes or contaminant sources and identification of other potentially responsible parties for remedial design and operating costs.

The date for completing the Phase III deliverables depends on the outcome of the Phase I and Phase II iterative process. Phase III activities will begin while Phases I and II are progressing. The following are deliverables for Phase III:

- A validated, functional three dimensional ground water flow field model to delineate the plume and evaluate remedial designs, and that is adaptable to evaluate system performance
- Expanded ground water contaminant transport modeling to accomplish alternative objectives (if necessary)
- Summary of program activities and their outcomes

The proposed phased approach for the Plume Delineation Program was developed to reach the primary objectives efficiently. If these objectives change, we will identify additional activities, appropriate schedules, and deliverables.

The process of Phase I data evaluation and Phase II field investigations is a concurrent, iterative process that periodically spins off the Phase III final products. The initial work scope for the modeling study elements in Phase I and III of this program are discussed in greater detail in the proposed ground water modeling work plan (Document Control #P8300903.DOC).