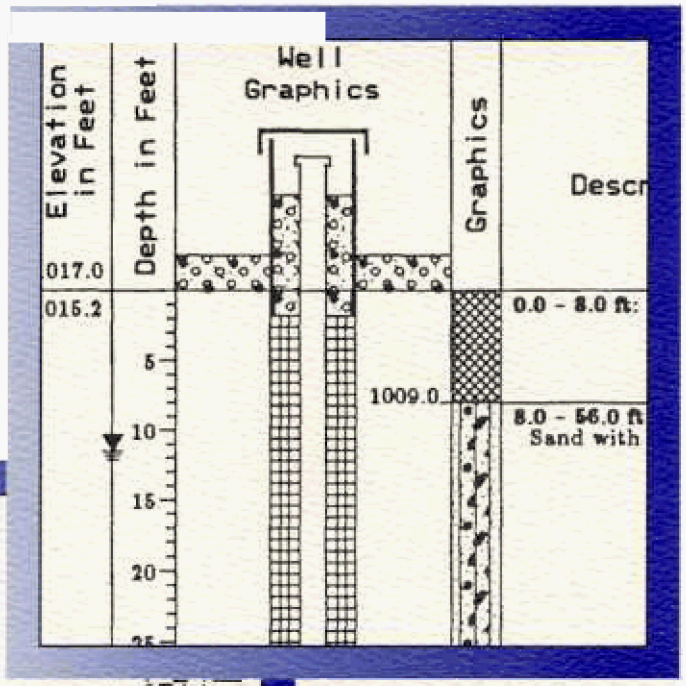
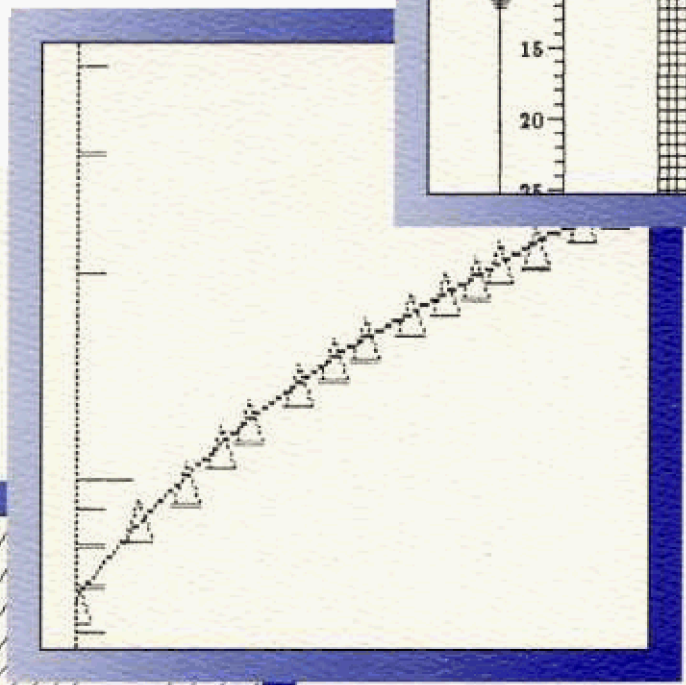
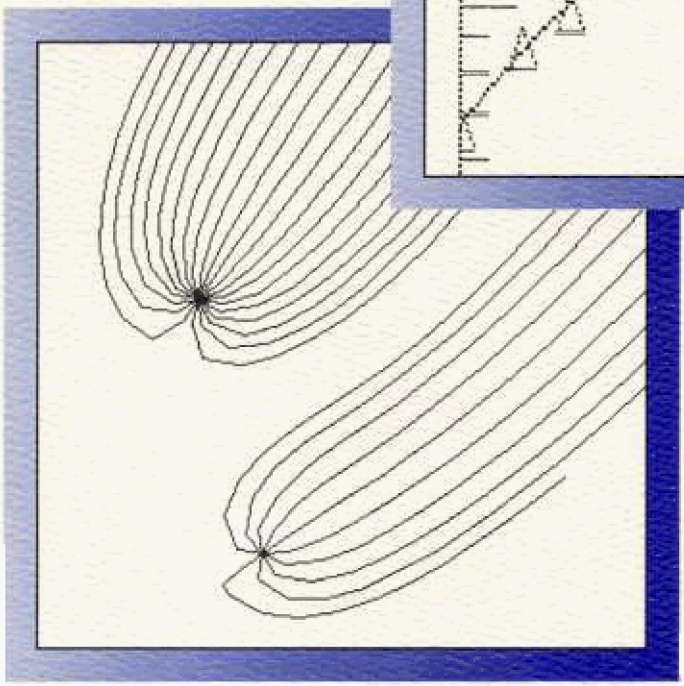
Reporting Hydrogeologic Characterization Data at Hazardous Substance Release Sites

Guidance Manual for Ground Water Investigations







State of California
Environmental Protection Agency

REPORTING HYDROGEOLOGIC CHARACTERIZATION DATA FROM HAZARDOUS SUBSTANCE RELEASE SITES

Guidance Manual for Ground Water Investigations

July 1995

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State of California

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The California Environmental Protection Agency:

Department of Toxic Substances Control
State Water Resources Control Board
Integrated Waste Management Board
Air Resources Board
Department of Pesticide Regulation
Office of Environmental Health Hazard Assessment

FOREWORD

The California Environmental Protection Agency (Cal/EPA) is charged with the responsibility of protecting the state's environment. Within Cal/EPA, the Department of Toxic Substances Control (DTSC) has the responsibility of managing the state's hazardous waste program to protect public health and the environment. The State Water Resources Control Board and the nine Regional Water Quality Control Boards (RWQCBs), also part of Cal/EPA, have the responsibility for coordination and control of water quality, including the protection of the beneficial uses of the waters of the state. Therefore, the RWQCBs work closely with DTSC in protecting the environment.

To aid in characterizing and remediating hazardous substance release sites, DTSC had established a technical guidance work group to oversee the development of guidance documents and recommended procedures for use by its staff, local governmental agencies, responsible parties and their contractors. The Geological Support Unit (GSU) within DTSC provides geologic assistance, training and guidance. This document was prepared by GSU staff in cooperation with the technical guidance work group and the RWQCBs. This document has been prepared to provide guidelines for the investigation, monitoring and remediation of hazardous substance release sites. It should be used in conjunction with the two-volume companion reference for hydrogeologic characterization activities:

Guidelines for Hydrogeologic Characterization of Hazardous Substances Release Sites
Volume 1: Field Investigation Manual
Volume 2: Project Management Manual

Please note that, within the document, the more commonly used terms, hazardous waste site and toxic waste site, are used synonymously with the term hazardous substance release site. However, it should be noted that any unauthorized release of a substance, hazardous or not, that degrades or threatens to degrade water quality may require corrective action to protect its beneficial use.

ACKNOWLEDGEMENTS

This document is based on guidance developed by the California Base Closure Environmental Committee (CBCEC, 1993). The CBCEC document was made possible by the efforts of the Site Characterization Process Action Team and, for military facilities, reflects the consensus of many California and federal agencies. For this document, the CBCEC guidelines have been adapted for application to a broader range of sites and facilities.

The preparation of this guidance document was achieved through the efforts of many individuals. The following people had primary responsibility for writing and editing:

Mark Vest	Hazardous Substances Engineering Geologist,
Bill Owen	Hazardous Substances Engineering Geologist,
John Woodling	Senior Hazardous Substances Engineering Geologist,
Steve Belluomini	Supervising Hazardous Substances Engineering Geologist I.

The technical guidance work group members participated in the development of this document, and provided helpful comments and criticism. Additional review and comments were provided by the Regional Water Quality Control Boards and Dennis Parfitt of the State Water Resources Control Board. We thank them for their cooperation and helpful suggestions.

Finally, thanks are extended to the staff of the Geological Services Unit and to the many anonymous reviewers outside DTSC, whose comments were indispensable for completing this document.

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1 INTRODUCTION

The objectives of these recommendations are to help responsible parties and regulators achieve and maintain consensus on hydrogeologic aspects of site investigations and avoid delays in completing investigations at sites where ground water contamination is a concern. The recommendations call for ongoing development and review of hydrogeologic **Technical Memoranda** (Tech Memos) and **Ground Water Quality Reports** as the investigation progresses. Tech Memos are iterative submittals of hydrogeologic data and interpretations; Ground Water Quality Reports are cumulative compilations of ground water monitoring data. In some cases, the two documents may be combined. All guidelines for data presentation are also applicable to final reports of hydrogeologic investigations. Development of Tech Memos is consistent with recommendations in the United States Environmental Protection Agency's Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final (USEPA, 1988).

In addition to providing a mechanism to present and review hydrogeologic data and interpretations, Tech Memos will provide for development and ongoing amendment of the site conceptual model. The site conceptual model should be developed in the scoping phase of site investigation, and should be amended and confirmed throughout the site investigation. The data presentation and interpretation described in these recommendations will allow the project team to develop and maintain consensus on hydrogeologic aspects of site characterization well in advance of preparation of the draft remedial investigation (RI) report. These efforts will help ensure timely review and approval of RI reports.

Tech Memos should present hydrogeologic data in formats that are amenable to interpretation and review and plainly support the hydrogeologic interpretations of the site-specific hydrogeology. Tech Memos should be organized such that insertion of revisions and updates of hydrogeologic data can be made as the investigation progresses.

Tech Memos are intended to promote:

1. interpretation of chemical and physical hydrogeologic data as they are obtained,

2. development, presentation, and review of site-specific hydrogeologic conceptual models,

3. ongoing review by all concerned parties as data are collected and interpreted,

4. amendment of hydrogeologic conceptual models to incorporate new data as they are collected,

5. timely identification and correction of data gaps and procedural errors in field investigations, and

6. development and maintenance of an organized inventory of physical and chemical hydrogeologic data to support the needs of remedial investigations, feasibility studies, remedial designs, long-term ground water monitoring programs, and operation and maintenance of remediation systems.

These are recommendations for appropriate presentation of hydrogeologic data. Data collection, chemical analyses, and data validation are not the subject of these recommendations and should be performed in accordance with approved plans.

2 GENERAL SCHEDULE AND CONTENT FOR HYDROGEOLOGIC TECHNICAL MEMORANDA

2.1 General Schedule for Reporting Hydrogeologic Data

Hydrogeologic Tech Memos should be prepared and submitted according to a regular schedule, to provide for timely presentation, review, amendment and eventual approval of the hydrogeologic characterization. A quarterly or semi-annual reporting and review schedule is recommended. Alternatively, a schedule could be developed based on project milestones identified in an approved workplan. In any case, tech memos should be prepared no less than annually. The level of effort required for reporting and review will vary in accordance with the nature of field work and data analysis performed during the reporting period.

2.2 General Content of Hydrogeologic Technical Memoranda

Each tech memo should provide results of hydrogeologic investigations performed during the reporting period. In addition, interpretation of the data and their effect on the site conceptual model should be presented. Tech memos should be concise working documents. As such, they need not undergo the approval process characteristic of formal RI/FS reports. However, since the investigations reported in these documents will eventually lead to a formal RI/FS report, technical deficiencies noted by the project team must be appropriately addressed in subsequent tech memos.

All interpretations should be clearly supported by tables, graphs, maps, and cross sections. The data and interpretations should include:

1. boring and well location maps,
2. lithologic and geophysical data,
3. well construction logs,
4. geologic and hydrogeologic cross sections,
5. geologic structure maps,
6. aquifer test data, and
7. ground water flow and contaminant transport models.

Every data type outlined above may not be needed for every site or tech memo. The responsible party, in consultation with the regulatory agencies, should identify and include site-specific data requirements as appropriate.

Tech memos should also evaluate the adequacy of investigative efforts during the reporting period, identify data gaps, and propose additional efforts or modifications to approved work proposals as needed.

3 GENERAL SCHEDULE AND CONTENT FOR GROUND WATER QUALITY REPORTS

3.1 General Schedule for Reporting Ground Water Quality Data

Ground water quality reports should be prepared and submitted according to a regular schedule that provides for timely presentation and review by the project team. Ground water quality reports should be prepared on a quarterly reporting and review schedule, and should provide timely and concise information to the project team. As such, they need not be elaborate. A brief letter report attached to a printout of results should usually be sufficient.

The results of ground water quality monitoring should be presented in detail on a schedule consistent with the reporting requirements of the technical memoranda. Consequently, **Ground Water Quality Summaries** should be submitted with the technical memoranda. Ground water quality summaries have similar reporting requirements to ground water quality reports, but provide additional data interpretation. As such, the results of one or more quarterly ground water quality reports will also be contained in the ground water quality summary report. Depending on the negotiated reporting schedule, a ground water quality summary report may be prepared in place of a quarterly ground water quality report.

The schedule for water level elevation surveys and ground water sampling should be developed as part of a long term ground water monitoring program. This program should provide an overall strategy for ground water monitoring, including integration of hydrogeologic data from all operable units under investigation. The monitoring program should specify sampling intervals for all wells used in the hydrogeologic characterization, and should allow modification to these intervals as data needs change. Sampling intervals should be determined based on the sampling history (if available) and location of each individual well. For example, upgradient wells used for background determination may have a longer sampling interval, wells within a contaminant plume or that have exhibited fluctuations in contaminant concentrations or stable isotope composition may need more frequent sampling. Monitoring plans should be submitted to appropriate agencies for review and approval. Wells constructed as part of ongoing investigations should be incorporated into the approved monitoring plan.

3.2 General Content of Ground Water Quality Reports

Each ground water quality report should provide complete results of ground water sampling and water level measurements performed during the reporting period. Ground water quality reports should specify if chemical data that are presented have been validated. Where appropriate, data qualifiers should be defined and carried throughout the presentation. For each well being monitored, the information provided should include:

1. cumulative sampling results and ground water elevation measurements,

2. well location flags (i.e., upgradient, downgradient, cross-gradient, within plume),

3. well screen elevations (if more than one zone is being investigated, also include a flag identifying the water-bearing zone monitored by each well),

4. identification and brief discussion of trends in analytical and potentiometric data (including relatively short-term transient effects),

5. identification and justification of divergence from approved sampling and analyses plans,

6. identification of damage to monitoring systems and recommended corrective actions, and

7. maps and cross sections illustrating measured and interpreted distributions of contaminants and hydraulic head (only if significant changes have occurred from the previous quarter).

Analytical results and potentiometric data from the reporting period should also be provided on computer storage media (i.e., disk or tape) in a data format acceptable to all parties reviewing the investigation.

3.3 General Content of Ground Water Quality Summaries

In addition to the requirements specified in section 3.2, ground water quality summaries should also include the following:

1. cumulative hydrographs for each well,

2. for the previous year, seasonal contour maps of contaminant concentrations in ground water for each aquifer monitored,

3. for the previous year, seasonal ground water elevation or potentiometric surface maps for each aquifer monitored,

4. A performance evaluation of the monitoring network and monitoring programs, to assess the adequacy of ground water monitoring data, and

5. recommendations and supporting rationale for changes to ground water monitoring systems or amendments to monitoring and reporting programs.

4 RECOMMENDATIONS FOR REPORTING HYDROGEOLOGIC DATA

The recommended presentation methods will form a basis to interpret and illustrate the subsurface configuration and hydraulic properties of geologic materials, the occurrence of ground water, the rates and directions of ground water flow, and the extent of contaminant transport. The data presentation methods comprise tables, graphs, maps, and cross sections. Narrative descriptions of the interpreted hydrogeology should also be provided. The narratives should be brief and plainly supported by the graphical presentations.

The following recommendations provide minimum content and presentation methods for reporting physical hydrogeologic data. Recommendations for reporting ground water quality data are provided in Section 5. The specified information should be developed, to the extent possible, during project scoping and updated through tech memos and ground water quality reports.

4.1 Personnel Qualifications

In accordance with the California Business and Professions Code, geologic plans, specifications, drawings, and reports should be prepared by, or under the direct supervision of, a California registered geologist, who will review and sign all such documents indicating responsibility for their content. Additionally, all engineering plans, specifications, drawings, and reports should be prepared by, or under the direct supervision of, a registered civil engineer who will review and sign all such documents indicating responsibility for their content.

4.2 Regional Hydrogeology

A brief discussion of the manner in which the regional hydrogeologic setting affects the site hydrogeology should be provided. The discussion should include identification and description of regional aquifers, nearby water supply wells, tidal influences, aquifer yield and ground water quality, regional recharge and discharge areas or points, and regional and local ground water flow directions.

4.3 Ground Water Elevations

The acquisition and interpretation of ground water level measurements are important elements of hydrogeologic characterization. With a knowledge of aquifer physical properties, hydraulic head measurements allow the rates and directions of ground water flow to be estimated.

For each water level elevation survey, the following data should be reported for each well in tabular format:

1. hydrostratigraphic zone monitored and elevation of well screen interval and filter pack interval,

2. surveyed reference point elevation,

3. depth to water measurement (or pressure measurement in feet of water and transducer depth),

4. calculated water surface elevation,

5. date and time of measurement,

6. tidal, river, or supply well influences, and

7. thickness of immiscible layers and (when appropriate) corrected hydraulic head measurement with discussion of correction method.

A tabular summary of the complete history of water level elevations in each well should also be provided. These tables should provide the zone monitored, water elevations, and dates of measurements. A map, or maps, showing the locations of all wells should be provided.

Ground water elevations should also be presented as hydrographs. Hydrographs allow for identification and interpretation of ground water level trends. Hydrographs should be constructed to illustrate and provide for interpretation of the variation of ground water levels measured in groupings of wells.

Hydrographs should be used to identify and illustrate:

1. ground water elevation trends in individual wells,

2. hydrostratigraphic zone responses to seasonal recharge and pumping,

3. appropriateness of definition of hydrostratigraphic zones and well completion depths,

4. interconnectedness of hydrostratigraphic zones,

5. vertical gradients within or between hydrostratigraphic zones, and

6. water level trends relative to isotopic or chemical concentration trends.

In general, hydrographs should be provided at the same scale for all wells or groups of wells.

The x-axis (time) on hydrographs should be the same scale as the x-axis on isotopic or chemical concentration graphs (discussed in Section 5).

Hydrographs should indicate hydrostratigraphic zone monitored and elevation of well screen and filter pack intervals.

4.4 Lithologic Logs, Well Construction Drawings and Borehole Geophysical Logs

Lithologic logs, well construction drawings and borehole geophysical logs are some of the most basic data needed to develop and support hydrogeologic characterization, ground water monitoring programs, and ground water remediation.

Inventories of these logs and drawings should be developed and maintained to reflect ongoing work. Generally, the inventories should be amended by providing, with each Tech Memo, pages for insertion that reflect work completed during the reporting period.

Lithologic logs should provide descriptions, depths, and thicknesses of all rock, sediment and other material encountered in the subsurface while drilling. The drilling and sampling methods, sample collection methods, sampling intervals, and percent recovery of samples should be specified. Drilling, Coring, Sampling and Logging at Hazardous Substance Release Sites (Cal/EPA, 1995) provides additional information.

Well construction details should be provided as drawings and in tabular form for all wells and should provide location (California State Plane coordinates), measuring point elevation, ground surface elevation, borehole diameter, total depth, drilling method, date of installation, casing and screen materials, casing diameter, screen type, slot size, screen interval, filter pack interval, formation and filter pack size gradation, transition seal type

and interval, grout sea1 type and interval, surface completion type, and other relevant information.

4.5 Hydrogeologic Cross Sections

Hydrogeologic cross sections illustrate the distribution of geologic materials and hydraulic properties that control ground water flow and influence contaminant transport. Identification of vertical and horizontal ground water flow paths is needed to support hydrogeologic characterization, ground water monitoring programs and ground water remediation. The resulting hydrogeologic cross sections will provide a basis for interpretation and illustration of contaminant distributions.

Site-specific hydrogeologic cross sections should be constructed. Cross sections should incorporate all available geologic and hydrogeologic information, including lithologic logs, cone penetrometer logs, borehole geophysical logs, surface geologic mapping, surface geophysical surveys and trench logs. Cross sections should be drawn to scales that clearly depict all important site features. Cross sections and accompanying maps should be presented at the same scales. A minimum recommended horizontal scale is one inch equals 200 feet, however, there may be exceptions. Vertical exaggeration should be cautiously applied where appropriate.

Site-specific cross sections should encompass areas beyond the known extent of soil and ground water contamination, and should illustrate:

1. lithologic, structural, and hydrogeologic features,

2. site-specific hydrogeologic units,

3. monitoring, injection, extraction, and supply well locations and completion intervals (screen and filter pack),

4. measured first water and static water levels (labeled with date of measurement),

5. interpreted potentiometric surface for each hydrostratigraphic zone, and

6. sampling intervals of boreholes.

Cross sections should depict the interpretation of hydrostratigraphy. A narrative describing and supporting the rationale for the interpretation should also be provided.

Cross sections should be amended as additional monitoring or geologic data are developed. If new data result in significant changes to the conceptual models, the results should be reported. Final drawings do not need to be submitted until the draft remedial investigation report is due.

4.6 Structure Contour Maps

Site-specific structure contour maps can be useful to illustrate the interpreted elevation of geologic contacts, thickness of geologic units and the saturated thickness, extent, and overall geometry of hydrostratigraphic zones.

Site-specific structure contour maps should be drawn at the same scale(s) as ground water elevation contour maps, cross sections, and contaminant distribution maps. Contour intervals should be selected commensurate with the density and precision of the data.

Maps should be amended (and the date of amendment noted) as additional monitoring or geologic data are developed. If new data result in significant changes to the conceptual models, the changes should be reported. Final drawings do not need to be submitted until the draft remedial investigation report is due.

4.7 Ground Water Elevation Contour Maps and Potentiometric Surface Maps

Ground water elevation contour maps provide for illustration and interpretation of the horizontal distribution of hydraulic head across a study area. Ground water elevation contour maps, combined with knowledge of aquifer hydraulic properties, provide for estimation of rates and directions of ground water flow (and associated contaminant transport) within specific hydrostratigraphic zones. Estimates of rates and directions of ground water flow are needed to develop and support site characterization, ground water monitoring and ground water remediation programs.

Site-specific ground water elevation maps should be drawn to scales that clearly depict all important site features. Ground water elevation contour maps should be provided for each water-bearing zone, to illustrate the extent of water-bearing zones, horizontal ground water flow directions, and to support interpretation and illustration of contaminant distribution. Maps and accompanying cross sections should be presented at the same horizontal scale. A minimum recommended scale is one inch equals 200 feet. However, exceptions are permitted to provide better illustration (e.g., large sites or a really extensive contamination).

Ground water elevation contour maps illustrate only the horizontal distribution of hydraulic head. Vertical distribution of hydraulic head should be illustrated on cross sections. All potentiometric data used to develop individual contour maps must be from the same hydrostratigraphic zone and possibly the same relative position within the zone. Ground water elevation contour maps should incorporate all potentiometric data obtained from a single ground water elevation survey for the hydrostratigraphic zone illustrated. Ground water elevation data should be clearly posted with the well identification on each map. Omission of water level data from contour maps should be justified based on evaluation of well construction data, stratigraphic relationships, and definition of hydrostratigraphic zones at the site. Historical flow directions and gradients should be compared to flow directions and gradients derived from the most recent ground water elevation survey.

Ground water elevation contour maps for each hydrostratigraphic zone should be revised each time water levels are measured. The revised maps should be presented in the subsequent Tech Memo.

4.8 Aquifer Properties

Estimates of the hydraulic properties of hydrostratigraphic units should be developed and reported. These include hydraulic conductivity of aquifers and aquitards, and the transmissivity and storage coefficient of aquifers. This information will aid in subsequent

determinations of monitoring locations and frequencies, predictions of contaminant fate and transport, and design of remedial measures.

Anisotropy of hydraulic properties should be reported. The range and spatial distribution of hydraulic conductivity and/or transmissivity should be depicted in graphical form, on maps and cross sections.

The means by which hydraulic properties are estimated should be identified, whether from pumping tests, slug tests, or laboratory tests of core samples.

For laboratory permeability tests, the locations, depths, and soil or rock classifications of samples should be identified. Laboratory reports should be provided.

For pumping tests, the locations of pumping and observation wells should be identified. The method(s) of data analyses and references should be provided. Discharge rates, methods of measurement of discharge rates and water levels, water level measurements and times, and distances to observation wells should all be provided. Time drawdown data should be provided to the project team. Well construction information should be provided as described in section 4.4. For analyses by curve matching methods, data plots and type curve matches should be presented. All information necessary to independently review the tests and results should be provided.

For slug tests, the methods of analyses and references should be included. Well construction information should be provided. Time drawdown data should be provided to the project team. All information necessary to independently review the tests and results should be provided.

For pumping or slug tests, all assumptions associated with the methods of analyses should be provided. Potential limitations of these assumptions should also be discussed.

4.9 Rates and Directions of Ground Water Flow

The hydraulic properties, when used in conjunction with water level and gradient information, should be used to estimate the rates and directions of ground water flow, the rate of transfer of water between aquifers, and the capture zones of wells. Any chemical or isotopic tracer data that provide constraints on fluid direction, flow velocity or mixing should also be included in the discussion.

Using potentiometric data and hydraulic properties, the rates and directions of ground water flow in each hydrostratigraphic unit should be depicted on maps and cross sections, and discussed in narrative form.

5 REPORTING RATE AND EXTENT OF MIGRATION OF CONTAMINATION IN GROUND WATER

The following recommendations are minimum content, frequencies, and presentation methods for reporting water chemistry data. The maps and cross sections developed in the previous section should be used as base maps for the presentations recommended below.

In addition to graphical presentations, each Ground Water Quality Report should provide a narrative description and interpretation of the data that are plainly supported by the graphical presentations.

5.1 Background Water Quality

Background water quality, including general water quality parameters, should be determined and reported. The sample locations and statistics used to define background should be clearly explained.

5.2 Summary Tables and Graphs

The Ground Water Quality Report should provide:

1. complete results from sampling and analyses completed during the previous reporting period including laboratory QA/QC summary reports and certifications,

2. concentrations of all contaminants detected during previous reporting periods, and

3. concentrations of contaminants of concern detected historically (prior to implementation of the Ground Water Quality Reports).

The tables should indicate regulatory MCL's (maximum contaminant levels), background values, or other appropriate criteria for comparison to the concentrations reported. Numerical values of reporting limits should be tabulated where appropriate. Definition of reporting limits should be provided. For each sampling event, well purge and recovery rates, well volume, purge volume, temperature, specific conductance, pH, turbidity, and other parameters measured in the field should be reported for each well sampled.

For Ground Water Quality Summary Reports, graphs-illustrating historical analytical data (for constituents of concern) should be provided for selected wells. Trends in concentrations should be interpreted and discussed in the narrative portion of the report as follows.

1. The x-axis (time) should be the same scale as the x-axis on water level hydrographs.

2. The y-axis should be selected such that a few common scales can illustrate the ranges of contaminants present in ground water at the site.

5.3 Contaminant Distribution Maps and Cross Sections

Site-specific maps and cross sections should be updated and submitted in each Ground Water Quality Summary Report (and Ground Water Quality Report, if a significant change has occurred). Maps and cross sections, originally developed for reporting site-specific hydrogeology, should be used as base maps for illustrating contaminant distribution.

Concentrations detected, or numerical values of reporting limits should be posted on the appropriate map or cross section rather than posting only those results above background, MCL's, or other water quality standards. If indicator chemicals (USEPA, 1988) or

isotopic information can be demonstrated to illustrate the extent and rate of migration of all contaminants in ground water, the number of constituents plotted may be reduced.

Maps and cross sections should be amended (and the date of amendment noted) as additional monitoring or geologic data are developed. If new data result in significant changes to the conceptual models, the changes should be reported. Final drawings do not need to be submitted until the draft remedial investigation report is due.

6 INCORPORATION INTO DRAFT REMEDIAL INVESTIGATION REPORT

Remedial Investigation reports provide the formal documentation of field investigation activities. The purpose of the RI is to provide the final results of the field investigations and the results of the baseline risk assessment. Following the guidelines presented in this document, formal documentation in an RI report should be a compilation and summary of information previously presented in the Tech Memos and Ground Water Quality Summaries. Suggested content for RI reports is presented in Table 1. Additional discussion of RI reports is provided by USEPA (1988).

As stated previously, the ongoing interpretation and presentation of data in Tech Memos and Ground Water Quality Reports will allow the project team to formulate a consensus on the hydrogeologic aspects of site characterization prior to preparation of the draft remedial investigation report. The level of effort required to develop the geology and hydrogeology sections of the draft remedial investigation report will vary according to the completeness of the compilation and interpretation presented in the Tech Memos. Therefore, it is recommended that interpretation efforts be concentrated in Tech Memos and Ground Water Quality Reports to the fullest extent practicable, thereby minimizing the amount of investigative effort and preparation spent on the RI/FS report.

Table 1. Recommended RI Report Content. Adapted from USEPA (1988) and CBCEC (1993).

1. Study Area Investigation

Discuss field activities associated with site characterization. These activities may include assessment or monitoring of some, but not necessarily all, of the following:

Surface features
Meteorology
Soil and Vadose zone
Ground water
Ecology.
Contaminant source
Surface water and sediment
Geology
Human population

2. Physical Characteristics of Study Area

Provide results of field activities; the following areas may be covered:

Surface features
Geology
Soils
Ecology
Meteorology
Surface water hydrology
Hydrogeology
Demography and land use.

3. Nature and Extent of Contamination

Present data on contaminant composition and extent for some, but not necessarily all, of the following media:

Source areas
Ground water
Air.
Soils and vadose zone
Surface water and sediments

Describe any spatial or temporal variations or trends in contamination.

4. Contaminant Fate and Transport

Describe potential routes of migration and estimated persistence of contaminants in the study area. Include physical, chemical and biological factors of importance for media of interest. Discuss factors affecting contaminant for media of importance. Present modeling methods and results if applicable.

5. Summary and Conclusions

Summarize results presented in previous sections, describe data limitations and any recommendations for additional work. Present recommended remedial action objectives.

Appendices

Appendices may include, but are not limited to, technical memoranda, analytical data, QA/QC evaluations and risk assessment methodology as appropriate.

7 REFERENCES

Cal/EPA, 1995, Drilling, coring, sampling and logging at hazardous substance release sites, California Environmental Protection Agency, Department of Toxic Substances Control, 27 p.

CBCEC (California Base Closure Environmental Committee), 1993, Recommended content and presentation for reporting hydrogeologic data during site investigations, pp.

USEPA, 1988, Guidance for conducting remedial investigations and feasibility studies under CERCLA, United States Environmental Protection Agency, Office of Emergency and Remedial Response, EPA/540/G-89/004 (OSWER Directive 9355.3-01).

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C O M M E N T S H E E T

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P.O. Box 806
Sacramento, CA 95812-0806

Attention: Geological Support

Name: Address:

Name and address are optional, but including them will help us follow-up and address your comments.

Title: Reporting Hydrogeologic Characterization Data from Hazardous Substance Release Sites

Section:
Comment:

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Suggested Revision:

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