APPENDIX J-6:
CITY OF LOS ANGELES, OFFICE OF THE CHIEF LEGISLATIVE ANALYST, "FINAL REPORT FOR CITY INVESTIGATION OF POTENTIAL ISSUES OF CONCERN FOR COMMUNITY FACILITIES DISTRICT NO. 4, PLAYA VISTA DEVELOPMENT PROJECT," MAY 2001

CITY OF LOS ANGELES
OFFICE OF THE CHIEF LEGISLATIVE ANALYST

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May 31, 2001

Ladies and Gentleman:

Attached, please find a final report prepared by the Chief Legislative Analyst Office (CLA) to provide information to the Planning and Land Use Management (PLUM) Committee and the City Council relative to a variety of potential risk factors at the Playa Vista Development site. The report will be used in connection with the Council's consideration of the issuance of Mello-Roos bonds for some of the infrastructure and ecological components of the Playa Vista Development Project.

The final report is based upon the March, 2000 report released by the CLA for public comment and review and the public comments received on that report. The comment letters received and responses to those comments are provided in Section 6 of the final report.

It is currently anticipated that the report will be considered by the PLUM Committee at its June 5, 2001 meeting. The PLUM Committee meets at 1:00 p.m. in Room 316, 200 N. Main Street, Los Angeles. It is recommended that you verify scheduling of consideration of the report by the PLUM Committee via the City Council Committee agendas posted on the City's web site (www.lacity.org) or by contacting the City Clerk's Office at "jwhite@clerk.lacity.org." The agenda for the PLUM Committee is generally published no later than the close of business on Friday's preceding the meeting.

Very truly yours,

Ronald F. Deaton
Chief Legislative Analyst Office

Attachment

CITY INVESTIGATION OF POTENTIAL ISSUES OF CONCERN FOR COMMUNITY FACILITIES DISTRICT NO. 4 PLAYA VISTA DEVELOPMENT PROJECT

Prepared by
City of Los Angeles
Office of the Chief Legislative Analyst

May, 2001

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Comment Letter #13: Stewart Morris
Comment Letter #14: Leslie Purcell
Comment Letter #15: Rick Archer, USC Earth Sciences
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List of Acronyms

BOE	City of Los Angeles, Department of Public Works, Bureau of Engineering
BTEX	benzene, toluene, ethyl-benzene, and xylene
CDM	Camp Dresser & McKee, Inc
CFD4	Community Facilities District No. 4, Playa Vista Development Project
CLA	City of Los Angeles, Office of the Chief Legislative Analyst
DTSC	State of California Environmental Protection Agency Department of Toxic Substanace Control
EIR	Environmental Impact Report
EPA	U.S. Environmental Protection Agency
ETI	Exploration Technologies, Inc
HRA	Health Risk Assessment
H_2S	hydrogen sulfide
LADBS	City of Los Angeles, Department of Building and Safety
LARWQCB	California Regional Water Quality Control Board, Los Angeles Region
OARS	City of Los Angeles, Office of Administrative Research Services
OEHHA	California Office of Environmental Health Hazard Assessment
ppmv	parts per million of volume
TAC	toxic air contaminant

List of Consultants and Contracting Agency

Consultant	Contracting Agency
Camp Dresser & McKee, Inc	Playa Vista Capital
Davis and Namson Consulting Geologists	Playa Vista Capital
Earth Consultants International	Playa Vista Capital
Exploration Technologies, Inc	City of Los Angeles
Geomatrix Consultant Inc	Playa Vista Capital
Integrated Environmental Services, Inc	Playa Vista Capital
Kleinfelder	City of Los Angeles
Sepich Associates Methane Specialists	Playa Vista Capital
Zymax Forensics	Playa Vista Capital

Lists of Reviewing State Agencies

California Department of Conservation

California Department of Conservation, Division of Geology and Mines

California Office of Environmental Health Hazard Assessment (OEHHA)

California Regional Water Quality Control Board, Los Angeles Region (LARWQCB)

EXECUTIVE SUMMARY

Study Purpose

This report has been prepared in response to the direction of City Council to the Office of the Chief Legislative Analyst (CLA) to provide information to the Planning and Land Use Management Committee and the City Council relative to a variety of potential risk factors at the Playa Vista Development site, so that Council can decide whether the City should provide Mello-Roos financing for some of the infrastructure and ecological components of the Playa Vista Development Project.

Community Facilities District No. 4 Playa Vista Development Project Description

Community Facilities District No. 4 (CFD4) is a portion of the master planned community known as Playa Vista (Playa Vista Development Project). The Playa Vista Development Project has an approximate area of 1,087 gross acres and is over three miles long and one mile wide. It is located on the west side of the City, approximately 11 miles west of downtown, four miles south of the City of Santa Monica and three miles north of Los Angeles International Airport (LAX). The overall Playa Vista Development Project includes residential units, office space, retail, media and technology facilities, community serving facilities (i.e. school, day-care, etc.), wetland and habitat restoration, open space and recreational areas, and infrastructure.

CFD4 is a portion of Phase I of the Playa Vista Development Project. CFD4 is located immediately east of Lincoln Boulevard on both sides of Jefferson Boulevard and consists of approximately 169 gross acres, of which 79.4 acres are expected to be subject to the proposed Mello-Roos Special Tax. The Developer's plans call for development of dwelling units, retail and commercial facilities, library, school, other community-serving facilities, open-space, habitat improvements/enhancements, and infrastructure development and improvements.

Background and Process

On June 6, 2000, the Budget and Finance Committee conducted a public hearing on the proposed issuance of Mello-Roos bonds for CFD4. During the hearing, several questions were raised which the Committee determined required further analysis. The Committee instructed the CLA to supervise the analysis and authorized the CLA to convene a working group of City departments and other agencies as necessary and contract with outside consultants to conduct the analysis. These instructions included holding a public hearing to obtain input from the public on the scope of the study. Once the analysis was complete, the CLA was instructed to report back to the Planning and Land Use Management Committee and the City Council to resolve the policy issues relative to the safety of the site. Once those policy issues are resolved, the intent is for the Budget and Finance Committee to again consider the issuance of the Mello-Roos bonds.

On June 20, 2000, the Council adopted the Budget and Finance Committee report. The CLA proceeded to convene a working group consisting of the Department of Building and Safety (DBS),

Planning, Department of Public Works Bureau of Engineering (BOE), City Attorney, and the Office of Administrative and Research Services (OARS). The CLA, with the assistance of the working group, developed a draft study scope.

Study Scope and Design

The draft Study Design and Scope, which included investigation of methane, hydrogen sulfide (H_2S), and air toxics (benzene, toluene, ethyl-benzene, and xylene (BTEX)) was released for public review and comment and a public hearing was held to accept public comments and in-put into the study design on July 18, 2000. In response to public comments received, the study was expanded to include a review of subsidence. Further, technical issues commented on by the public were considered as the study elements were developed and reviewed. During the investigation process, the study scope was further expanded to address risks associated with soil and groundwater contamination.

The Study was completed in three steps. This stepped approach allowed the City to maximize resources and avoid unnecessary duplication of data/information collection.

The City engaged the professional services of Kleinfelder to assist in review of methane data and to perform a health risk assessment for BTEX and H_2S emissions identified at the CDF4 site. The City requested the assistance of the California Department of Conservation Divisions of Mines and Geology (Division of Mines and Geology) and Oil, Gas, and Geothermal Resources (Division of Oil and Gas) in the review of earthquake fault and methane issues respectively. The City contacted the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB) regarding soil and groundwater remediation issues and associated health risks.

The study results were released for a 30 day public comment period. Various City department and state agency reviews were included in the appendices of the Report. Copies of the Report were directly mailed to more than 100 individuals, noticed in *Argonaut* and *Daily Breeze* newspapers, placed on the City's web site, and noticed via availability notices mailed to over 500 addresses. Studies included in the reference Section of the Report were made available for review at nine City locations. Twenty-four comment letters were received. Comment letters and responses to comments are included in Section 6 of this Report.

Summary of Findings

The City, with assistance from consultants in some cases, investigated the potential public health and safety impacts, and appropriate mitigations if any, associated with methane, subsidence, earthquake fault impacts, air toxic (benzene, toluene, ethyl-benzene, and xylene (BTEX)) and hydrogen sulfide emissions, and soil and groundwater contamination in the CFD4 area of the Playa Vista Development Project.

The study addressed five primary questions:

Is the adjacent Southern California Gas Company Playa Del Rey Gas Storage Facility leaking and, therefore, the source of the methane contamination on the site and a risk to workers and future residents?

Process - These issues were evaluated by the BOE, LADBS with their "Peer Reviewer," Dr. Jones, President of Exploration Technologies, Inc. (ETI), Kleinfelder, Playa Vista Capital consultants, and the Division of Oil and Gas.

Results - The Southern California Gas Company Playa Del Rey Gas Storage facility is not the source of methane contamination found at the site. Furthermore, there is no evidence which suggests that the gas storage facility is leaking or improperly maintained. There is no evidence that the gas storage facility presents a danger to workers or future residents.

Is the extent of the methane contamination fully defined and can it be mitigated?

Process - These issues were evaluated by the BOE, LADBS, ETI, Kleinfelder, Playa Vista Capital consultants, and the Division of Oil and Gas.

Results - Methane is detected at varying concentrations in the soil gas samples collected throughout the Playa Vista Development Project site, with the highest concentrations located in the western portion of the site. The numerous studies of methane concentrations at the Playa Vista Development Project site has yielded a data set that is more than adequate for the assessment of potential methane hazards and for the design of appropriate mitigation measures.

A methane mitigation system to prevent, detect, and monitor the presence of methane will be required for all structures built on the site. Mitigation measures will vary depending upon the concentration of methane present, with mitigations required for areas of higher methane concentrations being inclusive of all mitigations required for areas with lesser methane concentrations. Table 2 -1 in Section 2 of this report lists all mitigation requirements and methane concentration categories. These mitigation measures are adequate for the Playa Vista Development site.

Is there significant subsidence on the site currently, or will future methane mitigation measures cause subsidence issues which may undermine the structural integrity of the future development?

Process - This issue was first analyzed in the Draft Environmental Impact Report, First Phase for Playa Vista. The BOE conducted further surveys of the Playa Vista Development Project vicinity.

Results - No significant or clearly defined trend of increased subsidence within the Playa Del Rey Oil Field or any other specific area was observed in the vicinity of the Playa Vista Development Project site. Settlement, in the range of 2.66 inches over a 25 year period, is localized and appears to be associated with curb, sidewalk, and gutter settlement along major streets.

Design measures are adequate to address the minimal level of subsidence and uplift observed in the area. There is no evidence that proposed methane mitigation measures would result in increased potential for subsidence in the area.

Is there an active earthquake fault at the site which presents an unacceptable risk to workers and future residents?

Process - These issues were evaluated by several Playa Vista Capital consultants, BOE, LADBS, ETI, Playa Vista Capital consultants, and the Division of Mines and Geology.

Results - The geologic and geophysical data do not support the existence of the postulated Lincoln Boulevard fault. In addition, as indicated above, methane gas at the Playa Vista Development Project site does not come from the Southern California Gas Company Playa Del Rey Gas Storage Field. Therefore, the potential for large volumes of methane gas to escape from the Southern California Gas Company Playa Del Rey Gas Storage Field in the event of an earthquake is unsupported by the evidence.

Off-shore seismic data in the area of the entrance of Marina Del Rey identified two anomalies that could or could not be off-shore faults. The Division of Mines and Geology reviewed the data and information available regarding these anomalies and indicates that there are several plausible explanations for the anomalies. (Section 7, Letter # 23). It appears that the anomalies could be associated with depositional features characteristic of stream channels.

Is there BTEX and H2S contamination along with the methane which presents a health risk to workers and future residents?

Process - These issues were evaluated by Kleinfelder, CLA, and BOE. Potential cumulative impacts associated with soil and groundwater contamination have been addressed by the Regional Water Quality Control Board, Los Angeles Region (LARWQCB), in coordination with the California Office of Environmental Health Hazard Assessment (OEHHA).

Results - Potential health risks associated with BTEX and H_2S soil gas emissions at the Playa Vista Development Project site, whether associated with methane or soil and groundwater contamination, are below the benchmarks established by the regulatory agencies to indicate insignificant risk, with no further investigation or remediation warranted.

With regard to soil and groundwater contaminants, the LARWQCB, in coordination with OEHHA, has established a soil and groundwater remediation process which adequately protects human health and the environment, including addressing potential cumulative impacts. The health based remediation strategy established for the Playa Vista Development Project site is comprehensive in nature and will consider BTEX soil gases in the cumulative assessment completed for the site as remediation activities are completed. The LADBS has established procedures to ensure close coordination between the City and the LARWQCB as site development progresses. Therefore, potential cumulative impacts associated soil and groundwater contamination, including BTEX, will be addressed in a manner that is protective of human health.

SECTION 1

INTRODUCTION

1.0 Study Purpose

This report has been prepared in response to the direction of City Council to the Office of the Chief Legislative Analyst (CLA) to provide information to the Planning and Land Use Management Committee and the City Council relative to a variety of potential risk factors at the Playa Vista Development site, so that Council can decide whether the City should provide Mello-Roos financing for some of the infrastructure and ecological components of the Playa Vista Development Project.

1.1 Community Facilities District No. 4 Playa Vista Development Project Description

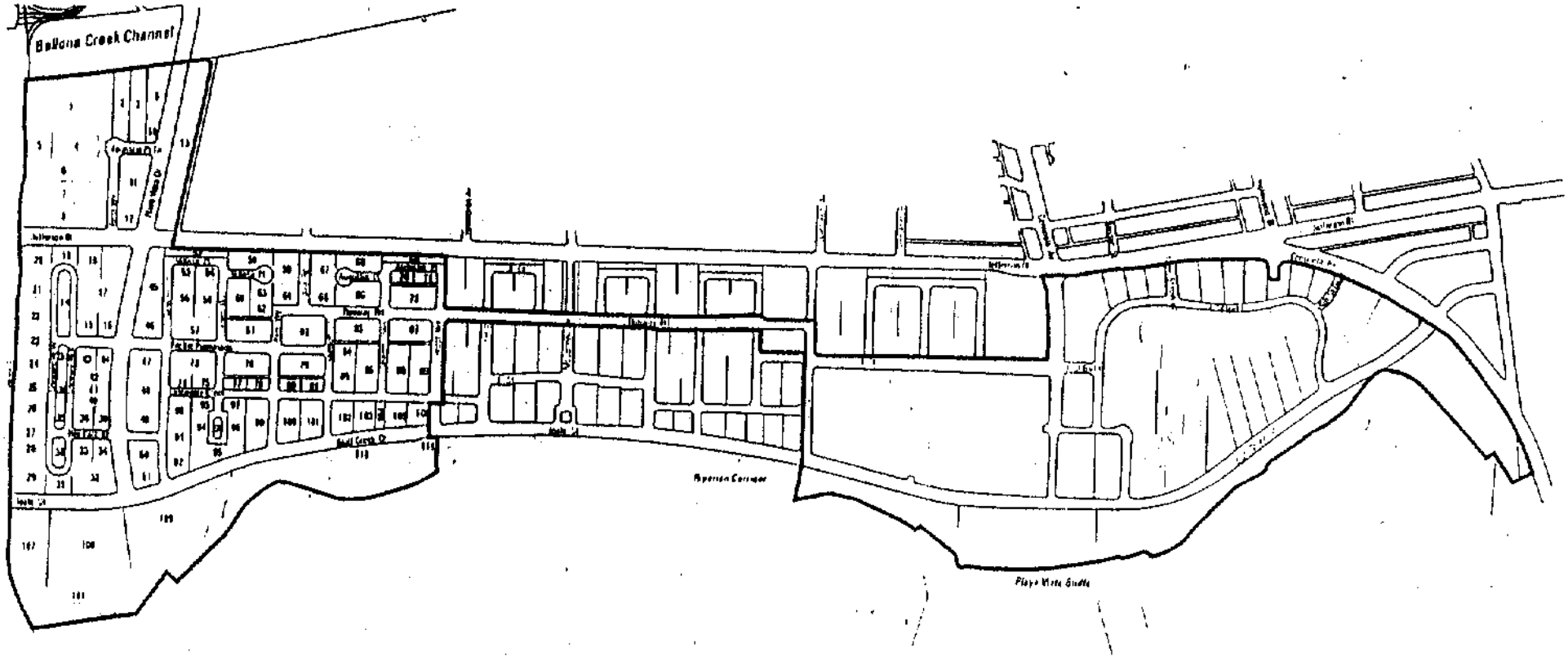
Community Facilities District No. 4 (CFD4) is a portion of the master planned community known as Playa Vista (Playa Vista Development Project). The Playa Vista Development Project has an approximate area of 1,087 gross acres and is over three miles long and one mile wide. It is located on the west side of the City, approximately 11 miles west of downtown, four miles south of the City of Santa Monica and three miles north of Los Angeles International Airport (LAX). The overall Playa Vista Development Project includes residential units, office space, retail, media and technology facilities, community serving facilities (i.e. school, day-care, etc.), wetland and habitat restoration, open space and recreational areas, and infrastructure.

CFD4 is a portion of Phase I of the Playa Vista Development Project. CFD4 is located immediately east of Lincoln Boulevard on both sides of Jefferson Boulevard and consists of approximately 169 gross acres, of which 79.4 acres are expected to be subject to the proposed Mello-Roos Special Tax. The Developer's plans call for development of dwelling units, retail and commercial facilities, library, school, other community-serving facilities, open-space, habitat improvements/enhancements, and infrastructure development and improvements. Figure 1-1 illustrates the boundaries of CFD4 and the Playa Vista Phase I Development Project area.

1.2 Background and Process

On June 6, 2000, the Budget and Finance Committee conducted a public hearing on the proposed issuance of Mello-Roos bonds for CFD4. During the hearing, several questions were raised which the Committee determined required further analysis. The Committee instructed the CLA to supervise the analysis and authorized the CLA to convene a working group of City departments and other agencies as necessary and contract with outside consultants to conduct the analysis. These instructions included holding a public hearing to obtain input from the public on the scope of the study. Once the analysis was complete, the CLA was instructed to report back to the Planning and Land Use Management Committee and the City Council to resolve the policy issues relative to the safety of the site. Once those policy issues are resolved, the intent is for the Budget and Finance Committee to again consider the issuance of the Mello-Roos bonds.

FIGURE 1.1



Playa Vista Los Angeles, California

Prepared by City of Los Angeles Planning Department • Graphic Services Section • July 2000

Not to Scale

On June 20, 2000, the Council adopted the Budget and Finance Committee report. The CLA proceeded to convene a working group consisting of the Department of Building and Safety (LADBS), Planning, Department of Public Works Bureau of Engineering (BOE), City Attorney, and the Office of Administrative and Research Services (OARS). The CLA, with the assistance of the working group, developed a draft study scope.

1.3 Study Scope and Design

The draft Study Design and Scope, which included investigation of methane, hydrogen sulfide (H_2S), and air toxics (benzene, toluene, ethyl-benzene, and xylene (BTEX)) was released for public review and comment and a public hearing was held to accept public comments and in-put into the study design on July 18, 2000. In response to public comments received, the study was expanded to include a review of subsidence. Further, technical issues commented on by the public were considered as the study elements were developed and reviewed. During the investigation process, the study scope was further expanded to address risks associated with soil and groundwater contamination.

The Study was completed in three steps (Figure 1-2). This stepped approach allowed the City to maximize resources and avoid unnecessary duplication of data/information collection.

The City engaged the professional services of Kleinfelder to assist in review of methane data and to perform a health risk assessment for BTEX and H_2S emissions identified at the CDF4 site. The City requested the assistance of the California Department of Conservation Divisions of Mines and Geology (Division of Mines and Geology) and Oil, Gas, and Geothermal Resources (Division of Oil and Gas) in the review of earthquake fault and methane issues respectively. The City contacted the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB) regarding soil and groundwater remediation issues and associated health risks.

The study results were released for a 30 day public comment period. Various City department and state agency reviews were included in the appendices of the Report. Copies of the Report were directly mailed to more than 100 individuals, noticed in *Argonaut* and *Daily Breeze* newspapers, placed on the City's web site, and noticed via availability notices mailed to over 500 addresses. Studies included in the reference Section of the Report were made available for review at nine City locations. Twenty-two comment letters were received. Comment letters and responses to comments are included in Section 6 of this Report.

Figure 1-2

STEPPED STUDY DESIGN

Step I - Issues Investigation

Step 1 in each of the four issue areas (methane, subsidence, potential fault impacts, health risk assessment for BTEX and H_2S)consisted of a review of existing studies and information and/or studies recently completed. Independent review of data and information and resolution of issues involved City staff review, responsible regulatory agencies, and consultants as appropriate. Regulatory and responsible regional and state agency review was sought as appropriate. Consultants with expertise in the areas of concern, and not found within the City, were hired.

If an area of concern was resolved through the Step I investigation and no impacts were identified, that issue was closed and no further work regarding that issue was undertaken. If, through the Step I investigation, impacts were identified and adequately characterized, that issue was addressed through Step III - Identification of Mitigations. If the Step I investigation resulted in the identification of data/information gaps essential to resolving issues or to better characterize impacts to allow for mitigation development, additional information was obtained through Step II - Additional Data/Information Gathering.

Step II - Additional Data/Information Gathering

If the Step I investigation identified data gaps essential to resolving issues or the need to better characterize impacts to allow for mitigation development, such information and data was collected through Step II. In some instances, additional data and site investigation work required consultants with the expertise and certification in the appropriate field.

If an area of concern was resolved through the additional/information obtained through the Step II investigation and no impacts were identified, that issue was closed and no further work regarding that issue was undertaken. If, through the Step II investigation, impacts were identified and characterized, that issue was addressed through Step III - Identification of Mitigations.

Step III - Mitigation Development

For all substantial impacts identified through Step I and II investigations, mitigations were investigated, evaluated, and recommended for implementation.

SECTION 2

METHANE

2.0 General Background

Methane gas is a colorless, odorless gas which is combustible.

At the direction of LADBS and with the concurrence of Playa Vista Capital, in spring/summer 1999, Exploration Technologies, Inc. (ETI) designed and supervised the collection and analysis of gas vapor surveys at the Playa Vista Development Project site to better document and understand the subsurface methane gas levels in the project area. The ETI report, dated April 17, 2000, summarizing the results of that effort and identifies areas of methane concentrations of concern in the CFD4 area.

The CLA authorized the hiring of of Kleinfelder to provide additional independent review of existing methane data and proposed mitigations.

2.1 Review of Existing Information/Studies

2.1.1 Source of Methane

Exploration Technologies, Inc.

ETI postulated that the methane gas detected at CDF4 site could be the result of methane gas seepage from the Southern California Gas Company Playa Del Rey Gas Storage Field via the postulated Lincoln Boulevard Fault plane (April 17, 2000).

2.1.2 Methane Levels and Mitigation

General

Several different studies have detected methane at varying concentrations in the soil gas samples collected throughout the Playa Vista Development Project site, with the highest concentrations located in the western portion of the site.

2.2 Additional Data/Information Gathering

2.2.1 Source of Methane

Camp Dresser & McKee Inc. (CDM) and Zymax Forensics

Camp Dresser & McKee Inc. (CDM) and Zymax Forensics undertook studies to determine the composition of the Southern California Gas Company Playa Del Rey Gas Storage Field gas and soil gas samples taken at the Playa Vista Development Project site (Camp Dresser and McKee Inc., September 5, 2000; Zymax Forensics, September 21, 2000). The composition of the storage facility gas was then compared to the soil gas samples from the development site. Dr. Ian Kaplan of Zymax Forensics concluded that the data showed that the chemical and isotopic characteristics of the natural gas stored by the Southern California Gas Company Playa Del Rey Gas Storage Field are different from the gas detected at the Playa Vista Development Project site.

California Department of Conservation Division of Oil and Gas

The Division of Oil and Gas is, among other things, responsible for regulating and overseeing the development, operation, and abandonment of gas storage facilities and oil wells. The Division of Oil and Gas indicates that the most recent testing at Playa Del Rey Gas Storage Field, which took place in December 1998 and April 2000, and the regular annual reviews indicate that no gas losses are occurring within the Field. The Division of Oil and Gas further indicates that upon review of information and studies, including information provided by ETI, Southern California Gas Company, and the Playa Vista Development Project, that they have no information to indicate that any gas at the Playa Vista Development Project site is from the Southern California Playa Del Rey Gas Storage Field.

The Division of Oil and Gas further indicated that they will require the Playa Vista Development Project proponent to replug any wells present in the project area to present-day standards. Any unrecorded wells identified during development will be required to be abandoned and plugged to present-day standards. Finally, the Division will recommend that all wells be vented if a structure is to be placed over or in proximity of a well (Division of Oil and Gas, October 10, 2000 (Appendix A)).

Kleinfelder

Kleinfelder reviewed several documents and reports regarding methane samples collected at the Playa Vista Development Project site (Kleinfelder, February 7, 2000 (b)). Kleinfelder indicates that the origin of methane detected in soil gas and groundwater at the Playa Vista Development Project site appears to be related primarily to a deep thermogenic source and is not associated with the Southern California Playa Del Rey Gas Storage Field. Kleinfelder further indicates that several methane samples collected appear to indicate there may be secondary shallow source areas comprised of decaying biological material.

2.2.2 Methane Levels and Mitigation

General

Methane is detected at varying concentrations in the soil gas samples collected throughout the Playa Vista Development Project site, with the highest concentrations located in the western portion of the site (Figure 2.1) (Kleinfelder, February 7, 2001 (b); LADBS, February 28, 2001 (Appendix B); Sepich Associates Methane Specialists, January 30, 2001). The volume of study of methane concentrations at the Playa Vista Development Project site has yielded a data set that is more than adequate for the assessment of potential methane hazards and for the design of appropriate mitigation measures (Kleinfelder, February 10, 2001 (b); Sepich Associates Methane Specialists, January 30, 2001).

Kleinfelder

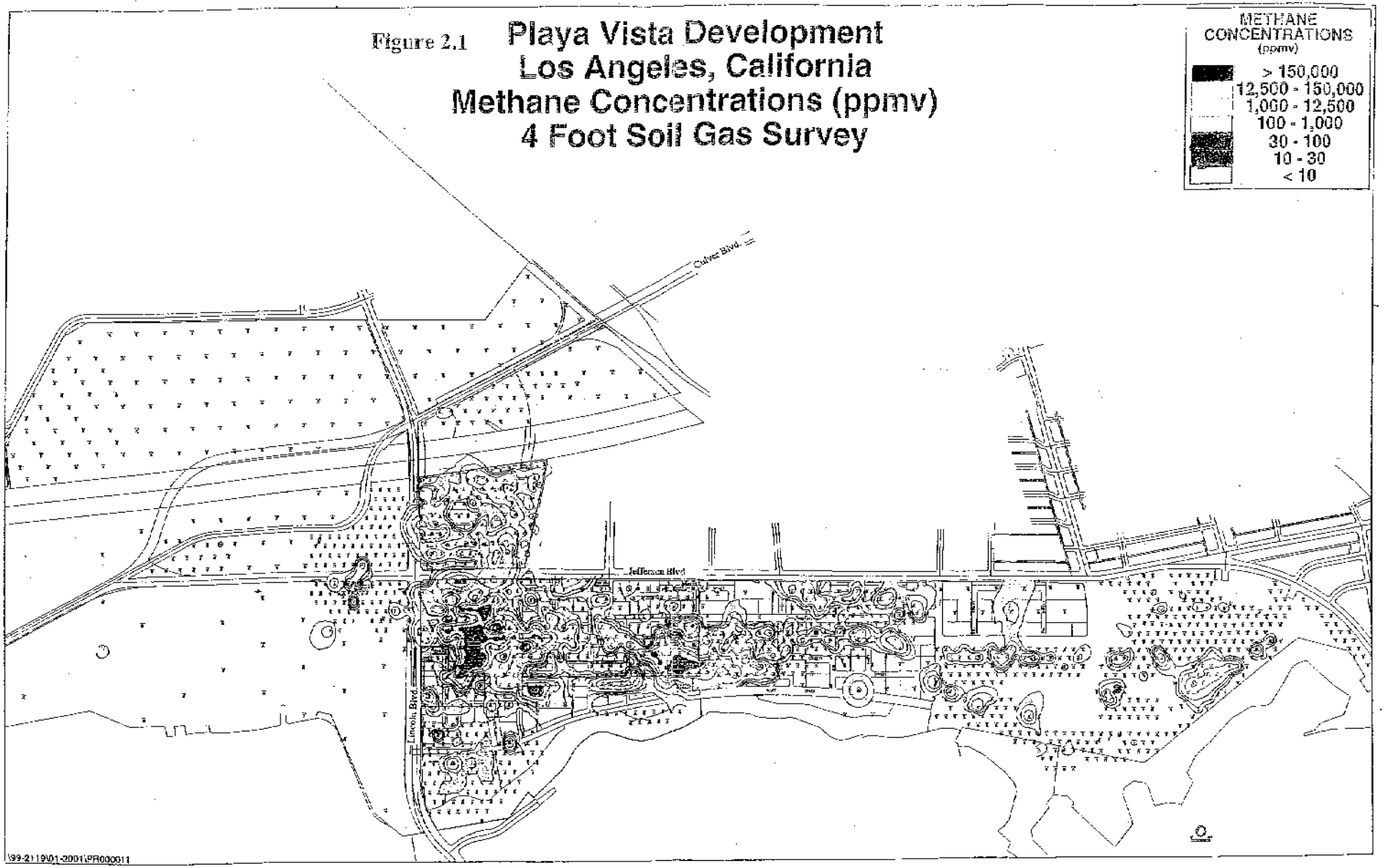
Kleinfelder concludes that methane mitigation systems are required for the Playa Vista Development Project site (Kleinfelder, February 7, 2001 (b)). Kleinfelder indicates that methane mitigations: 1) consistent with specification provided by the LADBS in the Los Angeles Building Code and in Memorandum of General Distribution No. 92; 2) consistent with the Division of Oil and Gas recommendations for oil well replugging and abandonment; and 3) consistent with the recommendations of Sepich and Associates 1999 report, would be considered adequate to protect the health and safety of the future residential and commercial occupants of the proposed Playa Vista Development Project. Kleinfelder further indicates that these mitigation measures have been effective in a variety of residential and commercial environments in Southern California, and are adequate for the Playa Vista Development site.

Sepich Associates

Sepich Associates Methane Specialists recommends a methane mitigation system, based upon methane levels present, to prevent, detect, and monitor the presence of methane (Sepich Associates Methane Specialists, January 30, 2001). The Sepich Associates report identifies three different levels of methane concentrations and associated mitgation levels for the project site: Level I, less than 100 parts per million of volume (ppmv); Level II, 100 and 12,500 ppmv, and; Level III above 12,500 ppmv. All three levels would require a basic mitigation prevention system below the building, including a 12-inch gravel blanket, with pipes to ventilate gas from underneath the impermeable membrane, and methane detection alarm systems within the building. For Levels II and III, automatic ventilation systems triggered by elevated methane concentration levels beneath the impermeable membrane and continuous monitoring systems would are also be required. Additionally, Level III would require a subsurface venting system consisting of vent pipes drilled into the 50-foot gravel aquifer to extract methane gas, thereby alleviating the accumulation of methane within the aquifer and below the ground surface and also reducing the surface emissions of methane.

Figure 2.1

Playa Vista Development
Los Angeles, California
Methane Concentrations (ppmv)
4 Foot Soil Gas Survey



Camp Dresser & McKee Inc. (CDM)

CDM implemented a pilot program for the subsurface methane venting system. More than 70 temporary vent wells were installed at the site to detect the feasibility and effectiveness of venting subsurface accumulations of methane in Level III mitigation areas. The program illustrated that subsurface methane can be vented. A permanent subsurface venting system is currently in progressive design that will establish criteria for determining the exact number, appropriate location, and engineering design of the subsurface wells (LADBS, February 28, 2001 (Appendix B)).

2.3 City Review, Conclusions, and Mitigations

2.3.1 Methane Source

LADBS, and their "Peer Reviewer," Dr. Jones, President of ETI, reviewed information and studies regarding the Southern California Gas Company Playa Del Rey Gas Storage Field and geochemical components of methane collected at the Playa Vista Development Project site. LADBS and ETI concluded that the gas seepage on the Playa Vista Development Project site appears to be derived from the Pico Sands at depth and does not come from the California Playa Del Rey Gas Storage Field (LADBS, February 28, 2001) (Appendix B); LADBS, January 31, 2001 (a) (Appendix C); ETI, January 31, 2001 (b) (Appendix D)). These findings are consistent with the conclusions of the Division of Oil and Gas, Kleinfelder, and Zymax Forensics.

2.3.2 Methane Levels and Mitigation

LADBS and ETI, reviewed information and studies regarding methane concentrations at the Playa Vista Development Project site and methane mitigations. The LADBS and ETI concluded that the methane mitigation systems recommended by Sepich Associates Methane Specialists, January 30, 2001 would adequately protect public safety (LADBS, January 31, 2001 (a) (Appendix C); LADBS, February 28, 2001 (Appendix B); ETI, January 31, 2001 (a) (Appendix D)). These measures exceed the recommendations of Kleinfelder.

2.3.3 Mitigations

A methane mitigation system to prevent, detect, and monitor the presence of methane will be required. Mitigation measures will vary depending upon the concentration of methane present, with mitigations required for areas of higher methane concentrations being inclusive of all mitigations required for areas with lesser methane concentrations. Table 2 -1 lists all mitigation requirements and methane concentration categories.

Level I mitigations will be required for areas with methane concentrations of less than 100 parts per million of volume (ppmv). Level I mitigations will include a basic mitigation prevention system below buildings, including a 12-inch gravel blanket with pipes to ventilate gas from underneath an impermeable membrane and membrane detection alarm systems within the building.

Level II mitigations will be required for areas with methane concentration levels between 100 and 12,500 ppmv. Level II mitigations will include all Level I mitigations, plus a requirement to install automatic ventilation systems triggered by elevated methane concentrations levels beneath the impermeable membrane and continuous monitoring systems.

Level III mitigations will be required for areas with methane concentrations levels above 12,500 ppmv. Level III mitigations will include all Level I and Level II mitigations, plus a requirement to install a subsurface venting system.

Utility vaults and similar substructures installed in the Playa Vista Development area will be required to implement appropriate mitigations necessary to prevent accumulation of methane in the structures. This could include but is not limited to, installation of impermeable membranes under the structures, venting of structures, installation of methane sensors and alarms, and other recommendations identified by methane specialists.

The developer/builder will have primary responsibility for the design and construction of building the methane prevention and building monitoring systems, and for ensuring appropriate operation. Upon certification of operational status of the building methane and monitoring systems, the building owner or property owners' association will have responsibility for the continued operation, testing, maintenance, repair, and replacements of the systems, as necessary.

The building owner or property owners' association shall test the system at least annually and submit a certification to the Los Angeles Fire Department and the LADBS that annual testing, maintenance, and service has been completed and certifying that all systems are operational. The building owner or property owners' association shall develop and submit for approval by the LADBS and the Los Angeles Fire Department an evacuation plan for the building. A copy of the evacuation plan shall be made available to residents and tenants. The building owner or property owners' association shall have financial responsibility for all costs and expenses associated with the building methane system and the monitoring system and for submitting required reports to be provided to the City.

For buildings that are located on common areas (i.e. not owned or controlled by an individual building owner or property owners' association), the Playa Vista Master Association shall have responsibility for testing, maintenance, repair, service, and reporting.

An individual or group should be engaged to monitor and oversee implementation of methane mitigations in all development, including infrastructure installed by various entities. This oversight should include authority to review design, installation, and initial operation of the required methane mitigation measures. The monitoring entity should report to the Planning Department.

Table 2-1: Methane Mitigations

METHANE SYSTEM REQUIREMENTS

A baseline soil gas survey shall be conducted for each building site to determine the areas of Playa Vista Phase I in which building methane prevention systems are required.[1]

Mitigation Measure	Methane Concentration Level		
	Level I[2] White: <10ppmv Blue: 10-<30ppmv Lt. Blue: 30-<100ppmv	Level II[2] Green: 100-<1000ppmv Yellow: 1000-<12,500ppmv	Level III[2] Orange: 12,500-<150,000ppmv Red: 150,000ppmv or >
Methane Prevention System[3]			
Passive - Underneath the Building			
• 12" gravel blanket	Required	Required	Required
• gas collection vent pipe	Required	Required	Required
• impermeable membrane	Required	Required	Required
Active - Mechanical Ventilation			
• ventilation triggered with elevated methane concentrations	None	Required[4]	Required[4]
Subsurface Ventilation	None	None	Required
Methane Detection System			
Within the Building			
• detectors in spaces located in the basement/lowest level in the building[5]	Required	Required	Required
• audible alarm[6]	Required	Required	Required
• visual alarm[6]	Required	Required	Required
• automatic notification of LAFD[6]	Required	Required	Required
Underneath the Building	None	Required	Required
• data collecting sensors below impermeable membrane[5]	Required	Required	Required
• data collecting sensors between impermeable membrane and lowest floor/basement slab[5]			
Methane Monitoring System			
• manual quarterly assessment	Required[7]	None	None
• continuous methane sampling and data collection accessible by the homeowners' association, LADBS and LAFD via the Internet	None	Required[8]	Required[8]
Maintenance of the Prevention, Detection and Monitoring Systems			
• annual testing to the satisfaction of LADBS and LAFD	Required	Required	Required
• homeowners' association to have financial responsibilities	Required	Required	Required

Table 2-1 cont.: Methane Mitigations

BUILDING SOIL GAS SURVEY
Page 2

Contingency Plan			
• when high methane concentration are detected within a building	Required	Required	Required
• when methane system components fail	Required	Required	Required

Footnotes:

1. Projects for which building permit applications were received by LADBS prior to January 1, 2002 may use as baseline methane concentration data the soil gas survey data prepared by CDM/ETI at Appendix 1. After January 1, 2002, all projects shall submit for approval to the satisfaction of LADBS, individual soil gas site assessments that characterize methane soil gas concentrations for the building site.
2. Levels of methane concentrations and corresponding colors on the methane concentration maps are identified in the Appendix 2 or individual building site soil gas assessments.
3. LADBS may reduce on requirements in areas where the methane concentrations in the area of building sites is non-detect.
4. When methane concentrations are detected at 37,500 ppmv by the sensors in the ventilation system below the impervious membrane, a mechanical ventilation system shall be automatically activated.
5. Number, type and location of detectors (or approved equivalents) to be determined by a qualified methane engineer, as approved by LADBS.
6. Audible alarm, visual alarm and notification of LAFD shall be triggered when methane concentrations are detected at 12,500 ppmv.
7. Sampling data reviewed by a qualified methane engineer shall be approved by LADBS. When such data is determined to be highly variable, additional manual sampling or electronic sampling may be required by LADBS. A qualified methane engineer shall submit a report to LADBS with conclusions and recommendations.
8. When the methane concentration data indicates significant changes in methane concentrations below the membrane, then a report by a qualified methane engineer shall be submitted to LADBS characterizing the reasons for such changes.

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Copied from the Sepich Associates Report, January 30, 2001

SECTION 3

SUBSIDENCE

3.0 General Background

Subsidence is the sinking of the ground to a lower level. Subsidence can be associated with sediment consolidation, groundwater withdrawal, and gas and oil production. Removal of fluids from underground reservoirs or aquifers can create voids that may result in eventual ground surface subsidence. Some have indicated that escaping gases, such as methane, could also result in subsidence. Ground subsidence can result in differential settlement and cause damage to engineered structures.

3.1 Review of Existing Information/Studies

Subsidence has been documented in several oil fields in the southern California region. However, the Playa Vista development site is not located in an area of known subsidence (City of Los Angeles, Draft Environmental Impact Report, First Phase for Playa Vista, September 28, 1992, State Clearinghouse No. 90010510).

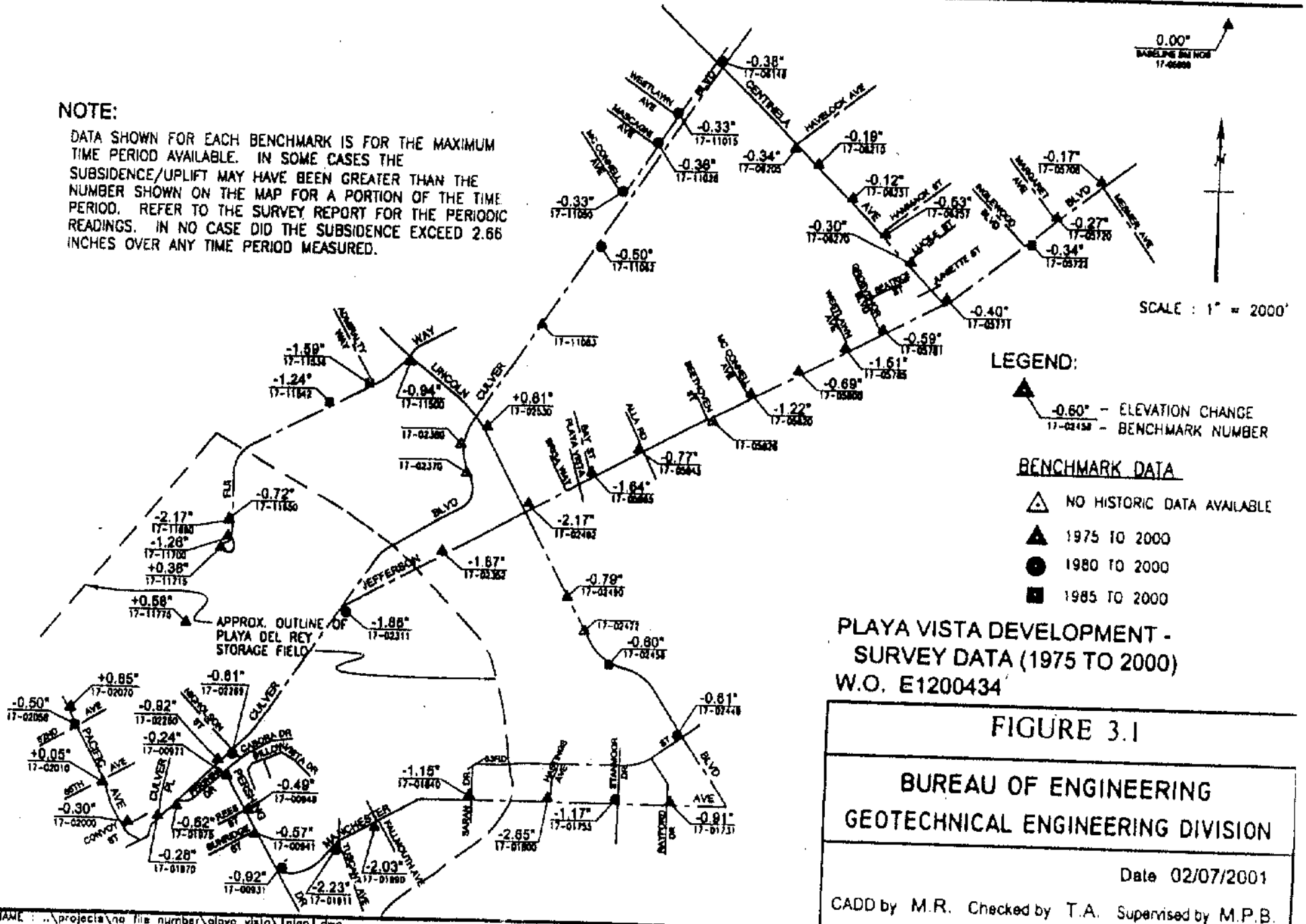
Development of the Playa Del Rey Oil Field in the vicinity of the Playa Vista development site began in the 1920's with production peaking in 1935. Only minor subsidence was noted in the Playa Del Rey Oil field between the primary production years of 1925 to 1938, with no subsidence noted between 1949 and 1955. Oil extraction at the present time is minimal, and the former oil reservoir is pressurized for natural gas storage.

3.2 Additional Data/Information Gathering

Bureau of Engineering (BOE) Survey Division

To evaluate subsidence in the Playa Vista Development Project area, the BOE, Survey Division performed a survey of the area in October, 2000 (BOE, October 24, 2000 (Appendix E)). Using a National Geodetic Survey benchmark as a baseline, the survey recorded the current elevations of benchmarks in the vicinity of the Playa Vista Development Project area and compared them to those same benchmarks as surveyed in 1975, 1980, and 1985. The survey met the tolerances for National Geodetic Survey, Second Order Class II, resulting in a high degree of accuracy.

The elevation change measured in the area over the 25 year period from 1975 to 2000 ranged from -2.66 inches (subsidence) to +0.81 inches (uplift). Figure 3.1 illustrates the location of each benchmark surveyed, the elevation change from the earliest available date, and the approximate limits of the oil field.


NOTE:
DATA SHOWN FOR EACH BENCHMARK IS FOR THE MAXIMUM TIME PERIOD AVAILABLE. IN SOME CASES THE SUBSIDENCE/UPLIFT MAY HAVE BEEN GREATER THAN THE NUMBER SHOWN ON THE MAP FOR A PORTION OF THE TIME PERIOD. REFER TO THE SURVEY REPORT FOR THE PERIODIC READINGS. IN NO CASE DID THE SUBSIDENCE EXCEED 2.66 INCHES OVER ANY TIME PERIOD MEASURED.
SCALE : 1" = 2000'
LEGEND:
-0.60" 17-02458 - ELEVATION CHANGE - BENCHMARK NUMBER
BENCHMARK DATA
NO HISTORIC DATA AVAILABLE
1975 TO 2000
1980 TO 2000
1985 TO 2000
APPROX. OUTLINE OF PLAYA DEL REY STORAGE FIELD
CULVER BLVD
LINCOLN BLVD
JEFFERSON
PLAYA VISTA DR
BAY ST
PACIFIC AVE
MANCHESTER
FALMOUTH AVE
ADMIRALTY WAY
GLENCOE AVE
MINDANAO WAY
CENTINELA
HAVELOCK AVE
JUNCTION BLVD
MARQUETTE ST
MESMER AVE
MC CONNELL AVE
BEETHOVEN ST
ALLA RD
PLAYA VISTA DR
SPRUCE ST
BIRCH ST
PERSIA AVE
CANOBA DR
BALLONA VISTA DR
CONVOY ST
BARRAN DR
ANTIOCH DR
ETIWANDA DR
HIGHLAND AVE
MARCASEL AVE
HIGHLAWN AVE
PLAYA DEL REY
PLAYA VISTA
W.O. E1200434
FIGURE 3.1
BUREAU OF ENGINEERING
GEOTECHNICAL ENGINEERING DIVISION
Date 02/07/2001
CADD by M.R. Checked by T.A. Supervised by M.P.B.
FILENAME : ..\projects\no file number\playa vista\fplan1.dwg

3.3 City Review, Conclusions, and Mitigations

The maximum subsidence observed by the BOE in the area over the period from 1975 to 2000 was 2.66 inches. This level of subsidence was confined to the location at an elevation marker placed on the curb of Manchester Boulevard at the intersection of Hastings Avenue. Another elevation marker displaying greater than 2 inches of settlement (2.17 inches) was located in a Lincoln Boulevard sidewalk. No significant or clearly defined trend of increased subsidence with the Playa Del Rey Oil Field or any other specific area was observed. This suggests that settlement is localized and may be associated with curb, sidewalk, and gutter settlement along major streets (BOE, February 26, 2001 (Appendix F)).

3.3.1 Mitigations

None required. Design measures are adequate to address the minimal level of subsidence and uplift observed in the area. There is no evidence that proposed methane mitigation measures would result in increased potential for subsidence in the area.

SECTION 4

POTENTIAL FAULT IMPACTS ON THE PLAYA DEL REY GAS STORAGE FACILITY

4.0 General Background

The ETI report (ETI, April 17, 2000) identified the possibility of a potential subsurface fault (called the Lincoln Boulevard Fault in the report). Concern was expressed that if such a fault does exist, a future earthquake with an epicenter close to the CFD4 site could potentially cause a rapid release of large volumes of gas from the Playa Del Rey Gas Storage Facility to the surface along the purported Lincoln Boulevard Fault plane.

4.1 Review of Existing Information/Studies

Exploration Technologies, Inc. (ETI)

The ETI report postulated a previously undiscovered fault with a shallow subsurface location just east of Lincoln Boulevard. ETI mapped a shallow oval-shaped methane anomaly just east of Lincoln Boulevard, as detected by a four foot soil gas survey and monitoring wells. ETI interpreted the anomaly to be a result of a postulated earthquake fault. ETI further postulated that the fault should be considered potentially active and that an earthquake event along the fault could result in large volumes of methane gas being released to the surface. ETI also postulated that the methane gas detected at CDF4 site could be the result of methane gas seepage from the Southern California Gas Company Playa Del Rey Gas Storage Field via the postulated Lincoln Boulevard Fault plane.

4.2 Additional Data/Information Gathering

Davis and Namson

Subsequent to the ETI April 17, 2000 report, Davis and Namson Consulting Geologists were engaged by Playa Vista Capital to evaluate the faulting issues at the Playa Vista Development Project site. Davis and Namson Consulting Geologists utilized five different geological and geophysical methods to evaluate the possibility of faulting at the Playa Vista Development Project site: 1) search of existing literature; 2) construction of subsurface maps and cross sections based on well data; 3) purchase and interpretation of preexisting Chevron seismic reflection data; 4) acquisition and interpretation of a 2-D high resolution reflection seismic line along Jefferson Boulevard and a 3-D seismic survey over the entire project site, and 5) an off-shore geophysical survey southwest of the site (Davis and Namson Consulting Geologists, November 16, 2000).

Davis and Namson reviewed existing geologic literature and unpublished consultant reports relevant to the Playa Vista Development Project area. Davis and Namson found no mention of the postulated Lincoln Boulevard fault in the literature prior to the ETI report (ETI, 2000). In addition, Davis and Namson conclude that the preexisting evidence cited by ETI to support the existence of the Lincoln

Boulevard fault does not support the presence of such a fault.

A study completed in 1935 by L.H. Metzner is cited by ETI to support the existence of the postulated Lincoln Boulevard fault. Davis and Namson's review of the Metzner report found that Metzner, on the basis of changes in topographic expression, inferred several faults in the Del Rey Hills southwest of the Playa Vista Development Project. However, Davis and Namson indicate that Metzner never claimed that there was a fault in the area of the postulated Lincoln Boulevard fault. Furthermore, Davis and Namson found that the result of oil exploration drilling and geophysical work subsequent to Metzner's work cast doubt on the validity of any of the surface faults postulated in the 1935 Metzner report. Finally, Davis and Namson report that none of the subsurface maps within the Division of Oil and Gas Summary reports completed subsequent to the 1935 Metzner report show Metzner's postulated surface faults.

Davis and Namson, and Jack West a California registered geologist, constructed subsurface maps and cross sections of the Playa Vista Development site using oil and gas well data and previous subsurface work. The group concluded that the two regional cross-sections constructed by Jack West and the three subsurface maps and four-cross sections constructed by Davis and Namson showed no significant fault is possible under the entire Playa Vista Development Project site. Davis and Namson further indicate that no faulting has occurred in the western part of the Playa Vista Development Project site during the last 2.5 to 3.0 million years.

Playa Vista Capital purchased a licensed seismic reflection line, located about 9,000 to 12,000 feet south of the Playa Vista Development site and oriented in an east-west direction, from Chevron. The seismic line is oriented so that it should intersect the southern projection of the postulated Lincoln Boulevard fault. Davis and Namson concluded that due to the unbroken reflectors in the Chevron seismic line and the lack of diffractions that either the postulated Lincoln Boulevard fault is nonexistent or dies out before reaching the line. Further, Davis and Namson state that the Chevron seismic line indicates no faulting has occurred in the last 3.0 million years.

An extensive seismic reflection study was completed under the direction of Davis and Namson. New on- and off-shore geophysical data, mostly seismic reflection, was acquired in a pattern that would image any faulting at the Playa Vista Development Project site. In July, 2000, Subsurface Exploration Company acquired a 2-D high resolution seismic line along the south side of Jefferson Boulevard, with subsequent data processing by Tricon Geophysical and interpretation and integration of the 2-D line with oil well data completed by Davis and Namson. The 2-D line transects most of the Playa Vista Development Project site in an east-west direction from the eastern edge of the Southern California Gas Company Playa Del Rey Gas Storage Field to the eastern end of the Playa Vista property. Davis and Namson state that the 2-D line shows a set of continuos reflectors along the entire line indicating there has been no faulting of any kind along the line during at least the last 1.0 million years. In addition, Davis and Namson conclude that the 2-D seismic line shows no evidence for either the postulated Lincoln Boulevard or Charnock faults in the Playa Vista Development Project site.

A 3-D seismic survey was acquired over the entire Playa Vista Development Project site (except a small area on the west end of the project site for which abundant well data illustrated no faulting during the last 2.5 to 3 million years) and over additional areas along Centinela and Ballona Creeks, Dockweiler State Beach south of Ballona Creek, and in the entrance to Marina Del Rey Harbor. Davis and Namson state that the 3-D seismic survey indicates that no faulting has occurred under the Playa Vista site during the last 2.0 million years. Further, Davis and Namson conclude that the 3-D seismic survey revealed no evidence for either the postulated Lincoln Boulevard or Charnock faults.

During July 2000 an extensive offshore geophysical survey was undertaken by Dr. Dan Francis of California State University Long Beach and Dr. Marc Legg of Legg Geophysical to better understand the origin of the bluffs just south of the Playa Vista Development site. Davis and Namson indicated that the study results show that the bluffs are the result of erosion by the ancestral Ballona Creek and not faulting and uplift.

Two east-west rending faults, with a vertical separation of 12 feet or less, were imaged near the entrance of Marina Del Rey. Davis and Namson concluded that these faults do not project on-shore.

In summary, based upon review of existing literature and extensive new seismic surveys, Davis and Namson (Davis and Namson Consulting Geologists, November 16, 2000) conclude there is no evidence to support the presence of the postulated Lincoln Boulevard or Charnock faults. Furthermore, they conclude that seismic reflection surveys show no faulting has occurred at the Playa Vista Development Project site in at least the last 2.0 million years.

Earth Consultants International, Inc.

Earth Consultants International, Inc. reviewed previously published geologic maps and reports covering the Playa Vista Development Project area and unpublished geologic and geotechnical reports pertinent to the Playa Vista site (Earth Consultants International, Inc., July, 2000). Earth Consultants International, Inc. also conducted a subsurface study of borings and Cone Penetrometer Tests across the location of the postulated Lincoln Boulevard fault. Earth Consultants International, Inc. did not find any evidence to support the existence of the postulated Lincoln Boulevard fault across the Playa Vista property.

California Department of Conservation, Division of Mines and Geology

The City requested the assistance of the California Department of Conservation, Division Mines and Geology in reviewing the 2-D and 3-D seismic studies undertaken at the Playa Vista Development Project site. The Division of Mines and Geology indicates there is no evidence to support the postulated Lincoln Boulevard fault (Section 6, Comment Letter #4).

The Division of Mines and Geology review of the data and information available regarding the two off-shore anomalies in the area of the entrance of Marina Del Rey indicates that there are several plausible explanations for the anomalies. (Section 6, Letter # 23). It appears that the anomalies could

be associated with depositional features characteristic of stream channels.

4.3 City Review and Conclusions

The BOE, LADBS, and ETI, reviewed the Davis and Namson study, the Earth Consultants International, Inc. report, and referenced studies and reports. The City departments, Division of Mines and Geology, and various consultants all agree that the geologic and geophysical data do not support the existence of the postulated Lincoln Boulevard fault (LADBS, December 19, 2000 (Appendix G); LADBS, February 28, 2001 (Appendix B); ETI, January 31, 2001 (b) (Appendix H)). In addition, as indicated in the methane section above, methane gas at the Playa Vista Development Project site does not come from the Southern California Gas Company Playa Del Rey Gas Storage Field. Therefore, the potential for large volumes of methane gas to escape from the Southern California Gas Company Playa Del Rey Gas Storage Field in the event of an earthquake is unsupported by the evidence.

4.3.1 Mitigations

No mitigation over and beyond compliance with existing seismic building codes and methane mitigation measure discussed in the Methane section above is required.

SECTION 5

HEALTH RISKS OF BTEX AND H_2S

5.0 General Background

Methane gas is not a toxic air contaminant (TAC). However, some TACs, such as benzene, toluene, ethyl-benzene, and xylene (BTEX) and hydrogen sulfide (H_2S) may be associated with methane emissions. The primary health risk of concern due to exposure to benzene is a potential increased risk of cancer. Non-cancer chronic and acute health effects are associated with BTEX and hydrogen sulfide. Potential non-cancer health effects of these pollutants of concern include eye and respiratory irritation, and central nervous system and reproductive concerns.

Potential health impacts associated with BTEX and H_2S are dependent upon pollutant concentration and duration of exposure. The U.S. Environmental Protection Agency (EPA), the State of California Environmental Protection Agency Department of Toxic Substance Control (DTSC), California Office of Environmental Health Hazard Assessment (OEHHA), and other regulatory agencies use the benchmark of a cancer risk of 1×10^{-6} to indicate insignificant carcinogenic public health risk, with no further investigation or remediation warranted. Exposure to carcinogens (only benzene in the case of BTEX and H2S) is averaged over a 70 year period reflecting the experience that cancer associated with contaminants of concern may manifest itself several years after exposure to contaminants of concern has ceased. EPA and other regulatory agencies use the benchmark of a hazard index of 1 to indicate insignificant non-carcinogenic public health risk, with no further investigation or remediation warranted. Exposure to non-carcinogens is averaged over 30-years reflecting the experience that non-cancer health effects generally manifest themselves during exposure to contaminants of concern.

The City engaged the professional services of Kleinfelder to assist in evaluating potential health risks associated with BTEX and H_2S associated with methane emissions.

5.1 Review of Existing Information/Studies

Geomatrix Consultant Inc.

Geomatrix Consultant Inc. undertook an "Evaluation of Potential Public Health Impacts Associated with the Presence of Potentially Toxic Compounds in Soil Gas at Playa Vista," for Playa Vista Capital (July 25, 2000). The Geomatrix report indicates that an insignificant risk is associated with BTEX and H_2S levels found at the Playa Vista Development Project site. The modeled ambient air concentrations of BTEX and H_2S modeled by Geomatrix did not exceed the exposure levels cited above.

The Geomatrix report also examined worker exposures and concluded that mitigation measures were appropriate. The report indicates that "it is possible that the combination of an elevated H_2S pocket and the confined space of an excavation could lead to an ambient air concentration in excess of

worker health criteria."

5.2 Additional Information/Data Gathering

City and Kleinfelder

The City and Kleinfelder reviewed the Geomatrix study and identified two concerns. First, the study appears to base its conclusions regarding residential exposure risks upon outdoor ambient air concentrations rather than upon more conservative indoor concentrations. Second, worker health criteria is less protective than health criteria established for the general public and the study concluded that ambient concentrations in confined spaces could potentially exceed worker health criteria.

Kleinfelder

Kleinfelder reviewed the soil gas data from three different Playa Vista Development Project site soil gas surveys (Kleinfelder, February 7, 2001(a)). Those three studies comprise a total of 1,155 soil gas samples. Only 3% of the samples taken contained benzene, 2% contained methylbenzene, 4% contained m-, p-Xylene, and less than 1% contained H_2S, 23% contained toluene, and 6% contained o-Xylene.

Kleinfelder conducted an HRA for BTEX and H_2S (Kleinfelder, February 7, 2001 (a)). The HRA was conducted utilizing procedures established by the EPA, DTSC, and OEHHA. The HRA utilized very conservative assumptions to assure maximum protection of public health.

The HRA assumes that an adult lives indoors on the site 24 hours a day, 350 days a year (leaving the site for only two weeks during the year) for 30 years. Indoor exposure to BTEX and H_2S is the worst case exposure scenario as gasses would be contained and not dispersed or diluted as would be the case with outdoor conditions. Inhalation exposure for adults (20 m^3/day) is greater than for children (10 m^3/day) due to the larger lung capacity of adults. Therefore, for the inhalation pathway adult exposure represents the worst case scenario and would be protective of children's health. The exposure duration of 30-years, 350 days a year, 24 hours per day is a standard assumption established by EPA and utilized by DTSC and OEHHA.

The HRA assumes an adult is continuously exposed to highest level of benzene (3.85 ppmv) detected at the Playa Vista Development Project site. The benzene level of 3.85 ppmv was only detected once in the 1,155 soil gas samples analyzed and is magnitudes higher than the next level of benzene detected (1.05 ppmv). The conservativeness of assuming continuos exposure to the highest benzene level detected is further magnified by the fact that benzene was not detected in 97% of the 1,155 samples analyzed.

Based upon the above methodology, cancer risk at the Playa Vista Development Project site was estimated in the HRA at 1×10^{-7}, well below the benchmark of insignificance. Using the average concentration of benzene detected at the site, still a conservative assumption since the average

benzene concentration is based upon the average of only 34 of the 1,155 samples taken in which benzene was detected, the estimated cancer risk is substantially lower: 7×10^{-6}.

Non-cancer hazards for BTEX and H_2S were assessed in the HRA utilizing the highest concentration of each of the pollutants of concern. For the same reasons discussed above, this is a very conservative assumption since pollutants of concern were detected in relatively few soil gas samples and in limited areas of the site. The non-cancer hazard index for the maximum concentrations of BTEX and H_2S detected at the site is estimated at 0.051, well below the benchmark of insignificance. The non-cancer hazard for the average concentration of the BTEX and H_2S (still a conservative assumption since of the total of 1,155 soil gas samples taken only 34 contained benzene, 267 contained toluene, 18 contained ethylbenzene, 49 contained m-,p-Xylene, 71 contained o-Xylene, and 10 contained H_2S) is estimated at 0.0001, again well below the benchmark of insignificance.

Both ETI and Kleinfelder concluded that the source of BTEX and H_2S observed at the Playa Vista Development Project site is associated with near surface soil and/or groundwater contamination and is not directly associated with methane observed at the site (ETI, 2000; Kleinfelder, February 7, 2001 (b)).

Integrated Environmental Services, Inc.

Since the BTEX contamination was determined to be associated with soil and groundwater, the City wanted to ensure that the cumulative health impacts associated with BTEX, H_2S, and other potential soil and groundwater contaminants were being appropriately addressed. The LARWQCB is the lead state agency currently overseeing the remediation efforts at the Playa Vista Development site and is coordinating and consulting with OEHHA as appropriate.

Soil and groundwater for the entire Playa Vista Development Project site will undergo separate, phased remediation programs. To expedite the cleanup of contaminated soils and groundwater, while ensuring protection of human health and the environment, a health based remediation program was developed by Integrated Environmental Services, Inc., reviewed by OEHHA ,and approved by the LARWQCB (Integrated Environmental Services, Inc., February, 2000; OEHHA, December 9, 1999; LARWQCB, December 27, 1999 and July 7, 2000). The health-based remediation strategy is designed to ensure that soil and groundwater contamination is remediated to a level of insignificance and that cumulative impacts associated with multiple contaminants and multiple exposure pathways do not exceed acceptable levels.

The health based remediation program derived constituent/pollutant-specific remediation goals so that exposure to any single constituent will result in incremental lifetime cancer risk of 1×10^{-6} or less and a hazard index of 0.2 or less. The use of such health based goals in soil and groundwater cleanup would result in site conditions that pose no significant health risk to future users from exposure to any one constituent. However, due to the complexity of exposure to multiple pollutants of concern through multiple exposure pathways, the cumulative health impacts associated with post-remediation site conditions cannot be fully characterized until site cleanup is complete. For this reason, the LARWQCB will require an assessment of final site conditions with post-remediation

confirmation sampling to verify that cumulative effects of pollutants of concern are adequately addressed and final remediation is protective of human health and the environment from a cumulative perspective.

The Playa Vista Development Project site has already undergone comprehensive environmental investigation and soil and groundwater remediation has been initiated, and in some instances completed.

The LADBS has established procedures to ensure that construction activities at sites with known contamination are precluded from commencing or continuing work until written clearance of appropriate remediation is received from the lead agency (LADBS, February 6, 1989). In the specific case of the Playa Vista Development Project site, the LADBS and LARWQCB are in close contact regarding site construction issues and clearances.

5.3 City Review, Conclusions, and Mitigations

Potential health risks associated with BTEX and H_2S soil gas emissions at the Playa Vista Development Project site, whether associated with methane or soil and groundwater contamination, are below the benchmarks established by EPA, DTSC, OEHHA, and other regulatory agencies to indicate insignificant risk, with no further investigation or remediation warranted.

With regard to other soil contaminants, the LARWQCB, in coordination with OEHHA, has established a soil and groundwater remediation process which adequately protects human health and the environment, including addressing potential cumulative impacts. The health based remediation strategy established for the Playa Vista Development Project site is comprehensive in nature and will consider BTEX soil gases in the cumulative HRA completed for the site as remediation activities are completed. The LADBS has established procedures to ensure close coordination between the City and the LARWQCB as site development progresses. Therefore, potential cumulative impacts associated soil and groundwater contamination, including BTEX, will be addressed in a manner that is protective of human health.

5.3.1 Mitigations

None required. The mitigation measures proposed for methane would further reduce the potential health risks associated with soil and groundwater contamination. The impermeable membrane required for methane mitigation would not only serve to ensure that methane is precluded from entering buildings and other confined spaces, but would also preclude soil gases of concern from entering those same spaces.

SECTION 6

Comment Letters Received on the March, 2001 CLA Report on Playa Vista Development Site

The CLA Report on Playa Vista Development Site dated March, 2001 was released for a 30 day public comment period. Copies of the Report were directly mailed to more than 100 individuals, noticed in *Argonaut* and *Daily Breeze* newspapers, placed on the City's web site, and noticed via availability notices mailed to over 500 addresses. Twenty-four comment letters were received. Comment letters and responses to comments are included in this Section.

Comment letters received are as follows:

Comment Letter #1: Howard Hackett, Past President Del Rey Homeowners

Comment Letter #2: Alfredo Urso

Comment Letter #3: Debra-Lynne Terrill

Comment Letter #4: William Bryant, Program Manager, Active Faults, California Department of Conservation, Division of Mines and Geology (also see Comment Letter #23)

Comment Letter #5: Airport Marina Group Sierra Club, Ballona Ecosystem Education Project, Grassroots Coalition, and Spirit of the Sage Council

Comment Letter #6: Patricia Trujillo

Comment Letter #7: Julia Judge

Comment Letter #8: Thomas Judge

Comment Letter #9: Patricia McPherson, President, Grassroots Coalition; Rex Frankel, Chair, Ballona Ecosystem Education Project; Kathy Knight, Special Projects Coordinator, Spirit of the Sage Council and Conservation Chair, Airport Marina Group Sierra Club

Comment Letter #10: Rose MacHardy

Comment Letter #11: Jonathan Aurthur

Comment Letter #12: 132 Form Letters with original individual signatures delivered by Playa Capital Companies, LLC

Comment Letter #13: Stewart Morris

Comment Letter #14: Leslie Purcell

Comment Letter #15: Rick Archer, USC Earth Sciences

Comment Letter #16: Marcia Hanscom, Executive Director, Wetlands Action Network; Robert van de Hoek, Chair, Sierra Club Ballona Wetlands Task Force

Comment Letter #17: John Geroch, Associate Engineering Geologist, Site Cleanup Unit I, California Regional Water Quality Control Board, Los Angeles Region

Attached Memorandum from Julio Salinas, Ph.D. Hazardous Waste Toxicology Section, Office of Environmental Health Hazard Assessment to John Georch, LARWQCB

Comment Letter #18: Suzanne M. DeBenedittis
Comment Letter #19: Faye Ku
Comment Letter #20: Bryan Gordon
Comment Letter#21: Michael De La Torre, Southern California as Company
Comment Letter #22: Kenneth E. Trott, Environmental Coordinator, California Department of Conservation
Comment Letter #23: William Bryant, Program Manager, Active Faults, California Department of Conservation, Division of Geology and Mines (also see Comment Letter #4)
Comment Letter #25: Giyora Doeh

Comment Letter #1

RECEIVED
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01 MAR 19 PM 1:43

March 14, 2001

Ronald F. Deaton
City of Los Angeles
Office of the Chief Legislative Analyst
Room 512 City Hall
Los Angeles, CA. 90012

Dear Sir,

Thank you for a copy of the "City Investigation of Potential Issues of Concern for Community District No. 4 Playa Vista Development Project" March 2001.

Although I am not an expert in any of the fields studied, I feel that the report answers all of the questions about the perceived ecological risks and dangers brought up by the opponents of the overall project. 1-1

This project has been stalled way to long by mostly bogus complaints and frivolous lawsuits.

In my opinion, the next steps should be taken expediently. If any other issues are raised they should be disregarded as irrelevant, costly, and regarded as a strategy to further stall the project.

Sincerely,

Howard Hackett

Howard Hackett
Past President-Del Rey Homeowners
5208 Etheldo Avenue
Culver City, CA. 90230-6025

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01 APR -5 PM 12:26

Comment Letter #2

April 4, 2001

Ronald F. Deaton
Chief Legislative Analyst

Re: Playa Vista – Mello-Roos

I will keep this simple.

The more I learn about the Playa Vista development the more I am appalled that the city of L.A would even consider issuing Mello-Roos bonds!

1. This development is bad for the health of the people that live in the area. 2- 1
2. Apart from the increased illness factors this project is not structurally sound and could be dangerous to potential residents. 2- 2
3. It is irresponsible to take this last piece of wetlands ecosystem away from the wildlife who depend on it for their survival. 2- 3
4 Whatever development has already been undertaken has to a large degree been immoral and illegal. 2- 4

Whichever way you look at it, this project is doomed to fail and to cause problems and law suits extending far into the future. 2- 5

Keeping the Ballona ECO-system will benefit all of us , humans and wildlife. 2- 6

DEFINITELY NO MELLO-ROOS BONDS FOR PLAYA VISTA.

Sincerely,

Alfredo Urso
4710 La Villa Marina # C
Marina Del Ray, 90292

April 3, 2001

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01 APR -5 PM 12:36

Barb Garrett
Office of the Chief Legislative Analyst
200 N. Main Street, Room 512
Los Angeles, CA 90012

Dear Ms. Garrett:

I have reviewed the City Investigation of Potential Issues of Concern for Community Facilities District No. 4 Playa Vista Development Project. There are a number of key problems with the report as presented:

1. Figure 2.1, Playa Vista Development, Los Angeles California, Methane Concentrations (ppmv) 4 Foot Gas Survey reflects methane concentrations at one point in time. Many of the methane concentrations are in the 40,000 parts per 1,000,000 parts range, i.e., dangerous levels. It is not properly reflected in the report that this methane migrates. In effect, methane situated in one location at these dangerous levels will move to other locations if it cannot freely escape through the surface. The concrete ground covering created by the proposed Playa Vista Development will force methane to migrate to the surrounding areas, creating dangers beyond the Development itself. Even if the problem is mitigated with protection, there is no guarantee of safety due to the volatile nature of methane. Residences and businesses in the areas surrounding the proposed Playa Vista Development are put at risk. 3- 1

2. While many methane problems can be contained and mitigated under normal, stable ground conditions, the proposed Playa Vista Development would be built over unstable ground conditions requiring pilings. It is impossible to create the necessary containment and mitigation methane sealants under these conditions. 3- 2

3. Figure 2.1 reflects a soil gas survey limited to only four feet. It is prudent to survey a site with Playa Vista's inherent properties at a number of different levels. It is irresponsible and potentially reckless to limit the gas survey to only the four feet level. 3- 3

4. The proposed Playa Vista Development is situated in Southern California, which has a high propensity for earthquakes. While some faults have been identified, others, as Santa Monica discovered in 1994, are hidden. The high methane concentrations as already identified on the property, and there will be surely more when different levels are surveyed, create a hazardous and potentially explosive situation in the event of earthquakes. 3- 4

5. The samples taken to assess the presence and concentration of H2S at the proposed Playa Vista Development site were not described in full and appropriate detail. The details are very important because the nature of the site, combining 3- 5

methane and bacteria from organic matter, indicates that much higher levels of H2S would be present than disclosed in the report. The H2S sampling process used to make the assessment and evaluation process needs to be clearly disclosed. It is implausible that less than one percent of the samples contained H2S. In effect, the statements made regarding the health risk are not properly founded.

3- C

6. The report fails to take into account the ramifications of methane, as a freely rising gas, interacting with benzene, toluene, ethyl-benzene and xylene, which flow closer to the ground. Proper disclosure requires that the impact of this interaction of gases be addressed.

3- 6

7. It is prudent that the Division of Oil and Gas would require that the proposed Playa Vista Development replug any wells present in the project area to present-day standards. While it is also a positive step that the Division would also require the developers to have unrecorded wells identified during development to be abandoned and plugged to present-day standards, it is reasonable to expect that not all of the unrecorded wells would be identified. The proposed Playa Vista Development sits on what might be described as a massive minefield of unrecorded wells. Since it is impossible to identify all of the unrecorded wells, it is reasonable to assume that the problems associated with those wells would not be mitigated and would pose an inherent danger.

3- 7

8. While it is reasonable to expect that membranes designed to contain methane in stable areas may be impermeable for extended periods of times, the sandy soil of the proposed Playa Vista Development which required pilings for development, does not provide a suitable foundation for membranes that will meet the test of time with impermeability.

3- 8

9. While pipes can help to mitigate the flow, they can also be problematic, as evidenced by the explosion and fires in the Fairfax District.

3- 9

As a resident of Playa del Rey, I am very disturbed that this report either failed to address or glossed over important safety points. Unlike the people who were contracted by Playa Vista Capital and the contributing agencies, my life and property are at stake. I trust that you will address each of the points that I have identified.

3- 10

Most importantly, the report must be created by an independent consultant or a group of consultants who do not have and have never had relationships with Playa Vista Capital and/or related parties. The March, 2001 Report has no credibility due to its contributors.

Sincerely,

Debra-Lynn Terrill
340 Fowling Street
Playa del Rey, CA 90293
Phone: 310/821-9763; Email: terrill3@pop.mindspring.com

Comment Letter #4

DEPARTMENT OF CONSERVATION
STATE OF CALIFORNIA

CLA

01 APR 12 PM 2:36

DIVISION OF
MINES & GEOLOGY

801 K STREET
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GRAY DAVIS
GOVERNOR

March 30, 2001

Barb Garrett
Office of Chief Legislative Analyst
512 City Hall
200 N. Main Street
Los Angeles, CA 90012

Dear Ms. Garrett:

This letter is a follow-up to our meeting on February 6, 2001 regarding the proposed "Lincoln Boulevard" fault and the Playa Vista site. At your office's request, I am nearing completion of reviews of fault investigation reports by Davis and Namson (11/16/2000) and Earth Consultants International (ECI, 7/25/2000), as well as a review of the data presented in the Exploration Technologies, Inc. report (ETI, 4/17/2000). We are scheduled to meet with T. Davis of Davis and Namson and D. Francis of California State University, Long Beach regarding interpretation of seismic data collected offshore of the Playa Vista site on April 17. I will summarize my preliminary conclusions.

Executive Summary

Based on my review of these reports, I find that there is no evidence to support the existence of the proposed "Lincoln Boulevard" fault. The ETI report attempted to explain the presence of methane gas detected at the Playa Vista site by postulating a fault they inferred to be potentially active (active within the past 1 6 million years) Because the existence of a methane gas anomaly does not require the presence of a fault, ETI cited several sources in support of the proposed "Lincoln Boulevard" fault. These sources reported a minor, approximately 2500-foot long fault located 1500 feet south of the Playa Vista site. However, that minor fault does not offset sedimentary rocks younger than 3 to 5 million years

Reports by Davis and Namson and ECI addressed the deep subsurface and near surface conditions, respectively, of the Playa Vista site and its immediate area, as well as evaluated the literature cited by ETI. Davis and Namson concluded that

the literature cited by ETI does not support the existence of a potentially active "Lincoln Boulevard" fault and supplied additional information that questions the existence of the minor bedrock fault located 1500 feet south of the site. The combination of geologic cross-sections based on oil well data and geophysical imaging of the Playa Vista site and the area to the south documented in the Davis and Namson report shows unfaulted 3 million year old sedimentary rocks in the vicinity of the proposed "Lincoln Boulevard" fault.

The ECI report investigated near-surface conditions at the Playa Vista site and reviewed previous fault investigations that mapped the 200,000 to 600,000 year old Lakewood Formation exposed in the bluffs just south of the site. Based on mapping no evidence exists for the proposed "Lincoln Boulevard" fault in the bluffs south of the site. ECI's subsurface investigations document that sedimentary deposits about 15,000 years old and younger are not offset along the inferred surface trace of the proposed "Lincoln Boulevard" fault. Both Davis and Namson and ECI concluded that the evidence of a surface trace of the proposed "Lincoln Boulevard" fault in the terrace surface south of the Playa Vista site reported by ETI (based on Metzner, 1935) is not supported in the geologic literature.

Analysis

In order to explain the detection of thermogenic methane gas, ETI postulated a north-northwest striking fault located sub-parallel to and just east of Lincoln Boulevard. This postulated fault, which ETI referred to as the "proposed Lincoln Boulevard fault," was characterized as a west-dipping normal fault (apparent dip 58° in ETI cross section A-A'). The older sedimentary rock formations in ETI cross section A-A' are displaced less than the younger formations, suggesting that the cross section is diagrammatic and the amount of bedrock displacement is poorly constrained. The diagrammatic nature of ETI's geologic cross-section is also suggested by the presence of data from only one oil well (Universal City Syndicate Vidor #1) that has been projected 2800 feet into cross section A-A'. Above the Pico/Repetto contact, displacement of the Pico Formation is diagrammatically inferred by discontinuous lines (bedding?) that have an apparent vertical separation suggestive of dip-slip displacement, but in the opposite sense (down to east) to offsets depicted lower in the cross-section (refer to attached stratigraphic column (ECI's Figure 3) for ages of sedimentary units).

In support of the existence of the proposed "Lincoln Boulevard" fault, ETI cited reports by Metzner (1935), Hodges (1944), Riegle (1953), and Wright (1991). Davis and Namson, in reviewing these reports, noted that Metzner (1935) showed a minor fault in the southeastern corner of section 27 (T 2S, R 15W) offsetting the top of the Catalina Schist (basement rock) (Metzner's Plate III). Metzner interpreted the existence of the fault based on changes in the

amounts of oil and water production between wells drilled into the oil and gas bearing schist conglomerate deposited on top of the basement rock. However, Metzner found no evidence of displacement along this inferred fault. This fault shown on Plate III extends for only about 2500 feet. Metzner's cross sections B-B' and C-C', located immediately to the north, do not show this fault and depict unfaulted Catalina Schist and overlying Miocene Puente Formation.

Hodges (1944, Plate II) also interpreted a minor fault offsetting the Catalina Schist as interpreted by Metzner (1935). This fault extends for only about 2500 feet and has an apparent vertical separation of the top of the basement rock of about 150 feet, down to the west. As interpreted by Hodges (1944, Plate I), this fault does not extend into and above the "Upper Bentonite Marker" (Upper Repetto Formation). Riegle (1953) shows the fault as depicted by Metzner and Hodges and supplies no new data.

Wright (1991) shows this minor bedrock fault interpreted by Metzner and Hodges in his cross section A-A' as a west-dipping normal fault that extends into Repetto Formation, but doesn't offset the Pico/Repetto contact. It is not clear from Wright's cross section how much, if any, displacement of contacts this fault may have. Davis and Namson state that the fault shown by Wright is based on reports by Metzner (1935) and Hodges (1944) and presents no new information.

Davis and Namson cite an unpublished report by Hester (1986) for the Southern California Gas Company. Hester reported that he could find no evidence for the fault in the southeastern corner of section 27. Davis and Namson concluded that the fault interpretation of Metzner (1935) is a non-unique explanation for the variations in oil and water production in the schist conglomerate layer deposited on the Catalina Schist.

ETI concluded that the proposed "Lincoln Boulevard" fault was potentially active (active within the past 1.6 million years) because of the assumption that the fault was expressed in the terrace surface south of the Playa Vista site. Surface expression of the proposed "Lincoln Boulevard" fault was inferred by ETI, based on a discussion of topographic provinces by Metzner (1935). Metzner divided the terrace just south of the Playa Vista site (Del Rey Hills) into 4 sub-provinces based on geomorphic expression and concluded that sub-provinces 3 and 4 were separated by a fault. Although Metzner stated it was unlikely that the surface morphology was due to eolian deposition, the preponderance of evidence in the literature supports an interpretation that the surface morphology is the result of either eolian deposition, offshore bar deposition, or a combination of depositional features, but not faulting (Eckis, 1934; Pierce and Pool, 1938, Pierce, 1939, Woodring and others, 1946, Poland and others, 1959; Handin, 1951; Poland and Piper, 1956, Terry and Uchupi, 1957, Merriam, 1949; Cooper, 1967; and Lajoie and others,

1992). Davis and Namson pointed out that although Metzner inferred a fault between his sub-provinces 3 and 4, he did not show a fault in his subsurface map of the top of the Catalina Schist.

My conclusion, as well as that of Davis and Namson, is that the literature cited by ETI in support of the proposed "Lincoln Boulevard" fault in fact does not document the presence of a fault.

In addition to literature review, Davis and Namson constructed cross-sections and subsurface maps of the Playa Vista region based on extensive oil well data, purchased Chevron seismic reflection line LAB 84-4 (located about 6000 feet south of the Playa Vista site), and acquired 2D high resolution reflection seismic data and 3D seismic survey data. The Chevron line LAB 84-4 data show reflectors (upper Repetto Formation) that are continuous and unfaulted across the projected location of the proposed "Lincoln Boulevard" fault. The 2D reflection seismic data show continuous, unfaulted reflectors correlated with the upper portion of the middle Pico Formation and interpretations of the 3D seismic survey indicate continuous reflectors correlated with the middle Pico Formation. This indicates that there has been no displacement in the past 3 million years.

The report by ECI addresses the near surface evidence for or against the proposed "Lincoln Boulevard" fault. ECI used existing borings and CPT data and CPT data collected for this investigation to document near surface (upper 50 feet) conditions across the surface trace of the proposed "Lincoln Boulevard" fault. In addition, ECI cited reports by Converse Ward Davis Dixon (1979) and LeRoy Crandall and Associates (1982, 1983, 1991) that document a lack of faulting in the late Pleistocene Lakewood Formation exposed in the bluffs immediately south of the site.

A key marker bed is the "50-foot gravel layer" of Poland (1959). ECI drove their CPT borings to the top of this latest Pleistocene gravel layer and produced a structural contour map of the top of this unit. The gravel layer has a shallow westerly gradient and an irregular, constructional surface consistent with data reported by Poland and others (1959). ECI stated that, based on the irregular configuration of the top of the latest Pleistocene gravel, a vertical displacement of 2 to 4 feet would not be detected. However, the lack of faulting observed in the older late Pleistocene Lakewood Formation exposed in the bluffs to the south of the Playa Vista site and the lack of offset of overlying Holocene fluvial deposits at the site supports ECI's interpretation that there is no offset of the late Pleistocene gravel layer. ECI concluded that there was no evidence supporting the existence of the postulated "Lincoln Boulevard" fault.

Preliminary Conclusions

In conclusion, my preliminary review of the Davis and Namson report and the ECI report indicates that they have adequately documented that the proposed "Lincoln Boulevard" fault as characterized in the 4/17/2000 Exploration Technologies, Inc. report does not exist. The investigations of the near surface conditions by ECI and the subsurface geologic conditions to the top of basement rocks by Davis and Namson represent a creditable and integrated effort at fault investigation.

I anticipate completing my review in the next few weeks.

Sincerely,

William A. Bryant, CEG 1554
Program Manager, Active Faults

Encl

cc J Davis, State Geologist
M Reichle, Supervising Geologist

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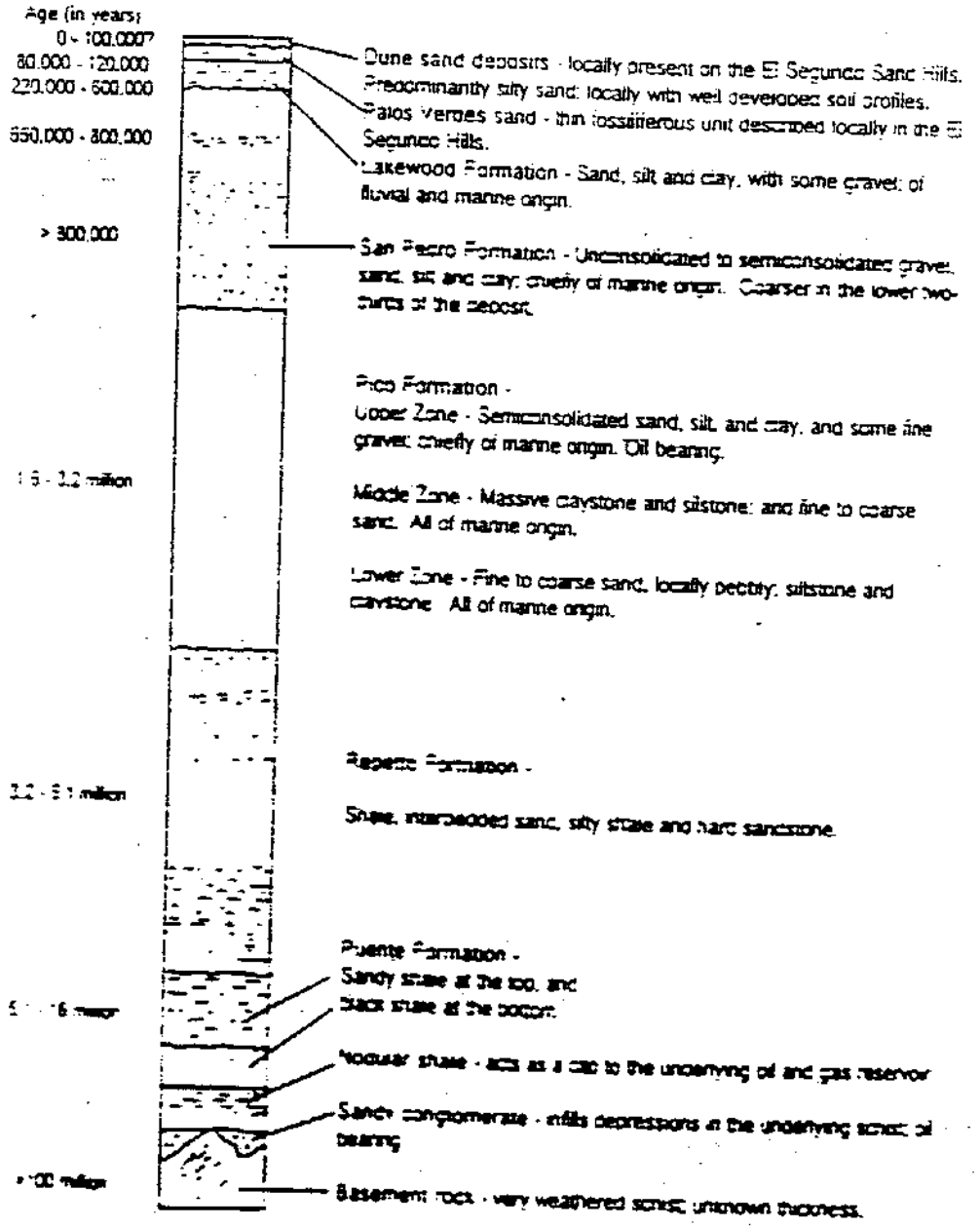
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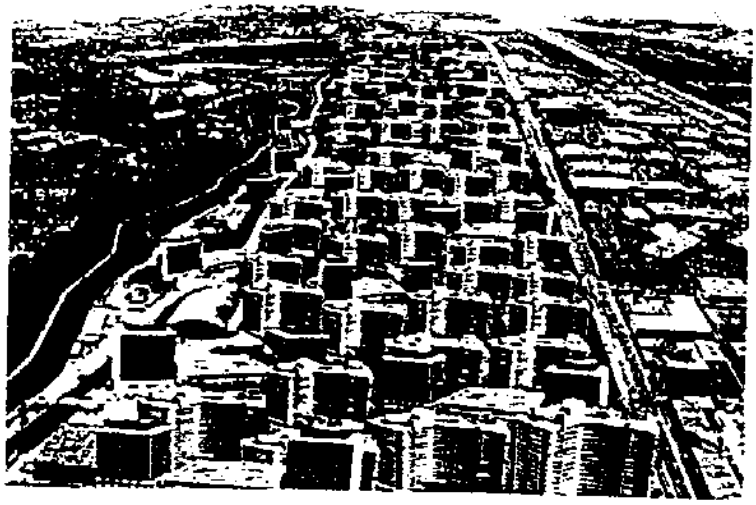
Approximate Scale: 1 inch = 1,000 feet

Earth Consultants International Project No. 800130-00 July, 2000	Stratigraphic Column for the West Portion of the Los Angeles Basin	Figure 3

Campaign to Save All 1,087 Acres of Ballona Wetlands & West Bluffs in Playa del Rey, CA
11924 W. Washington Blvd., Los Angeles, CA 90066, 310-636-3506, www.saveballona.org

April 3, 2001

Office of the Chief Legislative Analyst
Mr. Ron Deaton
200 N. Main St. Room 512
Los Angeles, CA 90012



Re: Inadequacies of CLA Report dated March 6, 2001 regarding dangers/mitigation plans at Playa Vista in Playa del Rey, California. Reply requested. Copies of video and this letter delivered to attached list.

From: **Airport Marina Group Sierra Club • Ballona Ecosystem Education Project Grassroots Coalition • Spirit of the Sage Council.**

GREED, GRIDLOCK AND GAS: The Playa Vista Story

The Playa Vista developers have plans to construct thousands of condominiums, apartments and single-family houses plus millions of square feet of office and commercial space on the Ballona Wetlands located between the LA Airport and Marina Del Rey.

By their own estimates, this would increase traffic on the 405 Freeway by almost 1/3rd. The result will be to create massive gridlock that could paralyze the entire western part of the city and impact everyone from Malibu to Northridge and south to Long Beach.

Now it has been revealed that the **Playa Vista site is situated over an abandoned oil field** that is leaking toxic and flammable gas, much like the infamous Belmont Learning Complex which had to be abandoned after the Los Angeles School District had spent almost $200 million constructing it.



The gases identified at Playa Vista are known to cause birth defects, cancer, and brain damage in growing children. By allowing the construction of a residential community on this dangerous land, the City and State are making themselves vulnerable to hundreds of millions of dollars in damages should the residents be injured or made ill by these toxic and explosive gases. These damages have the potential to bankrupt the City. 5- 1

Our elected Los Angeles officials need to investigate and answer the questions of concerned citizens that follow:

THE LOS ANGELES SCHOOL DISTRICT WAS FORCED TO ABANDON THE BELMONT HIGH SCHOOL COMPLEX AFTER SPENDING $200 MILLION DOLLARS BECAUSETHEY COULD NOT PROTECT THE STUDENTS FROM THE DANGEROUS GASES SEEPING UP THROUGH THE EARTH.

QUESTION If the experts could not design a reliable mitigation system for a single 35 acre high school site, what guarantee can the City and Developers provide that the massive mitigation system required for the thousand acre Playa Vista site will guarantee the safety of its residents who will face continuous exposure to Prop65 B-Tex and H2S chemicals which are known to cause birth defects, brain damage and cancer? 5- 2

THE CITY OF LOS ANGELES IS ALREADY PAYING OUT MILLIONS OF DOLLARS IN TAXPAYERS' MONEY TO SETTLE THE RAMPARTS POLICE CORRUPTION SCANDLE. NOW SOME OF OUR ELECTED OFFICIALS ARE PROMOTING THE CONSTRUCTION OF A HOUSING PROJECT ON A SITE KNOWN TO BE CONTAMINATED BY TOXIC GASES.

QUESTION Knowing the City could face hundreds of millions of dollars in punitive damages if any resident of the Playa Vista development where to be killed, injured or made ill by the gases, why are these Officials so vigorous in their support of this development? 5- 3

THE CITY'S OWN EXPERTS HAVE VERIFIED THAT THERE IS A GAS SEEPAGE PROBLEM AT THE PLAYA VISTA SITE AND CALLED FOR AN EXPENSIVE MITIGATION SYSTEM. IN THE CHIEF LEGISLATIVE ANALYST'S REPORT (CLA) REPORT ON PLAYA VISTA DATED MARCH 6, 2001 THERE ARE SEVEN (7) MITIGATION REQUIREMENTS LISTED. THE REPORT ALSO STATES THAT, ONCE THE UNITS ARE SOLD, THE HOME OWNERS WILL BE HELD RESPONSIBLE FOR MAINTAINING AT LEAST SOME OF THE FOLLOWING SYSTEMS:

(1) Gas detectors required in all basements
(2) Audible ALARMS required
(3) Visual ALARMS required
(4) Automatic notification of LA FIRE DEPARTMENT required
(5) Automatic continuous data collecting sensors required
(6) Methane sampling collection accessible to the homeowners association; LA FIRE DEPARTMENT required
(7) Ventilation pipes required

QUESTION By law there must be full disclosure to potential buyers of the hazardous gas problems at Playa Vista where condominium and single family dwellings will be priced from $300,000 to several million dollars. Once buyers are made aware of the hazards they face living at Playa Vista, and the almost unlimited expense and liability that will accrue to the Playa Vista Homeowners Association once the units are purchased, what guarantee can the City and Developers give us that the units will actually be sold? 5- 4

QUESTION If the approximately $500,000,000 in taxpayer subsidizies and bonds issued to build Playa Vista, and further investigation reveals that the planned gas mitigation techniques are inadequate, and the entire development has to be abandoned as was the case at the Belmont High School, who will reimburse the public for these hundreds of millions of dollars in losses? 5- 5

QUESTION And if the project is abandoned after being partially or fully completed, who will pay for its deconstruction and the restoration of the Wetlands? Or would it be left to weather and rot. 5-

REGARDING THE OVER 200 OLD AND LEAKING OIL AND GAS WELLS IN PLAYA VISTA, MARINA DEL REY AND VENICE PENINSULA RESIDENTIAL AREAS:

For many years the City has ignored the serious well-leakage problems in the Playa Vista Playa del Rey area and allowed developers to construct homes around and directly over the deteriorating and poorly capped oil and gas wells that dot the landscape.

QUESTION Why did the City block efforts, that were earlier proposed by the Exploration Technologies Inc. testing company, to perform soil gas testing in the vicinity of these 200 plus old oil wells? 5- 7

QUESTION Why has the City allowed Playa Vista to proceed with massive housing construction in areas that have the highest gas leakage problems, including the insertion of over three thousand pilings and other structures into the ground which provide additional paths for these toxic gases to enter the buildings and endanger their occupants? 5- 8

UNDERGROUND NATURAL GAS STORAGE:

For over 50 years, Southern California Gas has used the Ballona Wetlands as a storage area for natural gas by injecting hundreds of billions of cubic feet of this gas, under high pressure, into the old Playa del Rey oil field. This has greatly aggravated the well leakage problems.

QUESTION On March 6, 2001 the City issued a CLA Report (Chief Legislative Analyst's Report) on the on the Playa Vista site. Why has the City taken such great pains to exonerated SOCALGAS from having any responsibility to the public regarding the dangerous conditions in the areas surrounding the underground gas storage field at Playa del Rey? 5- 9

EXPLOSIVE GAS BUILD-UP IN SHALLOW ZONES:

It has been shown that the oil field gas continually migrates into the shallow 50 foot gravel zone that underlies the entire Playa Vista area, then spreads out laterally within this permeable zone, giving rise to a serious explosion hazard in areas far removed from the original source of the contamination. SOCALGAS and the City have both been aware of the dangers of this kind of gas migration in the shallow zones since the late 60's.

QUESTION Since there have been recent incidents in other areas of the country where, under similar conditions, underground gas has migrated and caused deadly explosions several miles from the source wells, what assurances can the city provide to the public that this will not happen in the Playa Vista development area? 5- 1(

QUESTION Why does the City now plan to issue close to $500 million in taxpayer subsidies and bond issues to place thousands of residents on top of one of the worst gas seeps in the country? 5- 1

A HIGHLY FLAWED REGULATORY PROCESS:

SOCALGAS is allowed to perform self-monitoring of their gas storage operations, with virtually no oversight provided by the State of California Division of Oil and Gas (DOG), or the Public Utilities Commission (PUC), the regulatory bodies that were created to protect public health and safety.

QUESTION Why did the City rely upon consultants paid for by the Playa Vista developers, and allow the scope of the Study to be controlled by the law firm of Latham & Watkins who simultaneously represent SOCALGAS, Playa Capital and other real estate development interests in the Playa del Rey area? 5- 1

Submitted by;

Airport Marina Group Sierra Club
Chair Rex Frankel, 6038 W. 75th St., Westchester, CA 90045, 310-572-6491

Ballona Ecosystem Education Project
President Rex Frankel, 6038 W. 75th St., Westchester, CA 90045, 310-572-6491

Grassroots Coalition
President Patricia McPherson, 3749 Greenwood Ave., Los Angeles, CA 90066, 310-397-5779

Spirit of the Sage Council
Special Project Coordinator Kathy Knight, 1122 Oak St., Santa Monica, CA 90405, 310-450-5961

CITY OF LOS ANGELES (CLA) REPORT

Comment Letter #5 cont.

(1) Gas detectors required in all basements.
(2) Audible ALARMS required.
(3) Visual ALARMS required.
(4) Automatic notification of LA FIRE DEPARTMENT required.
(5) Automatic continuous data collecting sensors required.
(6) Methane sampling collection accessible to the homeowners association & LAFD required.
(7) Ventilation pipes required.
(8) Contingency plan required ... (gas masks?)

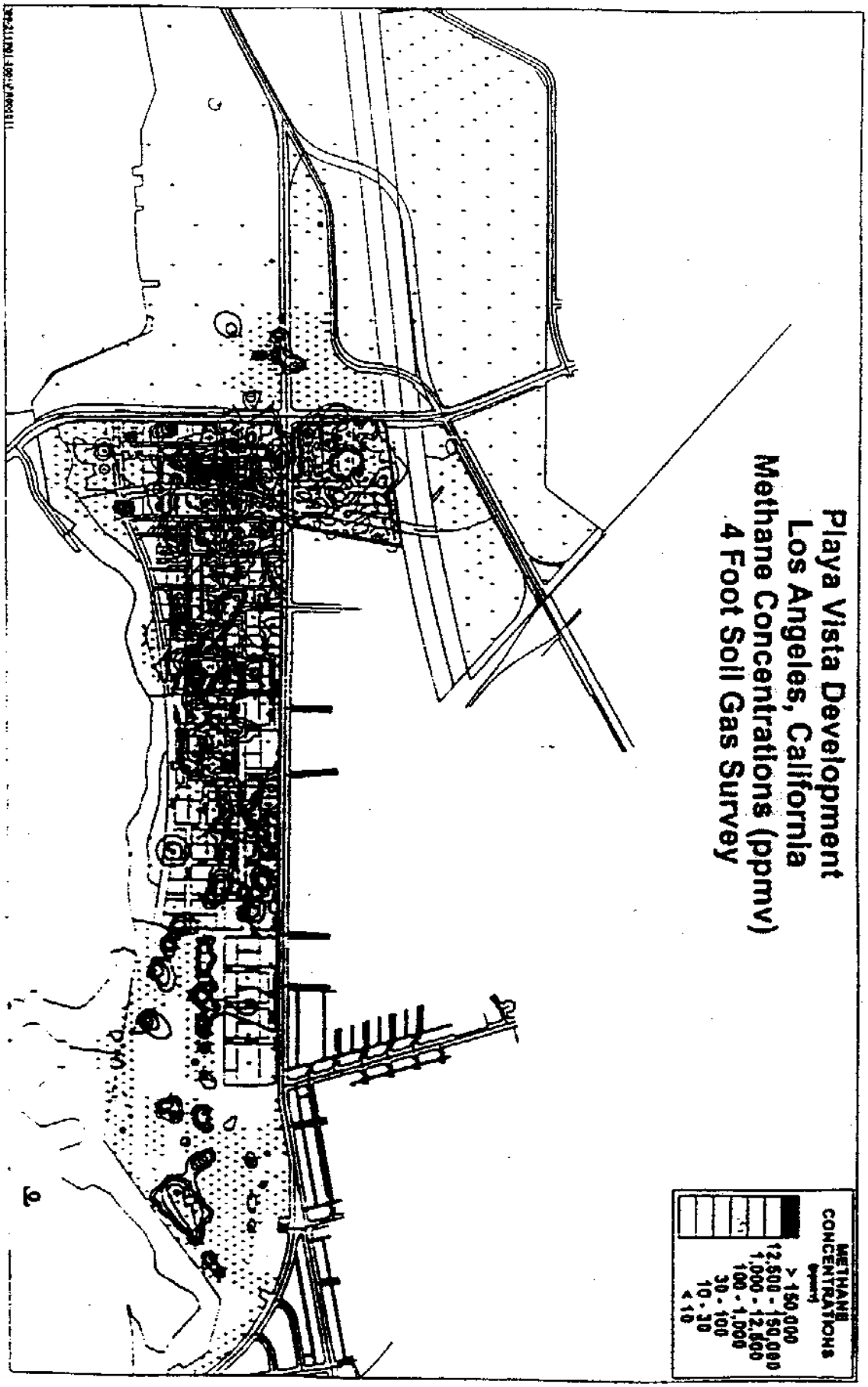

Playa Vista Development
Los Angeles, California
Methane Concentrations (ppmv)
4 Foot Soil Gas Survey
METHANE CONCENTRATIONS (ppmv)
> 150,000
12,500 - 150,000
1,000 - 12,500
100 - 1,000
30 - 100
10 - 30
< 10

Table 2-1: Methane Mitigations
METHANE SYSTEM REQUIREMENTS

A baseline soil gas survey shall be conducted for each building site to determine the areas of Playa Vista Phase I in which building methane prevention systems are required.[1]

Mitigation Measure	Methane Concentration Level		
	Level I[2] White:<10ppmv Blue:10-<30ppmv Lt. Blue:30-<100ppmv	Level II[2] Green:100-<1000ppmv Yellow:1000-<12,500ppmv	Level III[2] Orange:12,500-<150,000ppmv Red:150,000ppmv or >
Methane Prevention System[3]			
Passive - Underneath the Building			
12" gravel blanket	Required	Required	Required
gas collection vent pipe	Required	Required	Required
impermeable membrane	Required	Required	Required
Active - Mechanical Ventilation			
ventilation triggered with elevated methane concentrations	None	Required[4]	Required[4]
Subsurface Ventilation	None	None	Required
Methane Detection System			
Within the Building			
detectors in spaces located in the basement/lowest level in the building[5]	Required	Required	Required
audible alarm[6]	Required	Required	Required
visual alarm[6]	Required	Required	Required
automatic notification of LAFD[6]	Required	Required	Required
Underneath the Building			
data collecting sensors below impermeable membrane[5]	None	Required	Required
data collecting sensors between impermeable membrane and lowest floor/basement slab[5]	Required	Required	Required
Methane Monitoring System			
manual quarterly assessment	Required[7]	None	None
continuous methane sampling and data collection accessible by the homeowners' association, LADBS and LAFD via the Internet	None	Required[8]	Required[8]

Maintenance of the Prevention, Detection and Monitoring Systems			
- annual testing to the satisfaction of LADBS and LAFD	Required	Required	Required
- homeowners' association to have financial responsibilities	Required	Required	Required
Contingency Plan			
- when high methane concentration are detected within a building	Required	Required	Required
- when methane system components fail	Required	Required	Required

Footnotes:

1. Projects for which building permit applications were received by LADBS prior to January 1, 2002 may use as baseline methane concentration data the soil gas survey data prepared by CDM/ETI at Appendix 1. After January 1, 2002, all projects shall submit for approval to the satisfaction of LADBS, individual soil gas site assessments that characterize methane soil gas concentrations for the building site.
2. Levels of methane concentrations and corresponding colors on the methane concentration maps are identified in the Appendix 2 or individual building site soil gas assessments.
3. LADBS may reduce on requirements in areas where the methane concentrations in the area of building sites is non-detect.
4. When methane concentrations are detected at 37,500 ppmv by the sensors in the ventilation system below the impervious membrane, a mechanical ventilation system shall be automatically activated.
5. Number, type and location of detectors (or approved equivalents) to be determined by a qualified methane engineer, as approved by LADBS.
6. Audible alarm, visual alarm and notification of LAFD shall be triggered when methane concentrations are detected at 12,500 ppmv.
7. Sampling data reviewed by a qualified methane engineer shall be approved by LADBS. When such data is determined to be highly variable, additional manual sampling or electronic sampling may be required by LADBS. A qualified methane engineer shall submit a report to LADBS with conclusions and recommendations.
8. When the methane concentration data indicates significant changes in methane concentrations below the membrane, then a report by a qualified methane engineer shall be submitted to LADBS characterizing the reasons for such changes.

Copied from the Sepich Associates Report, January 30, 2001.

Playa Vista's Traffic Impacts on the Westside

Lately, it seems one does not have to go far to find gridlocked traffic on LA's Westside, one of the most congested areas in the state, if not the country. Unfortunately, while Los Angels city planners and development interests are busy approving one project after another, the consequences of this unrestrained development and increased density is more traffic congestion and gridlock on our roadways.

With our area's main collector roads, such as Centinela and Inglewood Ave. now unable to handle the current traffic capacity, increasing numbers of motorists are cutting through our residential streets, thereby posing a danger to pedestrians and children. Many of these "cut-through" motorists are also speeding. According to the **Los Angeles Department of Transportation (LADOT)**, the intersections of Venice at Centinela and at Inglewood are now rated at "F". The rating scale used by the LADOT grades traffic flows from "A" through "F". "A" represents free flowing traffic with no delays, while those rated at "F" are experiencing jammed conditions.

In response to the increasing traffic congestion throughout our community, the **Mar Vista Neighborhood Association**, MVNA, has forged a unique partnership with, LADOT, in an attempt to reduce the increasing volume and speed of "cut-through" traffic on our residential streets. Unfortunately, the LADOT has few viable solutions that will produce any significant relief for our existing traffic. In fact, on a larger scale, the LADOT has neither the resources nor the tools to provide any substantial improvements to the Westside's traffic gridlock. In Venice and other nearby communities the City is proposing major road widening projects in response to traffic congestion. Major street-widenings must condemn adjacent businesses, reduce or eliminate the "buffer zones" between pedestrians and moving vehicles and reduce street parking spaces. Wider roads also divide and bisect communities and serve as high-speed traffic barriers. **The Palms-Mar Vista-Del Rey District Plan** states that road widening projects are not recommended for our area due to the negative consequences and "costs" imposed on the community. The character of our community influences our property values and road widenings will impact these values.

The current disconnect that exists between City Planning's continued accommodation of unrestrained growth and the LADOT's inability to handle the downstream effects of increased traffic congestion has caused **over 75%** of the Westside's major intersections to be rated at or beyond the capacity they were designed for. Most of these roads and intersections have received grades of "E" and "F" from the LADOT. LA's dysfunctional planning process will quickly cause all our roads to be rated "F" – unless we do something about it. 5-1

Given the current traffic congestion on the Westside, it is even more shocking that the City of LA approved the **Playa Vista** development back in 1993. Traffic is already far worse than in 1993 and the project has only completed one building! According to the LADOT, **Playa's Master Plan will add over 224,000 vehicles per day on the Westside**. According to Playa Vista's own EIR (page III-43) the "Master Plan project traffic increases would range from **36% - 56%** along the Jefferson, Culver and Centinela Corridors". Based on the city's own documents, significant traffic congestion will result if Playa Vista is developed. Although Playa Vista claims that it will mitigate all its traffic impacts, it should be noted that **there is no mechanism nor consequences in place that will hold the developer accountable to its claim that it must mitigate its traffic.** The City's Building and Safety Dept. recently decided to deny approval of any new building permits until a lengthy 4 – 6 month study assesses the methane gas seepage that was recently discovered on the site. Adding insult to injury, Playa's survival is solely dependent on public subsidies. We are all unknowingly funding our own cut-through traffic.

In response to this, there are two choices: 1) we do nothing and wait until the traffic is at a crisis level or 2) use our knowledge of the facts and voices to let our leaders know our opinion. If you chose option 2), write to your Councilmember, the Mayor and city planners and let them know your concerns.

Comment Letter #6

RECEIVED
CLA
01 APR -6 PM 1:38

April 5, 2001

Barb Garrett
Legislative Analyst
200 N. Main Street, Room 512
Los Angeles, CA 90012

Re: Proposed Mello-Roos Financing of the Playa Vista Development Project

Dear Ms. Garrett:

I am against the proposed use of Mello-Roos bonds for the Playa Vista Development Project. I would think that the potential risk factors unearthed so far would make the investment of these funds for this proposed project out of the question. 6- 1

Dr. Jones and Exploration Technologies, Inc. originally found that the So. California Gas Co. Playa Del Rey Gas storage facility was a source of the methane contamination at the site. 6- 2

Since the off-shore seismic data concerning whether or not there are off-shore faults is as yet incomplete, and there is still uncertainty as to whether the Lincoln Blvd. Fault exists, I strongly urge that further investigation into the methane problem and earthquake risk be addressed before financial investment of Mello-Roos funds are granted. 6- 3

With reference to Figure 2.1 indicating methane concentrations, none of the streets are named, so I am unable to determine where the gas storage facility is in relation to the diagram Proper street names would seem appropriate for such a diagram. 6- 4

As a resident of the area of the proposed Playa Vista Development Project, I am extremely concerned that there has not been adequate study of the methane contamination risk factors and that continuing with the development is not a good idea 6- 5

It is one thing for the developers to risk their own funds in this venture, it is quite another to propose investment of public funds 6- 6

Sincerely,

Patricia Trujillo
7377 W 83rd Street
Los Angeles, CA 90045

Campaign to Save All 1,087 Acres of Ballona Wetlands & West Bluffs in Playa del Rey, CA
11924 W. Washington Blvd., Los Angeles, CA 90066, 310-636-3506, www.saveballona.org

SPOKESPERSONS for "Greed, Gridlock & Gas: The Playa Vista Story"

Bernard Endres, Ph.D.
Systems Safety Engineer
Bernard Endres is a trained Systems Safety Engineer, holding a Ph.D. from Pacific Western University. Additionally, he holds a Masters of Science in Engineering and Mathematics from the University of Michigan, and a Bachelors of Science in Aeronautical Engineering from the University of Detroit.

A long-time resident of Southern California, Endres is actively sought by environmental groups for his talents and expertise in oil and gas migration hazards and in geological and subsidence problems of the earth. He has worked and studied worldwide, been a guest lecturer and written papers, articles and co-authored a book on systems engineering and the issue of gas migration.

Through his research, studies and expertise he was instrumental in helping expose the toxic gas issues of the Belmont Learning Center site, has been a lecturer for both UCLA and USC on the environment, and has work experience spanning from The Aerospace Corporation to consulting in Environmental and Safety Engineering for corporations, non-profit organizations and for privately funded studies.

Endres has partnered with long-time volunteer and friend of the environment actress Patricia McPherson and Grassroots Coalition, and is currently working to bring out the truth regarding the toxic gas problems at Playa Vista. Endres can be reached for comments and interviews.

Patricia McPherson
Hazardous Toxic Sites Activist
Patricia McPherson has been a political activist since the 1980's. A trained actor and journalist, McPherson was one of the primary stars of the television series "Knight Rider" and has acted in movies and commercials. She also is a former employee of Los Angeles magazine and holds a Bachelor of Arts in Graphic Communications. Since her acting career, she has devoted her time to being a full-time activist and friend of the environment.

McPherson has worked with Dr. Endres, who holds a Ph.D. in Systems Safety Engineering. Together, they have actively been involved and continue to educate the LA Unified School District regarding the Belmont Learning Complex site. The duo was instrumental in the disclosure of the toxic issues with the site, conducting research and testing in the area, and they have become experts on the issues of gas migration and other gas leaks throughout the city of Los Angeles.

As a concerned citizen of Los Angeles, an environmental activist, and a volunteer in issues of gas migration, McPherson is extremely knowledgeable and familiar with the entire Playa Vista development and other hazardous toxic sites in the city.

McPherson is available to speak to government leaders and the press regarding the unsafe development of Playa Vista in the Playa Del Rey area.

Comment Letter #7

RECEIVED
CLA
01 APR -6 PM 1:37

March 27, 2001

Ms. Barb Garrett
Legislative Analyst
200 N. Main Street, Room 512
Los Angeles, CA 90012

RE: City Investigation of Potential Issues of Concern for Community Facilities District No. 4, Playa Vista Development Project

Dear Ms. Garrett:

I am submitting these comments on the Report of the above-referenced investigation. I want to commend the Office of the Chief Legislative Analyst for its thoroughness and for its attention to detail and scrupulous scientific standards. I find the report important for two reasons:

First, because of the results. As a member of the local community, I am relieved to learn that there is no evidence of a new earthquake fault in our community, that the Gas Company natural gas storage facility is not leaking, that Playa Vista is not subsiding, that the site poses no health risks, and that there are mitigation measures for any methane detected on the site.

Second, as a long-time Playa Vista supporter, I want to see the project move forward. I hope that your Report allows us to put the issues investigated behind us once and for all and that we will finally see the realization of a project that creates community, stimulates economic development, and undertakes the much-needed restoration of the Ballona Wetlands.

Thank you for your consideration.

Sincerely,

Julia Judge 4/6/01

Signature Date



Julia Judge
8004 Cowan Ave.
Los Angeles, CA 90045

City

Comment Letter #8

RECEIVED
CLA

01 APR -6 PM 1:37

March 27, 2001

Ms. Barb Garrett
Legislative Analyst
200 N. Main Street, Room 512
Los Angeles, CA 90012

RE: City Investigation of Potential Issues of Concern for Community Facilities District No. 4, Playa Vista Development Project

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Thank you for your consideration.

Sincerely,

Thomas A Judge
Signature

Apr. 5, 01
Date

Thomas Judge
8004 Cowan Ave.
Los Angeles, CA 90045
City

Comment Letter #9

FAXED TO:
(213) 680-0085

April 9, 2001

Ms. Barb Garrett, Legislative Analyst
City of Los Angeles
200 No. Main St., Room 512
Los Angeles, CA 90012

RE: Public Review Comments
City Investigation of Potential Issues of Concern Re: Toxic Gas Problem at Proposed Playa Vista Site and Issuance of $135 Million Mello Roos Bonds & Release of $33.6 Million Tax-Free Housing Bonds

Dear Ms. Garrett:

This letter is being written on behalf of Grassroots Coalition, Ballona Ecosystem Education Project, Airport Marina Group Sierra Club, and Spirit of the Sage Council.

We are totally appalled at the lack of carry-out of the mandate from last June 7, 2000 LA City Council Budget & Finance Committee hearing regarding this investigation. If you review carefully the minutes of that meeting, the Committee clearly wanted an independent investigation with experts hired by the City – NOT PLAYA VISTA'S CONSULTANTS AGAIN! This was the process that led to the INITIAL cover up in 1993 of this enormous gas problem. This is outrageous! 9- 1

Due to the fact that this comment is due today, and there are 3 major hearings tomorrow on Playa Vista issues (including 2 in Santa Barbara), we are going to have to give you brief comments today. We reserve the right to add more information later, as the time period for these comments was less than 30 days from when we received the report. One of the reasons we keep requesting and SEIR be done on this major change in the Playa Vista project, is so that the public would have the 45 days given us by law through the California Environmental Quality Act (CEQA). 9- 2

We submit that you did not do what we have requested, namely a Subsequent Environmental Impact Report (SEIR) that needs to be done on this changed circumstance and extremely important new information that has come to light since the 1993 EIR was certified by LA City. This new information is drastically changing both the project, its impact on the surrounding community, and its mitigation systems. Also, an SEIR would result in all affected government agencies being notified of such a study, and the public would benefit from their comments. That is one of the main purposes of CEQA. 9- 3

GRASSROOTS ET. AL
CLA REPORT
4-9-01

We hereby incorporate all the objections and information we are submitting in the Los Angeles Building and Safety Commission Appeal of the Playa Vista Gas Mitigation System Board File No. 010041 and File No. 010042 being heard on April 9, 2001. We include the entirety of the proceedings including transcript, exhibits and the revocation of the permit, in view of the thoroughness of what we are setting forth. We also include in our comments all information submitted to the Los Angeles Building and Safety Dept. both previous to July 19, 2000 and since then, including the many briefings we have given LA City and Building and Safety staff. This is a voluminous record of information presented by citizens at their own expense and in their own volunteer "off hours" time. We do not have million dollar budgets, staff, nor office equipment to do this work. Therefore, we are unable to reproduce it for each and every hearing. 9- 4

It is a big disappointment to us that you do not seem to have looked at much of this critical information we have been submitting for the past 7 years.

In addition to the above, we have the following comments:

1) A proper oilfield study needs to be done of the over 200 leaking wells in this region. Development is being allowed over abandoned wells with no gas mitigation system nor disclosure to homebuyers. To not do such a study is endangering the lives of thousands of people. This needs to be done also to properly assess the problem at Playa Vista. No funding or building should be done until the problem is comprehensively defined. 9- 5

2) A Hydrogen Sulfide study needs to be done of the Playa Vista site. The presence of the highly toxic H2S is documented in MANY city documents. This study MUST BE DONE! 9- 6

3) This report and what is going on in the City of Los Angeles to cover up the dangers and honest characterization of the oil field dangers is at the point where we characterize it as fraud. The untruthful story is being perpetuated to server powerful developers and large law firms. It is time to STOP! The City of LA needs to come clean on what the situation is – or they could be bankrupted by a disaster bigger than the $200 million taxpayer waste of Belmont High School. In addition, people could be sickened and killed – similar to the Hutchinson Kansas disaster last January. 9- 7

3) This report is flawed from the beginning because no independent studies were done. 9- 8

4) The CLA has not been truthful in saying that they never got the resumes of the underground gas migration experts we provided. We have documentation that Mr. David Hsu of LA Building and Safety walked them over to your office. To not draw upon these world class experts is unbelievable – especially when you have the worst gas seep over an oil field in the WORLD! 9- 9

GRASSROOTS ETAL,
CLA Report
4-9-01

5) Conclusionary statements are made in the report with no back up data. This would not be allowed under CEQA. 9- 10

6) Subsidence has not been properly examined. 9- 11

7) The Charnock fault does exist – it had an earthquake on it just last September 16, 2000. This fact alone shows what a ridiculous attempt to cover up the truth was used in the CLA report. 9- 12

8) No public hearings are scheduled on this report. That is outrageous. We need a chance to hear from the public. CEQA would have provided for this! In addition, many people have told me they called your office to meet with someone, and were denied. This is NOT the public process that Mr. Michael Feuer requested on June 7, 2000. 9- 13

Again, we incorporate all previous data we have submitted to the City on what the dangers are of the Playa Vista site, surrounding area, and from SOCALGASCO's underground storage area. 9- 14

Sincerely,

Patricia McPherson (pk)

Patricia McPherson
President, GRASSROOTS COALITION
3749 Greenwood Ave., Los Angeles, CA 90405
(310) 397-5779

Rex Frankel (rk)

Rex Frankel, Chair
BALLONA ECOSYSTEM EDUCATION PROJECT
6038 W. 75th St., Los Angeles, CA 90045
(310) 572-6491

Kathy Knight

Kathy Knight
Special Projects & Wetlands Coordinator
SPIRIT OF THE SAGE COUNCIL
Conservation Chair
AIRPORT MARINA GROUP SIERRA CLUB
Mailing Address: 1122 Oak St
Santa Monica, CA 90405
(310) 450-5961

Comment Letter #10

ALANandROSEMacHardy

TO: City Planning Department
RE: CLA Report on Playa Vista.
Date: April 9, 2001

I spoke at the July 18 Playa Vista hearing and would like to rebutt the findings of the CLA report by the City of Los Angeles. I understood that the investigation ordered by the City of LA would NOT be financed by Playa Capital or any of the investors in Playa Vista but by the City of LA, so as to prevent any bias towards Playa Vista. The CLA report DOES state that the investigation was paid for by Playa Vista. 10-

This makes any of the CLA findings difficult to accept, especially when many scientific experts have testified that the problems with methane and toxics caused (as they usually are) to the area by oil drilling have been found to be a severe problem at Belmont High School, an area with many of the same problems as the Playa Vista area. 10-

It seems to me that the proper study still needs to be done - **NOT FUNDED BY EITHER PLAYA VISTA DEVELOPERS OR THE CITY** - but a completely unbiased organisation. Otherwise, as I said in my statement, the hypocrisy of the LA City Council who issued the permits for the PV project AND the corruption which the City of LA planning department is accused of by the genuinely concerned residents of the Playa community, must still stand. Please address this problem. 10-3

Sincerely,

Rose MacHardy

(310) 827-7012

Comment Letter #11

jonathan aurthur

1115 euclid st. #5
santa monica, ca 90403
310 451 5258 aurthur@gte.net



April 9, 2001

To: Barbara Garrett, Office of CLA, Los Angeles
213-680-0085
Re: CLA methane report regarding Ballona Wetlands/Playa Vista project

Dear Ms. Garrett:

I am writing to urge you to postpone approving the March CLA report pending further review of the methane, toxic gas, and seismic issues at the Playa Vista site, particularly Area D, Phase One.

I have read the March report, just as I read last year's gas/seismic report done by ETI, Inc. I know that the new document, which refutes key points made by ETI, purports to be a deepening of the first investigation. But given the role of seven consultants associated with Playa Capital in fabricating the new report, I do not have confidence in its reliability. 11- 1

I do not mean to question anyone's integrity or motives. But recent events in the medical world, for example—such as the Rezulin matter as handled by FDA and many other cases regarding research published in medical journals—suggest that even the most competent scientists tend, perhaps subconsciously, to skew their results in the interests of the companies or organizations they are working for and being paid by. Often such biases, even when unconscious, result in the sickness or death of innocent people.

Similarly, there is the possibility of serious illness or death at Playa Vista if the not-always-disinterested experts turn out to be wrong. I believe that this fact alone is enough to create caution about the new report. 11- 2

My recommendation: We now have two conflicting reports about the advisability of building structures on Area D of the Ballona Wetlands near Jefferson and Lincoln, about the existence of the Lincoln Fault, and about the possibility of mitigating methane hazards at the site in new apartment buildings. In other words, we have a *one-one tie*. I would argue that, given the serious nature of the matters we are dealing with, we need a *third* investigation, a tie-breaker, to settle the matter once and for all. This investigation should be thoroughly vetted through public hearings and carried out by *thoroughly disinterested* parties—individuals without *any* professional or financial connections to any of the parties with an interest in the project. 11- 3

The possible liability exposure of the City of LA as well and dangers to persons who may end up living on the Playa Vista site call, I believe, for greater care than would be evidenced by hurried acceptance of the new CLA report. In the words of Hippocrates: First, do no harm. 11- 4

Thank you for your attention.

Respectfully,

Jonathan Aurthur

"The Angel and the Dragon"

Comment Letter #12
132 Form Letters with original individual signatures delivered by Playa Capital Companies, LLC

For ease of presentation a copy of the form letter is preser
with original signatures reproduced in a consolidated format.

March 27, 2001

Ms. Barb Garrett
Legislative Analyst
200 N. Main Street, Room 512
Los Angeles, CA 90012

RE: City Investigation of Potential Issues of Concern for Community Facilities District No. 4, Playa Vista Development Project

Dear Ms. Garrett:

I am submitting these comments on the Report of the above-referenced investigation. I want to commend the Office of the Chief Legislative Analyst for its thoroughness and for its attention to detail and scrupulous scientific standards. I find the report important for two reasons:

First, because of the results. As a member of the local community, I am relieved to learn that there is no evidence of a new earthquake fault in our community, that the Gas Company natural gas storage facility is not leaking, that Playa Vista is not subsiding, that the site poses no health risks, and that there are mitigation measures for any methane detected on the site.

Second, as a long-time Playa Vista supporter, I want to see the project move forward. I hope that your Report allows us to put the issues investigated behind us once and for all and that we will finally see the realization of a project that creates community, stimulates economic development, and undertakes the much-needed restoration of the Ballona Wetlands.

Thank you for your consideration.

Sincerely,

Javier Cano 3/27/01
Signature Date
JAVIER CANO
Print Name
2417 SEBALD AVE
Address
Redondo Beach CA
City 90278

March 27, 2001

Ms. Barb Garrett
Legislative Analyst
200 N. Main Street, Room 512
Los Angeles, CA 90012

RE: City Investigation of Potential Issues of Concern for Community Facilities District No. 4, Playa Vista Development Project

Dear Ms. Garrett:

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Thank you for your consideration.

Sincerely,

Signature _____ Date April 4, 2001

Print Name DOUG EHLERS

Address 5527 W. 77th

City LOS ANGELES, CA. 90045

3/27/01
Signature Date
John Andrew Dzubak, JR
Print Name
2232 Lincoln Blvd
Address
Venice, CA 90291
City

Linda Standaart 3/27/01
Signature Date
Linda Standaart
Print Name
13900 Panay Way, SR-311
Address
Marina Del Rey, CA 90292
City

3/27/01
Signature Date
A.J. CIANCIMINO
Print Name
7355 W. 83rd ST
Address
Los Angeles CA 90045
City

J.A Ciancimino 3-27-01
Signature Date
J.A Ciancimino
Print Name
7355 W 83rd St.
Address
Westchester, 90045
City

3.27.01
Signature Date
Nina Gorby
Print Name
120 Foxtail Dr
Address
Santa Monica
City 90402

Signature Date
CARLOS RAMIREZ
Print Name
7550 FLIGHT Ave
Address
L. A, 90045
City

Signature Date
Mrs. Lois Lindahl
Print Name
6210 Fairmont ST
Address
Westchester 90045
City

3-27-01
Signature Date
ALEX GORBY
Print Name
2904 WASHINGTON Blvd
Address
Venice
City 90291

3/27/01
Signature Date
PATRICIA YOUNGS
Print Name
5855 W. Century BLVD. & HOME ADDRESS: P.O. BOX 802168 SANTA CLARITA CA 91380
b. Address
LOS ANGELES, CA
City 90045

Helen J. O'Neill
Signature Date
Helen J. O'Neill
Print Name
P.O. Box 10092
Address
Marina del Rey, Ca
City 9[illegible]

Signature Date 3/27/01
Marcel Honoré
Print Name
8355 Manchester
Address
Playa Del Rey 90293
City

Signature Date
Thomas Honoré
Print Name
10822 Malony Rd.
Address
Culver City, CA 90230
City

Signature Date 3.27.01
CEDRIC W. SUTHERLAND
Print Name
4161 LINCOLN BLVD
Address
MDR 90292
City

Signature Date 3/27/01
Jan Honoré
Print Name
10822 Malony Rd.
Address
Culver City, Ca. 90230
City

Helfried Fahrendorf
Signature Date
HELFRIED FAHRENHOLZ 3.26.2001
Print Name
119 Culver Blvd.
Address
Playa del Rey.
City

Signature Date 3-27-01
Rev. Leonard B. Jackson
Print Name
2270 S. Harvard Blvd.
Address
Los Angeles, CA-90018
City

Signature Date 3/27/01
CHARLES M. PORITZKY
Print Name
7529 W. 85th ST.
Address
PLAYA DEL REY, CA 90293
City

Signature Date 03/27/01
KENNETH JORDAN
Print Name
3210 W. VERNON AVE
Address
L.A. CA 90008
City

Signature Date 3/27/01
MICHAEL R. BAUER
Print Name
10676 ESTERINA WAY
Address
CULVER CITY CA 90230
City

Signature Date 3/27/01
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Comment Letter #13

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April 9, 2001

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By fax: (213) 680-0085

Re: Public Review Comments
City Investigation of Potential Issues of Concern for CFD4 Playa Vista Development Project

Overview:
I do not agree that this report fulfills the requirements of the Budget & Finance Committee as determined at the June 7, 2000 meeting presided by Councilmember/Committee Chair Mike Feuer and Councilmember/Committee Member Cindy Miscikowski.

Much of what I read dissuaded me from any conclusion that the intention of this report was to bring truth to light. If that were really the committee's intention, there would have been at least some requests for more information from experts in the affected communities who were not specifically part of the committee. Even more telling, is that the July 18 public hearing comments transcripts were not included in the volumes of documentation addended to the Study. Instead the Study committee chose to work in a vacuum from the communities that generated the request for the study in the first place. 13- 1

Caveat:
As a member of the public with limited time, resources and access to public officials, please excuse any mistakes I may have made, but please inform me.

Please note that I have additional concerns about specific technical issues, beyond the one's I addressed, but I'll leave those for others with more informed opinions.

Thank you for the opportunity to present my concerns.

Sincerely,

Stewart Morris

Attachment: Stewart Morris/Public Review Comments

CLA March 2001 City Investigation of Potential Issues of Concern CFD4 Playa Vista
Public Review - Stewart Morris

1. **The CLA report did not account for all the relevant public comments/evidence presented July 18.**

After the July 18 public comments meeting the CLA apparently never formally or informally reported which public comments they considered relevant and how those would alter the proposed study plan. One can only assume that (a.) public comment was not formally considered and/or related discussions were not memorialized, (b.) if they were considered, there was no public record that they were presented to Councilmember Feuer for approval, which means that (c.) therefore the final CLA Study plan was never approved by those who engaged it in the first place. 13- 2

Nor could I find evidence of any meetings offered between the Study Members and the members of the public who presented technical evidence at the July 18 meeting, as requested by Councilmember Feuer. 13- 3

By reviewing transcripts from the June 7 meeting that initiated the study and the July 18 public hearing that solicited input, compared to the final March 2001 CLA report, one finds the following...

This study was instigated by the apparently strong public reaction to disagreements regarding public safety issues presented to the Council by the proponents of the Playa Vista project re solicitation of Mello-Roos funding. Councilmembers Feuer and Miscikowski requested the CLA Study be performed to ascertain the accurate data needed to make an informed decision regarding bond funding. The CLA Study was to be done as an open, impartial investigation of scientific evidence. 13- 4

The CLA report makes no mention of any public involvement other than the June 7 and July 18 public hearings. In fact, the last public involvement, at the 7/18 hearing, was clearly defined by Gerry Miller ACLA, who ran the meeting, as not a forum for any discussion and only a source of input re the draft CLA study. (publicly announced only one week prior, but not published in the primary local newspaper, The Argonaut.)

At the June 7 meeting, Councilmember Feuer made specific requests regarding public involvement...

"I think there should be a meeting, a public meeting, for people to be able to say what they think of the outcome of that determination. 'Here's what we think we ought to be studying.' 'Public, what do you think?' 'Is it too extensive?' ' Is it too narrow?' 'What's there?'"

"And then, informed by that public meeting, City staff then proceed to prepare a report with input from City staff experts and any other experts whom they deem appropriate from outside consultants and the like." Then they come back within a specified timeframe."

"... So, it's... What do we study and by when? Public, what do you think of that? Give what you think of that."

"...that COA report and consultation with that team results in a report that further analyzes, among other things, the issues raised in the peer review report submitted by Dr. Jones and includes, but is not limited to ..."

"And the CLA *shall consider any other evidence that it gets including evidence presented to this committee*." 13- 5

"...the process is, "What are the issues: public discussion".

"I believe that the task force can help us get to t a greater depth of that kind of specific analysis if it's done in a public forum and not behind closed door so that the public has the ability to exchange, involve and provide expertise as well."

"... the bottom line issues are how do we get to the best possible extent real information ...addresses the outstanding issues ... allows for meaningful public input and enables us as decision makers to feel confident that we have the universe of relevant information from public people, from consultants, from City staff to make a decision."

"... to pull together the information to create public process, to receive public documents from the public which help to inform the decision and help distill the decision, to let this process begin as a recommendation as best as possible..."

"... there would be an opportunity for a well-noticed public meeting at which to discuss, at that early stage, the array of issues to be considered and the time frame within which the report be prepared, to be followed by the actual preparation of the report ... I am very cognizant of the frustration of some or all sides here who felt they would have liked more time to discuss the substantive issues. There will be plenty of opportunity for that discussion."

13- 5 cor

2. The CLA report did not appear to include input from Dr. Jones, as explicitly requested by Councilmember Feuer (other than for peer review after tests were concluded).

The CLA report notes that Dr. Jones was asked to review specific reported conclusions, but does not describe his integration into the overall project process as explicitly requested by Councilmember Feuer.

There is an apparent double standard here. If the Study (p.23) describes his initial report as void because it was based on an outdated (1935) and inaccurate study, then why was he still considered a reliable peer-reviewer? Even a cursory review of that report would have determined any credibility problem well before July 18 (where it could have been presented to the public in the Study proposal.) And, what was unique about his participation, or lack of participation, that caused his name to be missing from the list of Consultants and Contracting Agencies? What occurred?

Is something unusual occured here, is there an issue to consider if it's also determined that he's the first and only consultant ever hired by Playa Vista (to report on a query from the City) who responded with findings contrary to the interests of the Developer?

13- 6

At the June 7 meeting, Councilmember Miscikowski said...

"What we really need is some entity that is our City agents who get the peer review testimony and those who are not on either side of promoting an issue or recommending a statement, but someone who knows the language, knows the system, knows the kind of questions that you and I don't n know how to ask..."

"...we need a task force for those contradictions and conflicts and others are going to be brought forward can be aired it can be resolved, can create a group of City agents who have some degree of technical knowledge and outside that the City will hire to help them clear the issue."

At the June 7 meeting, Councilmember Feuer said ...

"Dr. Jones ... needs to be part of that team because he's the peer review who's been in this. And, if I didn't say that explicitly, I wanted to be clear about it now."

3. The report does not document how the specific consultants were selected and what their existing or prior relationships to the Playa Vista project are/were.

During the June 7 meeting a question was raised regarding the potential conflict of interest resulting from the Gas Company and Playa Vista developers employing the same law firm... that is, how the two parties can have the same legal representation, even though they pursue apparently conflicting interests.

That unanswered question points to a related missing logic in the Study. The Study reviews potential Gas Company liability (methane leaks) determined, in part, by consultants employed by the Developer, who has the same incentive to find no leaks.

13- 7

At the June 7 meeting, a member of the public (Venskus) asked ...

"...perhaps look into and investigate the potential conflict of interest with Latham & Watkins representing both Southern California Gas and Playa Vista ...

4. The report does not make any specific comparisons to the conclusions reached prior to permitting and construction of Belmont.

During the public hearings, there was concern shown regarding the fact that similar safety studies were completed, and approved as safe, before Belmont was constructed, yet it now stands abandoned as unsafe. How are those concerns addressed here? This is not a comparison of safety issues, but of the credibilty of the studies due to lack of response to pubic input and lack of accountabilities to non-vested parties. 13- 8

5. Technical concerns.

The CLA report notes methane mitigation

Re venting. The report says that the actual number of vents is not determined yet. How can the City consider issuing bonds for a property development mitigation technology that is not fully defined? 13- 9

Re "active" venting. The report notes that Level III and some Level II concentration levels will require "active" mechanical ventilation systems. 13- 10

1. Where will the energy be supplied from and how will they source redundant/emergency power in the case of an earthquake or other catastrophic event? Is the State of California willing to approve special permit to exempt the project from electricity brownouts.
2. How will the ambient noise and additional expense be considered in the sale price of homes? Will that be reflected in the Development's updated financial pro-forma? 13- 11
3. If an audible and visual alarms and notification to LAFD are triggered when methane concentrations are detected above 12,500 ppmv, what occurs next? If a significant concentration is detected, who is liable for the evacuation costs, who is liable for the mitigation costs to determine the cause and re-route the gas? 13- 12

Re Monitoring. The report notes that manual assessments and monitoring will be required and the building owner or property owners association will be responsible for it's upkeep.

1. Who is accountable for ensuring that sites requiring monitoring are in fact monitored? 13- 13
2. What protection will the community have regarding compliance of the monitoring?
3. What examples of non-compliance did the Study review to determine that the plan to monitor is typically enforced, and who will be responsible for that enforcement at PV? (Opinion: Property owners associations are not typically associated with reliable, consistent actions and accountability.)
4. How will the disruption and additional expenses related to monitoring be considered in the sale price of homes? ? Will that be reflected in the Development's updated financial pro-forma? 13- 14

6. Subsidence.

The Study reviewed historical data to determine evidence of existing ground subsidence. It did not appear to review how adding millions of tons of property development, automobiles and people on a porous. historical wetland will effect the potential for future soil compaction and subsidence. 13- 15

If the property is situated on a significant aquifer, and the water (and gas) are diverted, what will occur as a result?

7. Input from all Study committee members.

The July 11 CLA report proposal and the completed March 2001 report note the Los Angeles Fire

Department as a member of the Study committee. However, I did not see any commentary from LAFD in the report.

1. What was LAFD's participation?
2. Where is the documentation re their participation?

13- 16

8. Post Study actions.

What are the next steps regarding the result of this public comment?

1. How will the Study members assimilate this comment into their report to the PLUM committee?
2. How much notice will the public receive before the PLUM committee meets to review this?
3. How will the public be notified?

13- 17

Comment Letter #14

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Fax 213-680-0085

April 9, 2001

In Regard to the City Investigation of Potential Issues of Concern for Community Facilities District No. 4 Playa Vista Development Project: (Report March, 2001)

I am writing to express several concerns:

On two consecutive days, March 14 and 15, 2001, I was on the northwest corner of Lincoln and Jefferson Blvds., where there is a bus-stop. On both afternoons, around 4 pm, I noticed that the air had a slight smell and after about 15 minutes or so, I began to feel a headache and the back of my throat began to feel sore. The smell of the gas vapor seemed to be coming from the large opening under the recently resurfaced curb. After I left the area, my headache disappeared, so I believe that it was caused by breathing whatever gas was escaping in that area. At least two other people in the vicinity had a similar experience at that time. 14- 1

I am concerned that the Playa Vista construction underway across Lincoln Blvd., (the Fountain Park Apts) may be causing gases to vent in adjacent areas, and that in fact the mitigations currently being tested are not sufficient. That area has one of the highest concentrations of methane gas acccording to your study map. Why is building going on while the mitigation system is still in the process of being designed? (pg 15 & Appendix B)) 14- 2

A thorough study of the old underlying oilfield and its 200 wells has not been done; moreover, as I understand it, such land could be very dangerous to build upon. On April 3, 2001, the Manhattan Beach Chamber of Commerce sponsored an educational session on methane gas with their Fire Chief which brought up some of these issues. 14- 3

Because of the liability the City of Los Angeles will face if significant problems develop in the future, adequate disclosure of the extent of the extremely high gas hazards must be made in all of the real estate transactions having to do with the proposed Playa Vista development. Who bears the liability and considerable expense for the ongoing methane monitoring for the "affordable" housing units? 14- 4

In terms of public input, I think that more could have been done to include the public in this process. I did go to the Venice Library to read the additional materials, but could not find them. Also, one of the important factors expressed by the public at the July "scoping" session was that independent consultants should be used. Yet, according to the CLA report, seven of the nine entities involved were hired by Playa Vista. 14- 5

In relation to the health risk assessment, I also have not seen an adequate response to the reported cancer cluster in the Bluffs area above Playa Vista, and the considerable increase in air pollution that would be due to the large increase in traffic in the area. 14- 6

Finally, I believe that a Subsequent Environmental Impact Report (SEIR) that would cover the entire Playa Vista site and project should be done to adequately address these concerns. 14- 7

Sincerely,

Leslie Purcell
1033 12th St., #306
Santa Monica CA 90403

Attn.

Bob Garrett
Legislative Analyst
City of Los Angeles

Re: Playa Vista
Development
Project

Re: Problems with isotope
data & scientific report
after peer review...

I read the review poeted by the city on the internet. I was surprised by a few aspects of the web based report. Some of the inconsistencies were missing figures and values, which, as a scientist, bother me. Of course, my background is academics. Geological evidence in terms of environmental consulting should maintain a central theme, that being: risk assessment. As such, I have read the report regarding the Playa Vista development project. It is my opinion that the conclusions reported by the City of Los Angeles are flawed in terms of interpretation regarding source material of methane. I will

One issue of large concern for me is this report does not approach any explaation as to how the methane gas is so different from storage gas. The city report states that methane derived from the subsurface soil is a combination of both thermogenic and biological sources. When I looked at the carbon-deuterium profile, this did indeed appear to be the case, however, the methane picture is not as simplistic as presented in the City of Los Angeles report. Biological alteration of methane occurs by methanogenic bacteria in alot of natural systems. Bacteria can alter the isotopic signature of methane. Also, the pathway and residence time of gas underground can lead to fractionation of thermogenic methane, as appeared to be the case here. Drawing a conclusion that the methane $\delta^{13}C$ signature somehow excludes the Playa Vista undeground gas storage without any sort of statistical relationship facility is therefore scientifically irresponsible. 15-1

Any conclusion for a scientist must be backed up statistically, otherwise conclusions are reduced to conjecture, opening up the party in question to counterproductive peer review and even possible litigation, as may be the case here. Merhane experts are aware of the highly complex cycling of methane. As such, we must know how our representative data compare statistically before attempting any inference in terms of source or pathway, as was done in the City of Los Angeles report.
No explanation of alternative $\delta^{13}C$ pathways, methanogenesis or oxidation has been presented here. As such, I this portion of the report highly disturbing as a scientist. It was and fast with alot of hand waving.

In retrospect, the largest problems I found in this report was that it was overall, not scientifically concise, poorly written and the conclusions regarding the biogeochemical pathways were unfounded. This report, if submitted to an academic journal would fail the test of peer review and objectivity so critical to scientific discourse. The biogeochemical characterization of your site is contrary to any other estuarine system I have yet reviewed. In addition, the presence of heavy hydrocarbons, complex LNAPLS such as BTEX, as with a $\delta 13C$ signature statistically similar to gas retained by natural gas companies , per the data released in the ETI report.

SYNAPSIS

INADEQUACIES OF CITY OF LOS ANGELES REPORT FROM A SCIENTIFIC PERSPECTIVE

1.) To date: No surface methane flux has been reported, only subsoil, and that, limited in spatial extent. Total methane fluxes out of soil are well over the minimum explosive limit. 15-2

2.) No statistical analysis of the δ13C data has been done in terms of analyzing the distribution of your isotopic data. This is important because we can elucidate the physical mechanisms behind 13C pathways in the environment as well as THERE RELATIVE SOURCE CONTRIBUTIONS. 15-3

3.) The evidence for a fault near Lincoln Blvd. may be inconclusive due to extensive modification of the surface sediment during development. The seismic profile does not exclude the fault's existence. Inference that the Lincoln fault does not exist is contrary to the spatial methane concentration for areas currently in development. 15-4

4.) Several biogeochemists in our department were very surprised at the existence of subsurface parrafin hydrocarbons, typically associated with petroleum products. This is very unlike any estuarine system we have seen to date in the literature. This does not preclude the possibility of a natural source, however, such a natural source does seem very unlikely. Only further δ13C analysis of methane from this locality will elucidate the possible methane source and strength.

I am at a loss to explain the extremely high concentrations of methane adjacent to Lincoln Blvd, however, the distribution pattern is non-random and not a sort of distribution we would expect to see for a biological system. It is possible that this distribution may be associated with subsurface venting of methane, similar to that seen in Hancock Park. Joints or cracks in the subsurface can lead to preferred outgassing pathways. Natural seeps are by and large methane, and CO2, not heavy parrafin. 15-5

5.) Overall I felt the ETI report was very solid in terms of methodology, but the IA City report neglects a balanced discussion of this topic. The citation by the consulting firm regarding 13C fractionation of methane was a direct quotation of a well known geochemical methane study (Reeburg et al., 1997), however, no attempt to cite, or even quote that author strikes me as irresponsible. 15-6

6.) The coverage of methane concentration data is heavily biased to the region adjacent to Lincoln Blvd. The full range of methane is not determined, spatially or isotopically. Furthermore, the data regarding methane concentration is remarkable for its nonrandom distribution, consistent with preferential venting of natural gas to the surface via fault line structures . Such preferred routes of gas emissions should be noted where the rates of methane escaping the ground are inline with advective processes, not diffusional gas transport processes as would be expected in any subsoil biological system or even the diffusion of thermogenic methane across the soil/atmosphere interfa ce. 15-7

7.) Finally, the remark that the Playa Vista underground storage facility is not leaking seems unfounded. Most underground gas storage facilities (upwards of %70-%80) at modern gas stations, do in fact leak. The presence of parrafin hydrocarbons at the Playa Vista site may be consistent with such a source. BTEX found in the ETI report cannot be produced by biological means and merits further investigation. 15-8

FINAL CONCLUSION**

While the environmental impact studies initially performed by ETI appear to be well composed and balanced, the City of Los Angeles study is incomplete, poorly written, citation, lacking data evidence and does not hold up to third party inquiry. Scientific conclusions presented in this study are unbalanced, and no strong scientific conclusion can be drawn, from a geologichemical standpoint, until statistical analysis is. Representation of the full picture of isotopic fractionation is not presented in this report. I saw no evidence to support Play Vista's conclusions that methane was not derived from gas storage facilities. On a first past, in fact, I was very surprised by the isotopic similarities. I will plot and analyze these data and contact you. I am submitting a reference biblio graphy for your use. In conclusion, I feel that the geological report by ETI was misconstrued, and that the developers are placing themselve in a position setting a precidence of present and future risk of financial liability in terms of further development at this site. 15-9

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Comment Letter #16

Wetlands Action Network

protecting & restoring wetlands along the Pacific Migratory Pathways

April 9, 2001

sent via facsimile to: (213) 680-0085
AND to: (213) 485-8983

Ms. Barb Garrett, Legislative Analyst
City of Los Angeles
200 No. Main Street, Room 512
Los Angeles, CA 90012

THESE COMMENT ARE ALSO SUBMITTED ON BEHALF OF SIERRA CLUB

re: City Investigation of Potential Issues of Concern for Community Facilities District No. 4 Playa Vista Development Project - Prepared by the City of L.A. Office of the Chief Legislative Analyst, March, 2001 (BALLONA WETLANDS)

Dear Ms. Garrett:

Thank you for the opportunity to comment on the above-mentioned report, as well as the process as originally outlined and dictated by the Los Angeles City Council Budget & Finance Committee and also the comments raised at the July 18th public scoping hearing on this process. We respectfully request that a full Subsequent Environmental Impact Report (SEIR) is required for this process to be legally valid under the California Environmental Quality Act (CEQA.) As stated by the City's consultant in the 6/7/00 Budget & Finance Committee hearing, "the initially EIR that was done on the project was not adequate in addressing methane." By law, a subsequent EIR is now required to be completed.

Process A. Scope of review: The title for this report is mis-guided, at best. The City Council Budget & Finance Committee directed the CLA's office to determine what problems related to methane gas and other potential public health and safety hazards, as well as potential city liability concerns related to the entire 1,087 acre Ballona Wetlands ecosystem/proposed Playa Vista site, not only the Mello-Roos District No. 4, as the title for this report suggests. Th broader scope of review was made very clear to City staff at the 6/7/00 hearing after Dr. Victor Jones of Exploration Technologies, Inc., the City's peer reviewer explained to the Budget & Finance Committee members that "the same procedure has to be followed over the entire structure, the entire acreage of 1,087 acres." 16-

Dr. Jones also explained that "Once the construction starts, the ability to map the natural seepage and relate it to the natural sources has been reduced. If we've going to build on this area, then it's very important that it be mapped properly before we cover it up."

Of course, the City has ignored this admonition of Dr. Jones' as they have allowed Playa Vista Capital to bulldoze, grade, stockpile atop and otherwise "cover up" the land throughout Areas D and in the location of the proposed polluted runoff basin in Area B, while proper mapping and studies have not been completed. What rationale does the City have for ignoring the advice of this expert? 16-

B. Not an independent analysis: Seven of the nine consultants listed on page iii were hired by the "Contracting Agency" of "Playa Vista Capital." The remaining two were contracted by the City of Los Angeles.

1) when did the private Wall Street-backed, Morgan Stanley Dean Witter/Goldman Sachs owned Playa Vista Capital become an "agency?" They have not yet received sufficient public financing to be termed an agency, but perhaps if the City provides them with the nearly $1/2 billion they want in public financing, that will be sufficient for them to be eemed a public "agency." 16-

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Comment Letter #16 cont.

Ballona Wetlands CLA Report comments
April 9, 2001

2) It was made abundantly clear in the 6/7/00 City of Los Angeles Budget & Finance Committee meeting that Playa Vista Capital was not to contract the consultants, but that these consultants were to be independent. The City Council motion authorized the CLA's office to hire consultants for this project, not to analyze work of consultants performed under the supervision of Playa Vista Capital.

Cindy Miscikowski stated on 6/7/00: "what we really need is some entity that is our City agents who get the peer review testimony and those who are not on either side of promoting an issue or recommending a statement but someone who knows the language, know the system, knows the kind of questions that you and I don't know how to ask..."

Mike Feuer stated on 6/7/00 that "Many of our processes in the City including building permit processes rely in the first instance on what the project proponent submits and I think, while that information is relevant, it cannot be deeme as dispositive nor the only baseline set of data." He also said, "...the one thing that you just said that I would not recommend it that is be - that whatever group of people is assembled, analyzes the reports prepared by Playa Vista's experts alone. That is not the charge."

16-
CO

Cindy Miscikowski stated on 6/7/00 also: "...in fact in this instance, I think why we're here is what the City's first effort of review through Building & Safety required was to go outside to get expertise and hire this peer reviewer, Dr. Jones, with whom now the applicant has some issues that they agree and some issues that they are in dispute."

Mike Feuer stated on 6/7/00 also: "The goal is to have information that reflects real life and if that includes people saying adamantly this is wrong and that's right, that's okay....I do contemplate that the CLA's report derived from thi consultation with all these folks will include consultation with experts - that are outside - expert consultants that are outside of the City family and draws on both because there've been a lot of discussions - you know, again to be very candid about it, in this committee about who knows what's going on and who is capable - who is and who isn't capabl of coming up with the right answer...it is imperative...that the information that's brought forward is viewed at least by everybody as being credible information with the analysis being thought to be thorough and to the point....The public needs to be confident and we need to be confident in that process.."

What has the CLA neglected these admonitions and instructions by the Council leader who initially requested this process be undertaken?

C. Flawed process:

1)The CLA obviously did not analyze all other evidence as submitted by Wetlands Action Network, Lawyers for Clea Water, Santa Monica Baykeeper, Sierra Club and Ballona Wetlands Land Trust during the hearings of the Building & Safety Commission last summer, after the CLA process was begun. At the 6/7/00 B&F hearing it was directed that "t CLA shall consider any other evidence that is gets including evidence presented to this committee." Given that the Building & Safety Dept. head was to be part of this CLA committee, it would be presumed that all evidence in the han of this department and other departments participating in this process should be analyzed. Instead, it is rather obviou that only the Playa Vista consultant-submitted reports have been analyzed.

16-

2) Dr. Victor Jones was to be part of the CLA review committee. As far as we can tell, he was never invited to nor allowed to participate in these closed-door meetings. He only participated in meetings with staff of the Building & Safety Dept., which was not the direction given by Budget & Finance Committee Chair Mike Feuer. ***Councilmember Feuer specifically stated on 6/7/00, " Mr. Jones - Dr. Jones, excuse me, needs to be part of that team because he's the peer reviewer who've been in this. And, if I didn't say that explicitly, I wanted to be clear about that now."***

Councilmember Feuer did not simply direct that Dr. Jones be a consultant, but rather that he be "part of the team" the CLA Task Force that produced this report. He was not. Why? 16-

3) Raymond Chan suggested at the 6/7/00 B&F hearing that the City's Department of Environmental Affairs, having expertise in some of the technical issues related to public health & safety, as well as the Personnel Dept. of Industrial Hygiene, be brought into the process. Why were these recommendations ignored in favor of the Playa Vista consulta being those who brought forward baseline data and analysis? 16-

4) Cindy Miscikowski recommended that the Fire Department should be part of the CLA committee on 6/7/00. Why was this recommendation not followed? 16- 7

5) At the 6/7/00 B&F hearing Gordon Hamilton of the City's Planning Dept. mentioned the discrepancies between a 1998 and 1999 report related to hydrogen sulfide. Since then field notes from various Playa Vista contractors have been submitted into the record addressing hydrogen sulfide, and other documentation has been found in the City records related to employee exposures to hydrogen sulfide on the site, yet the CLA report dismisses any problem related to ydrogen sulfide.

16-

At the this June, 2000 hearing, Councilmember Feuer stated that he wanted to be sure that all reports were analyzed by the CLA task force - "including reports that contradict one another - are both available to those who wish to analyze this and available to members of the public unless there's an exception to the public records act to which I'm unaware o at this moment....if there are specific issues, I want them resolved." There is no indication in the CLA report that these other hydrogen sulfide reports have been taken into account nor how these reports were reconciled with the likely biase reports submitted by Playa Vista consultants.

6) Please explain what role Latham & Watkins, the lawyers for BOTH Playa Vista Capital and Southern California Gas Company, played in the production of this report. We have heard that many documents sought between the various consultants and the City were considered privileged and confidential/attorney work-products, and, thus, were only able to be partially analyzed. ON 6/7/00 at the B&F hearing Ms. Sabrina Venskus raised the issue of the possible conflict o interest of Latham & Watkins representing both of Playa Vista Capital and Southern CA Gas Co./Sempra. What did th City do to insure that the data relating to whether or not the gas field gases are migrating was accurate and independent data and not a product that would protect one of the other of Latham's clients to the possible exclusion of the City and the public? 16- 9

7) Councilmembers Mike Feuer and Cindy Miscikowski on 6/7/00 at the B&F hearing both requested that the City's Engineering Geology Advisory Committee be part of the CLA process. There is no indication that such body did participate in preparation or review of the CLA report. Why? 16- 1

Councilmember Mike Feuer on 6/7/00 at the B&F hearing stated that there would be plenty of time for public revie d input into this process, and that the entire process would be open to the public. Please inform the public as to the meeting dates and times of the CLA Task Force and whether or not these meetings were properly noticed to the public 16- 1

Comment Letter #16 cont.

or even open to the public. Why were Wetlands Action Network and Sierra Club not invited to these meetings to participate in this process? Were the developers, their consultants, lobbyists and/or their lawyers involved in any o these meetings? Please inform the public as to who was present at each meeting related to the preparation of the CI report. 16- cont

II. Substantive Issues A. Fractures in the Earth that facilitate gas seepage:

While the CLA report states that there are no earthquake faults, and, thus no problems as previously thought related t this issue, the CLA fails to thoroughly and properly analyze this situation and the potential hazards and City liabilitie related to this issue. At the 6/7/00 B&F hearing, Dr. Jones talked about "fractures" that could serve to help collect methane gases. In his January 31, 2001, letter to Dr. David Hsu, Dr. Jones does not unequivocally state that there is fault, but merely that "interpretation of the chemical and geophysical data does not support the existence of the Linco Blvd. fault that was postulated to dip westward and possibly transect strata within the existing gas storage field, as communicated in our April 17, 2000 report to LADBS. This combined geochemical and geophysical information support that the methane gas seepage observed on the Playa Vista site does not come from the Southern California Ga Storage Field."

All that Dr. Jones is apparently saying is that the presumed fault does not appear to be connected to the Southern California Gas Company storage field. In this January 31, 2001 letter, while he abstains from using the word "fault" he still uses the term "fractures." He states, "Thus the near-surface gas anomalies appear to be issuing from fractures other disruptions that directly underlie the methane anomalies as defined by the soil gas surveys." 16-

These fractures - as explained by Dr. Jones in his April 10, 2000, report, can facilitate gas seepage to the surface. At 6/7/00 B & F hearing, he stated, in explaining how earthquake and other ground movements could change gas explosio hazards, that "it means that the gas seepage here that we mapped today might be an ordered magnitude or more -- gre in the morning than it is tonight. And that means that we have to be very careful in what mitigation is proposed to m sure that the design is capable of handling all the variations that nature might put upon it."

The CLA report fails to deal with the very real, and obviously still existing fractures, as mentioned in Dr. Jones' 1/31/2001 letter that could increase the hazards building atop large methane gas seepage areas in a known liquefaction zone.

B. The report does not address the issues as outlined by the Dept. of Building & Safety in their chart submitted to the 6/7/00 B&F hearing.

The Dept. of Building & Safety submitted a chart to the City Budget & Finance Committee that outlined the issues required to be addressed. No mention is made in the CLA report, and no update on the progress made as to the questions raised on that chart appears to exist. Why? 16- 1

Also, after talking with numerous officials in the Dept. of Building & Safety, it appears that the CLA review did not include regular meetings with nor collaboration with this department in issuing this new report. In fact, we understanc that not all of the Dept. of Building & Safety issues have yet been addressed, including the Level 3 mitigations for the largest methane concentration seeps. 16- 1

Comments on Report

The Report provides a succinct and detailed summary of the significant information available for this site. Based upon the information contained in the Report and Board staff's own review of information available for this site, meetings and telephone calls between Regional Board staff and various federal, state and local agencies involved with this project, Regional Board staff concur with the Report's conclusions that the Southern California Gas storage facility is not the source of methane found at the site, that the presence of methane or other gases do not pose an unacceptable health risk (comments regarding the evaluation of potential risk associated with the other gases is discussed in detail in Comments on Risk Assessment below), and that there is sufficient information for the assessment of and protection against potential health effects associated with other gases (methane is not considered toxic and any mitigation requirements for methane would be required for fire and explosion prevention, as determined by the City of Los Angeles).

Although Regional Board staff also reviewed and discussed information with other agencies regarding the potential for subsidence and the presence of an active earthquake fault, this was done from the perspective of surface and groundwater resources and human health protection, Regional Board staff are not qualified to comment on the adequacy or interpretation of information related to these issues for other reasons.

Comments on Risk Assessment

Upon receipt of your request for review and comment on the Risk Assessment, Regional Board staff forwarded a copy of the Report (for background information) and Risk Assessment to OEHHA. Regional Board staff requested OEHHA review the Risk Assessment to evaluate the rationale, methodology and information used to calculate the potential health risks associated with the BTEX and hydrogen sulfide gases.

OEHHA has completed its review of the Risk Assessment and concur that the rationale, methodology and information used to calculate the potential health risks associated with BTEX and hydrogen sulfide gases is reasonable and conservative. Therefore, Regional Board staff concurs with the Report's conclusion that "...Potential health risks...are below the benchmarks established by the regulatory agencies to indicate insignificant risk, with no further investigation or remediation warranted." Regional Board staff will continue to review and analyze additional information, as needed, to ensure the protection of human health and the environment. A written copy of OEHHA's review will be forwarded to you.

Please call me at (213) 576-6737 if you have any questions.

Sincerely,

John Geroch
Associate Engineering Geologist
Site Cleanup Unit I

Office of Environmental Health Hazard Assessment

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Winston H. Hickox
Agency Secretary

Gray Davis
Governor

MEMORANDUM

RECEIVED
2001 MAY 10 P 1:50

TO: John Geroch
California Regional Water Quality Control Board
Los Angeles Region
320 West 4th Street, Suite 200
Los Angeles, California 90013

VIA: James C. Carlisle, D.V.M., Chief
Applied Risk Assessment Unit

FROM: Julio Salinas Ph.D., Biochem.D.
Hazardous Waste Toxicology Section

DATE: April 9, 2001

SUBJECT: REVIEW OF THE HUMAN HEALTH RISK ASSESSMENT, PLAYA VISTA DEVELOPMENT, LOS ANGELES, CALIFORNIA

Upon the request of the Los Angeles Regional Water Quality Control Board (LARWQCB), I reviewed the document entitled "Human Health Risk Assessment, Playa Vista Development, Los Angeles, California" (hereinafter the Report) prepared by Kleinfelder, Inc., and dated February 6, 2001. I also reviewed the additional requested information provided on April 3, 2001 by Scott Dwyer to John Geroch, describing the procedure for the estimation of the soil concentration of the contaminants.

Verification of input data and output results

The risk assessment prepared by Kleinfelder is reasonable and believed to be protective of human heath. Some information is not explicitly explained, such as the calculations used to estimate soil concentrations from soil gas concentrations. Following the review of the two documents referenced before, I verified the calculations and assumptions related to soil concentrations and associated risk estimates, using the same Johnson and Ettinger Model, version 1.2 (September 1998) described in the Report. The procedure used by the authors consisted in the following four steps:

Step 1. Results of soil gas sampling and analysis from three reports conducted across the Playa Vista Site in 1999 and 2000 were compiled and the data were statistically reduced and analyzed.

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption.

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MAY-11-2001 11:15 FROM:CHIEF OF 2135766717 TO:213 6900085 P.002/006

Results of maximum and average values for the contaminants of potential concern expressed as soil gases (in ppmv) reported in Appendix B are:

Appendix B - Summary of Soil Gas Survey Analytical Results.

Concentration	Benzene	Toluene	Ethylbenzene	m-, p-Xylene	o-Xylene	H_2S
Maximum, ppmv	3.85	5.09	1.50	3.12	1.39	41
Average, ppmv	0.24	0.18	0.29	0.25	0.16	0.11

Step 2. Results from the table above expressed as concentration in soil gas (in ppmv) were converted to **concentration in air (in $\mu g/m^3$)**, and the results presented in Table 2-2 - Source Vapor Concentrations for the Chemicals of Concern. The conversion was done using the following expression and assuming *normal conditions* for the contaminant:

$$\mu g/m^3 = (1 part/10^6 parts) \times (MW, g/mol) \times (1 mol/22.4 L) \times 10^6 \mu g/g) \times (10^3 L/m^3)$$

The results of this conversion are:

Table 2-2 - Source Vapor Concentrations for the Chemicals of Concern

Concentration	Benzene	Toluene	Ethylbenzene	m-, p-Xylene	o-Xylene	H_2S
Maximum, $\mu g/m^3$	12,300 (13,000)	19,095 (21,000)	6,530 (7,100)	13,580 (15,000)	6,043 (6,600)	57,148 (62,000)
Average, $\mu g/m^3$	766	0.18	0.29	0.25	0.16	0.11

Results shown in parenthesis are those from this reviewer and found to be in reasonable agreement.

Step 3. In a third step, the Johnson and Ettinger model is typically used to estimate the magnitude of the migration of VOC contaminants from subsurface soil through a building foundations and into the indoor respirable air. The Johnson and Ettinger model however requires soil concentrations expressed in $\mu g/kg$ as input, and as shown before, the available concentrations in soil gas were in $\mu g/m^3$. To resolve this problem, the authors used the Johnson and Ettinger model in a "backwards" mode for calculating the source soil concentration that *would result* in the source vapor concentration (in $\mu g/m^3$) calculated in step 2.

Since the model is written as a spreadsheet, it is possible to test values using a "trial-and-error" approach. Values of soil concentration (C_R, µg/kg) were entered as input values until cell No. 15, "Source vapor concentration, C_{source}, in µg/m^3) showed the same values in Table 2-2.

Results of concentration of contaminants in soil (in µg/kg) used in the risk assessment are reported in several tables in Appendix A.

Appendix A – Johnson and Ettinger Model Spreadsheets

Concentration	**Benzene**	**Toluene**	**Ethylbenzene**	**m-, p-Xylene**	**o-Xylene**	**H_2S**
Average, µg/kg	1.52	2041	28.15	88.5	39.6	24.3
Maximum, µg/kg	24.3	57.6	5.45	7.15	4.56	0.0654

Step 4. Cancer risk and hazard estimates associated with the soil concentrations were then calculated by the Johnson and Ettinger model for each input data. The estimated Lifetime Extra Cancer Risks associated with long-term exposure to benzene using soil gas data from the Playa Vista site and using the Johnson and Ettinger model for subsurface vapor intrusion into buildings are shown in the table below:

	Benzene soil data and risk estimates	
Estimated input data, C_R	Maximum soil concentration: Average soil concentration:	24.3 µg/kg 1.52 µg/kg
Source vapor concentration, C_{source}	Maximum soil gas concentration: Average soil concentration:	.23E+04 µg/m^3 .66E+02 µg/m^3
Infinite source building concentration, $C_{building}$	Maximum indoor air concentration: Average indoor air concentration:	9.71E-03 µg/m^3 5.05E-04 µg/m^3
Incremental risk from vapor intrusion to indoor air, carcinogen	Associated with **maximum** concentration: Associated with **average** concentration:	**1.2E-07** **7.2E-09**

Results are for a soil screening risk assessment, using either the maximum or the average concentration of benzene appearing in the Report. Standard default values were used for all migration and physico-chemical properties as well as exposure factors. These values were verified and are conservative for the potential exposure scenarios that could occur at the Playa Vista site.

Elimination of contaminants for a risk assessment based on detection frequency

The Report endorses the elimination of low frequency detected contaminants from the risk assessment, and cites the U.S. EPA Risk Assessment Guidance for Superfund (RAGS), Human Health Evaluation Manual, Part A - Baseline Risk Assessment (December 1989) as reference. Preliminary elimination of contaminants for consideration in a risk assessment based on less than 5% positive detection frequency of chemicals among all analyzed samples is unsupported for contamination problem of the scale such as Playa Vista. Low positive detection frequencies are typically found in contamination problems involving extensive areas and relatively low severity of contamination. Also please consider the following situations:

(a) A soil surface area that has not been fully characterized for contamination as a result of an *inappropriate* sampling strategy. For example, if a grid with cells too large were selected for the sampling plan, this would decrease the probability of locating or generating "hits" for a hot spot, resulting in a false negative presence of hot spot. This source of potential error should be analyzed by conducting spatial distribution analysis.

(b) Groundwater samples collected from various monitoring wells (MWs) and the results collected over time and/or over locations (space) are pooled. For example, results collected on a certain date showed that few positives were from one single MW; although this contamination is real, according to the "low frequency criteria" the results would be wrongly eliminated. This is an unsupported decision, and a spatial analysis is recommended. If contamination levels are monitored over time, it is possible that the levels may change over time. If one or more MWs show decreasing or increasing levels over time, elimination of this information would be a serious error. In situations such as these, a temporal trend analysis is warranted to determine whether concentrations are related to time.

I do not agree with a *generic* assumption regarding the low frequency criteria as described in RAGS, in particular if elimination is done without considering the numerical values and spatial and temporal considerations. For a site as large as Playa Vista Development, where a very large number of samples have been collected and analyses done, professional judgment is critical. A frequency of 5% of 1,155 samples is equivalent to 58 results, and elimination of 58 results would be unacceptable. I concur with the authors regarding the inclusion of the entire data set as done in this Report, approach that provides a degree of conservatism to balance some of the uncertainties associated with the risk assessment.

17- 1

Review Summary

The approach used by Kleinfelder to estimate health risks associated with the chemicals detected in soil gas at the Playa Vista Redevelopment site is reasonable. The model used to estimate the subsurface vapor intrusion of contaminants into buildings is widely used in migration analysis and is recognized as a conservative model. The maximum concentration of benzene 24.3 µg/kg soil, is assumed to be constant for the next 30 years, and the associated indoor air concentration is assumed it will not be affected by outdoor air conditions such as wind, temperature, precipitation, or barometric pressure. In addition, a number of highly conservative assumptions were used, such as frequency (350 days per year) and duration (30 years), for 24 hours a day, a house built exactly above the point of maximum benzene concentration, and a number of other assumptions related to the toxicity characterization of benzene. The concentrations of air contaminants assume no soil remediation or no soil gas engineering control activities. The estimated maximum and average lifetime extra cancer risks associated with exposure to soil levels of benzene, as found in certain portions of the Playa Vista are in consequence, most likely overestimated. As long as the concentration of benzene in soil does not exceed values by more than an order of magnitude above those found on site, it is my opinion that cancer risks are expected to be below levels of biological significance.

Respectfully submitted.

Comment Letter #18

April 6, 2001

RECEIVED
CLA

01 APR -9 PM 3:24

Ronald F. Deaton
Chief Legislative Analyst

Dear Mr. Deaton:

I am writing to express concern and to make a recommendation.

CONCERN: In studying the report, I am not assured of the public's safety should Playa Vista develop the Ballona Wetlands. It is too tenuous & risky. It could cost us, Los Angeles Taxpayers, millions of dollars in losses and/or damages (as the Belmont Center already is)

RECOMMENDATION: In fairness to both us the taxpayers and the developers, as our elected representatives I Playa Vista know that Mello-Roos money will be made available to them if, and only if they make it a matter of public record that as a legal contract binding Goldman Sachs, Dean Witter, Morgan Stanley, Robert Macquire Partners and whomever else is involved as developers, binding in perpetuity to take full financial responsibility for any lawsuits and/or disasters arising from methane leaks, earthquakes/cancers, etc. on this questionable land they want to develop

18-

I am certain that you get the gist of what I am recommending. Let them put their money where their mouth is, rather than using our money to develop and then hold us economically responsible in the event of a disaster.

If they can stand behind this development by doing so, then we can take them seriously, especially if Goldman Sachs, Dean Witter and Morgan Stanley will indemnify the City of Los Angeles. If not, they are setting us up for economic rape.

I believe that your office and Legal Counsel can write up a nice, tight contract protecting us, the taxpayers and voters, while respecting the developers. For it is like having a father responsible for the welfare of his offspring, rather than expecting taxpayers to do so.

18-

I would like a personal response regarding this recommendation. My address: 12540 Mitchell Ave. in Yorba

Suzanne M. DeBenedetto

Comment Letter #19



CLA
01 APR 10 AM 11:41

Faye Ku

6202 Vista del Mar, Apt. #253
Playa del Rey, CA 90293

Telephone: (310) 745-2802
Email: mailto:littlefaith@mediaone.net
Web page: http://people.we.mediaone.net/littlefaith/

April 7, 2001

Barb Garrett
Office of the Chief Legislative Analyst
200 N. Main Street, Room 512
Los Angeles, CA 90012

Dear Ronald F. Deaton:

My family and I are residents of Playa del Rey, and we have examined the report prepared by your office regarding potential risk factors at the Playa Vista Development Site. Our comments are as follows:

1) It is unacceptable that so much of the fact-finding comes from consultants hired by the development company. Although city officials have reviewed the information, it is easy for the studies to be skewed by design, one-sided research to be presented. **19- 1**

2) There seemed to be a lot of focus on finding the source of the methane. It seems to be that thermogenic sources of methane are MORE difficult to mitigate and predict than leaks from human activity there. The letter from ETI (Appendix H) states "Thus the near-surface gas anomalies appear to be issuing from fractures or other disruptions that directly underlie the methane anomalies..." Even if the "Lincoln Blvd. Fault" does not exist, is there not still a chance that quakes from nearby faults could cause gasses trapped within the disrupted strata to move rapidly to the surface? In this situation, what level of mitigation can possibly be considered sufficient? **19- 2**

3) Given that there exists high levels of natural methane which all parties agree must be mitigated, it would make sense to focus more attention on the mitigation techniques. According to the letter from ETI (Appendix D), the proposed methane prevention system, the subsurface venting system, is still under research and design. We must see the results of this research before deciding whether the system is truly safe. **19- 3**

4) The reports regarding subsidence are impressive records of history. How does it predict future subsidence when the ground will be compacted by heavy new construction? **19- 4**

Thanks for recording our comments, and we hope that you will recommend a Subsequent Environmental Impact Report to be prepared before allowing any more bulldozing to occur in this Sensitive Environmental Area. While the methane problems are serious and disturbing, what's more disturbing is that this development is continuing against the will of the people in the community, and it will fill in one of the last open spaces available to Los Angelinos within the city, destroying an important habitat that can still been preserved for all the species that depend on it. This is poor use of public money in the form of bonds or any other assistance. We would like to see your report emphasize the uncertainties that still exist and seek to find truth, rather than the statements of Playa Vista's own consultants designed to mislead and pacify an angry public. 19- 5

Thank you,

Faye Ku David Cook

Faye Ku, David Cook, and Sage Cook (6 months)

Comment Letter #20

April 9, 2001

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01 APR 10 AM 11:41

Attention: Barb Garrett
Office of the Chief Legislative Analyst
City of Los Angeles
200 N. Main St., Room 512
Los Angeles, CA 90012

Subject: City Investigation of Potential Issues of Concern for CF District No. 4 Playa Vista Development

Dear Ms. Garrett:

Please accept this letter as my public comments in regards to the above referenced investigation.

I found the objectivity of the study to be highly questionable for the following reasons:

1. First the "Stepped Study Design" appeared to rely heavily on **past studies** or studies that were recently completed. Since most of the data produced by past studies was produced by consultants hired by Playa Vista, the data is highly subjective since the developer has a prejudiced interest in hiring a consultant that will produce date that is favorable for the development to occur. **This is a clear conflict of interest and undermines the reports conclusions.**
2. The "Stepped Study Design" also predetermined that no scenario could exist that would render the site unsuitable for development. This is the same flawed and subjective methodology that resulted in the city's approval to build on the contaminated Belmont Learning Center site. The Stepped Study implied that there would be feasible mitigation for any and all "areas of concern" regardless of the range of data for the areas of concern. This implies a heavily biased and subjective outcome before the data was even analyzed.

20- 1

There was a company or person, called Kleinfelder, whose opinion influenced this investigation. Who or what is Kleinfleder? Is this a California corporation, a sole proprietorship or a freelance consultant? Kleinfelder has no credibility to comment on this report unless the CLA can provide additional information to validate its reputation in analyzing methane samples.

20- 2

After reviewing **Figure 2.1 Methane Concentrations**, I was astounded to learn that under Section **2.3 City Review, Conclusions and Mitigations**, that the city appears to believe that a mitigation system actually exists that will function in an environment that contains methane concentrations above 150,000 ppmv within an aquifer that lies only 20 – 30 feet below the surface. This assumption is speculative at best, considering that if such a mitigation system existed it would have been installed at Belmont years ago.

20- 3

One enormous flaw with this analysis is that far too much of the data was produced by consultants or specialists hired or paid for by Playa Vista. Such data has very little credibility considering the enormous stake and financial interest that Playa Vista Capital has in eliminating or concealing any issues, which would jeopardize its investment.

20- 4

I strongly disagree with the CLA's conclusion that the methane contamination can be safely mitigated and will not pose a significant health risk to workers and inhabitants on the project site. Such a careless and speculative conclusion will pose a significant liability to the taxpayers of the City of Los Angeles for knowingly placing resident's in harms way.

20- 5

Sincerely,

Bryan Gordon

Bryan Gordon
3650 S. Barrington Ave.
Los Angeles, CA 90066
310-390-2064

Comment Letter #21

The Gas Company

RECEIVED
CLA
01 APR 10 AM 11:46

Michael M. De La Torre
Governmental Affairs Manager

Southern California Gas Company
555 W. Fifth Street
Los Angeles, CA
90013-1011

Mailing Address:
Box 513249, GT26E2
Los Angeles, CA
90051-1249

tel 213 244-2545
fax 213 244-4997

April 9, 2001

Ronald F. Deaton
Chief Legislative Analyst
200 N. Main Street
Los Angeles, CA 90012

RE: City Investigation of Potential Issues of Concern for Community Facilities District No. 4 Playa Vista Development Project

Dear Mr. Deaton:

The Gas Company is pleased that your findings verify what nearly 60 years of operation, studies and analysis have revealed:

- **There is no evidence of gas seepage from the storage field.**
- **There is no significant or clearly defined trend of increased surface subsidence.**
- **The postulated Lincoln Boulevard Fault's existence is not supported by any evidence.**
- **The risk from an earthquake causing large volumes of storage gas to escape is unsupported by the evidence.**

The Gas Company looks forward to providing any further information that you require in this matter.

Sincerely,

Michael De La Torre /pt

Michael De La Torre

Comment Letter #22

DEPARTMENT OF CONSERVATION
STATE OF CALIFORNIA

01 APR 13 AM 11:18

April 6, 2001

801 K STREET
SACRAMENTO
CALIFORNIA
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FAX
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INTERNET
consrv.ca.gov

GRAY DAVIS
GOVERNOR

Mr. Ronald F. Deaton
Chief Legislative Analyst
Room 512, City Hall
200 N. Main Street
Los Angeles, CA 90012

Subject: City of Los Angeles Investigative Report on Community Facilities District No. 4 Playa Vista Development Project, Prepared by Office of the Chief Legislative Analyst

Dear Mr. Deaton:

The Department of Conservation's Division of Oil, Gas and Geothermal Resources (Division) has reviewed the subject report received under cover letter dated March 12, 2001. The Division supervises the drilling, maintenance, and plugging and abandonment of oil, gas and geothermal wells in California. We offer the following comments on the report for your consideration. 22- 1

The Division concurs with the report that there is no indication that methane seepage within the project area is from the Playa Del Rey gas storage reservoir. However, the Division has not determined that the shallower Pico Sands are the source of the methane gas seepage either.

Determining the adequacy of the proposed methane mitigation measures for the project is beyond the Division's authority. However, the Division recommends that plugged and abandoned wells always be vented if structures are to be built over or in proximity of them.

Finally, the City's Planning Department should verify that building plans have undergone Division review prior to the start of construction. To ensure that the proper review is conducted, the Division informational packet, *Construction Project Site Review and Well Abandonment Procedure*, is available to planners and developers. The publication outlines the information a project developer should submit to the Division for review. The site review packet is available from the Division's Cypress district office. 22- 2

Thank you for the opportunity to review the report. If you have questions on our comments, or require technical assistance or information on oil and gas resources, please contact David Sanchez or Richard Baker at the Cypress district office: 5816 Corporate Avenue, Suite 200, Cypress, California 90630-4731; or, phone (714) 816-6847. If you have other questions you may contact me at (916) 445-8733.

Sincerely,

Kenneth E. Trott
Environmental Coordinator

cc: David Sanchez
Division of Oil, Gas and Geothermal Resources, Cypress

Linda Campion
Division of Oil, Gas and Geothermal Resources, Sacramento

Comment Letter #23

DEPARTMENT OF CONSERVATION
STATE OF CALIFORNIA

01 MAY 17 PM 4:29

DIVISION OF
MINES & GEOLOGY

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GRAY DAVIS
GOVERNOR

May 11, 2001

Barb Garrett
Office of Chief Legislative Analyst
512 City Hall
200 N. Main Street
Los Angeles, CA 90012

Dear Ms. Garrett:

I have completed my review of the November 16, 2000 fault investigation report by Davis and Namson for the Playa Vista site. This letter is an addendum to my letter to you dated March 30, 2001 in which I concurred with the Davis and Namson and Earth Consulting International (July 25, 2000) reports' conclusion that there was no evidence to support the existence of the proposed "Lincoln Boulevard" fault. This letter addresses the offshore geophysical investigation contained in the Davis and Namson report.

Davis and Namson subcontracted with Dr. D. Francis and Dr. M. Legg to conduct an offshore geophysical survey designed to address the possible fault-controlled nature of the east-northeast-striking bluffs just south of the Playa Vista property. Although no evidence of faulting was revealed in the vicinity of the bluffs, two minor features were interpreted by Francis and Legg as faults F1 and F2. These short, northeast-striking inferred faults were not shown to extend on land to the northeast. However, the evidence both for the features interpreted as faults and for their lack of continuity on shore was poorly documented in the Davis and Namson report. Subsequent conversations with T. Davis led to a meeting on April 17, 2001. At this meeting, attended by T. Davis, D. Francis, M. Kennedy, M. Reichle, and this writer, the original geophysical evidence was examined and additional published documentation was evaluated.

Based on this meeting, the following observations can be made:

- The existing data is equivocal and does not permit a definite interpretation. The features may or may not be faults.

- Equally plausible explanations for the apparent vertical separation of seismic reflectors imaged in seismic lines 3 and 9 include intra-formational faults (sedimentary consolidation features) that are not seismogenic, or normal depositional features characteristic of fluvial (river) depositional environments. These would not pose a significant seismic hazard to the site.

- If these features are faults:
  - The interpretation by Francis and Legg that the lack of continuity of seismic reflectors imaged above 300 feet (uniboom lines 3 and 9) is evidence of faults F1 and F2 is not compelling.

  - Image resolution is not sufficient to state that proposed fault F1 does not continue east of seismic survey line 11.

  - Additional seismic survey techniques (sparker seismic reflection survey) imaged unfaulted reflectors at depths between 300 and 2,000 feet. Either proposed fault F1 is confined to latest Pleistocene and Holocene deposits and does not offset older sedimentary deposits, or the total geologic displacement of proposed fault F1 is limited to early to mid Holocene time, which is an extremely unlikely hypothesis.

Following is a summary of the offshore geophysical survey data.

The interpretation of postulated faults F1 and F2 is based on uniboom seismic lines 3 and 9. The uniboom seismic reflection survey was used to image geological features to a depth of about 100 meters. A reflector imaged in uniboom line 3 can be interpreted to be vertically displaced by about 3 meters (F1). However, the reflector is poorly imaged over a distance of about 43 meters, so it is not possible to ascertain fault geometry if the interpreted feature is a fault. Therefore, it could have a near vertical dip, or postulated fault F1 could dip as shallow as about 5°. Postulated fault F1 is very poorly defined in uniboom line 9 and the reflector is not clearly detectable. Evidence for the proposed fault F2 is not convincing and no sense or amount of displacement can be interpreted.

The feature interpreted as fault F1 is confined only to the imaging of the uniboom survey (upper 100m). The sparker seismic refection surveys extend to a depth of about 600 meters (2000 feet). Significantly, continuous reflectors are imaged where F1 should extend. Therefore, the reflectors are not vertically displaced within the resolution of the sparker imaging, which is about 3-5 meters. This means that either the feature interpreted as fault F1 is not a fault, or that the total geologic

displacement is less than the image resolution of the sparker survey. Sedimentary rocks at a depth of about 1200 feet (360m) probably belong to the Upper Pico Formation (about 1.6 million years old, based on oil well data documented in Davis and Namson). Assuming that F1 is a fault with up to 3 ½ m of vertical separation, a geologic slip rate of about 0.3 – 0.4mm/yr is inferred if the fault offsets the 15,000yr/6,000yr unconformity. If a constant rate of displacement has occurred in the past 500,000 years, then 180m of total vertical displacement should have occurred. This amount of vertical displacement should be apparent on the deeper sparker surveys, but is not. It is remotely possible that proposed fault F1 is very young and all of its displacement has occurred in Holocene time, thus precluding its being imaged in the deeper sparker seismic reflection surveys. However, this possibility is considered extremely unlikely.

Onshore bedrock geology does not indicate a continuous fault zone along a northeasterly strike. Minor bedrock faults along a northeast trend similar to postulated fault F1 were interpreted by Metzner (1935) and Hodges (1944), but are confined to below the Upper Bentonite Marker (Upper Repetto Fm. - about 3.2 million years old). These faults are less than about 2000 feet long and have the opposite sense of vertical displacement. What is interesting, and perhaps significant, is that the faults interpreted as offsetting schist basement rocks are very short. The configuration of the top of the schist as depicted by Metzner and Hodges has a NW trending ridge. The short faults mapped by Metzner and Hodges do not cross this ridge, but instead seem to radiate from the ridge. This suggests an alternative interpretation that the "faults" are not faults but perhaps paleo stream channels or other irregularities in the schist surface. Later mapping by Hester (1986) showed short, minor faults offsetting the schist basement rocks along a significantly different strike. These minor faults did not offset the Upper Bentonite Marker.

In conclusion, the offshore seismic surveys in the Davis and Namson report are inconclusive with respect to demonstrating that the features identified as faults F1 and F2 are seismogenic structures.. Proposed fault F1 is best imaged on uniboom seismic line 3. Here a reflector is apparently vertically displaced (down to the north) about 4msec (about 12 feet or 3.6 meters). However, the imaging is not of sufficient resolution to determine dip angle and the distance between the possible correlation of reflectors across this interpreted structure is about 43m. Therefore, the dip angle is unconstrained between 90° and 5°. The unconstrained dip and the observation that the fault does not extend into older geologic rocks allows alternative explanations for the apparent offset of the reflector seen in uniboom seismic line 3. One alternative explanation is that F1 and F2 are intra-formational faults that are caused by the rapid deposition and consolidation of latest Pleistocene and Holocene fluvial deposits associated with the rise in sea level at the end of the Pleistocene

Epoch. Additional plausible explanations are that the apparent offset of the reflectors imaged in uniboom seismic lines 3 and 9 is due to lateral facies changes (changes in the type of sedimentary deposits) that are very common within fluvial depositional environments, or represent discrete stream channel margins. Therefore, it is uncertain to what extent these offshore features, which have been interpreted by D. Francis and M. Legg as faults F1 and F2, contribute to the onshore hazard of the Playa Vista site.

If you have any further questions, call me at (916) 323-9672 or e-mail me at bbryant@consrv.ca.gov .

Sincerely,

William A. Bryant

William A. Bryant, CEG 1554
Program Manager, Active Faults

cc: J. Davis, State Geologist
M. Reichle
M. Kennedy

References Cited

Davis and Namson Consulting Geologists, 2000, An evaluation of the subsurface structure of the Playa Vista project site and adjacent area, Los Angeles, California: Unpublished report prepared for Playa Vista, LLC, November 16, 2000.

Earth Consultants International (ECI), 2000, Geologic study to evaluate the potential for active faulting near the intersection of Lincoln and Jefferson boulevards, at the Play Vista site, in the City of Los Angeles, California: Unpublished report prepared for Playa Capital Company, LLC, project no. 800130-0001, July 25, 2000.

Hester, R.L., 1986, Geology of the Playa del Rey gas storage field, Los Angeles County, California: Unpublished report for Southern California Gas Company.

Hodges, F.C., 1944, Gas storage and recent developments in the Playa del Rey oil field: California Division of Oil and Gas, Summary of Operations – California Oil Fields, v. 30, no. 2, p. 3-10.

Metzner, L.H., 1935, The Del Rey Hills area of the Playa del Rey oil field: California Division of Oil and Gas, Summary of Operations – California Oil Fields, v. 21, no. 2, p. 5-27.

Comment Letter #24

RECEIVED
CLA
01 APR 11 PM 1:26

March 27, 2001

Ms. Barb Garrett
Legislative Analyst
200 N. Main Street, Room 512
Los Angeles, CA 90012

RE: City Investigation of Potential Issues of Concern for Community Facilities District No. 4, Playa Vista Development Project

Dear Ms. Garrett:

I am submitting these comments on the Report of the above-referenced investigation. I want to commend the Office of the Chief Legislative Analyst for its thoroughness and for its attention to detail and scrupulous scientific standards. I find the report important for two reasons:

First, because of the results. As a member of the local community, I am relieved to learn that there is no evidence of a new earthquake fault in our community, that the Gas Company natural gas storage facility is not leaking, that Playa Vista is not subsiding, that the site poses no health risks, and that there are mitigation measures for any methane detected on the site.

Second, as a long-time Playa Vista supporter, I want to see the project move forward. I hope that your Report allows us to put the issues investigated behind us once and for all and that we will finally see the realization of a project that creates community, stimulates economic development, and undertakes the much-needed restoration of the Ballona Wetlands.

Thank you for your consideration.

Sincerely,

Signature 4/4/01 Date

Givora Doeh
Print Name

11805 W. Jefferson Blvd. #2
Address

Culver City CA 90230
City

RESPONSES TO COMMENTS RECIEVED

Comment Letter #1: Howard Hackett, Past President Del Rey Homeowners

1-1 Comments noted.

Comment Letter #2: Alfredo Urso

2-1 The health risk assessment (HRA) completed by Kleinfelder ("Human Health Risk Assessment Playa Vista Development, Los Angeles, California," February 6, 2001) for benzene, toluene, ethylbeneze, and xylene (BTEX) and hydrogen sulfide emissions (H_2S) at the Playa Vista Development site indicates that BTEX emissions at the site present an insignificant health risk (see Report Section 5). The potential health impacts of BTEX and H_2S were assessed using very conservative assumptions, including the assumptions that the highest levels of BTEX found at the site enter a residence (a closed space with limited air dispersion and individuals exposed were present at the residences 24-hours a day, 350 day a year for 30-years). The proposed methane mitigations would further reduce the potential health risks associated with soil and groundwater contamination. The HRA has been reviewed by the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB) and the California Office of Environmental Health Hazard Assessment (OEHHA) (see Comment Letter #17) and those agencies indicate that the HRA is reasonable and conservative. The LARWQCB is the lead agency for soil and groundwater contamination at the site. The remediation process will ensure that site conditions are safe for proposed uses.

2-2 All structures to be built at the Playa Vista Development site will meet or exceed City and state code requirements. Building code requirements, including the designated methane mitigation system, accommodate unique site characteristics, such as soil type and load capacity, depth to groundwater, seismic zones, and methane emissions, to ensure the structural integrity of constructed facilities.

2-3 Wetland issues are outside the scope of the Report. The Environmental Impact Report (EIR) (EIR No. 90-0200(C)(CUZ)(CUB), State Clearinghouse No. 90010510) for Phase I of Playa Vista Project was certified in May 1993. Wetland issues and required mitigation measures are detailed in the Biotic Resources Section, Section V. D, of that EIR. In addition, wetland issues are regulated and overseen by the state and federal agencies. The Draft EIR for Phase II of the Playa Vista Project is under preparation and will address Wetland issues associated with the Phase II project area. Persons interested in being notified of the release of the Draft EIR for Phase II of the Playa Vista Project should contact the Planning Department at (213) 580-5266.

2-4 Development activities undertaken at the Playa Vista Development site are in compliance with the laws, rules, and regulations governing such activities.

2-5 Comment noted. See also Responses to Comments 5-2 and 5-5.

2-6 Comments noted.

Comment Letter #3: Debra-Lynne Terrill

3-1 Construction projects at the Playa Vista Development site are not anticipated to change subsurface methane migration patterns. The methane gas prevention and detection systems to be installed under building foundations allow for the collection and diversion of the soil gases, directly below the building, through vent pipes. In essence, this prevention and detection system allows the methane to "freely escape" upwards.

The recommended methane mitigations have several levels of protection to ensure public safety. All methane mitigation levels require methane prevention systems, methane detection systems, and methane monitoring requirements. These comprehensive measures assure that methane is properly mitigated, is monitored to ensure the effectiveness of the mitigations over time, and provide for contingency plans in the unlikely event that high methane levels are detected within a structure.

3-2 The City requires that a site-specific geotechnical report be completed prior to the construction of any structure to ensure that any specific site conditions are appropriately addressed in structure design. As discussed above in Response to Comment 2-2, all structures built in the City must meet or exceed City and state code requirements. Building code requirements, including the designated methane mitigation system, accommodate unique site characteristics, such as soil type and load capacity, depth to groundwater, seismic zones, and methane emissions, to ensure the structural integrity of constructed facilities. All structures built at the Playa Vista Development site will comply with such standard City practices and processes.

Among the design alternatives which can be used to address soil type and load capacity, depth to groundwater, and seismic zones, are pilings and grade beams, mat foundations, and stone columns. Piles and stone columns and the impermeable membrane required as methane mitigation can be "sealed" to accommodate methane mitigation systems. Stone columns and driven piles densify the soil surrounding them, decreasing soil porosity and permeability. In addition, other elements of the methane prevention system, such as vent pipes and gravel layers, will dilute and vent any methane gas, minimizing the amount of gas that can accumulate underneath the methane barrier.

3-3 Figure 2.1 only presents methane levels at the 4 foot level, as the methane concentrations at that depth were most pertinent to establishing the appropriate level of methane mitigations. However, many types of gas surveys were conducted to study the issue of methane and other gases on the site: including approximately 2,000 four-feet gas samplings to identify the methane concentration levels; surface flux surveys to measure the amount of gas seeping to the surface; deep vent well measurements to measure the amount of gas venting from the 50-ft. gravel aquifer; and several studies to identify the geologic conditions beneath the surface and to determine the characteristics of the aquifer.

3-4 Earthquakes are a substantial concern for all development within the southern California region. Building codes have been developed to address, to the maximum extent practicable, structural issues associated with earthquake events. There is no evidence to suggest that methane emissions at the Playa Vista Development site would be altered as a result of an earthquake and therefore create a risk different than that currently identified and mitigated.

3-5 Table 2-1 of the "Methane Sampling Data Assessment Playa Vista Development, Los Angeles, California," February 7, 2001 prepared by Kleinfelder, Inc. summarizes the studies in which H_2S concentrations in soil gas samples were measured. The summary includes a description of the assessment, a description of the measurements, and quality control assurance methods utilized in the studies. The studies themselves are referenced in that document and contain detailed information regarding sample locations and sampling methodology. A total 1,199 soil gas survey samples were analyzed for H_2S , with H_2S being detected in only 1% of the samples.

3-6 The impacts of both methane and BTEX were evaluated in the Report, refer to Sections 2 and 5, respectively. Methane is not an air toxic and is of primary concern due to its combustible nature. These impacts are appropriately mitigated. The HRA completed by Kleinfelder ("Human Health Risk Assessment Playa Vista Development, Los Angeles, California," February 6, 2001) for BTEX and H_2S considers the additive effects of benzene, toluene, ethylbeneze, xylene, and H_2S and determined impacts from such emissions to be insignificant. Also see Response to Comment 2-1and 3-1.

3-7 The procedures for identifying and re-abandoning oil wells at the Playa Vista Development are consistent with practices statewide and overseen by the California Department of Conservation, Division of Oil, Gas, and Geothermal Resources.

There are only three wells in close proximity to where building development is proposed. Playa Vista site is currently in the process of re-abandoning these three wells, in accordance with the California Department of Conservation, Division of Oil, Gas and Geothermal Resources, stringent requirements.

Additionally, letters from the California Department of Conservation, Division of Oil, Gas and Geothermal Resources dated April 2000 and May 2000, regarding the Fountain Park Apartments project and the Visitor Center project, state that "there are no active or abandoned oil wells located within or in close proximity (within ten feet) of the applicant's plan. Therefore this project does not require further review."

3-8 See Response to Comments 3-1 and 3-2.

3-9 Prior to the 1985 Fairfax district incident, methane mitigation code requirements were non-existent. After the development and implementation of the current mitigation measures, as stipulated in the Los Angeles Building Code, Division 71 and Memorandum of General Distribution (MGD) #92, including the use of vent pipes to dilute the gas migration underneath the building, there have been no further occurrences of this type. In addition, the

recommended methane mitigations for the Playa Vista Development site have several levels of protection to ensure public safety. All methane mitigation levels require methane prevention systems, methane detection systems, and methane monitoring requirements. These comprehensive measures assure that methane is properly mitigated, is monitored to ensure the effectiveness of the mitigations over time, and provides for contingency plans in the unlikely event that high methane levels are detected within a structure.

3-10 The report includes the independent review of various state agencies with specific expertise in the areas investigated, as well as the independent review of City staff and City consultants. As indicated in the study design released for public review in July, 2000, to maximize resources the City sought "regulatory and responsible regional and state agency review." The City received no comments regarding the use of public agencies as independent reviewers during the study design public review period.

The California Department of Conservation, Division of Mines and Geology independently reviewed all historic and recent fault related studies, (see Report Section 4; also see Comment Letters #4 and 23). The California Department of Conservation, Division of Oil, Gas, and Geothermal Resources independently reviewed methane information and data (see Report Section 2.2.1; also see Comment Letter #22).

The City contracted with Kleinfelder to perform a heath risk assessment for BTEX and H_2S emissions (see Report Section 5). Klienfelder had not previously worked on the Playa Vista Development project for the City, Playa Vista Capital, or any other party. The City also had Klienfelder independently review the methane studies performed to date and the proposed methane mitigations (see Report Section 2).

The LARWQCB and OEHHA independently reviewed the HRA prepared by Kleinfelder and the CLA Report (see Comment Letter #17).

All methane and fault related studies were independently reviewed by Dr. Jones, LADBS's "peer reviewer." Although Dr. Jones' contract is administered by Playa Vista Capital, Dr. Jones takes direction from and reports to LADBS. This arrangement is not unique to the Playa Vista Development Project, but is the general LADBS and Planning Department procedure used for all development projects that warrant outside expertise. In fact, it was the preliminary findings of Dr. Jones which precipitated several of the development issues investigated in the Report. Therefore, it was important that Dr. Jones review the additional information and investigations undertaken to further investigate and resolve those issues.

City staff independently reviewed the various reports and studies generated by the various consultants, comments and information presented by the public, and the reviews performed by outside public agencies.

Finally, the Report was widely circulated for a 30-day public review and comment period. All technical studies were made available for public review and comment. Additional information requested by reviewers was provided, as appropriate.

The firms and individuals contracted by Playa Vista Capital to perform various studies, collect additional information, and evaluate data are known in their fields and respected. Information generated by these entities was independently reviewed by state agencies, independent consultants, City staff, and the public as outlined above. No data or information has been presented to support an assertion that the reports prepared by those consultants are inaccurate.

Comment Letter #4: William Bryant, Program Manager, Active Faults, California Department of Conservation, Division of Geology and Mines (also see Comment Letter #23)

Comments noted. Also see Comment Letter #23.

Comment Letter #5: Airport Marina Group Sierra Club, Ballona Ecosystem Education Project, Grassroots Coalition, and Spirit of the Sage Council

5-1 See Response to Comments 2-1, 2-2, 3-2, 3-6, 3-9, and 5-3.

5-2 The City has undertaken several studies regarding various aspects of the Playa Vista Development site, to ensure appropriate development standards and mitigations are incorporated into development and building plans. Over 1,500 soil gas samples were taken to ensure comprehensive methane mapping of the site and development of appropriate methane mitigation systems. Additional studies will be required as appropriate to address site specific conditions as development proceeds. Also see Response to Comments 2-1 and 3-6.

5-3 The mitigation measures to be taken to address the presence of methane gas at the site are sufficient and adequate to remove any possible hazard to the residents, commercial, public, and recreational facilities. Public entities are not liable for punitive damages.

5-4 The mitigation measures to be taken to address the presence of methane gas at the site are sufficient and adequate to remove any possible hazard to the residents, commercial, public, and recreational facilities. With respect to future sales of residential units, the developers would disclose information relating to methane gas which they are legally required to disclose. There is no guarantee by the City that the units will be sold.

5-5 The bonds to be issued are Special Tax Bonds which are payable only from the revenues from a Special Tax levied on the properties within Community Facility District No. 4. The Special Tax is collected in the same manner and at the same time as the ad valorem taxes. No taxpayer subsidies are involved in the issuance or the repayment of these bonds. These bonds do not constitute an obligation of the City's general fund.

5-6 The property owner would be responsible for undertaking actions as appropriate in the event the project is abandoned.

5-7 The City did not block efforts to perform soil gas testing in the vicinity of old oil wells. Initially, ETI proposed soil gas surveys of the entire project site, including those areas beyond the proposed development sites. However, as the testing of various sites progressed, it was deemed unnecessary to survey the entire project site, as the gas(es) at the Playa Vista Development site did not appear to be attributed to any gas leakages from the old oil wells in the Venice and Playa del Rey areas located far from the proposed development.

5-8 Several consultants have verified that the installation of piles and stone columns will not create a long term increase of gas migration from the aquifer. See Response to Comment 3-2.

5-9 As indicated on page 3 of the Report, public concerns were raised regarding the potential of the Southern California Gas Company Playa Del Rey Gas Storage Facility being the source of the methane gas at the Playa Vista Development Site. The City conducted the studies and reviews appropriate to ensure that the methane detected at the Playa Vista Development site was not from the Southern California Gas Company Playa Del Rey Gas Storage Facility. Also see Response to Comment 6-2.

5-10 The incident that occurred in Hutchinson, Kansas will not occur at the Playa Vista Development Site. Hutchinson, Kansas has completely different geologic conditions than the Playa Vista Development Site. The soft soils conditions and underground salt mines in Kansas provided conduits for gas to migrate horizontally. The geologic conditions and rock types at the Playa Vista Development site would not accommodated that type of long distance horizontal gas migration. Also see Response to Comment 3-9.

5-11 See Responses to Comments 5-1 and 5-5.

5-12 See Response to Comment 3-10.

5-13 Traffic issues are outside the scope of the Report. The Environmental Impact Report (EIR) (EIR No. 90-0200(C)(CUZ)(CUB), State Clearinghouse No. 90010510) for Phase I of Playa Vista Project was certified in May 1993. Traffic issues and required mitigation measures are detailed in the Transportation and Circulation Section, Section V. L.1, of that EIR. The Draft EIR for Phase II of the Playa Vista Project is under preparation and will address transportation and circulation issues associated with the Phase II project area. Persons interested in being notified of the release of the Draft EIR for Phase II of the Playa Vista Project should contact the Planning Department at (213) 580-5266.

Comment Letter #6: Patricia Trujillo

6-1 See Responses to Comments 5-1 and 5-5.

6-2 Dr. Jones of ETI postulated that methane gas detected at the CDF4 site could be a result of gas seepage from the Southern California Gas Company Playa Del Rey Gas Storage Facility. To ensure that seepage from the Southern California Gas Company Playa Del Rey Gas

Storage Facility was not occurring and in response to public concerns regarding the potential for such seepage several studies were undertaken (refer to Section 2 of the Report). Based upon those studies, the City and Dr. Jones concluded that the gas seepage on the Playa Vista Development site appears to be derived from the Pico Sands at depth and does not come from the Southern California Gas Company Playa Del Rey Gas Storage Facility. Also see Comment Letter #22 and Response to Comment 5-9.

6-3 The off-shore geologic data does not relate to the postulated Lincoln Boulevard fault. There is no evidence to support the existence of the postulate Lincoln Boulevard fault (see Section 4 of the Report and Comment Letter #4). The California Department of Conservation, Division of Mines and Geology has completed their review of the off-shore anomalies and it appears that the anomalies could be associated with depositional features characteristic of stream channels (see Comment Letter #23).

6-4 The major streets have been identified on Figure 2.1.

6-5 See Response to Comments 3-1, 3-3, 3-5, and 3-10.

6-6 See Response to Comment 5-5.

Comment Letter #7: Julia Judge

Comments noted.

Comment Letter #8: Thomas Judge

Comments noted.

Comment Letter #9: Patricia McPherson, President, Grassroots Coalition; Rex Frankel, Chair, Ballona Ecosystem Education Project; Kathy Knight, Special Projects Coordinator, Spirit of the Sage Council and Conservation Chair, Airport Marina Group Sierra Club

9-1 See Response to Comment 3-10.

9-2 An Environmental Impact Report (EIR) (EIR No. 90-0200(C)(CUZ)(CUB), State Clearinghouse No. 90010510) for Phase I of Playa Vista Project was certified in May 1993. That document was circulated for public comment in conformance with the requirements of the California Environmental Qualitites Act (CEQA). This Report was prepared in response to a City Council request for additional information to assist in deciding whether the City should issue Mello Roos bonds for the project and is not a document required by law, rule, or regulation. A 30-day review period for the Report was appropriate and adequate due to the limited scope of the document.

9-3 When the matter of the City's issuing Mello Roos bonds first came before the Budget and Finance Committee, the City Attorney advised that the action of issuing the bonds was exempt from the California Environmental Quality Act (CEQA). Although not required by CEQA, the Committee desired additional environmental studies to assist in deciding whether the City should issue the bonds. The Report for which this comment has been submitted was prepared as a result of that decision. Moreover, the issue raised by this comment, whether recent studies relating to methane and related gases required preparation of a supplemental EIR, was resolved in the City's favor in the recent lawsuit entitled "Grassroots Coalition, et al. v. City of Los Angeles, et al.," Los Angeles Superior Court Case No. BS062858.

9-4 The Building and Safety Commission considered the information submitted and the evaluation was considered in the development of the Report.

9-5 See Response to Comment 3-7.

9-6 See Response to Comment 3-5.

9-7 See Response to Comments 2-1, 3-1, 3-2, 3-7, 5-5, 5-10, and 9-5.

9-8 See Response to Comment 3-10.

9-9 See Response to Comment 3-10.

9-10 The Report cites several studies directly utilized in developing the Report. Those studies were made available for review and duplication in 6 City locations. Those studies in turn reference several studies and documents.

9-11 The issue of subsidence has been adequately covered by published Division of Oil, Gas and Geothermal Resources report (1974, Sixtieth Annual Report) and the survey data from the Survey Division, Bureau of Engineering. The latter study covers the years 1975 through 2000, and shows negligible subsidence over that period and no pattern of increasing subsidence toward the Playa del Rey Oil Field (see Report Section 3). See also Response to Comments 13-15.

9-12 The extensive geophysical surveys found no evidence of the Charnock fault on the Playa Vista Development site. This does not mean that the fault does not exist anywhere; such a discussion is beyond the scope of the Report. There is simply no evidence of the fault on the Playa Vista Development site. The Charnock fault was named by Poland , Garret and Sinnott (1959, *Geology, Hydrology and Chemical Character of Groundwater in the Torrance-Santa Monica Area*, U.S. Geological Survey Water-Supply Paper 1461) based solely upon a groundwater level anomaly. Other interpretations are possible for the anomaly, and to date there is no published seismic image of the fault in the vicinity of the project. The recent geophysical studies indicate no offsets are visible in sediments deposited during the last 2.5 to 3.0 million years or older, including in areas of the proposed "Lincoln Boulevard

Fault" and the Charnock Fault.

According to research, the September 16, 2000 earthquake did not occur on the postulated Charnock Fault for the following reasons.

1. This 3.2 magnitude earthquake occurred along an east-west striking fault, whereas the postulated Charnock Fault is a north-south striking fault.
2. This earthquake was a thrust type earthquake, whereas the postulated Charnock Fault is most likely to be a strike-slip fault.
3. The focus of this thrust type earthquake occurred 7.6 miles below the surface and the fault plane projects upward seven to eight miles horizontally from the shallow postulated Charnock Fault.

9-13 The Report will be considered by the Planning and Land Use Management Committee of City Council. An opportunity for public comment is provided in all City Council Committee meetings. In addition, the Report was circulated for 30-day public comment and review period, providing an additional opportunity for public comment.

9-14 See Response to Comment 9-4.

Comment Letter #10: Rose MacHardy

10-1 See Response to Comment 3-10.

10-2 See Comments 3-1, 3-5, 3-9, and 5-2.

10-3 See Response to Comment 3-10.

Comment Letter #11: Jonathan Aurthur

11-1 ETI reviewed all subsequent reports and concurs with the findings of those reports and the CLA's Report. Also see see Response to Comment 3-10.

11-2 See Responses to Comments 2-1 and 3-6.

11-3 The reports are not in conflict, but rather build upon each other. See Response to Comment 3-10 and 11-1.

11-4 See Responses to Comments 2-1, 2-2, 3-1, 3-2, 3-4, 3-6, 3-9, 5-3, 5-4, and 5-5.

Comment Letter #12: 132 Form Letters with original individual signatures delivered by Playa Capital Companies, LLC

Comments noted.

Comment Letter #13: Stewart Morris

13-1 The City did consider the public comments provided at the July 18, 2000, public hearing. The study scope was expanded to specifically include investigation of subsidence issues in response to comments received at that hearing. Further, technical issues commented on by the public were considered as the study elements were developed and reviewed. The transcript from the July 18, 2000, public hearing has been added to the Reference Section of the Report. See also Response to Comment 3-10.

13-2 See Response to Comment 13-1 and Report Section 1.3.

13-3 Reports and information were independently reviewed by the City, its consultants, and responsible State agencies. See also Response to Comment 3-10 and 16-11.

13-4 The Report was intended to be a focused study to address specific potential safety issues associated with the Playa Vista Development Project site. The draft study scope was released for a 30-day public review and comment to provide in-put into the scope of issues and technical concerns that should be considered. On July 18, 2000, a public hearing was held on the draft study scope, providing an additional opportunity for public in-put. The draft study results were released for a 30- day public review and comment period. Finally, the Report will be considered by the Planning and Land Use Management Committee of City Council. An opportunity for public comment is provided in all City Council Committee meetings. Prior to this focused study on the Playa Vista Development site, several opportunities for public in-put into the project were provided by the City. Also see Responses to Comments 9-13 and 13-1.

13-5 See Responses to Comments 3-10, 9-2, 9-3, 9-13, 13-1, 13-3, and 13-4.

13-6 Dr. Jones of ETI was integrally involved in the development of study protocols, review of data collected, interpretation of data, and review of study conclusions. Also see the various letters submitted by Dr. Jones and referenced in the Report.

13-7 The City, its consultants, and the California Department of Conservation, Division of Oil, Gas, and Geothermal Resources all reviewed the Southern California Playa Del Rey Gas Storage Facility. See Report Section 2, Responses to Comments 3-10, 5-9, 6-2, 16-9 and Comment Letter #22.

13-8 See Response to Comment 5-2.

13-9 A pilot program consisting of 110 vent wells drilled at the site into the 50-foot aquifer to determine the feasibility and effectiveness of the subsurface venting system proved that the gas(es) in the aquifer could be vented. The venting of gas(es) from the aquifer will mitigate the accumulation of gas(es) within the aquifer and below the ground surface, and also reduce the surface emissions of gas(es). This subsurface venting system adds another preventive measure supplementing the active and passive detection systems. The number of vent wells

to be installed will be determined by site-specific investigations of each project site.

13-10 Back-up energy power will be provided by electric battery or equivalent back-up systems.

13-11 Ambient noise should not be of a concern with the methane mitigation systems proposed. With respect to future sales of residential units, the developers would disclose information relating to methane gas which they are legally required to disclose.

13-12 The methane alarm systems will notify the LAFD, who will respond and, if necessary, order an area to be vacated. Within ten calendar days following the activation of an alarm, a written report shall be submitted by the building owner or the property owners' association to the LAFD and LADBS regarding the alarm activation and the cause of the activation and, if needed, providing recommendations and corrective measures.

13-13 If methane detectors are on the premises during an inspection of fire safety devices, LAFD will check to determine whether or not a current methane detector report is on file. If a report is not on file, LAFD will issue a notice for compliance to the building owner.

13–14 The building owner or the property owner's association, as applicable, shall have financial responsibility for all costs and expenses associated with the building methane system and the monitoring system, including without limitation all costs associated with testing, maintaining, servicing and repairing the systems and any cost incurred in preparing required reports to be provided to the City. With respect to future sales of residential units, the developers would disclose information relating to methane gas which they are legally required to disclose.

13-15 The additional weight of any structure to be built on the project will be considered in site-specific geotechnical reports reviewed and approved by the LADBS. Soil shear strength, density, consolidation potential and other geotechnical soil properties will be measured for each building site. The weight of fully-loaded buildings will be supported by the ground with either conventional foundations, by pilings or grade beams where needed or by common ground modifications such as preconsolidation and pre-leading of fill combined with drains.

Any dewatering of the aquifer will require a hydrogeologic report to assess and mitigate any potential for subsidence. The hydrogeologic study will ensure that groundwater withdrawal will be less than the recharge rate of the aquifer. See also Response to Comments 2-2, 3-2, and 9-11.

13-16 The Los Angeles Fire Department was consulted regarding the development of the methane mitigation measures. See also Response to Comment 16-11.

13-17 All commenters on the Report will be provided a copy of the final Report and responses to comments received. The Planning and Land Use Management Committee Agenda will provide notice of the consideration of the Report by the Committee.

Comment Letter #14: Leslie Purcell

14-1 See Report Section 5, Responses to Comments 2-1, 3-5, 3-6, 14-6, and Comment Letter # 17.

14-2 See Responses to Comments 3-1, 3-3, 5-2, and 13-9.

14-3 See Response to Comment 3-7.

14-4 See Response to Comments 5-3, 5-5, 13-3 and 13-4 and Report Table 2-1.

14-5 See Responses to Comments 3-10, 9-2, 9-10, and 13-14.

14-6 See Response to Comment 2-1. General air quality issues are outside the scope of the Report. The Environmental Impact Report (EIR) (EIR No. 90-0200(C)(CUZ)(CUB), State Clearinghouse No. 90010510) for Phase I of Playa Vista Project was certified in May 1993. Air Quality issues and required mitigation measures are detailed in that EIR. The Draft EIR for Phase II of the Playa Vista Project is under preparation and will address air quality and traffic issues associated with the Phase II project area. Persons interested in being notified of the release of the Draft EIR for Phase II of the Playa Vista Project should contact the Planning Department at (213) 580-5266.

14-7 See Response to Comment 9-3.

Comment Letter #15: Rick Archer, USC Earth Sciences

15-1 Evidence of the lack of isotopic data showing a postulated origin of methane from the Gas Storage Facility has been documented in several previous studies, as has the lack of the marker helium. This includes recent investigations, such as the Camp Dresser & McKee (CDM) Methane Report dated April 29. 1999. This data was considered in conjunction with the review of the Playa Del Rey Gas Storage Facility integrity and the fault information for that area. The evidence in total was used to concluded that the Playa Del Rey Gas Storage Facility was not the source of methane gas at the Playa Vista Development site. See also Response to Comment 3-10, 5-9, 6-2, and 9-10.

15-2 See Responses to Comments 3-3.

15-3 The total methane concentration, regardless of the source, was used to develop methane mitigation measures. See also Response to Comment 15-1.

15-4 See Report Section 4 and Comment Letter #4.

15-5 See Response to Comment 15-3.

15-6 See Response to Comment 9-10, 13-6, and 16-5.

15-7 See Responses to comments 5-2 and 16-12.

15-8 See Response to Comment 15-1.

15-9 See Response to Comment 3-10, 9-10, 13-6, 15-1, and 16-5.

Comment Letter #16: Marcia Hanscom, Executive Director, Wetlands Action Network; Robert van de Hoek, Chair, Sierra Club Ballona Wetlands Task Force

16-1 See Response to Comment 9-3. The Report provides information for the entire Playa Vista Development site in most instances. As an example Finger 2.1 provides the methane levels for the entire area, not just CDF4.

16-2 The City has not ignored ETI's statement that the area be mapped prior to construction. Soil gas surveys have been conducted and mapped to identify the levels of methane concentration of the entire site. The identified level of concentration for an area determines the level of methane mitigation system required for a project. As each future project is submitted to LADBS for review, and prior to permit issuance, additional site-specific gas surveys will be required to identify any changes in the pre-established levels of concentration and to ensure that the level of mitigation system required is based on the most current levels of concentration. See also Response to Comment 5-2 and Report Section 2.

16-3 See Response to Comment 3-10.

16-4 See Responses to Comment 9-4 and 9-14.

16-5 See Response to Comment 13-6.

16-6 The Personnel and Fire Departments were consulted regarding potential health risks associated with BTEX and advised that consultant services were required to complete the HRA. It was further recommended that the as-needed consultant contracts administered by the Bureau of Engineering be utilized for such an effort. Kleinfelder was engaged pursuant to those recommendations. Also see Response to Comment 16-11.

16-7 See Response to Comment 16-6 and 16-11.

16-8 LADBS forwarded copies of all pertinent documents to the CLA. Also see Response to Comment 2-1 and 3-5.

16-9 Other than providing requested information, reports, and studies Latham and Watkins, Playa Vista Capital, and the Southern California Gas Company played no role in the production of the Report.

16-10 The City Council instructed the CLA to oversee the resolution of issues addressed in the Report and various other City Departments to cooperate with the CLA as appropriate. The

Bureau of Engineering participated in the development of he Report and represented all interests of that Bureau. See also Response to Comment 16-11.

16-11 The City Council did not establish a "task force," but instructed the CLA to oversee the resolution of issues addressed in the Report and various other City Departments to cooperate with the CLA as appropriate. In that effort, the CLA established a working group. Meetings of the working group were internal City meetings, which do not require public notice. Participants included the CLA's Office, City Attorney's Office, LADBS, Bureau of Engineering, Planning Department, Office of Administrative Research Services, and the Fire Department. Also see Response to Comments 9-2, 13-4, and 16-9.

16-12 ETI's research acknowledges that geologic formations and "fractures", at the Playa Vista Development site, allow subsurface gas(es) to migrate upwards to the site via the 50-foot aquifer. The methane mitigation system for this project was designed to ventilate the 50-foot aquifer, minimizing the accumulation of gases within the aquifer. Also see Responses to Comments 3-1, 3-2, 5-2, 5-3, 5-5, and Report Sections 2 and 4.

16-13 A draft chart, identifying potential additional studies and listing issues/questions and solutions for the Playa Vista Development Project, was presented at a June 2000 Budget and Finance Committee Meeting. The issues included: methane monitoring systems and contingency plans; geotechnical and seismological studies of the postulated Lincoln Blvd. Fault; the relationship between gases at the Playa Vista site and the gas storage facility; a health and risk assessment; ground subsidence; stone columns and pile driving; and future permits. Review of the draft chart illustrates that all of the issues included on the chart have been addressed.

16-14 See Responses to Comments 3-1, 3-10,13-9, 16-8, and16-11. In addition refer to the Report and correspondence from LADBS to the CLA included in the Report Appendices.

16-15 All the available geological related data was used in the Report, including the geophysical investigations, and the methods of analyses used included the standard petroleum geology technique of analysis. All available geologic literature on the area was reviewed, including reports on the Gas Company field, geotechnical boring logs, oil well logs, cone penetrometer logs (both new and existing) and extensive existing and new seismic imaging. Geomorphic analysis was employed. New geologic maps and cross-sections of the subsurface, based upon oil and gas wells and the seismic reflection data allowed the experts to come to an excellent understanding of the subsurface structure and stratigraphic framework under and near the project site. All data indicate no faulting on the project site. Refer to Section 4 of the report and Comment Letters #4 and 23.

16-16 Ethane, propane and butane are in a family of hydrocarbons with only single bonds. They share an origin with the thermogenic contribution of total methane, forming naturally with methane in oil-generating organic-rich sedimentary rocks (including the Pico formation). The April 17, 2000 ETI, Inc. report noted that ethane, propane and butane are coincident in occurrence with methane anomalies, corroborating this origin. Ethane is also less dense than

air so it will also tend to rise. Propane and Butane are heavier than air (although not as heavy as the BTEX gases).

The extensive methane mitigation system proposed for the project will adequately protect from these gases, which are at very low concentrations, and will be entrained in escaping methane.

16-17 Methane mitigations, which will address all other gases, such as BTEX, ethane, propane, and butane, and responsible parties are listed in Table 2-1 of the Report. Also see Responses to Comment 3-1, 3-9, 5-4, 13-9, 13-14, and 13-16.

16-18 See Responses to Comments 13-9 and 16-17.

Comment Letter #17: John Geroch, Associate Engineering Geologist, Site Cleanup Unit I, California Regional Water Quality Control Board, Los Angeles Region

Comments noted.

Attached Memorandum from Julio Salinas, Ph.D. Hazardous Waste Toxicology Section, Office of Environmental Health Hazard Assessment to John Georch, LARWQCB

OEHHA comments noted.

17-1 The City agrees that the use of screening criteria, such as low frequency of detection of pollutants, when determining health risks and the potential need to complete a full HRA must be carefully utilized, and requires concurrence from responsible regulatory agencies. Although the low frequency of detection of BTEX and H_2S is cited in the report, as you note, a complete HRA was conducted utilizing all available data. The reference to the 5% frequency screening level ha been deleted from the Report.

Comment Letter #18: Suzanne M. DeBenedittis

18-1 See Responses to Comments 2-1, 5-2, 5-4, and 5-5.

18-2 Comment noted.

Comment Letter #19: Faye Ku

19-1 See Response to Comment 3-10.

19-2 See Responses to Comments 3-1, 3-3, 3-4, 3-9, 5-2, 16-12.

19-3 See Response to Comment 13-9.

19-4 See Response to Comment 9-11 and 13-15

19-5 See Response to Comments 3-10, 5-5, 9-3.

Comment Letter #20: Bryan Gordon

20-1 The study design did not assume that a scenario could not exist that would render the site unsuitable for development. Step III of the study scope states: "The study will document any issues of concern for which adequate mitigations cannot be identified" (City of Los Angeles, Office of the Chief Legislative Analyst Office (CLA), July 2000, City Investigation of Potential Issues of Concern for the Community Facilities District No. 4 Playa Vista Development Project Draft Study Design and Scope of Work). Also see Responses to Comments 3-10 and 5-2.

20-2 See Response to Comment 16-6. Kleinfelder is an environmental consulting firm.

20-3 See Report Section 2 and Responses to Comments 5-2 and 13-9.

20-4 See Response to Comment 3-10.

20-5 See Response to Comments 2-1, 5-3, and 5-5.

Comment Letter#21: Michael De La Torre, Southern California as Company

Comments noted.

Comment Letter #22: Kenneth E. Trott, Environmental Coordinator, California Department of Conservation

22-1 Comments noted.

22-2 LADBS has documented permitting procedures that require written clearance by the State Department of Conservation, Division of Oil and Gas and Geothermal Resources, prior to the issuance of permits for projects where abandoned or active oil wells are identified on City Planning maps.

Comment Letter #23: William Bryant, Program Manager, Active Faults, California Department of Conservation, Division of Geology and Mines (also see Comment Letter #4)

Comments noted. See also Comment Letter #4.

Comment Letter #25: Giyora Doeh

Comments noted.

SECTION 7

References

The various City department and state agency review documents are included in the appendices of this report. The appendix location is indicated below.

Appendix	Reference
	California Department of Conservation, Division of Oil, Gas, and Geothermal Resources, 1999 Annual Report of the State Oil and Gas Supervisor, Publication PR06
A	California Department of Conservation, Division of Oil, Gas, and Geothermal Resources, Baker, R.K., District Deputy, October 10, 2000, Correspondence re: Southern California Gas Company Gas-Storage Operations, to Vitaly Troyan, City Engineer, Department of Public Works, City of Los Angeles
	California Department of Conservation, Division of Oil, Gas, and Geothermal Resources, Robert Samuelian, Construction Site Engineer, May 15, 2000, Correspondence re: review of building plans for Playa Vista Visitor Center, to Nick Tratta, LADBS
	California Department of Conservation, Division of Oil, Gas, and Geothermal Resources, Robert Samuelian, Construction Site Engineer, April 16, 2000, Correspondence re: review of building plans for Fountain Park Apartments, to Nick Tratta, LADBS
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APPENDICES

STATE OF CALIFORNIA – THE RESOURCES AGENCY **APPENDIX A** GRAY DAVIS, Governor

DEPARTMENT OF CONSERVATION
5816 Corporate Avenue, Suite 200
Cypress, CA 90630-4731

(714) 816-6847
FAX (714) 816-6853

710271

RECEIVED BY
OCT 19 2000
MIKE [illegible] C.E.G.

October 10, 2000

Mr. Vitaly B. Troyan
City Engineer
Department of Public Works
650 South Spring Street, Suite 200
Los Angeles, CA 90014

RE: Southern California Gas Company Gas-Storage Project Operations

Dear Mr. Troyan:

Thank you for your letter regarding the gas storage project and its relationship to the Playa Vista Project. The following is provided to address the issues expressed in your letter.

The Division's oversight of gas-storage projects consists of three elements: project review meetings, facilities testing, and environmental compliance inspections.

At least once a year, Division staff meet with project operators to review all aspects of each project, including any new geologic data, performance graphs, wellsite monitoring reports, pollution prevention activities at wellsites and facilities, and hydrogen sulfide production and its treatment. In addition, reservoir pressure graphs, which track the project's gas-injection rates and surface and inventory pressures, and reports on any gas waste or loss are reviewed. The reviews for Playa del Rey indicate that all reservoir conditions are consistent with prior year's performance and no gas losses are occurring within the project.

The most recent facilities testing at Playa del Rey took place in December 1998 and April 2000. Minor deficiencies were noted and all were corrected. Additional safety system testing is witnessed by Division engineers twice a year. The Division also witnesses tests of the surface and subsurface safety valves even if a well is inactive. All safety systems must be operational before a well can be put on line.

Environmental inspections are carried out annually by Division staff. If problems are found, they are corrected immediately by the operator or a follow-up inspection is

scheduled to confirm that corrective actions have been completed. The Division's last inspection was conducted on January 14, 2000, with a follow-up in March. The latest inspection indicated that Southern California Gas Company was in full compliance with Division regulations.

The overall safety and performance of Southern California Gas Company in Playa del Rey has been excellent. Furthermore, the gas company has received the Division's Outstanding Lease and Facility Maintenance Award for its "Dunlap" lease for 12 consecutive years, and for the "Treasure" and Blackline" leases for 7 consecutive years. This award is presented only to operators who have maintained their leases in an exemplary manner.

Our records indicate that there have been no significant problems or deviance from Division regulations. Our inspection records show that any problems are always corrected in a very timely manner.

As shown in the studies we have reviewed and the information we have received from the Playa Vista developer, Southern California Gas Company, and the Exploration Technologies, Inc. report for the City of Los Angeles, there are areas of the project where gas seepage is present. However, we have no information to indicate that any of this gas is derived from the Southern California Gas Company Playa del Rey gas storage project. (Tracer materials are added to the stored gas for leak-detection and other purposes.)

Concerning your final question regarding the plugging and abandonment requirements for wells, the Division will require any project proponent to replug any wells present in the project area to present-day standards. Also, if any unrecorded wells are discovered, the Division will require these wells to be plugged and abandoned to present-day standards. The Division will recommend that all wells be vented if a structure is to be placed over or in proximity of a well.

I hope that the above discussion has addressed your concerns regarding the Playa del Rey gas-storage project. If you have any other questions, please call me.

Sincerely,

R. K. Baker
District Deputy
Division of Oil, Gas, and Geothermal Resources

RKB:bd

RE: OF ENGINEERING
SERVICES
TER FILES

OCT 13 2000

SIGNED: MICHALSKI

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MAYOR

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BUILDING AND SAFETY
201 NORTH FIGUEROA STREET
LOS ANGELES, CA 90012-2627

ANDREW A. ADELMAN
GENERAL MANAGER

WALTER R. KRUKOW
EXECUTIVE OFFICER

APPENDIX B

February 28, 2001

Mr. Ron Deaton, Chief Legislative Analyst
Office of the Chief Legislative Analyst
200 N. Main Street, Room 512
Los Angeles, CA 90012

Attention: Gerry Miller
Assistant Chief Legislative Analyst

PLAYA VISTA PROJECT - CLA REPORT

At the City Council meeting of June 23, 2000, the City Council instructed the Chief Legislative Analyst, with the assistance of the departments of Building and Safety (LADBS), City Planning, Public Works, City Attorney, City Administrative Officer (CAO), and any other agencies, consultants or individuals deemed appropriate by the CLA, including, but not limited to Dr. Victor Jones (Project Peer Reviewer), to:

1) Oversee the development of tasks necessary for collecting and analyzing any additional information required to assess the structural, health and earthquake safety risks associated with methane and other gases on the site;

2) Hold a public meeting within three weeks, or as soon thereafter as possible, to obtain input relative to the issues that will be considered and the estimated time frames for preparing the report, and

3) Report back to the Planning and Land Use Management (PLUM) Committee in 120 days with a report and recommendations regarding issues raised during this process.

Subsequently, the CLA's office conducted a series of meetings with the aforementioned departments to identify all related issues and assign tasks and responsibility to various departments for addressing these issues. The following tasks were assigned to LADBS:

- Determine the relationship, if any, between gases at the Playa Vista Phase I (CFD4) project site and the gas in the Southern California Gas Company Storage Facility at Playa del Rey;
- Determine the existence of the postulated Lincoln Fault; and
- Identify and recommend methane mitigation and monitoring requirements.

BACKGROUND

In the Spring of 1999, preliminary soil gas surveys and testing were done at the Playa Vista site and the results revealed elevated concentrations of methane gas.

In the Summer of 1999, LADBS and Playa Vista agreed to retain the service of Exploration Technologies, Inc. (ETI) as the Peer Reviewer for the Playa Vista project to assist LADBS staff.

In the Fall and Winter of 1999 and the Spring of 2000, Playa Vista consultants, in consultation with ETI, conducted extensive soils gas surveys and testing in tract area 49104 of the Playa Vista Phase I project site. The result of this study, as summarized in the April 17, 2000 ETI report titled, "Subsurface Geochemical Assessment of Methane Gas Occurrences Playa Vista Development, First Phase Project," reflected various methane and geological conditions. Further studies to address these conditions were recommended

On June 7, 2000, the Budget and Finance Committee of the City Council discussed the Community Facilities District bond issues and raised concerns regarding environmental, planning, building and safety issues relative to the Playa Vista Project - Phase I, in relation to the issuance of Mello-Roos bonds for construction and acquisition of public facilities for this project.

On June 23, 2000, at the direction of the City Council, the CLA formed a task group comprised of the CLA's Office, LADBS, Public Works Bureau of Engineering, Department of City Planning, City Attorney, City Administrative Officer (now known as the Office of Administrative Research and Services (OARS)), and the Los Angeles Fire Department to address the above described issues. Different tasks and responsibilities were assigned to various departments for addressing these issues.

Since then, LADBS has conducted frequent meetings on the issues, including periodic joint meetings with the consultants and the Peer Reviewer to accomplish the three aforementioned tasks assigned to the Department. The results of numerous site surveys and testings, reviews and analyses of historical and new data, and technical evaluation sessions among experts are summarized below.

DISCUSSION OF THE RELATIONSHIP BETWEEN THE GASES AT THE PLAYA VISTA PHASE I (CFD4) PROJECT SITE AND THE GAS IN THE SOUTHERN CALIFORNIA GAS COMPANY STORAGE FACILITY AT PLAYA DEL REY

Playa Vista consultants conducted several soil gas studies and analyses, including nine gas samples taken directly from several of the storage and observation wells at the Southern California Gas Company Storage Facility. All samples were analyzed for composition and similarities with gas samples taken from the Playa Vista Phase I project site. These studies are summarized in the following reports:

- "Sampling and Analysis of Gas from the Southern California Gas Company Playa Del Rey Gas Storage Field", by Camp Dresser & McKee, Inc. (CDM), dated September 5, 2000 (Attachment 1)

- "Comparison of Gas Analyses from Southern California Gas Company Injection Wells and from Various Observation (Reservoirs Storage) Wells", by Dr. Ian Kaplan, Zymax Forensics, dated September 21, 2000 (Attachment 2)

According to Playa Vista consultant, Dr. Ian Kaplan, "...data show that the chemical and isotopic characteristics of the natural gas stored by Southern California Gas Company are different from the gas detected at the Playa Vista property." (Attachment 2, Page 5)

Peer Reviewer, ETI, reviewed and analyzed the above reports and concluded in their January 31, 2001 letter to LADBS that, "Comparison of the chemical and isotopic data from these wells with the near-surface and Ballona gravel aquifer gas samples previously analyzed on the Playa Vista site clearly shows that the storage gases are not present in any of the methane anomalies east of Lincoln Blvd. The gas seepage on the Playa Vista site appears to be derived from the Pico Sands at depth and does not have the geochemical signatures characteristic of storage gas." (Attachment 3)

LADBS staff reviewed ETI's conclusion and concur that the combined geochemical and geophysical information indicates that the methane gas observed at the Playa Vista Phase I project site does not come from the gas stored in the Southern California Gas Company Storage Facility at Playa del Rey. (Attachment 4)

DISCUSSION OF THE EXISTENCE OF THE POSTULATED LINCOLN FAULT

Playa Vista consultants conducted the following subsurface geologic evaluations of the Playa Vista project site:

- "Geologic Study to Evaluate the Potential for Active Faulting Near the Intersection of Lincoln and Jefferson Boulevards, at the Playa Vista site, in the City of Los Angeles, California", by Earth Consultants International, Inc., dated July 2000 (Attachment 5)

- "An Evaluation of the Subsurface Structure of the Playa Vista Project Site and Adjacent Area, Los Angeles, California", by Davis & Namson, dated November 16, 2000 (Attachment 6)

As part of their investigation, Earth Consultants International reviewed previously published geologic maps and reports covering the area and unpublished geologic and geotechnical reports prepared by other investigators for the Playa Vista site. They also conducted a subsurface study consisting of borings and Cone Penetrometer Tests across the area where the fault is postulated. From all of their data, they could not, "...find evidence to support the existence of a supposed 'Lincoln Boulevard fault' across the property." (Attachment 5, Page 1, Third Paragraph)

Davis and Namson's evaluation employed five different geologic and geophysical methods between May and October 2000 to evaluate the possibility of faulting at the site:

1) a search of the existing geologic literature;
2) construction of subsurface maps and cross sections based on well data;
3) purchase and interpretation of pre-existing Chevron seismic reflection data;
4) acquisition and interpretation of a shallow sub-surface geological survey along Jefferson Boulevard and a deeper seismic survey over the entire project site; and
5) an offshore geophysical survey southwest of the site.

From this work, they, "...could find no evidence for the postulated Lincoln Boulevard or postulated Charnock faults." (Attachment 6, Page 2, Second Paragraph)

Peer Reviewer, ETI, reviewed and analyzed the above reports and concluded in their January 31, 2001 letter to LADBS that, "...interpretation of the chemical and geophysical data does not support the existence of the Lincoln Blvd. Fault that was postulated to dip westward and possibly transect strata within the existing gas storage field ..." (Attachment 3)

LADBS staff reviewed ETI's conclusion and concur that the postulated Lincoln Boulevard Fault, as defined in ETI's April 17, 2000 report, is unsubstantiated. (Attachment 7)

DISCUSSION OF THE METHANE MITIGATION AND MONITORING REQUIREMENT

Playa Vista consultants, in consultation with ETI, conducted site testings and research analyses to establish design criteria for effective methane prevention, detection and monitoring systems.

A baseline methane soil gas survey that reflects methane concentration levels for the entire project site was conducted and provided a clearer understanding of the methane distribution. (Attachment 8) This data enabled Playa Vista consultants to develop a comprehensive program addressing the design criteria of the above methane systems, as described in the following report:

- "Playa Vista Methane Prevention, Detection and Monitoring Program", by Methane Specialists, Inc., dated January 30, 2001 (Attachment 9)

The report included a Methane System Requirements matrix that detailed specific mitigation and monitoring requirements for the entire project site based on the level of methane concentration. There are three different levels of methane concentrations identified for the project site: Level I, Level II and Level III. Level I represents concentration levels of less than 100 parts per million of volume (ppmv). Level II represents concentration levels of between 100 and 12,500 ppmv and Level III represents concentration levels of above 12,500 ppmv. All levels require a basic mitigation prevention system below the building, including a 12-inch gravel blanket, with pipes to ventilate gas from underneath an impermeable membrane and methane detection alarm systems within the building. For Levels II and III, automatic ventilation systems triggered by elevated methane concentration levels beneath the impermeable membrane and continuous monitoring systems are also required. Additionally, Level III requires a subsurface venting system consisting of vent pipes drilled into the 50-foot gravel aquifer to vent methane gas, thereby mitigating the accumulation of methane within the aquifer and below the ground surface and also reducing the surface emissions of methane. Playa Vista implemented a pilot program wherein more than 70 temporary vent wells were drilled at the site to determine the feasibility and effectiveness of venting subsurface accumulations of methane. The program demonstrated that subsurface methane gas can be vented. A permanent subsurface venting system is currently in a progressive design stage that will establish criteria for determining the exact number of, locations of, and size of permanent subsurface wells.

The repon concluded that, "Each of the levels will provide a comprehensive program of prevention, detection, and monitoring systems along with a maintenance and testing program. These systems will ensure adequate and appropriate safety for all building occupants." (Attachment 9, Page 1)

Peer Reviewer, ETI, reviewed and analyzed the above report and concluded in their January 31, 2001 letter to LADBS that, "...the proposed systems meet our recommendations, provided that the systems meet, or exceed all detail specifications as required by Department of Building and Safety." (Attachment 10)

LADBS staff reviewed and agree with ETI's conclusion that the proposed methane prevention, detection and monitoring systems for the Playa Vista project are adequate for safe development. (Attachment 11)

If you have any questions or need additional information, please call Raymond Chan, Chief of Engineering Bureau, at (213) 977-6380, or me at (213) 977-5960.

Very truly yours,

ANDREW A. ADELMAN, P.E.
General Manager

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LOS ANGELES, CA 90012

ANDREW A. ADELMAN
GENERAL MANAGER
WALTER R. KRUKOW
EXECUTIVE OFFICER

January 31, 2001

ATTACHMENT 4

APPENDIX C

David Nelson
Senior Vice President
Playa Capital Company
12555 W. Jefferson Bl., #300
Los Angeles, California 90066

CURRENT REFERENCE REPORT/LETTERS	REPORT NO.	DATE(S) OF DOCUMENT	PREPARED BY
Methane Report	-	1/31/01	ETI

The report concerning the Playa Del Rey Gas Storage Field and the Lincoln Boulevard fault has been reviewed by the Grading Section of the Department of Building and Safety. According to the report, the "combined geochemical and geophysical information proves beyond a reasonable doubt that the methane gas seepage observed on the Playa Vista site does not come from the Southern California Gas Storage Field." The Department of Building and Safety accepts this conclusion.

DAVID HSU
Chief of Grading Section

(213) 977-6329

cc: Exploration Technologies, Inc.

AN EQUAL EMPLOYMENT OPPORTUNITY – AFFIRMATIVE ACTION EMPLOYER

Exploration Technologies, Inc.
3698 Westchase Dr • Houston, Texas 77042 • (713) 785-0393 • FAX (713) 785-1550

ATTACHMENT 10

January 31, 2001

Mr. David Hsu
Chief, Grading Section
City of Los Angeles
Dept. of Building and Safety
201 North Figueroa Street
Los Angeles, CA 90012-2827

Dear David:

We have reviewed the proposed plan for the methane prevention, detection and monitoring systems from Methane Specialist and CDM, as defined in their report of January 30th, 2001 and outlined by their matrix table "METHANE SYSTEM REQUIREMENTS," and find that the proposed systems meet our recommendations, provided that the systems meet, or exceed all detail specifications as required by Department of Building and Safety.

One of the proposed methane prevention systems, the subsurface venting for the Level III areas which overlay the methane soil gas anomalies, is currently in the research and design stages. The subsurface venting system, which primarily targets the 50-foot gravel aquifer, provides a necessary level of protection, supplementing the building systems, for development of the Level III areas. Building in Level III areas is contingent upon a functional subsurface venting system to the satisfaction of the Department of Building and Safety in consultation with the peer review team.

If you have any questions or require additional information, please contact me.

Sincerely,
Exploration Technologies, Inc.

V.T. Jones III

Victor T. Jones, III, Ph.D
Peer Reviewer for LADBS
President, Exploration Technologies, Inc.

FORM GEN. 160 (Rev. 7-98)

CITY OF LOS ANGELES
INTER-DEPARTMENTAL CORRESPONDENCE

APPENDIX E

Date: October 24, 2000

To: Ronald F. Deaton,
Chief Legislative Analyst

Attention: Barbara Garrett, Analyst

From: Vitaly B. Troyan, P.E.
City Engineer

By: Michael P. Brown, Manager
Geotechnical Engineering Division

Subject: **PLAYA VISTA - INVESTIGATION OF POTENTIAL OIL FIELD SUBSIDENCE**

Per a request from your office, attached are the results of the survey of the Playa Vista area.

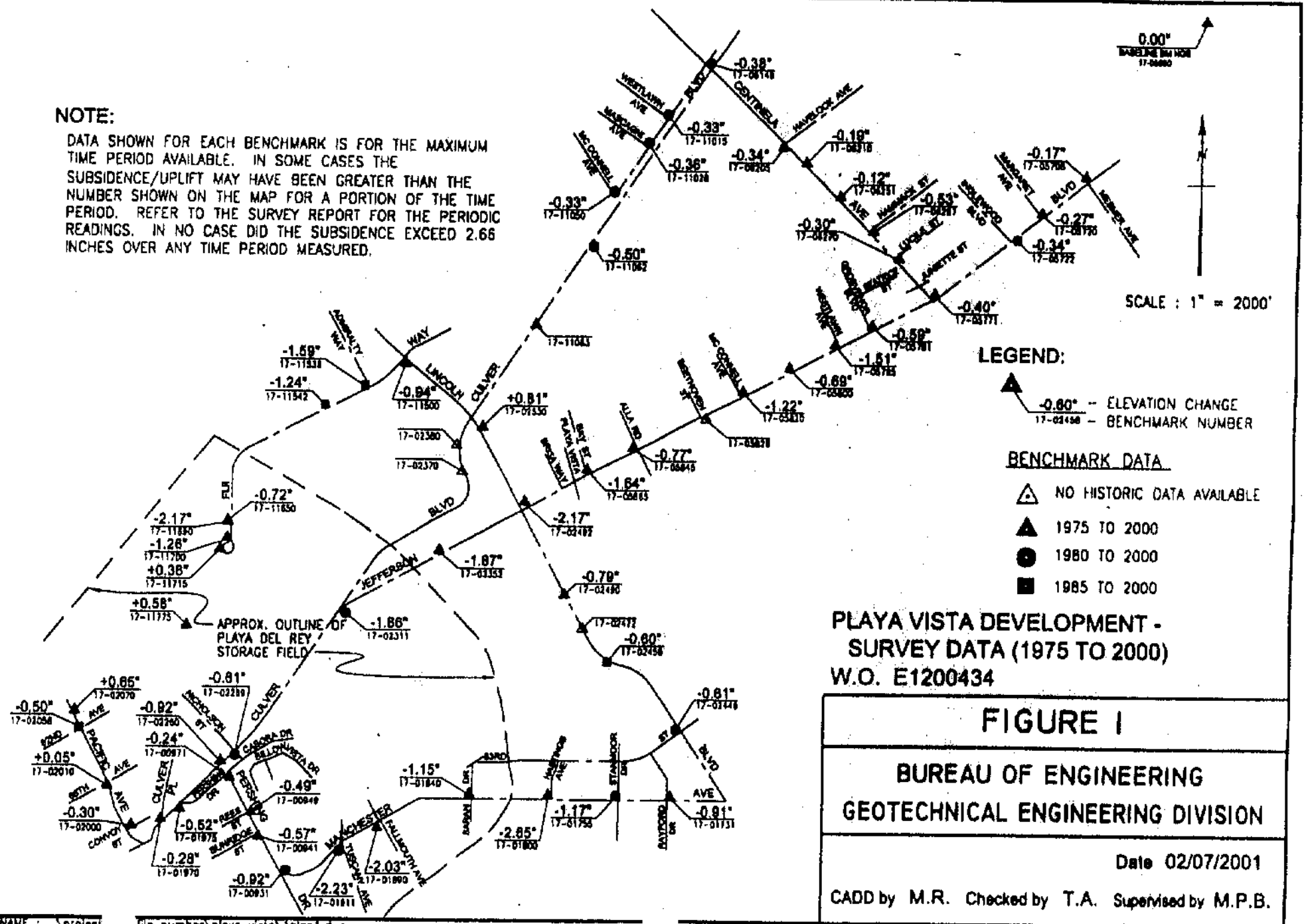
The survey was performed by the Bureau of Engineering's Survey Division in October, 2000. The survey recorded the current elevations of benchmarks in the area and compared them to the elevations of those same benchmarks in 1975, 1980, and 1985. These elevations were adjusted using a National Geodetic Survey (NGS) benchmark as the baseline. Not all of the benchmarks had data for 1975 and 1980, in those cases the partial data was provided. The survey met the tolerances for National Geodetic Survey, Second Order Class II, which means that loop closures were very small (8mm's times the square root of the loop distance in km). Therefore, the survey was completed to a very high degree of accuracy. The attached survey report describes the survey methods, and equipment used, in greater detail.

The elevation change measured in the area over the 25 year period ranged from –2.66 inches (subsidence) to +0.81 inches (uplift). In order to interpret the data more easily, our office has prepared a map depicting the location of each of the benchmarks as well as the elevation change from the earliest available date. The map also shows the approximate limits of the oil field.

If you have any questions regarding this information please contact Michael Mulhern or Ted Allen of my staff at (213) 847-4011 or (213) 847-4028, respectively.

Attachments: 1) Playa Vista Area Bench Mark Data report from BOE Survey Division
2) Playa Vista Development Survey Data Map from BOE Geotechnical Division

MPB MEMO A Q PROJECTS\No File Number\Playa Vista\Survey Files\Conclusions of the Survey Data IDC.doc


NOTE:
DATA SHOWN FOR EACH BENCHMARK IS FOR THE MAXIMUM TIME PERIOD AVAILABLE. IN SOME CASES THE SUBSIDENCE/UPLIFT MAY HAVE BEEN GREATER THAN THE NUMBER SHOWN ON THE MAP FOR A PORTION OF THE TIME PERIOD. REFER TO THE SURVEY REPORT FOR THE PERIODIC READINGS. IN NO CASE DID THE SUBSIDENCE EXCEED 2.66 INCHES OVER ANY TIME PERIOD MEASURED.
SCALE : 1" = 2000'
LEGEND:
-0.60" – ELEVATION CHANGE
17-02456 – BENCHMARK NUMBER
BENCHMARK DATA
NO HISTORIC DATA AVAILABLE
1975 TO 2000
1980 TO 2000
1985 TO 2000
APPROX. OUTLINE OF PLAYA DEL REY STORAGE FIELD
PLAYA VISTA DEVELOPMENT - SURVEY DATA (1975 TO 2000)
W.O. E1200434
FIGURE 1
BUREAU OF ENGINEERING
GEOTECHNICAL ENGINEERING DIVISION
Date 02/07/2001
CADD by M.R. Checked by T.A. Supervised by M.P.B.
FILENAME : ..\project file number\playa vista\1plan1.dwg

CITY OF LOS ANGELES

INTER-DEPARTMENTAL CORRESPONDENCE

Date: October 23, 2000

To: Vitaly B. Troyan, P. E.
City Engineer

From: Erich Ziebarth, Chief Surveyor

Subject: **Playa Vista area Bench Mark Data**

The attached spreadsheet was prepared in response to your request for evidence of settlement or uplift in the Playa Vista area.

Following is a synopsis of the Playa Vista area precise leveling that the Survey Division conducted:

Initially the published primary levels through the area were identified and leveling courses run. Additional leveling courses were run to form closed loops to check closure tolerances. A bench mark outside the area of influence was needed to establish a baseline for comparison. The bench mark selected (#17-05650) provided a tie into the leveling courses done by NGS (National Geodetic Survey) in 1997. The leveling procedures and methods used complied with, and all loop closures fell well within, the tolerances published by NGS for Second Order Class II precision criteria. The Leica Digital level used was calibrated before, during and after the leveling courses were run. There were no anomalies detected.

After collecting the field data, it was adjusted using STAR*LEV least squares adjustment software. Finally, all bench marks were placed on the same reference datum because a simple difference in published elevations of existing bench marks between subsequent years could not be used. A shift in the datum used between the 1975 and 1980 level runs, and again between the 1980 and 1985 level runs, made it impossible to do this. Therefore by placing all bench marks on the same reference datum (NGS, 1997), the difference in elevations will reflect any vertical movement.

PROFESSIONAL LAND SURVEYOR
ERICH A. ZIEBARTH
EXP. 12/31/01
NO. 5037
STATE OF CALIFORNIA

APPENDIX F

CITY OF LOS ANGELES
INTER-DEPARTMENTAL CORRESPONDENCE

Date: February 26, 2001

To: Ronald Deaton
Chief Legislative Officer

Attn.: Barbara Garrett

From: P.J. (Mike) Michalski, Engineering Geologist III
Bureau of Engineering

Subject: INTERPRETATION OF SURVEY DATA RELATING TO POTENTIAL SUSBSIDENCE
PLAYA VISTA PROJECT - (File 96-092) WO E1200434

On October 24, 2000, the Department of Public Works, Geotechnical Engineering Division (GED) provided a memo describing the benchmarks used and the degree of accuracy of the data and map summarizing the City of Los Angeles survey data. Per your request, this memo provides interpretation and conclusions of the data.

The maximum subsidence observed at one location in the area over the period from 1975 to 2000 was 2.66 inches. No significant or clearly defined trend of increased subsidence with the Playa Del Rey Oil Field or any other specific area was observed. The location with the greatest level of subsidence is an elevation marker placed on the curb of Manchester Boulevard at the intersection of Hastings Avenue. Another one of the markers displaying a greater than 2-inch settlement is in a sidewalk of Lincoln Boulevard at Jefferson Boulevard, a distance of approximately four-fifths of a mile from the previously-noted marker. This suggests that settlement is localized and may be associated with curb, sidewalk and gutter settlement along major streets.

Current building codes are adequate to address the minimal level of subsidence and uplift observed in the area. There is no evidence that proposed methane mitigation measures will result in increased potential for subsidence in the area.

If you have any questions with this review, please contact Mike Mulhern, CEG 1507, HG 306 at (213) 847-4011 or Ted Allen, CE, at 847-4028.

c: Clark Robins, Deputy City Engineer
Susan Pfann, Deputy City Attorney

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LOS ANGELES, CA 90012

ANDREW A. ADELMAN
GENERAL MANAGER

WALT KRUKOW
EXECUTIVE OFFICER

December 19, 2000

ATTACHMENT 7

APPENDIX G

Mr. David Nelson
Senior Vice President
Playa Capital Company
12555 W. Jefferson Bl., #300
Los Angeles, CA 90066

CURRENT REFERENCE REPORT/LETTER(S)	REPORT NO.	DATE(S) OF DOCUMENT	PREPARED BY
Review letter	-	12/07/00	ETI
Geologic Report	-	11/16/00	Davis & Namson

The referenced review letter and geologic report concerning an evaluation of the subsurface geologic structure of the Playa Vista project site have been received by the Grading Section of the Department of Building and Safety. The purpose of the geologic report was to evaluate the possibility of a Lincoln Boulevard fault, as postulated in the report of April, 2000 by Exploration Technologies, Inc. The conclusion of the report is that no evidence was found for the postulated Lincoln Boulevard fault. Exploration Technologies, Inc has reviewed the data and agrees that a postulated Lincoln Boulevard fault that would provide a pathway for gas from the Southern California Gas Co. storage field to the Playa Vista site is unsubstantiated. The Department accepts these conclusions.

DAVID HSU
Chief of Grading Section

(213) 977-6329

cc: Exploration Technologies, Inc
Davis & Namson

Exploration Technologies, Inc.

3698 Westchase Dr • Houston, Texas 77042 • (713) 785-0393 • FAX (713) 785-1550

January 31, 2001

Mr. David Hsu
Chief, Grading Engineering Section
City of Los Angeles
Dept. of Building and Safety
201 North Figueroa Street
Los Angeles, CA 90012-2827

Dear David,

Playa Del Rey Gas Storage Field and Lincoln Blvd. Fault:

As confirmed by our earlier letters (December 20, 2000 V T Jones to Ray Chan), we have completed our preliminary evaluation of the regional soil gas data collected over the entire Playa Vista site, including the locations for 119 infill soil gas samples to complete this data set. The regional soil gas data collected as part of Phase II evaluations shows no evidence of major gas leakage from the Playa Del Rey Gas Storage Field. In addition we have collected and completed evaluation of nine additional storage gas reservoir samples taken directly from several of the storage and observation wells. Comparison of the chemical and isotopic data from these wells with the near-surface and Ballona gravel aquifer gas samples previously analyzed on the Playa Vista site shows that the storage gases are not present in any of the methane anomalies observed east of Lincoln Blvd. The gas seepage on the Playa Vista site appears to be derived from the Pico Sands at depth and does not have the geochemical signatures characteristic of storage gas.

Preliminary interpretation of the geophysical data from seismic profiles supports the premise that the methane gas found east of Lincoln is moving upward within a vertical zone of disrupted strata from beds of the Pico Formation. Offsets in reflections of the seismic profile may be interpreted as zones of disrupted strata, which are likely permeable to gas. Preliminary data reprocessing suggests the presence of low-velocity zones (possibly due to the presence of gas) that appear to be associated with both the disrupted strata and with the location of the anomalous methane found on the Playa Vista site. Thus the near-surface gas anomalies appear to be issuing from fractures or other disruptions that directly underlie the methane anomalies as defined by the soil gas surveys. As noted in an earlier letter, (Victor Jones to Ray Chan, December 7, 2000) interpretation of the chemical and geophysical data does not support the existence of the Lincoln Blvd. Fault that was postulated to dip westward and possibly transect strata within the existing gas storage field, as communicated in our April 17, 2000 report to LADBS. This combined geochemical and geophysical information supports that the methane gas seepage observed on the Playa Vista site does not come from the Southern California Gas Storage Field.

Sincerely,

Victor T Jones, III, Ph.D
Peer Reviewer for LADBS
President, Exploration Technologies, Inc

Gary A. Robbins, Ph.D
Peer Reviewer for LADBS
Manager, Tankinfo LLC

REGISTERED GEOLOGIST
GARY A. ROBBINS
No. 4183
STATE OF CALIFORNIA

OTHER REFERENCES

ATTACHMENT 1

CDM Camp Dresser & McKee Inc.

consulting engineering construction operations

18881 Von Karman Avenue, Suite 650
Irvine, California 92612
Tel: 949 752 5452 Fax: 949 752-1307

September 5, 2000

Ms. Maria Hoye, Esq.
Latham & Watkins
633 W. Fifth Street, Suite 4000
Los Angeles, California 90071

Subject: Sampling and Analysis of Gas from the Southern California Gas Company Playa Del Rey Gas Storage Field

Dear Ms. Hoye:

Camp Dresser & McKee Inc. (CDM) sampled nine gas wells within the Southern California Gas Company (SoCalGas) Playa Del Rey Storage Field (Storage Field) on July 27, 2000. This letter report summarizes the sampling activities and analytical results.

1.0 Introduction

The purpose of the sampling is to obtain representative gas samples from the Storage Field to determine the composition of the storage gas for comparison to soil gas samples taken in the Playa Vista vicinity. A map of the Playa Vista vicinity and Storage Field is shown in Figure 1.

On July 27, 2000, CDM personnel collected gas samples from three (3) injection/ withdrawal wells located in the main portion of the Storage Field working area, six (6) observation wells distributed through the central and fringe portions of the Storage Field, and the metering station located near the intersection of Centinela Avenue and Jefferson Boulevard. The metering station is used to measure the flow of gas into, or out of, the Storage Field. The identification of the wells and metering station samples is as follows:

Well Identification Name/No.	Well Type
Meter	Metering Station
Vidor 13	Injection/withdrawal
SoCal 5	Injection/withdrawal
SCP 1	Injection/withdrawal
Del Rey 13	Observation
Del Rey 17	Observation
Harper 1	Observation
Vidor 1	Observation
Vidor 2	Observation
Vidor 14	Observation

Sampling and analyses of the gas samples were conducted in accordance with the gas sampling protocol provided as Attachment A. Figure 2, based on the California Department of Conservation, Division of Oil, Gas and Geothermal Resources oil field Map No. 120, shows the locations of the sampled wells.

Representatives of SoCalGas and Exploration Technologies, Inc. (ETI) observed the sampling activities. Eugene Covington, Jr., Gas Storage Technician, and Andy Cerezo, Chemical and Environmental Technical Specialist, represented SoCalGas; and Terry Thompson, Manager Technical Services, represented ETI. John Thompson of Jackson and Associates, Inc., consultant to SoCalGas, was also present at the sampling of the meter station.

2.0 Background

The Playa Del Rey Oil Field was discovered in 1929 and produced oil until the mid 1940s, when the United States government began storing natural gas to assure adequate supplies for the war effort (CDM 1998). SoCalGas acquired the natural gas storage operation after the war and has operated the facility since that time.

The Playa Del Rey Storage Field is within a porous sandstone reservoir from which oil was previously extracted and into which natural gas is now injected for storage. Natural gas piped from Texas, Wyoming, Canada, and other areas of California is compressed at the facility, cooled, and compressed again prior to injection. The reservoir is located approximately one mile or more below ground surface, beneath a thick impervious shale cap, and has a working capacity of approximately 2.6 billion cubic feet of natural gas. SoCalGas distributes natural gas through an extensive regional and local pipeline network. The Storage Field is used as a "peak-shaving" system that can supplement local gas demands during periods of high usage. Depending on actual and anticipated demands, natural gas can be injected into, or withdrawn from, the Storage Field.

SoCalGas is regulated by the California Department of Conservation-Division of Oil, Gas, and Geothermal Resources (DOGGR), which requires monthly reports on injection and extraction, and monthly monitoring of wells. The storage wells are equipped with four safety devices including; (1) a pressure sensor designed to automatically shut-down the well if an unsafe condition is detected; (2) a fusible plug that will seal off the well if a surface fire is detected; (3) sand probes to monitor for erosion; and (4) a manual remote system to shut off the well. When a well is in operation, it is monitored/checked by SoCalGas personnel on a 12-hour basis. When a well is not in operation, it is monitored/checked on a weekly basis.

The Playa Del Rey Storage Field is divided into three subareas. The Del Rey Hills area is the only subarea used for natural gas storage. SoCalGas operates 25 injection/withdrawal wells of its total of 54 wells. Twenty-six (26) of the wells are located within the Playa Vista property with the remaining wells located to the northwest and south of Playa Vista.

3.0 Sample Collection

The gas samples were taken from the reservoir using a sampling manifold with a pressure gauge supplied by SoCalGas attached either to the well tree or the sampling line connected to the well tree (Photograph 1). At each well/metering station, samples were collected in three (3) 300-cubic centimeter gas cylinders and two (2) 1-liter tedlar bags. The gas within one of the cylinders was analyzed for molecular and isotopic composition; and the remaining two served as sample duplicates. The cylinders were sent to Isotech Laboratories, Inc. of Champaign, Illinois (Isotech) for laboratory analysis. The samples within the tedlar bags were relinquished to SoCalGas immediately following collection. The vacuumed gas cylinders were provided by Isotech and tedlar bags supplied by SoCalGas. The gas cylinders were connected to the sampling manifold using a Swagelok® connector. The tedlar bags were connected to the sampling manifold with surgical tubing (Photograph 2).

Gas Cylinder Samples

Sampling using the gas cylinders was conducted in accordance with the approved sampling protocol. After attaching the sampling manifold, the six (6) observation wells and the sampling port at the metering station were allowed to purge for at least one minute prior to cylinder purging and sampling. Purging was conducted to remove stagnant gas within the line from the well/sampling port to the sampling manifold. The three (3) injection/withdrawal wells were allowed to purge for at least 30 minutes prior to sampling. This purging of the injection/withdrawal wells was conducted with the objective of obtaining a sample representative of the gas in the Storage Field.

Following the well/meter station purging, the sampling gas cylinder was attached to the sampling manifold using a Swagelok® connector and at least three volumes of the cylinder were purged prior to collecting the gas sample. During purging, the gas cylinder's valves were closed while air was still escaping to prevent the backflow of ambient air into the sampling vessel. A sample was then collected by closing the downstream valve followed by the upstream valve to close the cylinder. Following the sampling of each well, the Swagelok® connector was examined to check if it was clean. Connectors with visible residue were replaced prior to sampling at the next location. An example of the gas cylinder sampling is shown in Photograph 1.

Tedlar Bag Samples

Samples were collected within a tedlar bag after the samples were collected in the gas cylinders. The tedlar bag was connected to the sampling manifold with surgical tubing. To prevent ambient air from the surgical tubing entering the tedlar bag, the tedlar bag was connected to the surgical tubing while the gas was flowing out of the well/piping and through the tubing. Because some of the tedlar bags were wrinkled and may have been previously used, the tedlar bags were purged of three volumes prior to collecting the gas samples. During purging, the tedlar bag's valve was closed while air was still

escaping the manifold to prevent the backflow of ambient air into the bag. An example of the tedlar bag gas sampling is shown in Photograph 2. Samples were collected in the tedlar bag; the bags were labeled, and relinquished to SoCalGas.

Field Blank Samples

Three (3) field blank samples were collected prior to purging and sampling of the wells/metering station to assess ambient conditions. Each field blank consisted of two (2) vacuumed gas cylinders opened to ambient air next to the well/metering station. One field blank sample (CDM-METER-004/CDM-METER-005) was collected prior to sampling at the metering station. The remaining two samples (CDM-VIDOR2-004/005 and CDM-VIDOR13-004/005) were collected prior to gas sampling at wells Vidor 2 and Vidor 13. Photographs 3, 4, and 5 show the field blank sampling location in relationship to the well or metering station. Two (2) cylinders were filled per field blank sample; thus, a total of six (6) gas cylinders were filled. Field blanks were placed on hold in case unusual laboratory results were obtained in the analyses of the gas samples.

Field Observations and Laboratory Analyses

Field activities were logged and samples were labeled and recorded on chain-of-custody forms provided as Attachment B. A visible black residue was deposited on the Swagelok® connectors used during sampling of wells Vidor 1, Vidor 2, and Vidor 13. The residue may be oil or grease from the wellhead or oil residue from the Storage Field.

The laboratory results from Isotech are summarized in Table 1. Laboratory data and associated quality assurance/quality control data are provided as Attachment C.

The results of the analysis for molecular and isotopic composition presented in Table 1 indicate several data trends. Data for the injection/withdrawal wells and the metering station samples are very consistent, with methane as the primary constituent. Methane concentrations at these locations range from 95.39 percent by volume (% V) to 96.35 %V, with carbon dioxide and 2-carbon chain (i.e., C2 compounds ethane and ethene) representing the majority of the remaining gas constituents. C3 through C6 compounds represent less than 1%V of the gas constituents detected in these samples. Isotopic characterization of the methane, ethane, and carbon dioxide are all very consistent for injection/withdrawal wells and the metering station samples.

Data from the observation well samples indicate methane as the primary gas constituent. Methane concentrations at the observation wells ranged from 57.53 %V to 91.62 %V. Furthermore, the concentrations of C2 through C6 compounds are all greater in the observation well samples as compared to the injection/withdrawal well and the metering station samples. Variability in the isotopic composition from the observation wells may be considered moderate to high relative to the injection/withdrawal wells and metering station, with the largest variability observed in the isotopic characterization of carbon in carbon dioxide (-2.31 to -10.69 parts per mil). Finally, carbon dioxide concentrations for

the observation well samples indicate an appreciable range in concentrations, with values extending from below detection limits to 15.03 %V. Data from the injection/withdrawal wells and the metering station are generally more consistent than data collected from observation wells.

The hydrogen sulfide, oxygen, and helium data for all of the samples collected illustrate consistent trends (Table 1). Hydrogen sulfide and oxygen concentrations were below analytical detection limits for all samples analyzed. Helium was detected in all samples at concentrations ranging from 0.0013 to 0.0340 %V. Nitrogen concentrations ranged from 0.17%V to 1.26%V for nine of the ten samples. One sample (CDM-DELRAY 13-001) contained 28.13%V nitrogen, and no detectable concentrations of oxygen. Atmospheric air has oxygen and nitrogen present at 20.946 ± 0.002%V and 78.084%V, respectively (CRC Press, 1973). The low concentrations of nitrogen and the absence of oxygen indicate the samples were not contaminated by atmospheric air during sampling. The source of nitrogen in sample CDM-DELRAY 13-001 is unknown.

Reference: CRC Press, 1973. Edited by Robert C. Weast. Handbook of Chemistry and Physics. 54th edition.

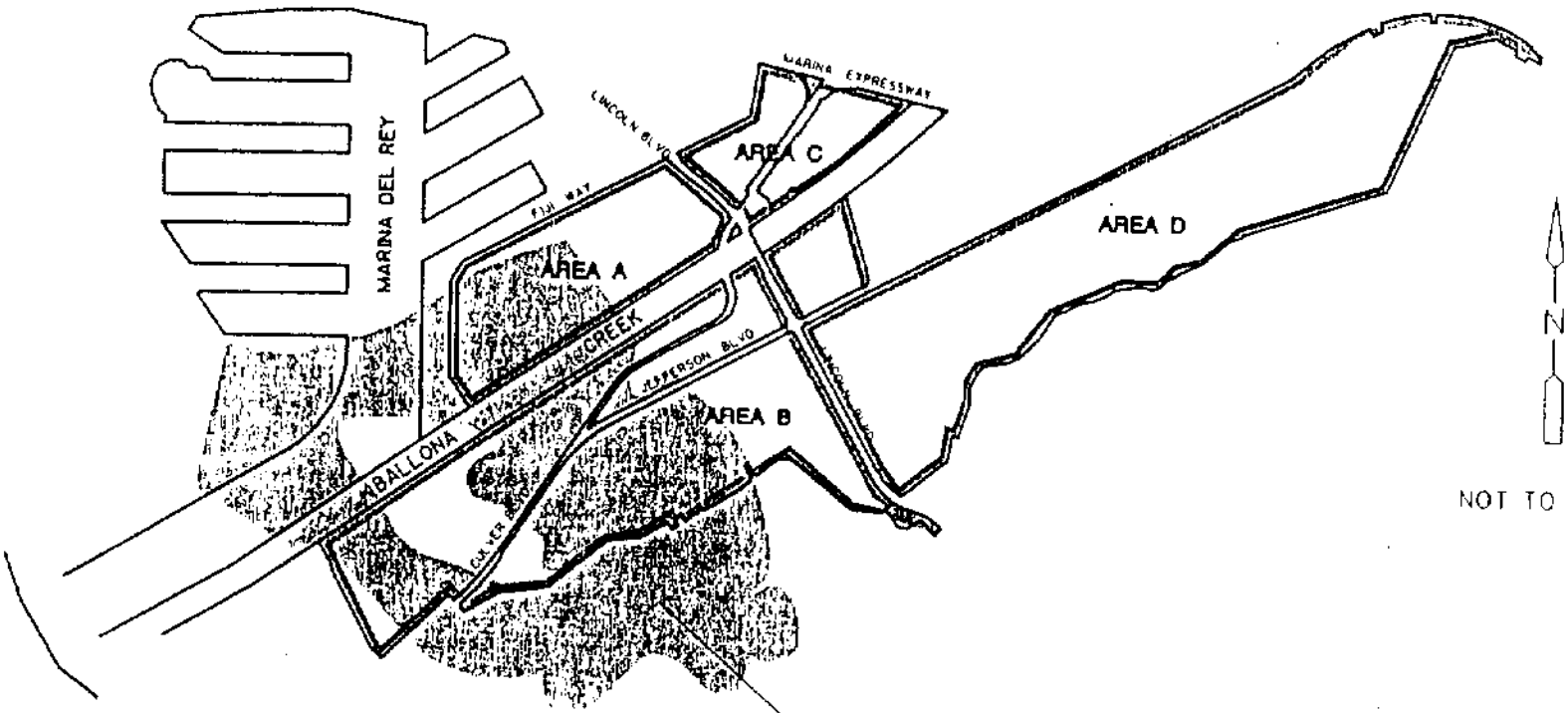
Very truly yours,

CAMP DRESSER & McKEE INC.

Anthony J. Skidmore
Principal

Michele Zyen, R. G.
Project Geologist

Attachment A – Protocol for Sampling and Analysis of Gas from the Southern California Gas Company Playa Del Rey Storage Field
Attachment B – Chain-of-Custody Forms
Attachment C – Isotech Laboratory Data and Associated Quality Assurance/Quality Control Data



Source: Southern California Gas Company

SAMPLE AND ANALYSIS OF GAS
FROM SOUTHERN CALIFORNIA GAS COMPANY PLAYA DEL REY STORAGE FIELD

Playa Vista and Playa del Rey Gas Storage Reservoir

CDM
environmental engineers, scientists, planners, & mana[illegible]l consultants

Figure 1

Figure 2
Well Location Map

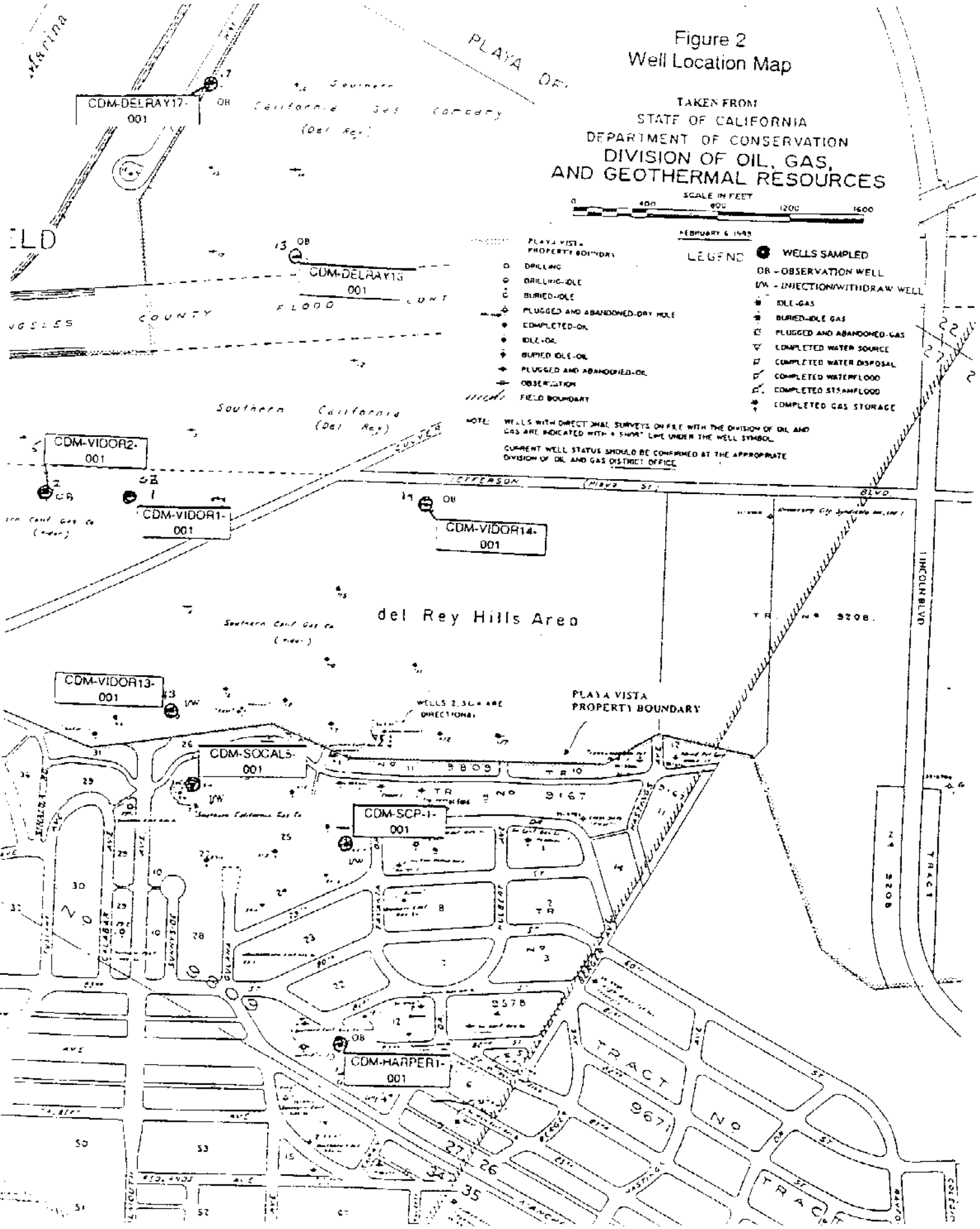


Table 1
Summary of Analytical Results
Compositional Analysis - SoCal Gas Wells
Playa Vista

Sample Names		Metering Station	Injection/Withdrawl Wells			Observation Wells					
		CDM-METER-001	CDM-SCP-1-001	CDM-SOCAL5-001	CDM-VIDOR13-001	CDM-VIDOR2-001	CDM-VIDOR14-001	CDM-DELRAY13-001	CDM-DELRAY17-001	CDM-VIDOR1-001	CDM-HARPER1-001
Sample Date		07/27/2000	07/27/2000	07/27/2000	07/27/2000	07/27/2000	07/27/2000	07/27/2000	07/27/2000	07/27/2000	07/27/2000
Carbon Monoxide	mol %	--	--	--	--	--	--	--	--	--	--
Hydrogen Sulfide	mol %	--	--	--	--	--	--	--	--	--	--
Helium	mol %	0.0110	0.0120	0.0110	0.0120	0.0013	0.0340	0.0022	0.0120	0.0082	0.0094
Hydrogen	mol %	0.0015	--	--	--	0.0020	0.0085	0.071	--	0.0081	--
Argon	mol %	0.0037	0.0066	0.0028	0.0053	--	0.0049	--	--	--	0.011
Oxygen	mol %	--	--	--	--	--	--	--	--	--	--
Carbon Dioxide	mol %	1.17	1.25	1.31	1.15	15.03	0.58	--	3.70	12.75	7.57
Nitrogen	mol %	0.55	0.65	0.56	0.69	0.17	1.26	28.13	0.43	0.40	1.17
Methane	mol %	96.35	95.62	96.03	95.39	75.40	91.62	57.53	89.21	78.14	81.86
Ethane	mol %	1.58	1.87	1.61	2.10	4.50	4.74	6.35	4.17	4.04	4.83
Ethylene	mol %	--	--	--	--	--	--	--	--	--	--
Propane	mol %	0.23	0.34	0.31	0.43	2.63	1.12	4.28	1.67	2.39	2.54
Iso-butane	mol %	0.031	0.047	0.042	0.055	0.35	0.10	0.65	0.16	0.38	0.36
n-Butane	mol %	0.034	0.067	0.058	0.075	0.82	0.17	1.57	0.31	0.90	0.76
Iso-pentane	mol %	0.01	0.02	0.016	0.02	0.33	0.053	0.49	0.058	0.31	0.24
n-Pentane	mol %	0.0065	0.019	0.014	0.016	0.31	0.059	0.44	0.05	0.27	0.21
Hexanes+	mol %	0.026	0.095	0.037	0.057	0.46	0.25	0.49	0.23	0.40	0.45
Delta 13C In Carbon Dioxide	per mil	13.26	11.26	12.70	11.17	-10.69	-2.99	n/a	-2.31	-11.32	-3.47
Delta 13C In Methane	per mil	-42.15	-42.18	-42.69	-42.31	-40.51	-42.37	-41.97	-41.25	-41.90	-44.88
Delta Deterium In Methane	per mil	-204.7	-202.4	-202.3	-202.2	-183.7	-174.2	-190.9	-184.0	-186.3	-197.1
Delta C13 In Ethane	per mil	-27.85	-28.57	-29.20	-28.43	-29.42	-32.66	-29.40	-29.71	-29.99	-30.80

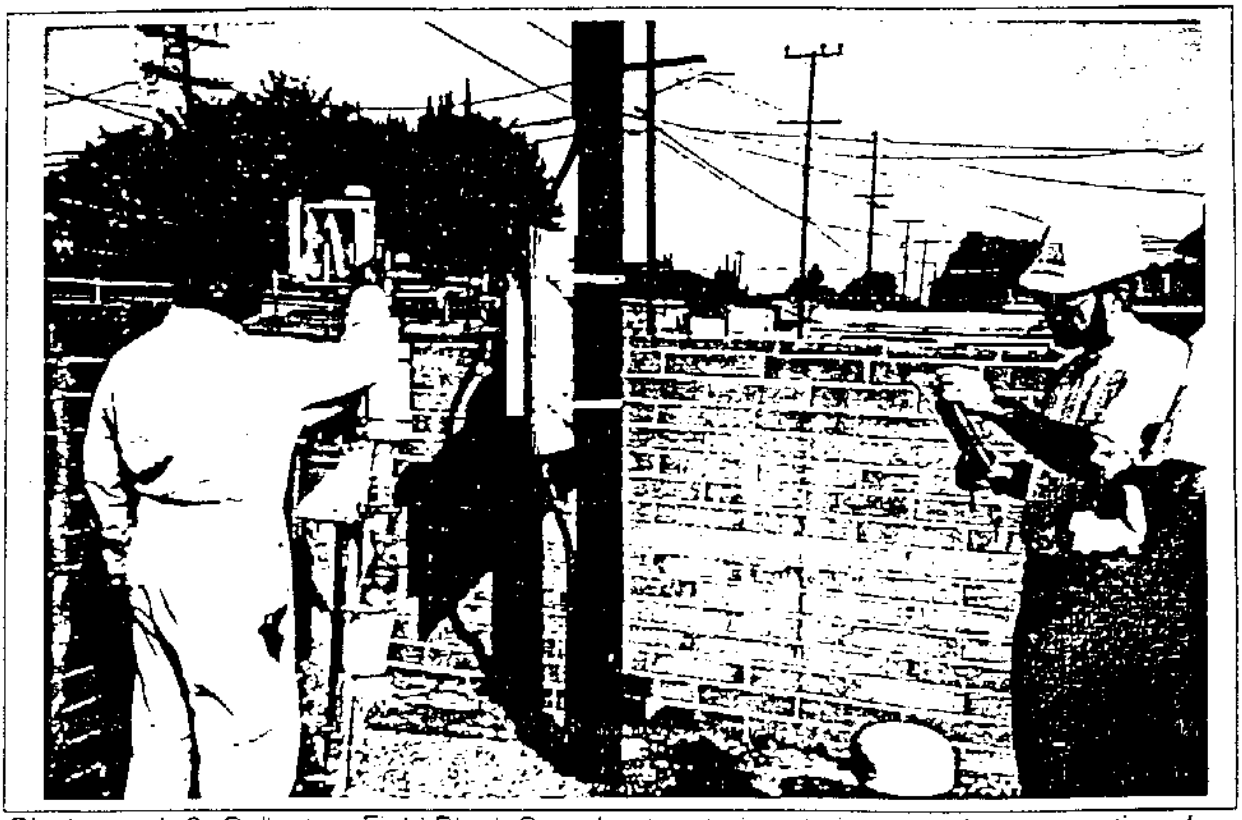
Note:
-- = Not detected
n/a - not available



Photograph 1: Sampling in a gas cylinder at metering station near the intersection of Centinela Avenue and Jefferson Boulevard.



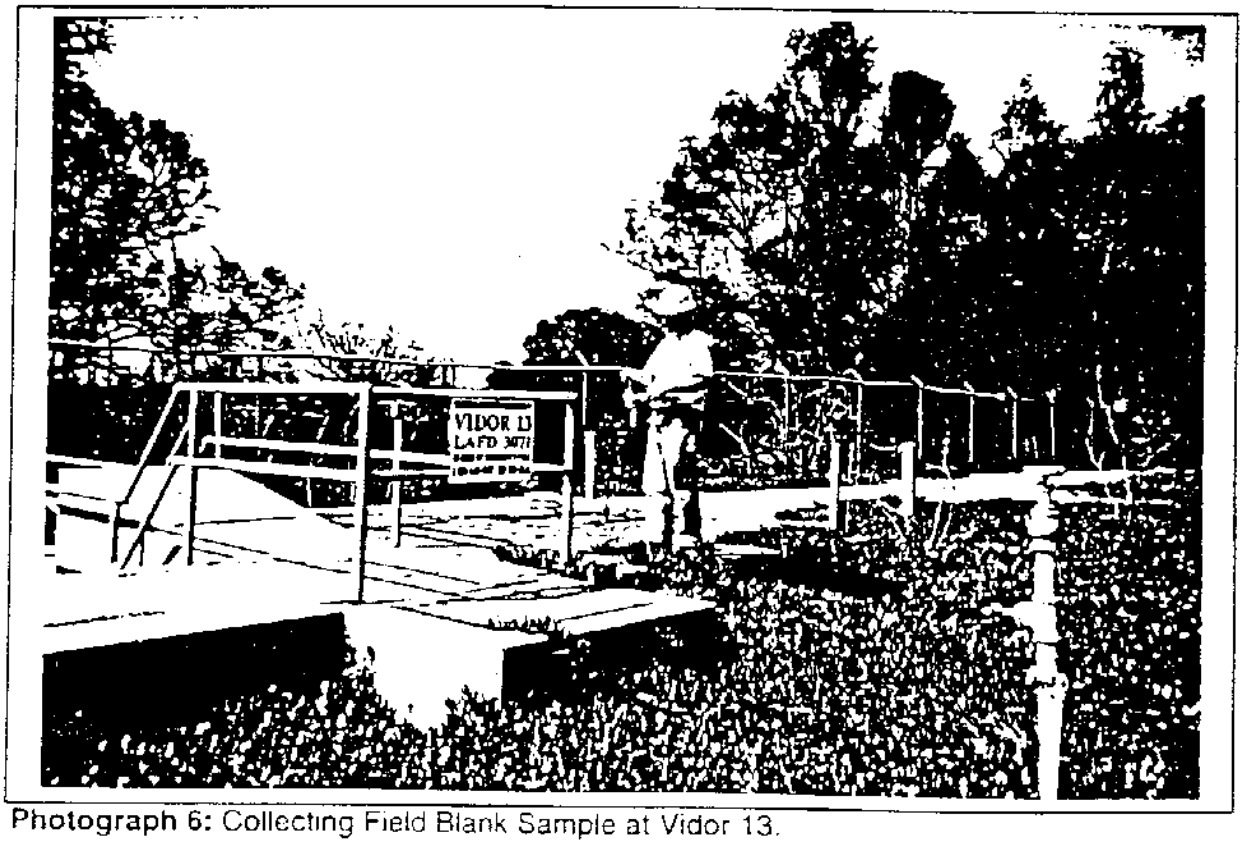
Photograph 2: Sampling in a tedlar bag at Del Rey 17.



Photograph 3: Collecting Field Blank Sample at metering station near the intersection of Centinela Avenue and Jefferson Boulevard.



Photograph 4: Collecting Field Blank Sample at Vidor 2.



Photograph 6: Collecting Field Blank Sample at Vidor 13.

Attachment A
Protocol for Sampling and Analysis of Gas from the Southern California Gas Company Playa Del Rey Storage Field

PROTOCOL FOR SAMPLING AND ANALYSIS OF GAS FROM THE SOUTHERN CALIFORNIA GAS COMPANY PLAYA DEL REY STORAGE FIELD

1.0 OBJECTIVE

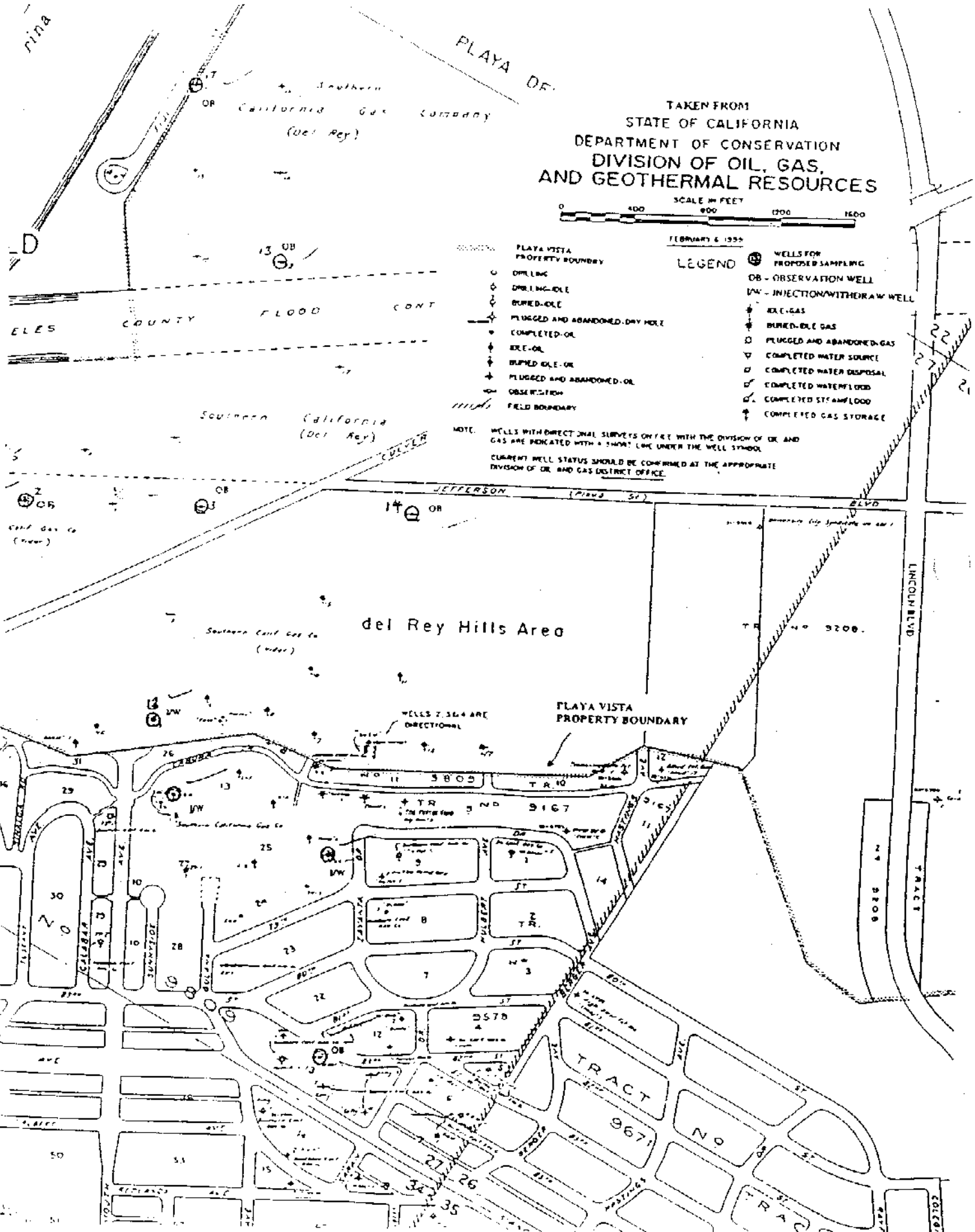
To obtain a cross-section of gas samples from the Southern California Gas Company (SoCalGas) Playa Del Rey Storage Field (Storage Field) and conduct a comprehensive program of laboratory analyses to identify key characteristics of the storage gas as can be compared to the characteristics of soil gas found at Playa Vista.

2.0 SOURCES OF GAS SAMPLES

2.1 Storage Field Gas

Gas samples will be drawn from nine (9) existing wells operated by SoCalGas that extend into the reservoir, either for the purpose of injection/withdrawal of natural gas at the reservoir or to monitor reservoir conditions (i.e., observation wells). SoCalGas operates 43 such wells of its total of 54 wells. Twenty-six (26) of the wells occur within the Playa Vista property and the remaining wells occurring to the northwest and south of Playa Vista. The proposed work program includes taking samples from three (3) injection/withdrawal wells located in the main portion of the storage field working area, and from six (6) observation wells distributed through the central and fringe portions of the storage field. Based on the California Department of Conservation, Division of Oil, Gas and Geothermal Resources oil field Map No. 120, Figure 1 shows the locations of the wells proposed to be sampled. As shown, the proposed sampling locations provide for broad geographic coverage of the Storage Field. Selection of the sampling location was determined in consultation with Mr. John Thompson, representative for SoCalGas. The identification name/number and type of each well to be sampled are as follows:

Well Identification Name/No.	Well Type
Vidor 13	Injection/Withdrawal
SoCal 5	Injection/Withdrawal
SCP 1	Injection/Withdrawal
Del Rey 13	Observation
Del Rey 17	Observation
Harper 1	Observation
Vidor 1	Observation
Vidor 2	Observation
Vidor 14	Observation


TAKEN FROM
STATE OF CALIFORNIA
DEPARTMENT OF CONSERVATION
DIVISION OF OIL, GAS,
AND GEOTHERMAL RESOURCES
SCALE IN FEET
0 400 800 1200 1600
FEBRUARY 6, 1954
LEGEND
PLAYA VISTA PROPERTY BOUNDARY
DRILLING
DRILLING-IDLE
BURIED-IDLE
PLUGGED AND ABANDONED-DRY HOLE
COMPLETED-OIL
IDLE-OIL
BURIED IDLE-OIL
PLUGGED AND ABANDONED-OIL
OBSERVATION
FIELD BOUNDARY
WELLS FOR PROPOSED SAMPLING
OB - OBSERVATION WELL
I/W - INJECTION/WITHDRAW WELL
IDLE-GAS
BURIED-IDLE GAS
PLUGGED AND ABANDONED-GAS
COMPLETED WATER SOURCE
COMPLETED WATER DISPOSAL
COMPLETED WATERFLOOD
COMPLETED STEAMFLOOD
COMPLETED GAS STORAGE
NOTE: WELLS WITH DIRECTIONAL SURVEYS ON FILE WITH THE DIVISION OF OIL AND GAS ARE INDICATED WITH A SHORT LINE UNDER THE WELL SYMBOL
CURRENT WELL STATUS SHOULD BE CONFIRMED AT THE APPROPRIATE DIVISION OF OIL AND GAS DISTRICT OFFICE
PLAYA VISTA
PROPERTY BOUNDARY
WELLS 7, 3&4 ARE DIRECTIONAL
del Rey Hills Area
JEFFERSON (BLVD ST) BLVD
LINCOLN BLVD
TRACT NO 9167
TRACT NO 9578
TRACT NO 9671
TRACT NO 9209
Southern California Gas Co (Del Rey)
Southern California Gas Co (Inset)
COUNTY FLOOD CONT
PLAYA DE

2.2 Pipeline Gas

SoCalGas imports natural gas from several out-of-state sources and distributes it through an extensive regional and local pipeline network. The Storage Field is used as a "peak-shaving" system that can supplement local gas demands during period of high usage. Depending on actual and anticipated demands, natural gas can be injected into, or withdrawn from, the storage field. A metering station located near the intersection of Centinela Avenue and Jefferson Boulevard is used to measure the flow of gas in to, or out of, the Storage Field. It is proposed that a sample of pipeline gas be taken at the metering station during a period when gas is being injected into the storage field to obtain a representative sample of pipeline gas.

3.0 SAMPLE COLLECTION PROCEDURES

3.1 Storage Field Gas

Collection of gas samples from each well will be conducted by Camp Dresser & McKee Inc. (CDM) personnel in accordance with the agreed upon procedures and protocol specified herein and will be observed by a representative of SoCalGas. Collection of samples will be conducted based on the requirements of American Society for Testing and Materials (ASTM) Standard Practice for Sampling Pressurized Gas for Gas Analysis (Designation: F 307-73 [Reapproved 1995]) provided hereto as Attachment A, with the particulars of sample collection to be conducted in accordance with the protocol specified in Attachment B.

At each well, samples will be collected in two (2) gas cylinders and one 1-liter tedlar bag. One of the gas cylinders is for chemical compositional analysis; and one is a sample duplicate. The tedlar bag samples will be analyzed by a separate lab under contract to SoCalGas Based on three samples per well, a total of 27 samples will be taken. Two (2) field blanks will be taken as background samples, but will not be analyzed unless unusual laboratory results are found in the analyses of the gas samples.

Field activities will be logged and samples will be labeled based on the standard operating procedures presented in Attachment C.

3.2 Pipeline Gas

Collection of line gas samples will occur in generally the same manner as described above for storage field gas and will include one (1) field blank.

4.0 LABORATORY ANALYSES

4.1 Compositional Analysis

Chemical compositional analysis for permanent gases and light hydrocarbons will include the following analytes:

Permanent Gas	Reporting Limit
Carbon Monoxide	40-70 PPMV
Helium	10-15 PPMV
Hydrogen	10-15 PPMV
Argon	30-40 PPMV
Oxygen	30-40 PPMV
Nitrogen	40-70 PPMV
Carbon Dioxide	40-70 PPMV
Light Hydrocarbons	
Methane	10-15 PPMV
Ethane	10-15 PPMV
Ethylene	10-15 PPMV
Propane	10-15 PPMV
Iso-butane	10-15 PPMV
N-butane	10-15 PPMV
Iso-pentane	10-15 PPMV
N-pentane	10-15 PPMV
Hexanes+	10-15 PPMV

In addition, stable carbon isotopes analysis will be completed for carbon dioxide (delta 13C), methane (delta 13C and delta D), and ethane (delta 13C).

It is anticipated that the compositional analysis will be performed by Isotech using ASTM Method D1945-96. The stable isotope analysis will also be performed by Isotech using the method presented in Attachment D.

4 LABORATORY ANALYSIS RESULTS

Data results from the laboratory analyses shall be compiled and reported in hard-copy form and prominently marked "PRIVILEGED AND CONFIDENTIAL" and "DRAFT FOR DISCUSSION PURPOSES ONLY".

ATTACHMENT A

ASTM STANDARD FOR SAMPLING PRESSURIZED GAS

Designation: F 307 – 73 (Reapproved 1995)ε¹

An American National Standard

Standard Practice for Sampling Pressurized Gas for Gas Analysis[1]

This standard is issued under the fixed designation F 307; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

ε Note—Section 7 was added editorially in June 1995.

1. Scope

1.1 This practice describes the procedure for obtaining a sample of pressurized gas for gas analysis from a system or component.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For hazard statement, see Section 5, Fig. 1.

2. Terminology

2.1 *Definitions:*

2.1.1 *sample port*—the designated point in a system or component from which a representative gas sample may be taken.

3. Summary of Practice

3.1 A sample vessel is evacuated and sealed with a minimum vacuum pressure. The vessel is then attached to the designated pressurized sample port. The pressurized gas is allowed to enter the sample vessel until the pressure is equal to the pressure of the system or component. The pressure is secured and the sample vessel assigned for appropriate analysis.

4. Apparatus

Note 1—All apparatus used in the sample taking should be verified as cleaned and packaged within the requirements of the allowable contamination of the system, unless otherwise noted.

4.1 *Connecting Lines*, rigid or flexible, pressure rated and identified within recognized safety codes.

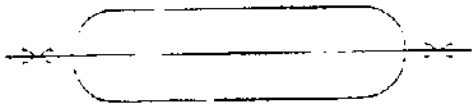


FIG. 1 Gas Sample Vessel.

4.2 *Miscellaneous Fittings*, as needed for sampling point adaption.

4.3 *Tie-downs*, suitable for sample line restraint in accordwith pressure, temperature, and recognized safety codes.

4.4 *Gas Sample Vessel*, evacuated to a suitable pressure for the gas analysis method to be used. This vessel should have valves at inlet and outlet to enable lockup of vacuum or pressure.

Note 2—The gas sample vessel capacity is in accord with desired sample volume. A recommended 500-in^3 (8-L) volume has been determined adequate to aerospace industry. The gas sample vessel must be pressure-rated for the system or component to be sampled.

5. Safety Hazards

5.1 Personnel must stand clear of exiting gas.

5.2 Ear protection must be used when gas flow approaches sonic velocity.

5.3 All lines and associated equipments must be connected and operated within the requirements of recognized safety codes.

6. Procedure

6.1 Establish and maintain a minimum purge at the sample port.

6.2 Connect one end of a suitable connecting line to the sample port, and continue to purge.

6.3 Install tie-down as required for safety code.

6.4 Continue to purge and connect the other end of sample line to sample vessel inlet.

6.5 Open sample vessel inlet valve.

6.6 Increase purge until system pressure is equalized in sample vessel.

6.7 Open outlet valve and purge for 1 s, then close and secure outlet valve.

6.8 Close and secure inlet valve.

6.9 Reduce system pressure to minimum purge and disconnect sample line from sample vessel.

[1] This practice is under the jurisdiction of ASTM Committee E-21 on Space Simulation and Applications of Space Technology and is the direct responsibility of Subcommittee E21.05 on Contamination. ASTM Committee D-2 on Petroleum Products and Lubricants maintains a continued interest in this practice and will make use of it in the future.

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6.10 Disconnect sample line from sample port and secure system.

6.11 Identify sample vessel and contents to required safety codes and analysis procedure.

6.12 Deliver sample vessel to analysis facility.

7. Keywords

7.1 gas analysis; pressurized gas

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ATTACHMENT B

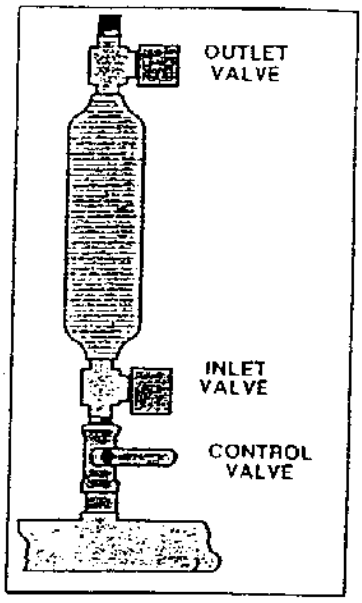
COLLECTION OF GAS SAMPLES WITH DOUBLE-ENDED GAS CYLINDERS

Collection of Gas Samples With Double-Ended Gas Cylinders

1. Check the pressure on the well or pipeline to be sampled with a reliable pressure gauge. If the pressure exceeds 1800 psi, STOP, a pressure reduction regulator **must** be used to collect the sample as the **maximum rated pressure** for these gas cylinders is **1800 psi**.

2. Remove the end caps from both ends of a cylinder and clean off the threads. Using the teflon tape provided, place 2 to 4 wraps of tape on the threads on one of the valves.

3. Locate a valve or gauge port having a ¼" NPT female thread suitable for collecting the sample. Crack the control valve on the sampling port slightly so that you can hear a small amount of gas escaping.



4. With the gas still flowing slightly (to purge the air from the valve) screw the taped end of the gas cylinder valve into the sampling port as shown on the drawing and snug it down with a wrench. The control valve can now be fully opened

5. Carefully open the inlet valve on the cylinder and allow 5 or 10 seconds for the cylinder to become pressurized up to the well pressure.

6. Close the cylinder inlet valve and then open the outlet valve to vent the gas in the cylinder. Leave the outlet valve open just until you can no longer hear gas escaping, and then close it.

7. Although these cylinders are fully evacuated before sending them to the field, it is advisable to repeat steps 5 and 6 once or twice to insure that all air has been flushed from the connecting line.

8. When the cylinder has been adequately flushed, check to see that the cylinder outlet valve is firmly closed and then open the inlet valve one more time. Allow 20 or 30 seconds for the cylinder to become pressurized and then close the inlet valve. **Do not use wrenches or pliers to close the valves. They have soft seats and excessive force can ruin them.**

9. Close the control valve on the well or pipeline and remove the cylinder. Be sure to use an adjustable or open-end wrench on the valve body; do not use a pipe wrench on the cylinder as this could loosen the valve from the cylinder. Clean the used tape off of the thread.

10. Wrap the threads on both ends of the cylinder with teflon tape and replace the end caps. Use two wrenches to snug the end caps. This is important to insure that the sample will not be lost if one of the valves should leak or accidentally open.

11. Record the well name or number, the sample pressure, and the sampling date on the cylinder tag and return the cylinder to the shipping carton. Ship the samples to Isotech as explained in the enclosed shipping instructions.

ATTACHMENT C

STANDARD OPERATING PROCEDURES FOR FIELD AND SAMPLE DOCUMENTATION

SOP-FL-002
SAMPLE DOCUMENTATION AND IDENTIFICATION

1.0 INTRODUCTION

The following procedures describe proper documentation to be included in field notebooks. Documentation includes describing data collection activities, logging sample locations, sample IDs, container labeling and chain-of-custody forms (see SOP-FL-013). Procedures for sample classification to insure proper labeling of samples are also included.

2.0 RESPONSIBILITIES

The field geologist/field inspector is required to oversee drilling of the boreholes, installation of monitoring wells, sample soils and groundwater, fill out field book logs, soil boring logs, monitoring well logs, submit samples for analysis, COC forms and labeling of drums. Also, the field geologist/field inspector is required to adhere to the Site Specific Health & Safety Plan. Drilling inspectors must record Health and Safety monitoring performed during drilling activities. Field book entries should state starting time of monitoring, equipment used and results.

The field geologist/field inspector will be notified by the site manager of the following:

- When and where to implement contingency borings so the extent of subsurface contamination may be better defined.
- When to request accelerated turn around times for laboratory analysis of samples. This may be the result of project schedule, excessive contamination that requires TCLP analysis, or other reasons.
- Which samples to hold for TCLP analysis.
- When to install additional groundwater monitoring wells due to evidence indicating the presence of floating product.
- When to change the sampling strategy because of contamination, borehole depth, or variation in material types.
- In order for the site manager to make the above described decisions, communication between the field team and the site manager must be thoroughly maintained.

2.0 FIELD NOTEBOOKS

Complete and thorough logging of field events is essential to a timely and accurate completion of this project. The field geologist/field inspector is responsible to account for particular actions and times for these actions of the contractor while in the field. Also, sample identification (numbers and descriptions) of field samples, duplicates samples and blank samples should also be accounted in the field book. For a particular workshift, the field book should contain the following:

- Field personnel name, contractors name, number of persons in crew, equipment used, weather, date, time, and location at start of day (boring number).

- Sample identification number, depth, time, blow counts, amount of sample recovery in split-spoon sampler, HNu or OVM reading and burmeister soil descriptions.

- Description of any unusual surface or subsurface soil conditions

- Record of Health and Safety monitoring; time, equipment and results

- Record of site accidents or incidents

- Record of any visitors

- Potential of delays

- Materials (grout, well screen, etc.) and equipment used during borehole/well installation

- Final daily tally of work completed including list of samples obtained

- Completion of daily QA/QC log sheet

- Contractor downtime, decontamination time, equipment breakdowns, movement tracking throughout the day, etc.

- Any other data that may be construed as relevant information at a later date.

The field logs should confirm the contractor's data including billing, boring logs, etc. Field notes should be photocopies weekly and returned to the site area manager by the field supervisor.

In addition, the field personnel are responsible to complete a sample log form for each boring or test pit. This log form is considered a deliverable to the client and must be complete, accurate and organized. These forms should be completed so as not to require future reference into the field books. Note observations on these forms (oil odor, etc.). These forms are to be filled out upon completion of a particular borehole. These logs are simply a sectional view of the borehole generated from the data contained in the field book.

If a borehole is completed as a monitoring well, simply note this on the form, and complete the monitoring well log. Examples of completed boring logs should be reviewed and adequate blank log forms obtained.

Monitoring well logs are required in addition to the boring log form if the borehole is completed as a monitoring well. These are to be completed in the field after a monitoring well is installed. They should include data such as screen length, riser length, materials used, etc. Examples of monitoring well logs should be reviewed and adequate blank log forms obtained.

3.0 DRUM LABELING

Labeling of drums is essential for tracking hazardous materials. Although it is the contractor's responsibility to collect, handle, and store the drums, it is the responsibility of field personnel to label these drums appropriately. There is a significant cost implication if drums are not property labeled. Unknown material must be disposed of as hazardous waste if any hazardous waste is found on-site.

The following drum labeling procedures are to be adhered to:

- Field staff shall adhere packing list envelopes to the side of the drum(s) at the completion of a boring.
- Field staff shall print with an indelible marker on information cards all information pertaining to the contents of the drum(s). If more than one drum is collected from the same borehole, each information card shall be numbered sequentially in parenthesis starting with the number one after the boring number. The information shall include:
  - Program Area
  - Boring No.(s)
  - Date collected
  - Description of contents (i.e., soil cuttings, well water, etc.)
  - Amount of water (specify in inches)
  - Fullness of drum (not including free liquid, specify in fractional form)

NA

- Field staff shall insert information card into packing list envelope. The packing list envelope shall be sealed at this time.
- Field staff shall record in field book all information pertaining to the contents of the drum that was printed on the information card.
- Program manager, upon receipt of the analytical data for the drums, shall prepare a summary table of the analytical results on a weekly basis, and provide the designated coordinator.
- Based on the tabulated information the designated coordinator will determine and prepare the appropriate storage labels required:
  - Hazardous Waste label
  - Non-hazardous label
- The designated coordinator will fill out these labels.
- Field staff shall adhere these labels to the appropriate drums. If the information cards inside the packing list envelopes are found to be damaged they shall also be reprinted at this time.

4.0 SAMPLE IDENTIFICATION

The sample identification process is a logical labeling of the samples collected for analysis. The samples should be labeled according to the example below:

CDM - SB - 035 - 001
CDM - MW - 03 - 001
CDM - SB - 035 - 003

Where:
- CDM = for Camp Dresser & McKee
- SB = Soil Boring
- 035 = Borehole Number
- 001 = Sample Number (This must be identified on the COC)
- MW = Represents groundwater sample from Monitoring Well

SOP-FL-001
FIELD LOG BOOK CONTENT

1.0 INTRODUCTION

Information recorded in field log books include observations, data, calculations, time, weather, description of the data collection activity, methods, instruments, and results. Additionally, the log book may contain descriptions of wastes, biota, geologic material, and site features including sketches maps, or drawings as appropriate.

2.0 PREPARATION

In addition to this SOP, site personnel responsible for maintaining log books must be familiar with other pertinent SOPs. These should be consulted as necessary to obtain specific information about equipment and supplies, health and safety, sample collection, packaging, decontamination, and documentation. These procedures should be located at the field office.

Prior to use in the field, each log book should be marked with a specific control number. The field notebook will then be assigned to an individual responsible for its care and maintenance.

Field log books shall be bound with lined, consecutively numbered pages. All pages must be numbered prior to initial use of the log book. The following information shall be recorded inside the front cover of the log book:

- Field log book document number
- Activity (if the log book is to be activity-specific)
- Person and organization to whom the book is assigned, and phone number(s)
- Start date

The first five pages of the log book shall be reserved for a table of contents. Mark the first page with the heading and enter the following:

TABLE OF CONTENTS

Date/Description	Page
(Start Date)/Reserved for TOC	1-5

The remaining pages of the Table of Contents will be designated as such with "TOC" written on the top center of each page.

3.0 OPERATION

The following is a list of requirements that must be followed when using a log book:

- Record work, observations, quantities of materials, calculations, drawings, and related information directly in the log book. If data-collection forms are specified by an activity-specific plan, this information need not be duplicated in the log book. However, any forms used to record site information must be referenced in the log book.

- Do not start a new page until previous one is full or has been marked with a single diagonal line so that additional entries cannot be made. Use both sides of each page.

- Do not erase or blot out any entry at any time. Before an entry has been signed and dated, any changes may be made but care must be taken not to obliterate what was written originally. Indicate any deletion by a single line through the material to be deleted.

- Do not remove any pages from the book.

- Record as much information as possible.

Specific requirements for field log book entries include:

- Initial and date each page.

- Sign and date the final page of entries for each day.

- Initial and date all changes.

- Multiple authors must sign out the log book by inserting the following:

  Above notes authored by:

  - (Sign name)
  - (Print name)
  - (Date)

- A new author must sign and print his/her name before additional entries are made.

- Draw a diagonal line through the remainder of the final page at the end of the day.

- Record the following information on a daily basis:

    - Date and time
    - Name of individual making entry
    - Description of activity being conducted including station (i.e., well, boring, sampling location number) if appropriate
    - Weather conditions (i.e., temperature, cloud cover, precipitation, wind direction, and speed) and other pertinent data
    - Level of personnel protection to be used

Entries into the field log book shall be preceded with the time (written in military units) of the observation. The time should be recorded frequently and at the point of events or measurements that are critical to the activity being logged. All measurements made and samples collected must be recorded unless they are documented by automatic methods (e.g., data logger) or on a separate form required by an operating procedure. In these cases, the log book must reference the automatic data record or form.

At each station where a sample is collected or an observation or measurement made, a detailed description of the location of the station is required. Use a compass (include a reference to magnetic declination corrections), scale, or nearby survey markers, as appropriate. A sketch of station location may be warranted. All maps or sketches made in the log book should have descriptions of the features shown and a direction indicator. It is preferred that maps and sketches be oriented so that north is towards the top of the page.

Other events and observations that should be recorded include:

- Changes in weather that impact field activities.

- Deviations from procedures outlined in any governing documents. Also record the reason for any noted deviation.

- Problems, down-time, or delays.

- Upgrade or downgrade of personnel protection equipment.

4.0 POST-OPERATION

To guard against loss of data due to damage or disappearance of log books, copies of completed pages shall be periodically (weekly, at a minimum) and security stored at the field office. Documents which are separated from the log book shall be copied and submitted regularly and as promptly as possible to the field office. This includes all automatic data recording media (print-outs, logs, disks or tapes) and activity-specific data collection forms required by other SOPs.

At the conclusion of each activity or phase of site work, the individual responsible for the log book will ensure all entries have been appropriately signed and dated, and that corrections were made properly (single lines drawn through incorrect information, then initialed and dated). The completed log book shall be submitted to the field office records file.

5. REFERENCES

Sandia National Laboratories. 1991. Procedure for Preparing, Sampling and Analysis Plan, Site-Specific Sampling Plan, and Field Operating Procedures, QA-02-03. Albuquerque Environmental Program Department 3320. Albuquerque, New Mexico.

Sandia National Laboratories. 1992. Division 7723. Field Operation Procedure for Field Logbook Content and Control. Environmental Restoration Department. Albuquerque, New Mexico.

ATTACHMENT D

PROCEDURE FOR STABLE ISOTOPE ANALYSIS OF GAS SAMPLES

Procedures for Stable Isotope Analysis of Gas Samples

1. $\delta^{13}C$ (Delta C-13, Carbon Isotope Analysis) of CH_4

The $\delta^{13}C$ of CH_4 is determined by injecting a gas chromatograph (GC) with enough sample for approximately 2 cc of CH_4 to be converted to CO_2 and H_2O. After GC separation, the CH_4 is flushed with a helium carrier gas into a cupric oxide combustion furnace maintained at 850°C. The CH_4 is oxidized to CO_2 and H_2O within the furnace then carried to a trap cooled with a liquid nitrogen bath. After removal of the He carrier gas by evacuation, a dry-ice/isopropyl-alcohol bath is substituted for the liquid nitrogen bath. The CO_2 is then cryogenically transferred to a cold finger attached to an electronic manometer for volumetric yield determination. The CO_2 is then transferred into ¼" Pyrex tubing immersed in liquid nitrogen and sealed with a torch for mass spectrometric analysis.

2. $\delta^{13}C$ (Delta C-13, Carbon Isotope Analysis) of CO_2

Preparation of samples for measurement of the $\delta^{13}C$ of CO_2 is performed by first injecting a sufficient amount of the sample gas into a gas chromatograph (GC) for CO_2 separation. After GC separation, the CO_2 is passed via a helium (He) carrier gas into a liquid nitrogen trap. After removal of the He carrier gas by evacuation, a dry-ice/isopropyl-alcohol bath is substituted for the liquid nitrogen bath and the CO_2 is transferred cryogenically into a cold finger. After yield is calculated using an electronic manometer connected to the cold finger, the CO_2 is transferred into ¼" Pyrex tubing immersed in liquid nitrogen, and sealed for mass spectrometric analysis.

3. δD (Hydrogen Isotope Analysis) of CH_4

The δD of CH_4 is determined using the water of combustion collected as described in Section 1 above. After transfer of the CO_2 is complete, the dry-ice/isopropyl-alcohol bath is removed and upon warming the trap with a heat gun, the H_2O is transferred into a ¼" Pyrex tube immersed in liquid nitrogen. This ¼" tube contains zinc (100mg for the H_2O from 2cc of CH_4) that has been prepared by baking under vacuum with a heating jacket set to at least 350°C. When transfer is complete, the tube is sealed for reaction and mass spectrometric analysis.

Gas Chromatographic Analysis of Gases

A. Analysis of hydrocarbons

Hydrocarbon gases are analyzed using a Carle AGC 400 Gas Chromatograph which was custom designed by the manufacturer for Isotech. The GC is equipped with both thermal-conductivity (TCD) and flame ionization (FID) detectors. Data processing is provided by a Nelson Analytical PC Interface coupled with a personal computer. Samples are injected into an evacuated gas sampling valve on the GC using a gas-lock syringe. Sample size is precisely controlled by a sample loop. The Carle AGC 400 operates under isothermal conditions, utilizing different columns and valve switching to separate the various components. Helium is used as the carrier gas. After introduction of the sample, all valve switching during the analysis is computer-controlled. The detectors are connected to the GC Interface, which converts the analog signal to digital and sends the data to the PC software for processing. The software for the Nelson system does component detection and area integration. The resulting component peak areas are quantified (given raw percent values) by comparing them to previously run standards. The raw percentage values for each sample are recorded and normalized. This computer record is maintained for each sample corresponding to its individual lab number.

B. Analysis of fixed gases

Fixed gases are analyzed using both the Carle AGC 400 Gas Chromatograph and a Carle AGC 100 Gas Chromatograph with dual TCD detectors, and Nelson Analytical GC Interface. Samples are injected into an evacuated gas sampling valve on each GC using a gas lock syringe. Sample size is precisely controlled by a sample loop. The Carle AGC 400 is used for nitrogen, CO_2, and CO. The Carle AGC 100 is used for H_2-He and O_2-Ar separation. This machine also operates under isothermal conditions, utilizing different columns and valve switching to separate the various components. After introduction of the sample, all valve switching on the AGC 100 is manually controlled by the operator. Nitrogen is used as the carrier gas for the H_2-He separation. O_2-Ar separation takes place in an external packed column, which is cooled with a dry ice slush. The TCD detectors on the AGC 100 are connected to the Nelson Interface, where the signal is converted, quantified, and recorded into the sample record in the same manner as for the AGC 400.

Mass Spectrometric Analysis

All mass spectrometric analyses are run on either a Finnigan MAT Delta S or Delta^{Plus} XL Mass Spectrometer.

A. Measurement of $^{13}C/^{12}C$ ($\delta^{13}C$, Delta C-13) and $^{18}O/^{16}O$ ($\delta^{18}O$, Delta O-18) in CO_2

Because $^{13}C/^{12}C$ and $^{18}O/^{16}O$ analyses are performed simultaneously, the procedure described here generates both measurements. A mass spectrometric analysis involves comparisons of a sample to a working standard; in this case the comparisons are measurements of mass 44, 45, and 46, giving the both the oxygen and carbon isotopic compositions. This is accomplished by a dual inlet system where the sample and the working standard are measured alternately. At the beginning of each day, a working standard is introduced into the standard side of the inlet system, and this standard is generally used for the entire session. There are two different working standards in aluminum cylinders which are permanently mounted on the MS inlet system. The sample to be analyzed against the standard is introduced into the system via an evacuated inlet system and tube-cracker. With the inlet system fully evacuated, the sample (which is sealed into ¼" Pyrex tubing) is introduced by breaking the glass sample tube and allowing the sample to fill a variable volume bellows. Once the sample has been introduced into the MS, the actual analysis is computer controlled using equipment obtained from the manufacturer. Each analysis is given a specific reference name and/or number, utilizing the lab number as the primary reference. Final results are calculated by the manufacturer's software, and are stored on the hard drive of the computer, recorded in a bound lab notebook, and stored as the computer generated printout.

B. Measurement of $^{2}H/^{1}H$ (δD, Delta D) in H_2

Samples for hydrogen/deuterium analysis are sealed into ¼" Pyrex tubing as H_2O, along with a measured quantity of zinc. Each sample tube is labeled and reacted in a heating block at 500°C for 35 minutes to generate hydrogen gas. Once the sample has been reacted, it is introduced into the sample side of the MS inlet system and analyzed against the working standard. Once the sample has been introduced into the MS, the analysis is computer controlled. Each analysis is given a unique label, using the lab number as the primary reference. The final result is calculated by the manufacturer's software and recorded into a bound lab notebook, as well as being stored on computer hard disk and computer generated printout of results.

GENERAL QA/QC PROCEDURES

A. SAMPLES

1. Sampling Procedures

It is the responsibility of the person collecting a sample to follow a sound sampling procedure. This will ensure that the sample collected is representative of the whole. Unless employees of Isotech do the sample collection, the entire responsibility for sample collection resides with the client. However, we at Isotech in addition to being available for sample collection, will provide advice on sampling methods, sample storage procedures, and sample size requirements.

2. Sample Containers

Sample containers should be matched in size, type and condition to the anticipated analysis that will give best representation of the source, while preserving the sample integrity prior to analysis. Unless sample containers are provided by Isotech, the responsibility for adequate containers resides with the client. Again, in addition to being able to provide appropriate sample containers, shipping cartons and shipping instructions, Isotech will provide advice on sample containers/cartons and shipping procedures.

3. Sample Custody

A completed "Chain of Custody" record is the responsibility of the client and, if required, should be submitted with the samples. Isotech will provide a "Chain of Custody/Request for Analysis" form if needed. Isotech assumes full responsibility for all samples received and stored for analysis at our laboratory. If any samples are removed from Isotech for additional analysis at other laboratories, a "Chain of Custody" form will be completed. All samples received for analysis are assigned a unique, non-duplicated laboratory number which is used as an identifier for each analysis performed.

BBB. INSTRUCTIONS AND PROCEDURES

1. Instrument Operation Procedures

Analyses performed with manufactured analysis instruments are carried out by the methods either specified or recommended by the manufacturer of the instrument as identified in the instrument manual or provided by on-site training through the manufacturer's service technicians. Much of the operation of these instruments is controlled by personal computers utilizing software written and licensed by the manufacturers.

2. Analytical Procedures

The analytical procedures used routinely at Isotech are described in written standard operating procedures (SOP's) for each analysis. Additional procedures may be used, as needed, in the process of satisfying a client's specific analysis requirements. These procedures will either follow published analytical methods, or methods developed at Isotech for a specific analysis. If the Isotech developed procedure becomes routine, then a standard operating procedure is written. All procedures are reviewed and approved by the laboratory supervisors. Various procedural tests and verifications performed are recorded in bound maintenance log books.

CcCC. CALIBRATION AND STANDARDIZATION

1. Calibration Procedure and Frequency

Depending on the analytical technique, instruments used for quantitative analyses are either calibrated at the beginning of every operating period or the calibration is checked by using a reference sample or a calibration standard. The instrument calibration is also checked at appropriate intervals during analyses. Specific instruments that form components of a sample preparation system are calibrated using duplicate sample analysis as well as analysis of a reference sample at appropriate intervals. Records of calibration results are kept in laboratory notebooks or other secure medium (see Documentation).

2. Method Validation

Analytical methods are validated by one or more of the following techniques:

a. check or reference samples are analyzed and the results are compared with the internal documented or external certified (primary and secondary standards) values,

b. results from the candidate method are compared with those from another method known to be applicable and reliable, or

c. spiked samples and surrogate samples are analyzed and the method results are compared with the known concentrations.

3. Check/Reference Samples

For stable isotope analysis and gas compositional analysis, a check/reference sample is re-analyzed approximately every tenth analysis. This, in essence, results in a test of

the method. Check/reference samples are chosen which have been analyzed many times over a period of years with consistent results.

4. Standards

Primary standards are obtained from the International Atomic Energy Agency, Vienna, Austria, and certified by NIST (National Institute of Standards and Technology, formerly U.S. National Bureau of Standards) or directly from NIST. Secondary standards are obtained from commercially available sources recognized in the industry. Working standards are prepared by direct calibration against primary and secondary standards.

5. Duplicate Samples

For stable isotope analysis and gas compositional analysis, duplicate analyses are performed approximately every tenth analysis. This duplicate sample analysis is performed approximately five analyses after the check/reference sample analysis. Therefore, for a particular analysis procedure, a test of the method is performed every five analyses. This assures that 20% of all analyses are for maintaining QA/QC.

6. Specific Routine Procedures to Assess Performance

Standard reference samples, chosen to match the submitted samples as closely as possible, in conjunction with duplicate samples and check samples, provide a matrix for performance evaluation. Control charts of replicate analytical data for reference samples are kept for each analytical method practiced routinely. Control charts are used to check the performance of an instrument and/or analytical technique. Analysts may participate in round-robin testing sponsored by outside organizations.

7. External Quality Control Checks

Blind duplicates, check samples, blanks, and spiked samples may be submitted by the client, and this practice is encouraged.

dD. ANALYSES AND ANALYTICAL RESULTS

1. Data Reduction and Reporting

If possible, calculations made in reducing raw data to reportable form, are verified (preferably by a second person) before reporting the results of analysis to the client. If a computer program is used to perform calculations, then the accuracy of the input data is verified by comparison with the raw data. In all cases in which computer programs are used to make the calculations, the person making the calculations verifies that the proper program is used. The computers that control the instruments

perform data reduction and calculation automatically. Reported results are verified relative to the computer printouts. This verification involves copying the value from the printout to a report format and is generally performed by the same person who performed the analyses.

Attachment B
Chain-of-Custody Forms

Analysis requested by

Name Michele Zych

Company Camp Dresser & McKee Inc

Address 18881 Von Karman Ave.
Suite 650
Irvine, CA 92612
(949) 752-5452

Project Playa Vista I.

Location 10610-30279-RT.SCG
Box 411

Sampled by Eric Schinsing/
K. Tsou

ISOTECH

PRIVILEGED & CONFIDENTIAL

6-DAY RUSH

Sample Description

Cylinder Number	Source or Description of Sample	Date Sampled	NG-1 Analysis	NG-2 Analysis	NG-3 Analysis	BG-1 Analysis	BG-2 Analysis	BG-3 Analysis	STW analysis	PAG Analysis	TAG Analysis	Comments
			Analyses & Services Requested									
2046	COM-VIDOR2-001	7/27/00 1225		✓								6-DAY RUSH
2085	COM-VIDOR2-002	7/27/00 1235										HOLD
2005	COM-VIDOR2-003	7/27/00 1239										
2074	COM-VIDOR2-004	7/27/00 1212										
2091	COM-VIDOR2-005	7/27/00 1213										
2053	COM-HARPER1-001	7/27/00 1425		✓								6-DAY RUSH
2052	COM-HARPER1-002	7/27/00 1428										HOLD
2047	COM-HARPER1-003	7/27/00 1430										

Chain of Custody Record

	Signature	Company	Date	Time
Relinquished by		CAMP DRESSER & MCKEE INC.	7/27/00	1800
Received by	FED EX	TRACKING# 298638 4203	7/27/00	1800
Relinquished by				
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Anal

Requested by
Name Michele Zych
Company Camp Dresser & McKee Inc.
Address 18881 VonKarman Ave.
Suite 650
Irvine, CA 92612
(949) 752-5452

Project Playa Vista
Location 10610-30279-RT.1.SG4
Box G36
Sampled by Eric Schinsing/
K. Tzou

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Sample Description

Cylinder Number	Source or Description of Sample	Date Sampled	NG-1 Analysis	NG-2 Analysis NMOC	NG-3 Analysis	BG-1 Analysis	BG-2 Analysis	BG-3 Analysis	SIW analysis	RAG Analysis	TAG Analysis	Comments
2090	CDM-METER-001	7/27/00 0917	✓									6-DAY RUSH
2021	CDM-METER-002	7/27/00 0925										HOLD
2033	CDM-METER-003	7/27/00 0931										
2024	CDM-METER-004	7/27/00 0915										
2014	CDM-METER-005	7/27/00 0916										
2098	CDM-DELREY13-001	7/27/00 1030	✓									6-DAY-RUSH
2060	CDM-DELREY13-002	7/27/00 1037										HOLD
2018	CDM-DELREY13-003	7/27/00 1042										

6-DAY R

Chain of Custody Record

	Signature	Company	Date	Time
Relinquished by		CAMP DRESSER & MCKEE INC.	7/27/00	1800
Received by	FED EX	TRACKING # 298638 4203	7/27/00	1800
Relinquished by				
Received by				
Relinquished by				
Received by				

Analysis Requested by

Name Michele Zych

Company Camp Dresser & McKee, Inc.

Address 18881 Von Karman Ave.
Suite 650
Irvine, CA 92612
949-752-5452

Project Playa Vista

Location 10610-30279-RT.1.SCG
Box G24

Sampled by Eric Schinsing / K. Tzou

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6-DAY RUS

Sample Description

Cylinder Number	Source or Description of Sample	Date Sampled	NG-1 Analysis	NG-2 Analysis	NG-3 Analysis	BG-1 Analysis	BG-2 Analysis	BG-3 Analysis	SIW analysis	RAG Analysis	TAG Analysis	Comments
			Analyses & Services Requested									
2058	COM-DELREY17-001	7/27/00 1110		✓								6-DAY RUSH
2036	COM-DELREY17-002	7/27/00 1113										HOLD
2001	COM-DELREY17-003	7/27/00 1120										HOLD
2096	COM-VIDOR1-001	7/27/00 1151		✓								6-DAY RUSH
2072	COM-VIDOR1-002	7/27/00 1157										HOLD
2022	COM-VIDOR1-003	7/27/00 1200										HOLD
2035	COM-VIDOR13-004	7/27/00 1611										HOLD
2028	COM-VIDOR13-005	7/27/00 1612										HOLD

Chain of Custody Record

	Signature	Company	Date	Time
Relinquished by		CAMP DRESSER & MCKEE INC.	7/27/00	1800
Received by	FED EX	TRACKING #298638 4203	7/27/00	1800
Relinquished by				
Received by				
Relinquished by				
Received by				

Ana , Requested by

Name Michele Zych

Company Camp Dresser & McKee Inc.

Address 18881 Von Karman Ave
Suite 650
Irvine, CA 92612
949-752-5452

Project Playa Vista

Location 10610-30279-RT.1.SCG
Box 617

Sampled by Eric Schinsing/
K. Trou

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Sample Description

Cylinder Number	Source or Description of Sample	Date Sampled	Analyses & Services Requested: NG-1 Analysis	NG-2 Analysis	NG-3 Analysis	BG-1 Analysis	BG-2 Analysis	BG-3 Analysis	SIW analysis	RAG Analysis	TAG Analysis	Comments
2048	COM-SOCAL5-001	7/27/00 1522		✓								6-DAY RUSH
2081	COM-SOCAL5-002	7/27/00 1529										HOLD
2007	COM-SOCAL5-003	7/27/00 1534										
2008	COM-VIDOR13-001	7/27/00 1618		✓								6-DAY RUSH
2054	COM-VIDOR13-002	7/27/00 1620										HOLD
2009	COM-VIDOR13-003	7/27/00 1625										

6-DAY RU

Chain of Custody Record

	Signature	Company	Date	Time
Relinquished by	FED EX	CAMP DRESSER & MCKEE INC.	7/27/00	1800
Received by		TRACKING #298638 4203	7/27/00	1800
Relinquished by				
Received by				
Relinquished by				
Received by				

Analysis requested by

Name Michele Zych

Company Camp Dresser & McKee Inc.

Address 18881 Von Karman Ave.
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Irvine, CA 92612
949-752-5452

Project Playa Vista

Location 10610-30279-RT.1SCG
Box G16

Sampled by Eric Schinsing / K. Tran

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Sample Description

6-DAY RUSH

Cylinder Number	Source or Description of Sample	Date Sampled	Analyses & Services Requested: NG-1 Analysis	NG-2 Analysis NM-2D	NG-3 Analysis	BG-1 Analysis	BG-2 Analysis	BG-3 Analysis	SIW analysis	RAG Analysis	TAG Analysis	Comments
2010	COM-VIDOR 14-001	7/27/00 1303	✓									6-DAY RUSH
2075	COM-VIDOR 14-002	7/27/00 1307										HOLD
2069	COM-VIDOR 14-003	7/27/00 1312										
2004	COM-SCP-1-001	7/27/00 1550	✓									6-DAY RUSH
2025	COM-SCP-1-002	7/27/00 1555										HOLD
2067	COM-SCP-1-003	7/27/00 1557										

Chain of Custody Record

	Signature	Company	Date	Time
Relinquished by	[signature]	CAMP DRESSER & MC KEE INC.	7/27/00	1800
Received by	FED EX		7/27/00	1800
Relinquished by				
Received by				
Relinquished by				
Received by				

Attachment C
Isotech Laboratory Data and Associated Quality Assurance/Quality Control Data

ISOTECH®

Isotech Laboratories, Inc. 1308 Parkland Court Champaign, IL 61821-1826 Telephone 217/398-3490 FAX 217/398-3

FAXED

August 4, 2000

PRIVILEGED AND CONFIDENTIAL
ATTORNEY WORK-PRODUCT
prepared at the request of
and for legal counsel, prepared
in anticipation of litigation.

Michele Zych
Camp, Dresser & McKee, Inc.
18881 Von Karman Ave., Suite 650
Irvine, CA 92612

Dear Michelle:

Enclosed are the analysis reports for the 10 gas samples that you recently submitted for the Playa Vista project. I hope the data are helpful to you.

If you have any questions concerning this data, or if there is anything else we can do for you, please do not hesitate to contact us.

Sincerely Yours,

Dennis D. Coleman
Laboratory Director

DDC:el

Enclosure

ANALYSIS REPORT

Lab #:	26655	Job #:	2321
Sample Name/Number:	CDM-VIDOR2-001		
Company:	Camp Dresser McKee, Inc.		
Date Sampled:	7/27/2000	Cylinder:	2046
Container:	300 ml stainless		
Field/Site Name:	Playa Vista		
Location:	California		
Formation/Depth:			
Sampling Point:			
Date Received:	7/28/2000	Date Reported:	8/04/2000

Component	Chemical mol. %	Delta 13C per mil	Delta D per mil	Delta 15N per mil
Carbon Monoxide	nd			
Hydrogen Sulfide	nd			
Helium	0.0013			
Hydrogen	0.0020			
Argon	nd			
Oxygen	nd			
Nitrogen	0.17			
Carbon Dioxide	15.03	-10.69		
Methane	75.40	-40.51	-183.7	
Ethane	4.50	-29.42		
Ethylene	nd			
Propane	2.63			
Iso-butane	0.35			
N-butane	0.82			
Iso-pentane	0.33			
N-pentane	0.31			
Hexanes +	0.46			

Total BTU/cu.ft. dry @ 60deg F & 14.7psia, calculated: 998

Specific gravity, calculated: 0.788

nd = not detected. na = not analyzed. Isotopic composition of carbon is relative to VPDB. Isotopic composition of hydrogen is relative to VSMOW. Calculations for BTU and specific gravity per ASTM D3588. Chemical compositions are normalized to 100 percent. Mol. % is approximately equal to vol. %

ANALYSIS REPORT

Lab #:	26656	Job #:	2321
Sample Name/Number:	CDM-HARPER1-001		
Company	Camp Dresser McKee, Inc		
Date Sampled:	7/27/2000	Cylinder:	2053
Container:	300 ml stainless		
Field/Site Name:	Playa Vista		
Location:	California		
Formation/Depth:			
Sampling Point			
Date Received:	7/28/2000	Date Reported:	8/04/2000

Component	Chemical mol. %	Delta 13C per mil	Delta D per mil	Delta 15N per mil
Carbon Monoxide	nd			
Hydrogen Sulfide	nd			
Helium	0.0094			
Hydrogen	nd			
Argon	0.011			
Oxygen	nd			
Nitrogen	1.17			
Carbon Dioxide	7.57	-3.47		
Methane	81.86	-44.88	-197.1	
Ethane	4.83	-30.80		
Ethylene	nd			
Propane	2.54			
Iso-butane	0.35			
N-butane	0.76			
Iso-pentane	0.24			
N-pentane	0.21			
Hexanes +	0.45			

Total BTU/cu.ft. dry @ 60deg F & 14.7psia, calculated: 1057

Specific gravity, calculated: 0.716

nd = not detected na = not analyzed. Isotopic composition of carbon is relative to VPDB. Isotopic composition of hydrogen is relative to VSMOW. Calculations for BTU and specific gravity per ASTM D3588. Chemical compositions are normalized to 100 percent. Mol. % is approximately equal to vol. %

ISOTECH Laboratories, Inc. 1308 Parkland Ct. Champaign, IL 61821 217/398-3490

ANALYSIS REPORT

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and for legal counsel, prepared
in anticipation of litigation.

Lab #	26657	Job #:	2321
Sample Name/Number:	CDM-VIDOR14-001		
Company	Camp Dresser McKee, Inc.		
Date Sampled:	7/27/2000	Cylinder:	2010
Container:	300 ml stainless		
Field/Site Name:	Playa Vista		
Location:	California		
Formation/Depth:			
Sampling Point:			
Date Received:	7/28/2000	Date Reported:	8/04/2000

Component	Chemical mol. %	Delta 13C per mil	Delta D per mil	Delta 15N per mil
Carbon Monoxide	nd			
Hydrogen Sulfide	nd			
Helium	0.034			
Hydrogen	0.0085			
Argon	0.0049			
Oxygen	nd			
Nitrogen	1.26			
Carbon Dioxide	0.58	-2.99		
Methane	91.62	-42.37	-174.2	
Ethane	4.74	-32.66		
Ethylene	nd			
Propane	1.12			
Iso-butane	0.10			
N-butane	0.17			
Iso-pentane	0.053			
N-pentane	0.059			
Hexanes +	0.25			

Total BTU/cu.ft. dry @ 60deg F & 14.7psia, calculated: 1067
Specific gravity, calculated: 0.611

nd = not detected. na = not analyzed. Isotopic composition of carbon is relative to VPDB. Isotopic composition of hydrogen is relative to VSMOW. Calculations for BTU and specific gravity per ASTM D3588. Chemical compositions are normalized to 100 percent. Mol. % is approximately equal to vol. %

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ANALYSIS REPORT

Lab #:	26658	Job #:	2321
Sample Name/Number:	CDM-SCP-1-001		
Company:	Camp Dresser McKee, Inc		
Date Sampled:	7/27/2000	Cylinder:	2004
Container:	300 ml stainless		
Field/Site Name:	Playa Vista		
Location	California		
Formation/Depth:			
Sampling Point:			
Date Received:	7/28/2000	Date Reported:	8/04/2000

Component	Chemical mol. %	Delta 13C per mil	Delta D per mil	Delta 15N per mil
Carbon Monoxide	nd			
Hydrogen Sulfide	nd			
Helium	0.012			
Hydrogen	nd			
Argon	0.0066			
Oxygen	nd			
Nitrogen	0.65			
Carbon Dioxide	1.25	11.26		
Methane	95.62	-42.18	-202.4	
Ethane	1.87	-28.57		
Ethylene	nd			
Propane	0.34			
Iso-butane	0.047			
N-butane	0.067			
Iso-pentane	0.020			
N-pentane	0.019			
Hexanes +	0.095			

Total BTU/cu.ft. dry @ 60deg F & 14.7psia, calculated: 1021

Specific gravity, calculated: 0.586

nd = not detected. na = not analyzed. Isotopic composition of carbon is relative to VPDB. Isotopic composition of hydrogen is relative to VSMOW. Calculations for BTU and specific gravity per ASTM D3588. Chemical compositions are normalized to 100 percent. Mol. % is approximately equal to vol. %

ISOTECH Laboratories, Inc. 1308 Parkland Ct. Champaign, IL 61821 217/398-3490

ANALYSIS REPORT

Lab #	26659	Job #:	2321
Sample Name/Number:	CDM-METER-001		
Company:	Camp Dresser McKee, Inc.		
Date Sampled:	7/27/2000	Cylinder:	2090
Container	300 ml stainless		
Field/Site Name:	Playa Vista		
Location	California		
Formation/Depth:			
Sampling Point.			
Date Received:	7/28/2000	Date Reported.	8/04/2000

Component	Chemical mol. %	Delta 13C per mil	Delta D per mil	Delta 15N per mil
Carbon Monoxide	nd			
Hydrogen Sulfide	nd			
Helium	0.011			
Hydrogen	0.0015			
Argon	0.0037			
Oxygen	nd			
Nitrogen	0.55			
Carbon Dioxide	1.17	13.26		
Methane	96.35	-42.15	-204.7	
Ethane	1.58	-27.85		
Ethylene	nd			
Propane	0.23			
Iso-butane	0.031			
N-butane	0.034			
Iso-pentane	0.010			
N-pentane	0.0065			
Hexanes +	0.026			

Total BTU/cu.ft. dry @ 60deg F & 14.7psia, calculated: 1015

Specific gravity, calculated: 0.579

nd = not detected. na = not analyzed. Isotopic composition of carbon is relative to VPDB. Isotopic composition of hydrogen is relative to VSMOW. Calculations for BTU and specific gravity per ASTM D3588. Chemical compositions are normalized to 100 percent. Mol. % is approximately equal to vol %

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ANALYSIS REPORT

Lab #:	26660	Job #:	2321
Sample Name/Number:	CDM-DELRAY13-001		
Company:	Camp Dresser McKee, Inc.		
Date Sampled:	7/27/2000	Cylinder:	2098
Container:	300 ml stainless		
Field/Site Name:	Playa Vista		
Location:	California		
Formation/Depth:			
Sampling Point:			
Date Received:	7/28/2000	Date Reported:	8/04/2000

Component	Chemical mol. %	Delta 13C per mil	Delta D per mil	Delta 15N per mil
Carbon Monoxide	nd			
Hydrogen Sulfide	nd			
Helium	0.0022			
Hydrogen	0.071			
Argon	nd			
Oxygen	nd			
Nitrogen	28.13			
Carbon Dioxide	nd			
Methane	57.53	-41.97	-190.9	
Ethane	6.35	-29.40		
Ethylene	nd			
Propane	4.28			
Iso-butane	0.65			
N-butane	1.57			
Iso-pentane	0.49			
N-pentane	0.44			
Hexanes +	0.49			

Total BTU/cu.ft. dry @ 60deg F & 14.7psia, calculated: 938

Specific gravity, calculated: 0.804

nd = not detected. na = not analyzed. Isotopic composition of carbon is relative to VPDB. Isotopic composition of hydrogen is relative to VSMOW. Calculations for BTU and specific gravity per ASTM D3588. Chemical compositions are normalized to 100 percent. Mol % is approximately equal to vol %

ANALYSIS REPORT

Lab #:	26661	Job #:	2321
Sample Name/Number:	CDM-DELRAY17-001		
Company:	Camp Dresser McKee, Inc.		
Date Sampled:	7/27/2000	Cylinder:	2058
Container:	300 ml stainless		
Field/Site Name:	Playa Vista		
Location:	California		
Formation/Depth:			
Sampling Point:			
Date Received:	7/28/2000	Date Reported:	8/04/2000

Component	Chemical mol. %	Delta 13C per mil	Delta D per mil	Delta 15N per mil
Carbon Monoxide	nd			
Hydrogen Sulfide	nd			
Helium	0.012			
Hydrogen	nd			
Argon	nd			
Oxygen	nd			
Nitrogen	0.43			
Carbon Dioxide	3.70	-2.31		
Methane	89.21	-41.25	-184.0	
Ethane	4.17	-29.71		
Ethylene	nd			
Propane	1.67			
Iso-butane	0.16			
N-butane	0.31			
Iso-pentane	0.058			
N-pentane	0.050			
Hexanes +	0.23			

Total BTU/cu.ft. dry @ 60deg F & 14.7psia, calculated: 1052
Specific gravity, calculated: 0.642

nd = not detected. na = not analyzed. Isotopic composition of carbon is relative to VPDB. Isotopic composition of hydrogen is relative to VSMOW. Calculations for BTU and specific gravity per ASTM D3588. Chemical compositions are normalized to 100 percent. Mol. % is approximately equal to vol. %

ANALYSIS REPORT

Lab #:	26662	Job #:	2321
Sample Name/Number:	CDM-VIDOR1-001		
Company:	Camp Dresser McKee, Inc.		
Date Sampled:	7/27/2000	Cylinder:	2096
Container:	300 ml stainless		
Field/Site Name:	Playa Vista		
Location	California		
Formation/Depth:			
Sampling Point:			
Date Received:	7/28/2000	Date Reported:	8/04/2000

Component	Chemical mol. %	Delta 13C per mil	Delta D per mil	Delta 15N per mil
Carbon Monoxide	nd			
Hydrogen Sulfide	nd			
Helium	0.0082			
Hydrogen	0.0081			
Argon	nd			
Oxygen	nd			
Nitrogen	0.40			
Carbon Dioxide	12.75	-11.32		
Methane	78.14	-41.90	-186.3	
Ethane	4.04	-29.99		
Ethylene	nd			
Propane	2.39			
Iso-butane	0.38			
N-butane	0.90			
Iso-pentane	0.31			
N-pentane	0.27			
Hexanes +	0.40			

Total BTU/cu.ft. dry @ 60deg F & 14.7psia, calculated: 1010

Specific gravity, calculated: 0.761

nd = not detected. na = not analyzed. Isotopic composition of carbon is relative to VPDB. Isotopic composition of hydrogen is relative to VSMOW. Calculations for BTU and specific gravity per ASTM D3588. Chemical compositions are normalized to 100 percent. Mol. % is approximately equal to vol. %

ANALYSIS REPORT

Lab #	26663	Job #:	2321
Sample Name/Number:	CDM-SOCAL5-001		
Company:	Camp Dresser McKee, Inc		
Date Sampled:	7/27/2000	Cylinder:	2048
Container:	300 ml stainless		
Field/Site Name:	Playa Vista		
Location:	California		
Formation/Depth:			
Sampling Point:			
Date Received:	7/28/2000	Date Reported:	8/04/2000

Component	Chemical mol. %	Delta 13C per mil	Delta D per mil	Delta 15N per mil
Carbon Monoxide	nd			
Hydrogen Sulfide	nd			
Helium	0.011			
Hydrogen	nd			
Argon	0.0028			
Oxygen	nd			
Nitrogen	0.56			
Carbon Dioxide	1.31	12.70		
Methane	96.03	-42.69	-202.3	
Ethane	1.61	-29.20		
Ethylene	nd			
Propane	0.31			
Iso-butane	0.042			
N-butane	0.058			
Iso-pentane	0.016			
N-pentane	0.014			
Hexanes +	0.037			

Total BTU/cu.ft. dry @ 60deg F & 14.7psia, calculated: 1016

Specific gravity, calculated: 0.583

nd = not detected. na = not analyzed. Isotopic composition of carbon is relative to VPDB. Isotopic composition of hydrogen is relative to VSMOW. Calculations for BTU and specific gravity per ASTM D3588. Chemical compositions are normalized to 100 percent. Mol. % is approximately equal to vol. %

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ANALYSIS REPORT

Lab #:	26664	Job #	2321
Sample Name/Number:	CDM-VIDOR13-001		
Company:	Camp Dresser McKee, Inc		
Date Sampled:	7/27/2000	Cylinder:	2008
Container	300 ml stainless		
Field/Site Name:	Playa Vista		
Location	California		
Formation/Depth:			
Sampling Point:			
Date Received:	7/28/2000	Date Reported:	8/04/2000

Component	Chemical mol. %	Delta 13C per mil	Delta D per mil	Delta 15N per mil
Carbon Monoxide	nd			
Hydrogen Sulfide	nd			
Helium	0.012			
Hydrogen	nd			
Argon	0 0053			
Oxygen	nd			
Nitrogen	0 69			
Carbon Dioxide	1 15	11.17		
Methane	95 39	-42.31	-202.2	
Ethane	2.10	-28.43		
Ethylene	nd			
Propane	0.43			
Iso-butane	0.055			
N-butane	0.075			
Iso-pentane	0.020			
N-pentane	0.016			
Hexanes +	0.057			

Total BTU/cu.ft. dry @ 60deg F & 14.7psia, calculated: 1024

Specific gravity, calculated: 0.586

nd = not detected na = not analyzed. Isotopic composition of carbon is relative to VPDB. Isotopic composition of hydrogen is relative to VSMOW. Calculations for BTU and specific gravity per ASTM D3588. Chemical compositions are normalized to 100 percent. Mol. % is approximately equal to vol. %

CDM Camp Dresser & McKee

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ZymaX FORENSICS

September 21, 2000

To: David Nelson, Playa Capital Company, LLC

From: Ian Kaplan

Re Comparison of Gas Analyses from Southern California Gas Company Injection Wells and from Various Observation (Reservoirs Storage) Wells

The majority of gas stored in the depleted Del Rey oil field reservoir by SoCal Gas Company is transported from the central-west Texas region. This gas is a relatively "dry" gas containing over 96 mol% methane and only about 1-2 mol% ethane. Other hydrocarbon gases occur in very small concentrations amounting in total to less than 0.5 mol% of the total. Of particular interest, is that this gas contains a small, but readily measurable, amount of helium, varying from about 0.01 to 0.04 mol% helium, depending on the time of delivery from Texas to California. Most worldwide natural gas accumulations, including those of Southern California contain only trace amounts of helium (less than 0.001 mol%). The carbon isotope ratios ($\delta^{13}C$ and δD) of the methane in the imported Texas gas has values of -42‰ to -43‰ and -200‰ to -205‰, respectively, whereas the carbon isotope ratio of ethane is in the range of -28‰ to -30‰.

Compositional measurements for the gas received at the Playa Vista metering gauge as well as gases obtained from three injection/withdrawal wells and six observation wells by CDM in July 2000 were submitted to Isotech Laboratories, Inc., Champaign, IL for chemical composition and stable isotope analyses. The results of analyses are shown in Table 1.

The gas at the metering gauge and the three injection/withdrawal wells have a

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laboratory 71 Zaca Lane • San Luis Obispo CA 93401 • fax 805.544.8226 • voice 805.544.4696
email forensics@ZymaXusa.com

relatively constant composition. The average methane composition is 95.85±0.5 mol% the average ethane composition is 1.79±0.31 mol%, average propane composition is 0.33±0.10 mol%; average helium composition is 0.0115±0.001 mol% and average CO_2 composition is 1.23±0.06 mol%. Additionally, an average of 0.51±0.08 mol% nitrogen (N_2) is also present. In the injected gas, the average carbon isotope ratio for methane is -42.33±0.36‰; for ethane it is -28.51±0.69‰ and for CO_2 the average $\delta^{13}C$ is +12.10±1.13‰. The average δD for methane is -203.13±1.3‰. Both the compositional and isotopic measurements fall into narrow ranges. Slight differences in compositions between the gas measured at the metering gauge and the injection wells are probably due to the latter representing an average from many injections.

The average content of methane in the five observation wells excluding Del Rey 13 is 83.25±8.37 mol%; for ethane it is 4.46±0.42 mol%; for helium it is 0.013±0.21 mol%; for CO_2 it is 7.93±7.35 mol%; for N_2 it is 0.69±0.56 mol%; and for propane it is 2.07±0.97 mol%. The composition for well Del Rey 13 was not used for these average compositional calculations because the nitrogen content of this well was 28.13 mol% and would have skewed all such calculations. The average carbon isotope ratios for methane, ethane, and carbon dioxide for the observation wells are -42.15±2.73‰, -30.33±2.33‰ and -5.23±6.09‰, respectively, and for δD of methane it is -186.0±11.1‰.

These average data are shown in Table 2 to illustrate similarities and differences between the compositions of gas injection/withdrawal wells and the observation wells.

The average composition of gases in the observation wells are measurably different from those in the injection/withdrawal wells. The major differences are (1) enrichment in

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email: forensics@zymaxforensics.com

CO_2, (2) enrichment in ethane and propane and consequently (3) depletion of methane in the observation wells (Table 2). These differences probably result from mixing of the injected Texas gases with residual natural gas and condensate in the Del Rey reservoir.

The change in the carbon isotope ratio of methane between the injection wells and the observation wells ($\delta^{13}C$ = -42.33‰ vs -42.15‰, respectively) is not significant, although there is a greater variation in this measured value for the observation wells than for the injection wells. The $\delta^{13}C$ values for ethane, however, is about 2‰ more negative in the observation wells. The largest difference between the injection well averages and the observation well averages is in the $\delta^{13}C$ of the carbon dioxide; for the injection wells this value is +12.10‰, whereas for the observation wells the $\delta^{13}C$ of carbon dioxide is -5.23‰. The deuterium/hydrogen ratio of the observation well is also a little more enriched in deuterium.

Whereas identifiable differences between the chemical and isotopic averages in gases in the injection wells and observation wells are measurable, the methane and ethane carbon isotope ratios are very similar and the average methane/ethane compositional ratio for the injection wells is about 2.9 greater than for the observation wells. By contrast, the differences between the gas compositions and stable isotope ratios of the gases from the 50 ft Gravel Aquifer and either the injection well gases or observation well gases are very different.

First, ethane is highly depleted in the aquifer gases. All measured contents are below 0.6% of total gas concentrations and methane to ethane ratios, for gases which contain over 80% methane, range from 188-325 (Table 3), by contrast with a value of

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53.55 for the injection wells and 18.67 for the observation wells (Table 2).

Second, the $\delta^{13}C$ values for methane in aquifer gases range from -49.18‰ to -64.75‰ vs. -42.33‰ to -42.15‰ in the injection and observation wells.

Third, the $\delta^{13}C$ of ethane in the aquifer gases is a narrow range of approximately -20‰, whereas in the injection and observation wells, the values are in the range of -28.5‰ to -30.3‰.

Fourth, the $\delta^{13}C$ of methane - $\delta^{13}C$ of ethane is in the narrow range of -13.8‰ to -11.8‰, respectively, for the injection and observations wells (Table 2), whereas for the aquifer wells this range of $\delta^{13}C$ values is -29.3‰ to -44.4‰ (Table 3).

Finally, whereas the $\delta^{13}C$ of carbon dioxide in the injection well gases is +12.1‰ and -5.2‰ (Table 2) in the observation well gases, the average value for the aquifer gases is -28.7‰ (Table 3).

To summarize the data described above more succinctly, a graphic display has been constructed in Figure 1 where all the parameters listed in Table 3 are displayed for gases in the aquifer wells as well as for the injection and observation wells shown in Table 2. It is very apparent from this figure, that the gases in the 50 ft aquifer have different chemical and isotopic properties from those stored by Southern California Gas Company either in the injection wells or observation wells.

Because the ETI Report (April 17, 2000) did not contain stable isotope measurements of soil gases, a comparable comparison with injection or observation well gases could not be made. However, based on the low ethane and propane contents compared to methane content in the soil gas, there is also no evidence for migration of

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Southern California Gas Company stored gas into the soil.

CONCLUSIONS

The above data show that the chemical and isotopic characteristics of the natural gas stored by Southern California Gas Company are different from the gas detected at the Playa Vista property. Thus, the measured data show that natural gas stored by Southern California Gas Company has not migrated to the Playa Vista property.

Nelson Deposition2.wpd

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ATTACHMENT 3

Exploration Technologies, Inc.

3698 Westchase Dr • Houston, Texas 77042 • (713) 785-0393 • FAX (713) 785-1550

January 31, 2001

Mr. David Hsu
Chief, Grading Engineering Section
City of Los Angeles
Dept. of Building and Safety
201 North Figueroa Street
Los Angeles, CA 90012-2827

Dear David,

Playa Del Rey Gas Storage Field and Lincoln Blvd. Fault:

As confirmed by our earlier letters (December 20, 2000 V T Jones to Ray Chan), we have completed our preliminary evaluation of the regional soil gas data collected over the entire Playa Vista site, including the locations for 119 infill soil gas samples to complete this data set. The regional soil gas data collected as part of Phase II evaluations shows no evidence of major gas leakage from the Playa Del Rey Gas Storage Field. In addition we have collected and completed evaluation of nine additional storage gas reservoir samples taken directly from several of the storage and observation wells. Comparison of the chemical and isotopic data from these wells with the near-surface and Ballona gravel aquifer gas samples previously analyzed on the Playa Vista site shows that the storage gases are not present in any of the methane anomalies observed east of Lincoln Blvd. The gas seepage on the Playa Vista site appears to be derived from the Pico Sands at depth and does not have the geochemical signatures characteristic of storage gas.

Preliminary interpretation of the geophysical data from seismic profiles supports the premise that the methane gas found east of Lincoln is moving upward within a vertical zone of disrupted strata from beds of the Pico Formation. Offsets in reflections of the seismic profile may be interpreted as zones of disrupted strata, which are likely permeable to gas. Preliminary data reprocessing suggests the presence of low-velocity zones (possibly due to the presence of gas) that appear to be associated with both the disrupted strata and with the location of the anomalous methane found on the Playa Vista site. Thus the near-surface gas anomalies appear to be issuing from fractures or other disruptions that directly underlie the methane anomalies as defined by the soil gas surveys. As noted in an earlier letter, (Victor Jones to Ray Chan, December 7, 2000) interpretation of the chemical and geophysical data does not support the existence of the Lincoln Blvd. Fault that was postulated to dip westward and possibly transect strata within the existing gas storage field, as communicated in our April 17, 2000 report to LADBS. This combined geochemical and geophysical information supports that the methane gas seepage observed on the Playa Vista site does not come from the Southern California Gas Storage Field.

Sincerely,

V. T. Jones III

Victor T. Jones, III, Ph.D
Peer Reviewer for LADBS
President, Exploration Technologies, Inc

Gary A. Robbins

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GEOMATRIX

July 25, 2000
Project 6571

Mr. David Nelson
Playa Capital Company, LLC
12555 Jefferson Boulevard
West Tower, Suite 300
Los Angeles, California 90066

RE: Evaluation of Potential Public Health Impacts Associated with the Presence of Potentially Toxic Compounds in Soil Gas at Playa Vista

Dear Mr. Nelson,

As requested, we have reviewed a large amount of information describing the presence of a variety of hydrocarbon compounds in soil gas and groundwater at the referenced site. While the primary focus of the geological/geochemical investigation has been on the presence of methane and the development of mitigation methods for eliminating any impacts (e.g., atmospheric concentrations that reflect a physical flammability hazard), the data have also indicated the presence of other larger aliphatic hydrocarbons (e.g., ethane, propane and butane) and sporadic detection of low levels of benzene, toluene, ethylbenzene and xylenes (BTEX), as well as sporadic detection of hydrogen sulfide (H_2S). It is for these latter chemicals that you specifically requested an analysis of the potential for adverse health impacts that might be associated with their presence secondary to development of the site. We have not included methane in our analysis as it poses minimal toxicological concerns. As outlined below, we have considered potential impacts to both the future resident or visiting population at the site and adjacent areas as well as workers that might be involved in excavation activities at the site. Our review of the available data and analysis of potential exposure to these chemicals strongly supports that, with substantial margins of safety, adverse health effects would not be expected. Because a series of worst-case assumptions were used in this screening assessment, it is unlikely that more refined assessments, conducted once specific projects are better defined, will suggest higher exposures and risks. Nevertheless, the results of health risk assessments will be used to assist in the design of specific mitigation measures, if any

Available Data

We were provided with extensive data describing the results of soil gas investigations for shallow soils[1] and deeper soils including groundwater[2]. These reports also address additional

[1] Camp Dresser & McKee, Inc. Methane Report – Playa Vista Second Phase. Prepared for Playa Capital Company, LLC, April 22, 1999; ENSR, Data Review and Limited Phase II Subsurface Site Assessment at Playa Vista Property, October, 1997

[2] Exploration Technologies, Inc. Subsurface Geochemical Assessment of Methane Gas Occurrences – Playa Vista Development, April 17, 2000 Phase 1 project

activities that have characterized soil gas and the presence of other chemicals at the site. While the volume of data characterizing the site is huge with hundreds of discrete sampling locations and large variations in methane concentrations, the presence of other chemicals can be very simply summarized:

- Simple aliphatic hydrocarbons that are chemically related to methane (e.g., ethane, propane and butane), if present, are present in shallow soils at very low part per million levels (e.g., approximately 0.001% or less of the total soil gas is made up of these compounds). Levels in deeper soils are higher, but always a small fraction of the amount of methane present.

- BTEX chemicals, normally an indicator of the presence of petroleum-related hydrocarbons, are only sporadically detected across the site in shallow soils. When detected, concentrations are at extremely low part per million levels.

- H_2S was detected in shallow soils across the site. The majority of H_2S detections were at the low part per billion level (e.g., 0.000001%). Only a few samples (9 out of 810) showed concentrations in the part per million range and the highest concentration detected appeared to be only 41 parts per million. The next highest concentrations were below 10 parts per million.

Simple inspection of the data based on our experience in evaluating potential risks due to chemicals in soil at a large number of sites suggests that levels of chemicals of potential concern are so low as to not represent a health hazard.

Potential Exposures to On-Site Populations

The presence of non-methane simple hydrocarbons, BTEX and H_2S (i.e., chemicals of potential concern or COPC) in soil gas suggests that on-site individuals could be exposed to these chemicals. Because all of the COPCs are either gases or volatilize readily at ambient temperatures, the potential pathway for exposure is through inhalation. Other theoretical routes of exposure such as dermal contact, incidental ingestion of soil or migration into backyard garden produce are not applicable for these materials. Processes applicable to this site that might lead to inhalation exposures include the release of soil vapor into ambient air due to migration through soil and the purposeful collection and venting of soil gases (i.e., as a methane mitigation) into ambient air to eliminate physically hazardous methane buildup. Although the soil gas flux into buildings is normally a pathway of exposure, the methane mitigation measures will eliminate this pathway of exposure. Further, preliminary application of a vapor risk assessment model demonstrates that the theoretical maximum health risk indoors even without methane mitigation is substantially below levels of concern. Rather, soil

surface flux into outdoor air, if any, represents the most likely exposure pathway. For the on-site worker, this pathway may be enhanced due to activities that occur below grade. Trenching or other on-site digging could be expected to increase surface flux, while decreasing normal dispersion of the chemicals due to containment. The collection of soil gas and release through a single vent could potentially lead to slightly higher exposures to the COPCs in soil gas. This would theoretically occur because the soil gas over larger areas would be collected and released at a single point.

The significance of these potential exposure pathways and the means for quantitatively evaluating their potential significance are discussed below.

Toxicology of COPCs

The potential for chemicals to cause adverse health effects in an exposed population is a function of the toxicology profile for the chemical (e.g., what adverse effects might be seen), the dose-response relationship for the toxicity (e.g., the exposure level at which a specific toxic effect might be observed) and the measured or estimated exposure. One of the metrics available for this determination are the "health criteria" developed by various expert or regulatory bodies that are levels of exposure that have been determined to not cause adverse health effects with a substantial margin of safety.

The toxicology of each of the COPCs has been extensively studied and there is considerable human experience with each of them that allows for a prediction of the level of exposure that will not be associated with adverse health effects with a substantial margin of safety. In general, however, the aliphatic hydrocarbons that are closely related chemically to methane, in addition to being ubiquitous in the environment from any number of natural processes, have little biological activity and are not viewed as a potential health hazard. The exception to this is that very high concentrations in air, by excluding oxygen, can lead to suffocation. In addition, butanes at extremely high doses have an anesthetic effect. No adverse health effects would be expected from exposure to any of the methane-like hydrocarbons found at the site.

The toxicology profile for the other COPCs is more complex. Benzene is a known human carcinogen at levels historically occurring in the work environment and current public health policy assumes that it might also be carcinogenic at low environmental levels. In evaluating the public health impacts of potential carcinogens, the regulatory community including regulatory agencies in California dealing with exposures to toxic chemicals, generally evaluate the level of risk based on theoretical extrapolations of lifetime increased cancer risk. Given the highly health-conservative derivation of cancer risk estimates, increased lifetime risk in the range of 100 in one million to 1 in one million may be acceptable under various regulatory

programs. A risk less than 1 in one million is usually described as insignificant. The air concentration associated with a lifetime increase in cancer risk of 1 in one million for benzene using California's Office of Health Hazard Assessment (OEHHA) calculations is 0.03 ug/m^3. Exposure to this level of benzene in air for 24 hours per day for a lifetime increases the theoretical risk of cancer by a probability of 1 in one million. This level of exposure is substantially lower than any level associated with non-cancer health effects.

The toxicology profile of toluene and xylenes are similar in that the effects occurring at the lowest exposure levels are minor central nervous system effects and eye and respiratory irritation effects. Toluene has been evaluated by OEHHA as a toxic air contaminant. A Reference Exposure Level of 400 ug/m^3 in air has been developed as being protective of minor effects with a substantial margin of safety. Similarly, OEHHA has developed a Reference Exposure Level of 200 ug/m^3 for xylenes. This level is also protective of minor effects with a substantial margin of safety.

The toxicology profile for ethylbenzene, while similar to toluene and xylenes, also includes data suggesting adverse reproductive effects in animals at high dose levels. OEHHA has established a Reference Exposure Level of 1000 ug/m^3 as being protective of possible reproductive effects as well as irritation effects with a substantial margin of safety.

H_2S is strongly odiferous at relatively low concentrations in air and can lead to subjective complaints at concentrations only slightly above the odor threshold. In addition, long-term inhalation studies in animals have detected alterations in the lining of the nose at relatively high concentrations. OEHHA has established a Reference Exposure Level of 10 ug/m^3 as being protective of possible adverse health effects. This level is also below the odor threshold.

For all COPCs the Reference Exposure Levels not only include adjustment factors to account for possible uncertainty in the underlying data, but also include factors to protect the sensitive individual, if any, in the exposed population. The health criteria presented above provide the basis for determining the potential for adverse health effects that might be associated with exposure to the COPCs in soil gas under the various exposure scenarios.

Reflecting the lack of toxicological impact, the simple methane-like hydrocarbons do not have Reference Exposure Levels.

Quantifying Exposure

The health criteria for each of the COPCs are intended to be used as a basis for comparison to evaluate the significance of measured or estimated environmental concentrations of each of the chemicals. While simple examination of the soil gas data shows levels of a few of the COPCs above the health criteria, any ambient air concentration of the COPC due to soil surface flux or a mitigation venting system will be significantly less than the soil gas concentration. Our experience in similar situations strongly supports that environmental exposures from ambient air given the soil gas concentrations of COPCs will be substantially lower than health criteria

Techniques exist for quantifying potential exposures to the COPCs that might be associated with on-site activities. Some of those techniques have already been used and provide support for the general opinion that COPC concentrations in soil gas will not lead to ambient air exposures in excess of the health criteria. For H_2S, ambient air monitoring was conducted at the locations of highest H_2S concentrations in soil gas[3]. The highest measured concentration in ambient air was 2.68 ppb (3.35 ug/m^3). This level does not exceed the OEHHA Reference Exposure Limit of 10 ug/m^3, which is a level of exposure without adverse health effects with a substantial margin of safety assuming continuous 24 –hour, 365-day per year exposure. Considering that the appropriate exposure metric should actually be the representative site average concentration reflecting the movement of an individual during the day, the 3.35 ug/m^3 ambient air concentration is clearly an overestimate of actual likely exposures.

The possible contribution of a venting system to ambient air concentrations of BTEX have also been estimated[4]. In this case the proposed methane venting mitigation for the Fountain Park Apartments was evaluated for possible local impacts on air quality by estimating mass emissions of BTEX followed by air dispersion modeling (ISCST, hourly meteorology data from Hawthorne, CA). Maximum annual average concentrations of BTEX predicted by the model were 0.0008 ppb (0.003 ug/m^3), 0.0007 ppb (0.0026 ug/m^3), 0.0006 ppb (0.0026 ug/m^3) and 0.0006 ppb (0.0026 ug/m^3) for benzene, toluene, ethylbenzene and xylene, respectively. These values are all substantially lower than the Reference Exposure Levels developed by OEHHA and, for benzene, is less than the 1 in one million lifetime cancer risk level.

The available quantitative analyses described above demonstrate that exposures at the site due to the presence of COPCs in soil gas under the conditions evaluated do not present a threat of public health impacts under likely situations. Because theoretical off-site impacts will be lower, there will also be no off-site impacts expected. If questions arise regarding specific

[3] Integrated Environmental Services, 2000
[4] Integrated Environmental Services, 2000

situations, additional quantitative analyses can be conducted, but the data available to date strongly suggest that public health impacts should not be anticipated with a substantial margin of safety.

Worker Exposures

The one possible exception to our opinion that ambient air concentrations of COPCs will be substantially below health criteria relates to the on-site construction worker. Although the extensive shallow soil sampling effort identifies only a few isolated locations of H_2S in soil gas approaching occupational health criteria (only one exceeds the Threshold Limit Value of 10 ppm) and the levels of the other COPCs are equally low relative to occupational health criteria, it is possible that the combination of an elevated H_2S pocket and the confined space of a excavation could lead to an ambient air concentration in excess of the worker health criteria. The possibility that worker exposures could exceed worker health criteria in this type of situation is recognized and is appropriately managed through a health and safety program.

There are several standard industry practices and OSHA/Cal OSHA regulations designed to protect workers from excessive exposure to hydrogen sulfide gas associated with biogenic emissions. At the request of Playa Vista, we previously prepared health and safety recommendations to address the potential occupational exposures to methane, hydrogen sulfide, and petroleum hydrocarbons, including BTEX during sub-surface investigation and construction activities at Playa Vista. A copy of the recommended health and safety procedures is attached for your reference.

Summary

The available data, including two quantitative determinations of possible ambient air concentrations of the chemicals of concern strongly support that the low levels of methane-like hydrocarbons, BTEX and H_2S found in soil gas at the Playa Vista project will not result in public health impacts with substantial margins of safety. While the possibility of construction worker (e.g., soil excavation) exposure to chemicals of concern above worker health criteria can not be excluded, the health and safety measures we recommended are designed to be protective of worker health and take into account the unknown nature of potential problems. Because a series of worst-case assumptions were used in this screening assessment, it is unlikely that more refined assessments, conducted once specific projects are better defined, will suggest high exposures and risks. Nevertheless, the results of health risk assessments will be used to assist in the design of specific mitigation measures, if any.

We are available at your convenience if you have any comments or questions.

Sincerely yours,
GEOMATRIX CONSULTANTS, INC

James W. Embree, Ph.D., DABT
Principal Toxicologist

[illegible]

Attachment

GEOMATRIX

Appendix B

RECOMMENDED HEALTH AND SAFETY PROCEDURES FOR OCCUPATIONAL EXPOSURES TO CHEMICALS OF CONCERN DURING SUB-SURFACE WORK ACTIVITIES AT THE PLAYA VISTA PROJECT SITE

These health and safety recommendations were prepared by Geomatrix Consultants at the request of Playa Vista Capital to address the potential occupational exposures to chemicals of concern during sub-surface investigation and construction activities at the Playa Vista project site. The primary chemicals of concern is shallow soil at the site are methane, hydrogen sulfide, and petroleum hydrocarbons, including the monoaromatic compounds of benzene, toluene, ethylbenzene and xylenes (collectively "BTEX"). These health and safety recommendations are limited to chemical exposure hazards to methane, hydrogen sulfide, and petroleum hydrocarbons, including BTEX, that may be present in the sub-surface and do not cover other types of hazards associated with work on this project.

CHEMICAL EXPOSURE HAZARD ASSESSMENT

Methane

Methane is a gas at normal temperatures and pressures. The primary hazard associated with methane is its explosivity. Methane forms an explosive mixture in air at concentrations between 5 and 15 %. Methane is practically inert and has no demonstrated physiological or toxicological effects. At very high concentrations, methane acts as a simple asphyxiant by causing oxygen deprivation.

Hydrogen Sulfide

Hydrogen sulfide is a gas under usual atmospheric conditions. Hydrogen sulfide is an irritant to the eyes and respiratory tract at low concentrations. At higher concentrations, it causes respiratory paralysis with consequent asphyxiation and, possibly, death. At lower concentrations, hydrogen sulfide (H_2S) has an odor similar to rotten eggs, however people rapidly lose the ability to smell it (olfactory fatigue), so odor is not an effective way of detecting the presence of H_2S. The California Occupational Safety and Health Administration (CalOSHA) permissible exposure limit for H_2S is 10 parts per million (ppm). The concentration considered immediately dangerous to life and health (IDLH) is 100 ppm.

Petroleum Hydrocarbons

Petroleum hydrocarbons are a mixture of a number of individual petroleum compounds falling into several broad categories of widely varying physical, chemical, and toxicological properties. In general, the majority of these compounds are of minimal concern with respect to human health hazards. However, certain mixtures contain several aromatic compounds that may be of concern. These include the monoaromatic compounds of BTEX present in gasoline and, to a lesser extent, in diesel fuel. BTEX compounds are volatile liquids and will readily evaporate into air. In addition to inhalation, people can also be exposed to BTEX through direct skin contact with the liquid.

With regard to toxicity, benzene is classified as a known human carcinogen based on the increased occurrence of leukemia in several worker populations exposed to high levels of benzene. Toluene, ethylbenzene, and xylenes are not considered to be carcinogens, however they can cause irritation of the mucous membranes and central nervous system depression at higher concentrations. They may also affect the liver or kidney following chronic exposure to low doses.

The table below lists Cal/OSHA permissible exposure limits (PELs)(Title 8, California code of Regulations, Section 5155), applicable Cal/OSHA STELs (short term exposure limits), and IDLH (Immediately Dangerous to Life or Health) values for selected chemicals of concern at the site. PELs are 8-hour time-weighted average exposure concentrations, and STELs are maximum recommend limits for exposure during a 15-minute period. IDLH values are non-regulatory criteria.

Chemical	PEL	STEL	IDLH
Methane	None	None	0.4% in air (10% of the lower explosive limit)
Hydrogen Sulfide	10 ppm	15 ppm	100 ppm
Benzene	1 ppm	5 ppm	500 ppm
Toluene	50 ppm	150 ppm	500 ppm
Ethylbenzene	100 ppm	125 ppm	800 ppm
Xylenes	100 ppm	150 ppm	900 ppm

PERSONAL PROTECTIVE EQUIPMENT

If petroleum-affected soil is encountered during sub-surface work for this project, personnel in contact with the affected soil should use the following personal protective equipment (PPE):

- Disposable Tyvek coverall
- Nitrile rubber gloves
- Rubber boots

In addition, personnel working near the affected soil should have available air-purifying respirators (full or half-face) with organic vapor cartridges. These personnel need to be participants in their employer's written respiratory protection program, including medical clearance to wear a respirator and recent fit-testing in the particular respirator they may use. The need for respiratory protection will be determined based upon results of air monitoring as discussed in the next section.

GEOMATRIX

AIR MONITORING AND ACTION LEVELS

The following air monitoring should be conducted during all sub-surface work activities for this project. Personnel performing the air monitoring must be trained in proper use of the equipment. All instruments should be maintained and calibrated according to manufacturer's specifications.

Methane

Monitor continuously for methane in all trenches and excavations during excavation, prior to any entry, and during entry using a combustible gas meter (CGM) calibrated to methane. Also monitor continuously for methane at the tops of any bore holes being drilled.
If the CGM reads 10 % of the LEL (lower explosive limit) or more, evacuate all personnel from the excavation, stop work, and allow the excavation to ventilate. If CGM readings over 10% of the LEL are encountered during drilling, stop work and allow the borehole to ventilate. Atmospheres inside boreholes can be rendered inert by introducing nitrogen gas into the bottom of the borehole or by adding dry ice (solid carbon dioxide) to the borehole. These gases will displace oxygen in the borehole over a period of time. Continue monitoring until CGM readings drop below 10% of the LEL or oxygen levels drop below 10%. (Note: most CGMs will not operate properly in reduced oxygen environments. Typical multigas instruments will have both LEL and oxygen meters, and both types of monitoring should be used when checking boreholes after the addition of nitrogen or dry ice.)

Hydrogen Sulfide

Monitor continuously for H2S in personnel breathing zone spaces during all sub-surface work using an H2S meter. Monitor for H2S in trenches and excavations prior to and during entry. If the H2S meter reads 10ppm or more, stop work and evacuate personnel from areas with high H2S readings until readings have dropped below 10 ppm

Petroleum Hydrocarbons

If petroleum-affected soil is encountered during sub-surface work, monitor for volatile organic compounds in personnel breathing zones using a photoionization detector (PID). In addition, monitor intermittently for benzene using colorimetric tubes (e.g., Draeger Tubes).
Respirators should be worn when air monitoring indicates that concentrations in the breathing zone air exceed the following action levels:

VOC Concentration	Action
PID < 5 ppm	Continue air monitoring
PID = 5 to 20 ppm	Monitor for benzene using colorimetric tubes
PID > 20 ppm (or) Benzene detector tube > 1 ppm	Wear half-face respirators with organic vapor cartridges
PID > 100 ppm (or) Benzene detector tube > 10 ppm	Wear full-face respirators with organic vapor cartridges
PID > 1000 ppm (or) Benzene detector tube > 50 ppm	Stop work. Evacuate the area. Evaluate the need for supplied air respiratory protection

PERSONNEL WORK PRACTICES AND DECONTAMINATION

1. Personnel should wear protective equipment and clothing as required.

2. Personnel should not eat, drink, or use tobacco in work areas where chemical hazards are present.

3. Personnel should remove Tyvek coveralls and nitrile gloves and wash their hands and face with soap and water prior to eating, drinking, tobacco use, and at the end of the workday.

TRAINING

Personnel engaged in sub-surface work at the Playa Vista project site should be trained in the potential chemical hazards they may encounter. Training should include chemical hazard information, use of required PPE, and other information included in this appendix. If respirators are to be used, training, fit testing, medical evaluations and all other aspects of the Cal/OSHA respirator regulations must be followed.

BUILDING AND SAFETY COMMISSIONERS

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JOYCE L. FOSTER
VICE-PRESIDENT

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ANDREW A. ADELMAN
GENERAL MANAGER

WALTER R. KRUKOW
EXECUTIVE OFFICER

January 31, 2001

ATTACHMENT 4

David Nelson
Senior Vice President
Playa Capital Company
12555 W. Jefferson Bl., #300
Los Angeles, California 90066

CURRENT REFERENCE REPORT/LETTERS	REPORT NO.	DATE(S) OF DOCUMENT	PREPARED BY
Methane Report	-	1/31/01	ETI

The report concerning the Playa Del Rey Gas Storage Field and the Lincoln Boulevard fault has been reviewed by the Grading Section of the Department of Building and Safety. According to the report, the "combined geochemical and geophysical information proves beyond a reasonable doubt that the methane gas seepage observed on the Playa Vista site does not come from the Southern California Gas Storage Field." The Department of Building and Safety accepts this conclusion.

DAVID HSU
Chief of Grading Section

(213) 977-6329

cc: Exploration Technologies, Inc.

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METHANE SAMPLING DATA ASSESSMENT
PLAYA VISTA DEVELOPMENT
LOS ANGELES, CALIFORNIA

February 7, 2001

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A Report Prepared for:

City of Los Angeles
Department of Public Works/Bureau of Engineering
650 South Spring Street, Suite 600
Los Angeles, California 90014-1911

METHANE SAMPLING DATA ASSESSMENT
PLAYA VISTA DEVELOPMENT
LOS ANGELES, CALIFORNIA

Kleinfelder Job No. 58-9503-01-001

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February 7, 2001

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EXECUTIVE SUMMARY

Kleinfelder evaluated existing information regarding methane concentrations detected in soil gases measured by several investigators at the Playa Vista development in Los Angeles, California. Kleinfelder reviewed information regarding soil gas methane concentrations measured at the Playa Vista site from the following resources: (1) files maintained by the Regional Water Quality Control Board, Los Angeles Region (RWQCB); (2) files maintained by the City of Los Angeles, Geotechnical Engineering Division; and (3) documents supplied for our review by Playa Capital and their consultants. Based on our review of the available resources, the following key documents were selected for more detailed evaluation:

- ENSR, 1997. Data Review and Limited Phase II Subsurface Site Assessment at Playa Vista Property. ENSR, Inc. October.
- CDM, 1998. Report Methane Management Recommendations Playa Vista First Phase. Camp, Dresser & McKee, Inc. October 14.
- Sepich, 1999. Methane Recommendations Related to Issuance of Mass Grading Permit at Proposed Playa Vista Project, Los Angeles, California. Sepich Associates, Inc. April 2.
- CDM, 1999. Methane Report Playa Vista Second Phase. Camp, Dresser & McKee, Inc. April 29
- ETI, 2000. Subsurface Geochemical Assessment of Methane Gas Occurrences – Playa Vista Development, First Phase Project. Exploration Technology, Inc. April 17.
- CDM, 2000a. Report of Sampling and Analysis of Soil Gas for Methane – Phase 2 Portion of Playa Vista. Camp, Dresser & McKee, Inc. November 2.
- CDM, 2000b Report of Sampling and Analysis of Soil Gas for Methane in Tracts 49104-01, -03, -05, -05, and -06 – Playa Vista, Area D. Camp, Dresser & McKee, Inc. November 9.

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GENERAL OBSERVATIONS

- Methane has been detected at varying concentrations in soil gas samples collected throughout the Playa Vista project site
- Methane has been detected in groundwater, located at approximately 50 feet below ground surface (bgs). This layer has been referred to in site-related documents as the "gravel aquifer."
- The origin of methane detected in soil gas and groundwater at the site appears to be related primarily to a deep thermogenic source. However, several samples have been collected that indicate there may be secondary shallow source areas comprised of decaying biological material.
- Soil gases generated at depth appear to be charging the gravel aquifer, which in turn appears to be releasing gases to the near-surface soils.

COMPARISON OF REPORTED DATA

CDM (CDM 2000b) performed a brief study to evaluate the differences between soil gas data collected using ETI's non-standard methods (ETI 2000), and those required by the State of California, Regional Water Quality Control Board (RWQCB). Soil gas samples were collected at six locations in which ETI had previously reported elevated methane levels (ETI 2000). Four discrete grab samples were collected and analyzed at each of the six locations: two using the RWQCB method, and two using the ETI method (ETI 2000). The following summarizes the primary findings of the comparison:

- Samples collected using the ETI method were higher in methane concentration than the RWQCB samples at each location.
- The highest variance in methane concentration was detected in samples collected using the ETI method (zero to 3 orders of magnitude). Paired RWQCB samples varied in methane concentration by zero to one order of magnitude.
- Paired RWQCB and ETI samples varied in methane concentration from zero to four orders of magnitude.

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- No "false positives" or "false negatives" were indicated with either method. In other words, methane concentrations were detected using both methods, but the magnitude of the concentration detected varied between the methods.

VARIANCE OF METHANE CONCENTRATIONS

Variations in methane concentrations were assessed with respect to geographic location and sampling / analysis techniques (CDM 2000b). However, the following potential shortcomings were noted during this assessment:

- Soil gas samples for each of the reviewed studies were referenced with respect to depth below local ground surface. Data were not reported with respect to elevation above mean sea level. As a result, variations in methane concentrations could not be assessed with respect to discontinuities in topographic features (e.g., surcharge soil stockpiles, pits, mounds, and other surface undulations).
- Variations in methane concentrations were not assessed with respect to deep and near-surface soil lithologies (i.e., the presence of sands and clayey materials were not compared to detected methane levels).
- Variations in methane concentrations were not assessed with respect to time, season, barometric pressure, or other variables known to affect the distribution and concentration of detected soil gases. As a result, it is not known whether the observed variation in paired sampling results may have been attributable to the ephemeral nature of soil gas-related methane concentrations.

DATA TRENDS

- Methane levels appear to be highest in the western portion of the Playa Vista project site.
- Helium was not detected in soil gas samples collected at the Playa Vista project site. Based on this finding and the results of isotopic analyses, methane detected in soil gas samples is not associated with the nearby natural gas reservoir (Sepich 1999, ETI 2000).

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- Levels of benzene, toluene, ethylbenzene, and xylenes (commonly referred to as BTEX) were detected infrequently, and at low concentration in data reported in each of the reviewed studies (CDM 2000a, CDM 2000b, ETI 2000). Although it is possible that BTEX compounds detected at the site may be attributable to a deep thermogenic source, BTEX levels do not appear to be associated with methane concentrations. BTEX was infrequently detected at sample locations where high methane levels were reported. Locations of peak BTEX levels did not coincide with locations of peak methane levels (CDM 2000b). ETI indicates in their report (ETI 2000) that BTEX levels at the site are assumed to be associated with contaminants present in near-surface soils or groundwater.
- Hydrogen sulfide was detected at relatively low levels in each of the reviewed studies. Data indicated that the presence of hydrogen sulfide is not well correlated with methane. Hydrogen sulfide appears to be associated with biological decomposition of near-surface materials.

EFFECT OF SURFACE DISTURBANCE ACTIVITIES

Samples collected before and after construction activities associated with the Fountain Park Apartments (Tract 03) indicate that the surface disturbances associated with installing 1,000 stone columns, piles and infrastructure improvements did not affect the concentration or distribution of subsurface methane in Tract 03 (CDM 2000a).

SUMMARY AND RECOMMENDATIONS

- A potential exists for methane present beneath the Playa Vista project site to collect under building slabs, roadways, parking lots, and other structures.
- Methane mitigation systems are required for the site, and should be installed in accordance with specifications provided by the City of Los Angeles Department of Building and Safety, in 71 LABC, and Memorandum of General Distribution (MGD) No. 92.
- Other routine methane mitigation measures not addressed by the City code, such as utility trench plugs and yard vault protection should be implemented for private and public structures to be erected at the site.

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- The California Division of Oil and Gas and Geothermal Resources (DOGGR) must certify that oil wells at the project site have been properly abandoned.
- As recommended by Sepich and Associates (Sepich 1999), a qualified methane engineer should design and oversee installation of the methane mitigation system, comprised of the design elements and procuring the approvals recommended in Sepich and Associates April 2, 1999 report.
- No area of the site is identified as exempt from methane control unless proposed by a qualified methane engineer.
- The methane mitigation systems described in the preceding discussion have been effective in a variety of residential and commercial environments in southern California. The systems are considered by the City of Los Angeles Department of Building and Safety, City of Los Angeles Fire Department, and other California regulatory agencies to be adequate to protect the health and safety of the future residential and commercial occupants of methane affected sites.
- ETI has recommended installation of a groundwater treatment system to remove methane from the gravel aquifer (ETI 2000). Insufficient data have been presented by ETI to provide a chemical, geological, hydrogeological, and engineering justification for the recommended system. The rationale presented by ETI suggests that a groundwater treatment system would be necessary to provide protection during potential upset events (i.e., possible releases of large quantities of soil gas during a seismic event). Based on Kleinfelder's review of the ETI report and experience with similar sites, the proposed groundwater treatment system would only supplement the methane mitigation system specified in the Los Angeles code, and would provide no greater protection during an upset event.

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1.0 INTRODUCTION

An assessment of soil gas methane data collected by various researchers at the Playa Vista development site in Los Angeles, California was performed for the following purposes:

- Assess the influence of differing analytical techniques upon conclusions regarding potential methane hazards at the Playa Vista Development.
- Identify trends evident in soil gas methane sampling data collected at the site. In addition, evaluate trends, if any, in the distribution of other soil gases (i.e., hydrogen sulfide and BTEX compounds).
- Assess the adequacy of collected data in characterizing methane concentrations at the site.
- Evaluate the adequacy of soil gas mitigation systems proposed for installation at the Playa Vista development.

The remainder of this document is organized as follows: Section 2 identifies the key documents reviewed as part of this assessment, and summarizes the pertinent aspects of each document; Section 3 presents a comparison of the reported data, and addresses the variance in methane concentrations observed between the different studies performed; Section 4 identifies the trends observed during comparison of data collected by the various researchers, and addresses the adequacy of collected data in characterizing methane concentrations at the site; and Section 5 presents conclusions regarding the adequacy of soil gas mitigation systems proposed for installation at the Playa Vista development.

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2.0 SUMMARY OF EXISTING METHANE DATA

Kleinfelder reviewed information regarding soil gas methane concentrations measured at the Playa Vista site from the following resources: (1) files maintained by the Regional Water Quality Control Board, Los Angeles Region (RWQCB); (2) files maintained by the City of Los Angeles, Geotechnical Engineering Division; and (3) documents supplied for our review by Playa Capital and their consultants. Based on our review of the available resources, the following key documents were selected for more detailed evaluation:

- ENSR, 1997. Data Review and Limited Phase II Subsurface Site Assessment at Playa Vista Property. ENSR, Inc. October.
- CDM, 1998. Report Methane Management Recommendations Playa Vista First Phase. Camp, Dresser & McKee, Inc. October 14.
- Sepich, 1999. Methane Recommendations Related to Issuance of Mass Grading Permit at Proposed Playa Vista Project, Los Angeles, California. Sepich Associates, Inc. April 2.
- CDM, 1999. Methane Report Playa Vista Second Phase. Camp, Dresser & McKee, Inc. April 29.
- ETI, 2000. Subsurface Geochemical Assessment of Methane Gas Occurrences – Playa Vista Development, First Phase Project. Exploration Technology, Inc. April 17.
- CDM, 2000a. Report of Sampling and Analysis of Soil Gas for Methane – Phase 2 Portion of Playa Vista. Camp, Dresser & McKee, Inc. November 2.
- CDM, 2000b. Report of Sampling and Analysis of Soil Gas for Methane in Tracts 49104-01, -03, -05, -05, and -06 – Playa Vista, Area D. Camp, Dresser & McKee, Inc. November 9.

Table 2-1 provides a brief synopsis of the technical aspects of each report, with respect to useful information and potential shortcomings.

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TABLE 2-1
SUMMARY OF METHANE OBSERVATIONS

Study Area	Data Source	Technical Attributes	Description of Assessment	Description of Measurements	Quality Assurance Methods	Observations/ Assumptions	Report Recommendation
Methane Data Assessment	ENSR, 1997	Qualitative, screening-level assessment.	Screening-level assessment based on an irregularly spaced array of 37 sampling locations (26 locations in Area D). Soil gas was measured using FID and PID at 5 feet below ground surface. Selected soil gas samples were collected for analysis by a fixed laboratory. ***The sample collection method did not comply with LARWQCB guidelines.*** Ground water samples were not collected from soil gas borings.	Qualitative (i.e., order of magnitude) accuracy for field measurements and laboratory analyses, due to collection method (the sample collection method did not comply with LARWQCB guidelines) Field FID measurements ranged from 0 to > 1,000 ppm (maximum instrument reading). Eight soil gas samples were sent to a fixed laboratory for analysis of methane, and related gases. Methane levels ranged from 300 ppm to 44,000 ppm. Ethane and other measured light gases correlated with methane levels. Laboratory results correlated with field measurements. Hydrogen sulfide was measured only in the samples sent to the laboratory, and was detected in only one of the analyzed samples, at a concentration of 3.3 ppm.	The sample analysis method did not comply with LARWQCB guidelines. Calibration of field instruments was performed. Selected samples were collected in Tedlar bags and analyzed at a fixed laboratory.	No assumptions were made. Study was investigative.	Additional investigation of the magnitude and extent of elevated methane zone(s)

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TABLE 2-1 (*Continued*)
SUMMARY OF METHANE OBSERVATIONS

Study Area	Data Source	Technical Attributes	Description of Assessment	Description of Measurements	Quality Assurance Methods	Observations/ Assumptions	Report Recommendatio
Methane Data Assessment (continued)	CDM, 1998	Quantitative, screening-level assessment	Screening-level assessment based on two separate field surveys. In the first survey (February 1998), four locations were sampled in the west portion of Area D (adjacent to ENSR, 1997 locations reporting elevated methane) Soil gas samples were collected in syringe and Mylar bags between 3 and 9 feet below ground surface. Soil gas concentrations were measured in syringe samples using an onsite laboratory. Mylar bag samples were sent to a fixed laboratory for analysis One groundwater sample was collected from a soil gas boring in February 1998 In June 1998, the second soil gas survey, focusing on the eastern portion of Area D was performed. 50 soil gas samples were collected in this survey. Soil gas was measured using FID and PID at 5 feet below ground surface. Eight soil gas samples were collected for subsequent analysis at a fixed laboratory. Groundwater samples were not collected during the June, 1998 survey	Quantitative accuracy for field and fixed lab measurements. Collection and analysis of field and laboratory samples complied with LARWQCB guidelines. February 1998: Field soil gas measurements ranged from 1 to 81 percent methane. Methane levels reported by the fixed laboratory ranged from 0.1 to 84 percent. Ethane and other measured light gases did not correlate with methane levels. Laboratory results correlated with field measurements. Methane concentrations measured by CDM were higher than those measured by ENSR, but peak values were found in the same locations. Low levels of hydrogen sulfide were detected in each analyzed sample. Isotope analysis of two samples indicated methane is between 23,000 and 46,000 years old. ***Isotope analysis indicates dissimilarities with gas reservoir.*** 8 percent methane was detected in the groundwater sample (soil gas methane level at this location was 41 percent). June 1998: Field soil gas measurements indicated that methane is present in the eastern portion of Area D, but at low levels: from 0 to >1,000 ppm. Methane levels reported by the fixed laboratory ranged from non-detect to 1,600 ppm. Ethane results correlated with elevated methane levels. Laboratory results correlated with field measurements. Hydrogen sulfide and isotope analyses were not performed on these samples.	Collection and analysis of field and laboratory samples complied with LARWQCB guidelines. Analyses for methane and related light gases were performed by California certified laboratories. Isotope analyses were performed by Lawrence Livermore National Laboratory.	Elevated methane levels reported by ENSR, 1997 are not correlated with utility or well locations Methane may be related to bacterial decomposition of an ancient lagoon area. Assumption is based on analysis of two samples	A gas control specialist should participate in the formulation of detailed developme plans for the weste portion of Area D t identify specific methane mitigation management measures for the proposed buildings. Plans should be reviewed by the Cit of Los Angeles Department of Building and Safety

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TABLE 2-1 (*Continued*)
SUMMARY OF METHANE OBSERVATIONS

Study Area	Data Source	Technical Attributes	Description of Assessment	Description of Measurements	Quality Assurance Methods	Observations/ Assumptions	Report Recommendation
Methane Data Assessment	Sepeh, 1999	Qualitative, screening-level assessment	The report briefly summarized the results of previous soil gas investigations performed at the Playa Vista site. Five methane monitoring wells were installed at the site. The wells were completed in three zones (shallow vadose, mid-Lakewood Aquifer sands, and Ballona Aquifer – also known as the "50-foot gravel aquifer")	The laboratory results closely confirmed the field combustible gas concentrations, and also identified the gas found in the sandy zone at well #3 to be isotopically nearly identical to the gas found in the deeper gravelly zone at well#2. The methane concentrations ranged from 0.40 percent to 82.5 percent.	Collection and analysis of field and laboratory samples complied with LARWQCB guidelines. Analyses for methane were performed by a California certified lab.	Based on previous investigations, especially the October 14, 1998 CDM report, soil gases at the site appear to be related to a thermogenic source of methane, largely of marine microbial nature.	Methane mitigation systems are required for construction of buildings at the site.
Methane Data Assessment (continued)	CDM, 1999	Quantitative, screening-level assessment	Screening-level assessment based on an irregularly spaced array of 35 sampling locations (9 locations in Area D). Soil gas was measured using FID and PID at 5 feet below ground surface. Ten soil gas samples (4 from Area D) were collected for subsequent analysis at a fixed laboratory. Ground water samples were not collected from soil gas borings.	Quantitative accuracy for field and fixed lab measurements. Collection and analysis of field and laboratory samples complied with LARWQCB guidelines Field FID measurements ranged from <1 to >10,000 ppm. Methane levels reported by the fixed laboratory ranged from 3 to 15,000 ppm. Ethane and other measured light gases did not correlate with methane levels. Laboratory results correlated with field measurements. Hydrogen sulfide levels were not analyzed. Isotope analysis of one sample indicates methane is recent, less than 200 years old, and possibly from decomposition of old lagoon deposits.	Collection and analysis of field and laboratory samples complied with LARWQCB guidelines. Analyses for methane and other gases were performed by a California certified lab. Laboratory methods met or exceeded Level III QA/AC requirements and were in accordance with the RWQCB Well Investigation Program (WIP). A Chicago laboratory performed isotope analyses.	Methane may be related to bacterial decomposition of an ancient lagoon area. Assumption is based on analysis of one sample.	A gas control specialist should participate in the formulation of detailed development plans for the western portion of Area D to identify specific methane mitigation management measures for the proposed buildings. Plans should be reviewed by the City of Los Angeles Department of Building and Safety

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TABLE 2-1 (*Continued*)
SUMMARY OF METHANE OBSERVATIONS

Study Area	Data Source	Technical Attributes	Description of Assessment	Description of Measurements	Quality Assurance Methods	Observations/ Assumptions	Report Recommendation
Methane Data Assessment (Continued)	1111 2000	Qualitative, detailed assessment	Two shallow soil vapor surveys based on a regularly-spaced array of 812 sampling locations, placed on a 100-foot staggered grid (602 locations in Area D). Soil gas samples were collected at 4 feet below ground surface. Samples were collected in glass vials, and shipped to a fixed laboratory for analysis. ***The sample collection method did not comply with LARWQCB guidelines.*** Groundwater samples were collected from 41 monitoring wells screened in the 50-foot gravel aquifer. 32 of the wells were installed by CDM as part of the author's assessment. 9 monitoring wells were installed prior to the initiation of the author's investigation. Dissolved gas and free gas samples were collected from the monitoring wells. Note: The author reports observations regarding "minor blowouts" occurring during CDM's drilling of the groundwater monitoring wells. The author does not substantiate this observation in his report, and CDM boring logs contain no references to these occurrences.	The soil gas sample collection method used in this assessment does not comply with LARWQCB guidelines. Non-standard methods were employed to collect water samples. The laboratories used to analyze samples are not certified by the State of California. Sampling and analysis activities were not performed or overseen by a registered California Geologist or Professional Engineer. Soil gas samples were analyzed by the fixed laboratory for methane, ethane, and related light gases. Methane results ranged from < 1 ppm to 80 percent. Ethane and related light gases appeared to be correlated with elevated methane. Soil gas samples were also analyzed for BTEX and hydrogen sulfide content. BTEX was non-detect in most samples, and at low levels (i.e., ppb-range) when detected. Hydrogen sulfide was detected in the ppb-range in most samples, except for 9 readings between 1 and 7 ppm, and one reading at 41 ppm. Dissolved gas and free gas samples collected from site groundwater monitoring wells were analyzed by the fixed laboratory for methane, ethane, and related light gases. Methane was reported between 0.14 and 48 mg/L in dissolved gases, and between 0.29 and 98 percent in free gas samples. Free gas samples collected from site groundwater monitoring wells were also analyzed by the fixed laboratory for carbon isotopes. Based on the results of this analysis, the lab analyst concluded the methane to be thermogenic in origin.	The report contains Quality Assurance procedures to be followed in the collection, analysis, and interpretation of results. However, the report contains no documentation verifying that the adopted QA/AC procedures were in fact implemented. No information is provided for calibration, matrix spikes, duplicate samples, etc. No laboratory report is provided as part of the report. No field logs are provided to document sampling of soil gas or groundwater. Hydrogen sulfide was analyzed using a field instrument. Fixed lab verification of field-hydrogen sulfide was not performed. ***The sample collection method did not comply with LARWQCB guidelines. Samples were not analyzed by a California certified laboratory.***	Based on isotope evaluation, groundwater sampling data, and other observations, elevated methane is derived from two independent thermogenic sources (one near Lincoln Blvd. and one near the center portion of Area D). Soil gases are migrating to the surface via an active fault (newly proposed by the author as the "Lincoln Blvd. Fault". Minor "blowouts" were observed during drilling of CDM groundwater monitoring wells. Ethane and related light gases (termed by the author as "methane homologs") are correlated with elevated methane levels. Hydrogen sulfide and BTEX levels in soil gas are attributable to near-surface, man-made sources.	The author claims that a seismic event having an epicenter close to the propose development could potentially cause a rapid flux of large volumes of methane gas to the surface along the proposed "Lincoln Blvd. Fault". Therefore, methane mitigation and monitoring systems should be required for all buildings in the first development phase. In addition, a groundwater pump and treat system is recommended to remove methane from the 50-foot gravel aquifer. Continuously measure methane gas concentrations in the 50-foot gravel aquifer. Additional assessment is required in other areas of the first and second development phases. Two adjacent oil wells should be reabandoned.

TABLE 2-1 (*Continued*)
SUMMARY OF METHANE OBSERVATIONS

Study Area	Data Source	Technical Attributes	Description of Assessment	Description of Measurements	Quality Assurance Methods	Observations/ Assumptions	Report Recommendation
Methane Data Assessment	CDM, 2000a	Quantitative detailed assessment	CDM observed the collection of soil gas samples from 215 locations within Areas A, B, C and D (Phase 2 Portion) of Playa Vista between October 2 and 10, 2000	Soil gas in much of Area B could not be completed as the water table was too close to the land surface. The samples were tested for light hydrocarbons (C-1 to C-4). The detected levels of methane ranged from a minimum of 0.85 ppmv (parts per million per, by volume) to a maximum of 159,900 ppmv.	Soil gas sampling and analysis was performed in accordance with previous ETI methods (ETI 2000) Analyses for methane were not performed by a California certified lab.	None described in the report.	None described in th report.

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TABLE 2-1 (*Continued*)
SUMMARY OF METHANE OBSERVATIONS

Methane Data Assessment	CDM, 2000b	Quantitative, detailed assessment	CDM observed the collection of soil gas samples from 198 locations within Area D (Tract 01, 03, 05, and 06) of Playa Vista between August 14 and 22, 2000	192 soil gas samples were collected, using ETI's method, in Tract 03 near the zone in which approximately 1,000 stone columns, and infrastructure improvements had been recently installed. Laboratory data summarized in the report indicates that methane peaks coincide with peaks of other light gases. Methane levels ranged from 0.85 ppmv to 28 percent. An addition 6 locations were separately assessed in Tracts 01, 05, and 06. Three locations were adjacent to sites at which ETI had previously reported high methane concentrations (ETI 2000). The remaining three were at locations where ETI had previously reported lower methane levels. Four discrete grab samples were collected at each location (2 using the RWQCB method, and 2 using the ETI method). Methane ranged from 7.6 ppmv to 88 percent.	Soil gas sampling and analysis was performed in accordance with previous ETI methods (ETI 2000). Sampling of 6 locations in Tracts 01, 05, and 06 were performed in accordance with LARWQCB protocol Analyses for methane were not performed by a California certified lab.	None described in the report.	None described in t report.

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Review of the preceding documents indicates that over 1,200-soil gas methane samples have been collected in recent years, focused in an area of approximately 200 acres, at the Playa Vista development. Samples have been collected using a variety of methods, and the analytical results have been used to support a varying array of conclusions.. Notwithstanding the variations between the methods and times at which soil gas methane concentrations have been sampled at the site, the following general observations are evident based on a review of the available data:

- Methane has been detected at varying concentrations in soil gas samples collected throughout the Playa Vista project site.
- Methane has been detected in groundwater, located at approximately 50 feet below ground surface (bgs). This layer has been referred to in site-related documents as the "gravel aquifer."
- The origin of methane detected in soil gas and groundwater at the site appears to be related primarily to a deep thermogenic source. However, several samples have been collected that indicate there may be secondary shallow source areas comprised of decaying biological material.
- Soil gases generated at depth appear to be charging the gravel aquifer, which in turn appears to be releasing gases to the near-surface soils.

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3.0 COMPARISON OF REPORTED DATA

CDM (CDM 2000b) performed a brief study to evaluate the differences between soil gas data collected using ETI's non-standard methods (ETI 2000), and those required by the State of California, Regional Water Quality Control Board (RWQCB). Soil gas samples were collected at six locations in which ETI had previously reported elevated methane levels (ETI 2000). Four discrete grab samples were collected and analyzed at each of the six locations: two using the RWQCB method, and two using the ETI method (ETI 2000). The following summarizes the primary findings of the comparison:

- Samples collected using the ETI method were higher in methane concentration than the RWQCB samples at each location.
- The highest variance in methane concentration was detected in samples collected using the ETI method (zero to 3 orders of magnitude). Paired RWQCB samples varied in methane concentration by zero to one order of magnitude.
- Paired RWQCB and ETI samples varied in methane concentration from zero to four orders of magnitude.
- No "false positives" or "false negatives" were indicated with either method. In other words, methane concentrations were detected using both methods, but the magnitude of the concentration detected varied between the methods.

Variations in methane concentrations were assessed with respect to geographic location and sampling / analysis techniques (CDM 2000b). However, the following potential shortcomings were noted during this assessment:

- Soil gas samples for each of the reviewed studies were referenced with respect to depth below local ground surface. Data were not reported with respect to elevation above mean sea level. As a result, variations in methane concentrations could not be assessed with respect to discontinuities in topographic features (e.g., surcharge soil stockpiles, pits, mounds, and other surface undulations).

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- Variations in methane concentrations were not assessed with respect to deep and near-surface soil lithologies (i.e., the presence of sands and clayey materials were not compared to detected methane levels).
- Variations in methane concentrations were not assessed with respect to time, season, barometric pressure, or other variables known to affect the distribution and concentration of detected soil gases. As a result, it is not known whether the observed variation in paired sampling results may have been attributable to the ephemeral nature of soil gas-related methane concentrations.

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4.0 DATA TRENDS

The volume of data and the thoroughness of the sampling performed in recent years at the Playa Vista development yield a dataset that is more than adequate for the assessment of potential methane hazards and design of appropriate mitigation measures. Based on a review of the documents cited in Section 2, the following data trends have been identified in soil gas samples collected at the Playa Vista development:

- Methane levels appear to be highest in the western portion of the Playa Vista project site.
- Helium was not detected in soil gas samples collected at the Playa Vista project site. Based on this finding and the results of isotopic analyses, methane detected in soil gas samples is not associated with the nearby natural gas reservoir (Sepich 1999, ETI 2000).
- Levels of BTEX were detected infrequently, and at low concentration in data reported in each of the reviewed studies (CDM 2000a, CDM 2000b, ETI 2000). Although it is possible that BTEX compounds detected at the site may be attributable to a deep thermogenic source, BTEX levels do not appear to be associated with methane concentrations. BTEX was infrequently detected at sample locations where high methane levels were reported. Locations of peak BTEX levels did not coincide with locations of peak methane levels (CDM 2000b). ETI indicates in their report (ETI 2000) that BTEX levels at the site are assumed to be associated with contaminants present in near-surface soils or groundwater.
- Hydrogen sulfide was detected at relatively low levels in each of the reviewed studies. Data indicated that the presence of hydrogen sulfide is not well correlated with methane. Hydrogen sulfide appears to be associated with biological decomposition of near-surface materials.
- Samples collected before and after construction activities associated with the Fountain Park Apartments (Tract 03) indicate that the surface disturbances associated with installing 1,000 stone columns, piles and infrastructure improvements did not affect the concentration or distribution of subsurface methane in Tract 03 (CDM 2000a).

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5.0 SUMMARY AND RECOMMENDATIONS

The following presents a list of the primary observations noted during the performance of this methane data assessment. In addition, the following list highlights Kleinfelder's recommendations regarding mitigation of the potential methane hazard identified at the Playa Vista development:

- A potential exists for methane present beneath the Playa Vista project site to collect under building slabs, roadways, parking lots, and other structures.
- Methane mitigation systems are required for the site, and should be installed in accordance with specifications provided by the City of Los Angeles Department of Building and Safety, in 71 LABC, and Memorandum of General Distribution (MGD) No. 92.
- Other routine methane mitigation measures not addressed by the City code, such as utility trench plugs and yard vault protection should be implemented for private and public structures to be erected at the site.
- The California Division of Oil and Gas and Geothermal Resources (DOGGR) must certify that oil wells at the project site have been properly abandoned.
- As recommended by Sepich and Associates (Sepich 1999), a qualified methane engineer should design and oversee installation of the methane mitigation system, comprised of the design elements and procuring the approvals recommended in Sepich and Associates April 2, 1999 report.
- No area of the site is identified as exempt from methane control unless proposed by a qualified methane engineer.
- The methane mitigation systems described in the preceding discussion have been effective in a variety of residential and commercial environments in southern California. The systems are considered by the City of Los Angeles Department of Building and Safety, City of Los Angeles Fire Department, and other California regulatory agencies to be adequate to protect the health and safety of the future residential and commercial occupants of methane affected sites.
- ETI has recommended installation of a groundwater treatment system to remove methane from the gravel aquifer (ETI 2000). Insufficient data have been presented by ETI to provide

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a chemical, geological, hydrogeological, and engineering justification for the recommended system. The rationale presented by ETI suggests that a groundwater treatment system would be necessary to provide protection during potential upset events (i.e., possible releases of large quantities of soil gas during a seismic event). Based on Kleinfelder's review of the ETI report and experience with similar sites, the proposed groundwater treatment system would only supplement the methane mitigation system specified in the Los Angeles code, and would provide no greater protection during an upset event.

In summary, methane mitigation measures required for this project and by the City of Los Angeles, Department of Building and Safety are more than adequate to address the potential hazards associated with this gas.

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6.0 REFERENCES

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STATE OF CALIFORNIA – THE RESOURCES AGENCY

GRAY DAVIS, *Governor*

DEPARTMENT OF CONSERVATION

5816 Corporate Avenue, Suite 200
Cypress, CA 90630-4731

(714) 816-6847
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713271



RECEIVED BY

OCT 19 2000

MIKE MICHALSKI C.E.G.

October 10, 2000

Mr. Vitaly B. Troyan
City Engineer
Department of Public Works
650 South Spring Street, Suite 200
Los Angeles, CA 90014

RE: Southern California Gas Company Gas-Storage Project Operations

Dear Mr. Troyan:

Thank you for your letter regarding the gas storage project and its relationship to the Playa Vista Project. The following is provided to address the issues expressed in your letter.

The Division's oversight of gas-storage projects consists of three elements: project review meetings, facilities testing, and environmental compliance inspections.

At least once a year, Division staff meet with project operators to review all aspects of each project, including any new geologic data, performance graphs, wellsite monitoring reports, pollution prevention activities at wellsites and facilities, and hydrogen sulfide production and its treatment. In addition, reservoir pressure graphs, which track the project's gas-injection rates and surface and inventory pressures, and reports on any gas waste or loss are reviewed. The reviews for Playa del Rey indicate that all reservoir conditions are consistent with prior year's performance and no gas losses are occurring within the project.

The most recent facilities testing at Playa del Rey took place in December 1998 and April 2000. Minor deficiencies were noted and all were corrected. Additional safety system testing is witnessed by Division engineers twice a year. The Division also witnesses tests of the surface and subsurface safety valves even if a well is inactive. All safety systems must be operational before a well can be put on line.

Environmental inspections are carried out annually by Division staff. If problems are found, they are corrected immediately by the operator or a follow-up inspection is

scheduled to confirm that corrective actions have been completed. The Division's last inspection was conducted on January 14, 2000, with a follow-up in March. The latest inspection indicated that Southern California Gas Company was in full compliance with Division regulations.

The overall safety and performance of Southern California Gas Company in Playa del Rey has been excellent. Furthermore, the gas company has received the Division's Outstanding Lease and Facility Maintenance Award for its "Dunlap" lease for 12 consecutive years, and for the "Treasure" and Blackline" leases for 7 consecutive years. This award is presented only to operators who have maintained their leases in an exemplary manner.

Our records indicate that there have been no significant problems or deviance from Division regulations. Our inspection records show that any problems are always corrected in a very timely manner.

As shown in the studies we have reviewed and the information we have received from the Playa Vista developer, Southern California Gas Company, and the Exploration Technologies, Inc. report for the City of Los Angeles, there are areas of the project where gas seepage is present. However, we have no information to indicate that any of this gas is derived from the Southern California Gas Company Playa del Rey gas storage project. (Tracer materials are added to the stored gas for leak-detection and other purposes.)

Concerning your final question regarding the plugging and abandonment requirements for wells, the Division will require any project proponent to replug any wells present in the project area to present-day standards. Also, if any unrecorded wells are discovered, the Division will require these wells to be plugged and abandoned to present-day standards. The Division will recommend that all wells be vented if a structure is to be placed over or in proximity of a well.

I hope that the above discussion has addressed your concerns regarding the Playa del Rey gas-storage project. If you have any other questions, please call me.

Sincerely,

R. K. Baker
District Deputy
Division of Oil, Gas, and Geothermal Resources

RKB:bd

RF [illegible] OF ENGINEERING
[illegible]VE SERVICES
[illegible]TER FILES

OCT 13 2000

ASSIGNED: MICHALSKI

Publication No. PR06

1999 ANNUAL REPORT OF THE STATE OIL & GAS SUPERVISOR



California Department of Conservation
Division of Oil, Gas, & Geothermal Resources

STATE OF CALIFORNIA
GRAY DAVIS, *Governor*

RESOURCES AGENCY
MARY D. NICHOLS, *Secretary*

DEPARTMENT OF CONSERVATION
DARRYL YOUNG, *Director*

DISTRICT NO. 1



Richard K. Baker, District Deputy, Cypress

PROFILE FOR 1999

Active fields:	44	
Oil produced:	33.7	million barrels
Gas produced (net):		
Associated gas	13.8	billion cubic feet
Nonassociated gas	30.8	million cubic feet
Number of producing wells:		
Oil	4,147	
Gas	3	
Number of wells:		
Drilled	17	
Completed	18	
Redrilled	14	
Plugged & abandoned	294	
Number of notices filed:		
Drill new wells	55	
Rework existing wells	648	
Plug & abandon wells	620	
Number of permits issued:		
Drill new wells	55	
Rework existing wells	283	
Plug & abandon wells	483	
Supplementary	504	
Number of inspections:		
Performed	18,434	
Reports issued	868	
Incremental oil produced:	26.4	million barrels
Thermal	0.8	million barrels
Waterflood	25.7	million barrels

PROGRAM HIGHLIGHTS:

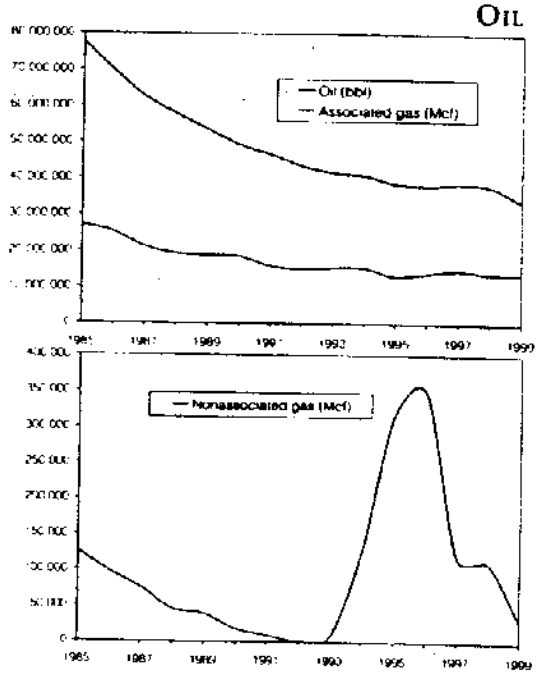
ENVIRONMENTAL AND SAFETY INSPECTIONS In 1999, safety equipment and operational facilities were inspected at 12 urban drill sites and 8 offshore sites, and surface and subsurface safety systems were tested in gas-storage facilities at Montebello and Playa Del Rey oil fields. Also, inspections were made on 932 above-ground tanks associated with oilfield operations.

ENVIRONMENTAL REVIEWS The district reviewed and commented on 52 environmental documents, compared with 46 in 1998. The documents described new projects and significant changes to existing ones.

CONSTRUCTION SITE REVIEWS Both the number of construction site plans reviewed and the number of wells reviewed increased in 1999. The district reviewed and commented on 299 construction plans, compared with 251 in 1998, and conducted 599 well reviews, compared with 518 in 1998.

SUBSIDENCE Elevation leveling surveys conducted during 1999 indicated that the elevation of

OIL AND GAS PRODUCTION



Year	Oil (bbl)	Net associated gas (Mcf)	Nonassociated gas (Mcf)
1985	77,807,948	27,166,281	126,773
1986	69,642,179	25,293,981	98,635
1987	62,486,993	21,280,129	75,934
1988	57,713,288	19,372,172	46,021
1989	53,328,795	18,855,776	39,290
1990	49,229,686	18,592,142	18,463
1991	46,581,864	15,973,328	9,524
1992	43,515,387	15,109,767	1,569
1993	41,583,008	15,493,197	7,295
1994	40,796,258	15,481,450	125,941
1995	38,577,612	13,182,102	316,131
1996	38,078,891	13,937,324	349,612
1997	38,572,227	14,825,089	118,831
1998	37,939,344	13,934,465	110,898
1999	33,734,275	13,777,122	30,842

Wilmington oil field was stable, except for minor changes in the older portion of the field. Elevation changes from November 1998 to November 1999 are shown in Figure 1. The total rebound in elevation, from lowest benchmark level, is shown in Figure 2.

The central and eastern areas of the City of Long Beach showed no elevation changes through the year. Minor elevation losses of 0.10 feet (1.2 inches) were noted in the older, western portion of the field.

The center of elevation loss migrated slightly eastward—from the Fault Block II steamflood project to Fault Block III, indicating that the conversion of the steamflood project to water injection was decreasing the rate of subsidence. The elevation loss in Fault Block III was due to a slight under-balance of injection compared with gross production. In the second half of the year, additional wells were placed on injection and elevation losses were stabilized in both fault blocks.

IDLE WELL PROGRAM Under the idle-well review and testing program, 98 idle wells were plugged and abandoned during 1999. Since the program was implemented in January 1991, 1,064 long-term idle wells have been plugged and abandoned in the district.

WELLS PLUGGED AND ABANDONED In 1999, 294 wells were plugged and abandoned in the district. Of these, 248 were production wells and 46 were service wells. Wilmington oil field accounted for 46 percent of well plugging and abandonment activity.

ENVIRONMENTAL AWARDS The Department of Conservation presented 20 awards to prior award winners for continued outstanding oilfield lease maintenance activities in 1999. Awards for two years of outstanding oilfield lease maintenance were presented to Roger Vititow for the Barnes Bush lease in Long Beach oil field, and Hagee-Lewis Petroleum Corporation for the El Segundo lease in El Segundo oil field. Three-year recipients included Axis Petroleum Company for a well site in Long Beach oil field, and Padre Oil Company in Chino-Soquel oil field.

Operators earning four-year outstanding oilfield lease maintenance awards were: Axis Petroleum Company for a well site in Long Beach oil field; the City of Newport Beach for the Newport Beach lease in West Newport oil field; O'Donnell Oil Company for a well site in Huntington Beach oil field; Signal Hill Petroleum, Inc., for well sites in Long Beach oil field; THUMS Long Beach Company for Island Grissom in Wilmington oil field; and Breitburn Energy Company LLC for the Hole lease in East Coyote oil field.

A five-year award went to Brea Cañon Oil Company for the Joughin Unit and South Torrance leases in Torrance oil field. The Southern California Gas Company earned a seven-year award for the Blackline and Treasure leases in Playa Del Rey oil field. Stocker Resources, Inc., earned a 10-year award for operations in Beverly Hills oil field and an 11-year award for operations in San Vicente oil field.

Other 11-year awards were presented to the Graner Oil Company for the Baass, Orr, and Wilson leases in Torrance oil field; Southern California Gas Company for the Monterey, La Merced, and Burke Community leases in Montebello oil field; and Breitburn Energy Company LLC for operations in Beverly Hills oil field.

Twelve-year awards were given to Cooper and Brain, Inc., for the Howard Park lease in Rosecrans oil field and Southern California Gas Company for the Dunlap lease in Playa Del Rey oil field.

Cecille M. Colvin received a 17-year award for operations in Long Beach oil field.

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MAYOR

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DEPARTMENT OF
BUILDING AND SAFETY
201 NORTH FIGUEROA STREET
LOS ANGELES, CA 90012-2627

ANDREW A. ADELMAN
GENERAL MANAGER

WALTER R. KRUKOW
EXECUTIVE OFFICER

February 28, 2001

Mr. Ron Deaton, Chief Legislative Analyst
Office of the Chief Legislative Analyst
200 N. Main Street, Room 512
Los Angeles, CA. 90012

Attention: Gerry Miller
Assistant Chief Legislative Analyst

PLAYA VISTA PROJECT - CLA REPORT

At the City Council meeting of June 23, 2000, the City Council instructed the Chief Legislative Analyst, with the assistance of the departments of Building and Safety (LADBS), City Planning, Public Works, City Attorney, City Administrative Officer (CAO), and any other agencies, consultants or individuals deemed appropriate by the CLA, including, but not limited to Dr. Victor Jones (Project Peer Reviewer), to:

1) Oversee the development of tasks necessary for collecting and analyzing any additional information required to assess the structural, health and earthquake safety risks associated with methane and other gases on the site;

2) Hold a public meeting within three weeks, or as soon thereafter as possible, to obtain input relative to the issues that will be considered and the estimated time frames for preparing the report; and

3) Report back to the Planning and Land Use Management (PLUM) Committee in 120 days with a report and recommendations regarding issues raised during this process.

Subsequently, the CLA's office conducted a series of meetings with the aforementioned departments to identify all related issues and assign tasks and responsibility to various departments for addressing these issues. The following tasks were assigned to LADBS:

AN EQUAL EMPLOYMENT OPPORTUNITY – AFFIRMATIVE ACTION EMPLOYER

- Determine the relationship, if any, between gases at the Playa Vista Phase I (CFD4) project site and the gas in the Southern California Gas Company Storage Facility at Playa del Rey;
- Determine the existence of the postulated Lincoln Fault; and
- Identify and recommend methane mitigation and monitoring requirements.

BACKGROUND

In the Spring of 1999, preliminary soil gas surveys and testing were done at the Playa Vista site and the results revealed elevated concentrations of methane gas.

In the Summer of 1999, LADBS and Playa Vista agreed to retain the service of Exploration Technologies, Inc. (ETI) as the Peer Reviewer for the Playa Vista project to assist LADBS staff.

In the Fall and Winter of 1999 and the Spring of 2000, Playa Vista consultants, in consultation with ETI, conducted extensive soils gas surveys and testing in tract area 49104 of the Playa Vista Phase I project site. The result of this study, as summarized in the April 17, 2000 ETI report titled, "Subsurface Geochemical Assessment of Methane Gas Occurrences Playa Vista Development, First Phase Project," reflected various methane and geological conditions. Further studies to address these conditions were recommended.

On June 7, 2000, the Budget and Finance Committee of the City Council discussed the Community Facilities District bond issues and raised concerns regarding environmental, planning, building and safety issues relative to the Playa Vista Project - Phase I, in relation to the issuance of Mello-Roos bonds for construction and acquisition of public facilities for this project.

On June 23, 2000, at the direction of the City Council, the CLA formed a task group comprised of the CLA's Office, LADBS, Public Works Bureau of Engineering, Department of City Planning, City Attorney, City Administrative Officer (now known as the Office of Administrative Research and Services (OARS)), and the Los Angeles Fire Department to address the above described issues. Different tasks and responsibilities were assigned to various departments for addressing these issues.

Since then, LADBS has conducted frequent meetings on the issues, including periodic joint meetings with the consultants and the Peer Reviewer to accomplish the three aforementioned tasks assigned to the Department. The results of numerous site surveys and testings, reviews and analyses of historical and new data, and technical evaluation sessions among experts are summarized below.

DISCUSSION OF THE RELATIONSHIP BETWEEN THE GASES AT THE PLAYA VISTA PHASE I (CFD4) PROJECT SITE AND THE GAS IN THE SOUTHERN CALIFORNIA GAS COMPANY STORAGE FACILITY AT PLAYA DEL REY

Playa Vista consultants conducted several soil gas studies and analyses, including nine gas samples taken directly from several of the storage and observation wells at the Southern California Gas Company Storage Facility. All samples were analyzed for composition and similarities with gas samples taken from the Playa Vista Phase I project site. These studies are summarized in the following reports:

- "Sampling and Analysis of Gas from the Southern California Gas Company Playa Del Rey Gas Storage Field", by Camp Dresser & McKee, Inc. (CDM), dated September 5, 2000 (Attachment 1)

- "Comparison of Gas Analyses from Southern California Gas Company Injection Wells and from Various Observation (Reservoirs Storage) Wells", by Dr. Ian Kaplan, Zymax Forensics, dated September 21, 2000 (Attachment 2)

According to Playa Vista consultant, Dr. Ian Kaplan, ". . .data show that the chemical and isotopic characteristics of the natural gas stored by Southern California Gas Company are different from the gas detected at the Playa Vista property." (Attachment 2, Page 5)

Peer Reviewer, ETI, reviewed and analyzed the above reports and concluded in their January 31, 2001 letter to LADBS that, "Comparison of the chemical and isotopic data from these wells with the near-surface and Ballona gravel aquifer gas samples previously analyzed on the Playa Vista site clearly shows that the storage gases are not present in any of the methane anomalies east of Lincoln Blvd. The gas seepage on the Playa Vista site appears to be derived from the Pico Sands at depth and does not have the geochemical signatures characteristic of storage gas." (Attachment 3)

LADBS staff reviewed ETI's conclusion and concur that the combined geochemical and geophysical information indicates that the methane gas observed at the Playa Vista Phase I project site does not come from the gas stored in the Southern California Gas Company Storage Facility at Playa del Rey. (Attachment 4)

DISCUSSION OF THE EXISTENCE OF THE POSTULATED LINCOLN FAULT

Playa Vista consultants conducted the following subsurface geologic evaluations of the Playa Vista project site:

- "Geologic Study to Evaluate the Potential for Active Faulting Near the Intersection of Lincoln and Jefferson Boulevards, at the Playa Vista site, in the City of Los Angeles, California", by Earth Consultants International, Inc., dated July 2000 (Attachment 5)

- "An Evaluation of the Subsurface Structure of the Playa Vista Project Site and Adjacent Area, Los Angeles, California", by Davis & Namson, dated November 16, 2000 (Attachment 6)

As part of their investigation, Earth Consultants International reviewed previously published geologic maps and reports covering the area and unpublished geologic and geotechnical reports prepared by other investigators for the Playa Vista site. They also conducted a subsurface study consisting of borings and Cone Penetrometer Tests across the area where the fault is postulated. From all of their data, they could not. "...find evidence to support the existence of a supposed 'Lincoln Boulevard fault' across the property." (Attachment 5, Page 1, Third Paragraph)

Davis and Namson's evaluation employed five different geologic and geophysical methods between May and October 2000 to evaluate the possibility of faulting at the site:

1) a search of the existing geologic literature;
2) construction of subsurface maps and cross sections based on well data;
3) purchase and interpretation of pre-existing Chevron seismic reflection data;
4) acquisition and interpretation of a shallow sub-surface geological survey along Jefferson Boulevard and a deeper seismic survey over the entire project site; and
5) an offshore geophysical survey southwest of the site.

From this work, they, "...could find no evidence for the postulated Lincoln Boulevard or postulated Charnock faults." (Attachment 6, Page 2, Second Paragraph)

Peer Reviewer, ETI, reviewed and analyzed the above reports and concluded in their January 31, 2001 letter to LADBS that, "...interpretation of the chemical and geophysical data does not support the existence of the Lincoln Blvd. Fault that was postulated to dip westward and possibly transect strata within the existing gas storage field..." (Attachment 3)

LADBS staff reviewed ETI's conclusion and concur that the postulated Lincoln Boulevard Fault, as defined in ETI's April 17, 2000 report, is unsubstantiated. (Attachment 7)

DISCUSSION OF THE METHANE MITIGATION AND MONITORING REQUIREMENT

Playa Vista consultants, in consultation with ETI, conducted site testings and research analyses to establish design criteria for effective methane prevention, detection and monitoring systems.

A baseline methane soil gas survey that reflects methane concentration levels for the entire project site was conducted and provided a clearer understanding of the methane distribution. (Attachment 8). This data enabled Playa Vista consultants to develop a comprehensive program addressing the design criteria of the above methane systems, as described in the following report:

- "Playa Vista Methane Prevention, Detection and Monitoring Program", by Methane Specialists, Inc., dated January 30, 2001 (Attachment 9)

The report included a Methane System Requirements matrix that detailed specific mitigation and monitoring requirements for the entire project site based on the level of methane concentration. There are three different levels of methane concentrations identified for the project site: Level I, Level II and Level III. Level I represents concentration levels of less than 100 parts per million of volume (ppmv). Level II represents concentration levels of between 100 and 12,500 ppmv and Level III represents concentration levels of above 12,500 ppmv. All levels require a basic mitigation prevention system below the building, including a 12-inch gravel blanket, with pipes to ventilate gas from underneath an impermeable membrane and methane detection alarm systems within the building. For Levels II and III, automatic ventilation systems triggered by elevated methane concentration levels beneath the impermeable membrane and continuous monitoring systems are also required. Additionally, Level III requires a subsurface venting system consisting of vent pipes drilled into the 50-foot gravel aquifer to vent methane gas, thereby mitigating the accumulation of methane within the aquifer and below the ground surface and also reducing the surface emissions of methane. Playa Vista implemented a pilot program wherein more than 70 temporary vent wells were drilled at the site to determine the feasibility and effectiveness of venting subsurface accumulations of methane. The program demonstrated that subsurface methane gas can be vented. A permanent subsurface venting system is currently in a progressive design stage that will establish criteria for determining the exact number of, locations of, and size of permanent subsurface wells.

The report concluded that, "Each of the levels will provide a comprehensive program of prevention, detection, and monitoring systems along with a maintenance and testing program. These systems will ensure adequate and appropriate safety for all building occupants." (Attachment 9, Page 1)

Peer Reviewer, ETI, reviewed and analyzed the above report and concluded in their January 31, 2001 letter to LADBS that, "...the proposed systems meet our recommendations, provided that the systems meet, or exceed all detail specifications as required by Department of Building and Safety." (Attachment 10)

LADBS staff reviewed and agree with ETI's conclusion that the proposed methane prevention, detection and monitoring systems for the Playa Vista project are adequate for safe development. (Attachment 11)

If you have any questions or need additional information, please call Raymond Chan, Chief of Engineering Bureau, at (213) 977-6380, or me at (213) 977-5960.

Very truly yours,

ANDREW A. ADELMAN, P.E.
General Manager

ATTACHMENT 6

DAVIS & NAMSON

Consulting Geologists
301 S. Maclay St., Suite 201, San Fernando, CA 91340 USA
Tel. (818) 838-1828 Fax (818) 838-0366
www.davisnamson.com
Davnamthom@aol.com

November 16, 2000

Mr. George J. Mihlsten Esq.
Attorney
Latham & Watkins
633 West Fifth Street, Suite 4000
Los Angeles, CA 90017-2007

Re: An Evaluation of the Subsurface Structure of the Playa Vista Project Site and Adjacent Area, Los Angeles, California.

Dear Mr. Mihlsten,

At the request of Playa Capital Company, LLC ("Playa Vista"), Davis and Namson Consulting Geologists have conducted a subsurface evaluation of the Playa Vista Project Site located in Los Angeles, California. Specifically Davis and Namson were requested to evaluate the possibility of a Lincoln Boulevard fault as proposed in the April 2000 report Subsurface Geochemical Assessment of Methane Gas Occurrences, Playa Vista Development First Phase Project, Los Angeles, California, prepared for the City of Los Angeles, Department of Building and Safety, by Exploration Technologies, Inc (ETI, 2000), and to evaluate the possibility of subsurface faulting in other portions of the project site and surrounding area. In order to evaluate the faulting issues at the Playa Vista Project Site. Davis and Namson took a multiphase approach to understanding the subsurface conditions at the site. Five different geologic and geophysical methods were employed between May and October 2000 to evaluate the possibility of faulting at the site: 1) a search of the existing geologic literature, 2) construction of subsurface maps and cross sections based on well data, 3) purchase and interpretation of preexisting Chevron seismic reflection data, 4) acquisition and interpretation of a 2D high resolution reflection seismic line along Jefferson Boulevard and a 3D seismic survey over the entire project site, and 5) an offshore geophysical survey southwest of the site. From this work we could no evidence for the postulated Lincoln Boulevard fault (ETI, 2000) or the postulated Charnock fault (Poland, et al., 1959), and much of the data is inconsistent with the presence of these postulated faults.

The subsurface geologic studies show there can be no significant fault under the entire

Playa Vista site, and abundant well data in the western portion of the site show it is unlikely that any faulting has occurred during the last 3.0 to 2.5 million years (Hodges, 1944; Hester, 1986). The 2D high resolution line shows a set of continuous reflectors along the entire line indicating there has been no faulting of any kind under the central and eastern portions of the site during the last 1.0 million years. In addition the 2D seismic line shows no evidence for either the postulated Lincoln Boulevard fault or the postulated Charnock fault. The 3D seismic survey shows that nearly the entire Playa Vista site is underlain by continuous reflectors belonging to the middle Pico Formation. The continuous reflectors indicate that no faulting has occurred under the Playa Vista site during the last 2.0 million years with the exception of a small unimaged area at the western end of the project site. The 3D seismic survey revealed no evidence for either the postulated Lincoln Boulevard or the postulated Charnock faults. Where these postulated faults cross the 3D survey there are continuous seismic reflectors to about 4500 feet depth indicating no faulting during the last 4.0 million years. The offshore geophysical data show continuous reflectors across the offshore projection of the bluffs south of the Playa Vista Project Site indicating no faulting in the offshore late Quaternary age deposits. The results of the offshore survey show that the bluffs are the result of erosion by the ancestral Ballona Creek and not faulting and uplift.

In summary we could find no evidence for the postulated Lincoln Boulevard or postulated Charnock faults. Furthermore the seismic reflection surveys and subsurface geologic data show that no faulting has occurred under the entire Playa Vista site in at least the last 2.0 million years.

Respectfully submitted by Davis and Namson Consulting Geologists

Thomas L. Davis PhD
Geologist/Partner
Registered Geologist 4171

Executive Summary

At the request of Playa Capital Company, LLC, Davis and Namson Consulting Geologists have conducted a subsurface evaluation of the Playa Vista Project Site located in Los Angeles, California. Specifically Davis and Namson were requested to evaluate the possibility of a Lincoln Boulevard fault as proposed in the April 2000 report Subsurface Geochemical Assessment of Methane Gas Occurrences, Playa Vista Development First Phase Project, Los Angeles, California, prepared for the City of Los Angeles, Department of Building and Safety, by Exploration Technologies, Inc (ETI, 2000), and to evaluate the possibility of subsurface faulting in other portions of the project site and surrounding area. Davis and Namson took a multiphase approach to understanding the subsurface conditions at the site. Five different geologic and geophysical methods were employed between May and October 2000 to evaluate the possibility of faulting at the site. The methods and the conclusions drawn from these methods are as follows:

1) The existing geologic literature and unpublished consultant reports on the Playa Vista Project Site were reviewed, and Davis and Namson could find no mention of a Lincoln Boulevard fault in the literature before the ETI (2000) report. In addition the preexisting geologic evidence cited by ETI (2000) for the Lincoln Boulevard fault, i.e. Metzner (1935), does not support the presence of the Lincoln Boulevard fault.

2) Davis and Namson, and Mr. Jack West, a registered geologist (RG 2755) with 50-plus years of petroleum geology experience in the subsurface of the Los Angeles basin, constructed subsurface maps and cross sections of the site and surrounding area using well data and previous subsurface work. The maps and cross sections show no significant fault is possible under the entire site. In addition under the western part of the Playa Vista site the density of wells is high thus reducing the possibility of a small discontinuity between the wells. Other subsurface studies show that no faulting has occurred in the western part of the Playa Vista site during the last 2.5 to 3.0 million years (Hodges, 1944).

3) During May and June 2000 a search and review was done for existing seismic reflection data near the Playa Vista area. Playa Vista purchased a seismic data license from Pacific Seismic Company for Chevron Line LAB 85-4. This line is located south of the Playa Vista site and in an orientation that would be intersected by the postulated Lincoln Boulevard fault. The postulated Lincoln Boulevard fault is not imaged on the line. Either the postulated Lincoln Boulevard fault is nonexistent or it dies out before reaching the line. Above 1.4 sec (approximately 4500 ft depth) the seismic line shows a number of reflectors that are continuous across the entire line and indicate no faulting has occurred in the last 3.0 million years.

4) An extensive seismic reflection study was initiated and completed under the direction of Davis and Namson. New onshore and offshore geophysical data, mostly seismic reflection, was acquired in a pattern that would image any faulting at the Playa Vista site. The onshore data was acquired by Subsurface Exploration Company in July 2000, processed by Tricon Geophysics Inc. from August through October 2000, and interpretation of the seismic data by Davis and Namson took place in September and October 2000. A 2D high resolution seismic line was acquired along Jefferson Boulevard from the join of Jefferson and Culver Boulevards eastward to the end of the Playa Vista site. The 2D line shows a set of continuous reflectors along the entire line indicating there has been no faulting of any kind along the line during at least the last 1.0 million years. In addition the 2D seismic line shows no evidence for either the postulated Lincoln Boulevard fault of ETI (2000) or the postulated Charnock fault (Poland, et al., 1959).

A 3D seismic survey was acquired by Playa Vista over the entire Playa Vista project site, and over additional areas along Centinela and Ballona Creeks, Dockweiler State Beach south of Ballona Creek, and in the entrance to Marina Del Rey Harbor (bay cable). The 3D seismic survey shows that nearly the entire Playa Vista site is underlain by continuous reflectors belonging to the middle Pico Formation. The continuous reflectors imaged in the 3D seismic survey indicate that no faulting has occurred under

the Playa Vista site during the last 2.0 million years with the exception of the small unimaged area at the western end of the project site. At the western end of the Playa Vista site abundant well data show it is unlikely that any faults cut the upper Repetto Formation indicating no faulting there during the last 3.0 to 2.5 million years (Hodges, 1944; Hester, 1986). The 3D seismic survey revealed no evidence for either the postulated Lincoln Boulevard or the postulated Charnock faults. Where these postulated faults cross the 3D survey there are continuous seismic reflectors to about 1400 milliseconds or about 4500 feet depth indicating no faulting during the last 4.0 million years. The conclusion of no Lincoln Boulevard fault in much of the sedimentary section under the Playa Vista site is consistent with the results of the 2D high resolution seismic line, and the Earth Consultants International study of the shallow geology of the site (ECINTL, 2000). The conclusion of no Charnock fault present in strata younger than 4.0 million years seismic is also consistent with the results of the 2D high resolution seismic line.

5) During July 2000 an extensive offshore geophysical survey was conducted southwest of the Playa Vista Project site under the direction of Dr. Dan Francis of California State University at Long Beach and Dr. Marc Legg of Legg Geophysical. Drs. Francis and Legg processed and interpreted the offhsore data during August and September 2000. The purpose of the survey was to better understand the origin of the bluffs (Ballona escarpement) just south of the Playa Vista site. The offshore geophysical data show continuous reflectors along the offshore projection of the bluffs indicating no faulting in the offshore Quaternary age deposits. The results of the offshore survey show that the bluffs are the result of erosion by the ancestral Ballona Creek and not faulting and uplift.

The fact that the postulated Lincoln Boulevard is not observed in either the 2D or 3D seismic surveys down to about 4500 feet depth argues against the existence of the fault. The only reason for interpreting the fault at the Playa Vista site would be to explain the shallow methane anomaly at the Playa Vista site ETI (2000). As the seismic

surveys show there is no fault above 4500 feet, consequently the methane anomaly must have some cause other than a fault. Methane anomalies and seepages can result from a variety of subsurface conditions, not all of them requiring faulting (Thrasher, et al., 1996; Matthews, 1996). The postulated Lincoln Boulevard fault is a possible but not unique interpretation of the methane anomaly, however, it is inconsistent with the existing geophysical and geologic data from the Playa Vista area.

In summary Davis and Namson could find no evidence for the postulated Lincoln Boulevard or postulated Charnock faults. Furthermore the seismic reflection surveys show that no faulting has occurred at the Playa Vista site in at least the last 2.0 million years.

An Evaluation of the Subsurface Structure of the Playa Vista Project Site and Adjacent Area

1.0 Introduction

1.1 Problem:

Davis and Namson Consulting Geologists were retained by Playa Vista to evaluate the possibility of subsurface faulting at the Playa Vista project site (Figure 1). Specifically Davis and Namson were requested to evaluate the possibility of a Lincoln Boulevard fault as proposed in the April 2000 report Subsurface Geochemical Assessment of Methane Gas Occurrences, Playa Vista Development First Phase Project, Los Angeles, California, prepared for the City of Los Angeles, Department of Building and Safety, by Exploration Technologies, Inc (ETI, 2000), and to evaluate the possibility of subsurface faulting in other portions of the project site and surrounding area. This would include any previously undiscovered faults under or near the Playa Vista site (Figure 1), evaluation of the postulated Charnock fault (Poland et al., 1959), and evaluation of faults within the Del Rey Hills Area of the Playa Vista oil field interpreted in the California Division of Oil and Gas Summary Operation reports (Metzner,1935; Hodges, 1944, and Riegle, 1953).

1.2 Approach and status of work:

Evaluation of the postulated Lincoln Boulevard fault and other faulting issues at the Playa Vista site has taken two approaches because of the thick Holocene deposits and the shallow water table at the site. These conditions prevented shallow trenching at the site to evaluate active faulting. Earth Consultants International, Inc. (ECINTL) has completed a fault evaluation of the surface and shallow geologic setting at the site (< 50 feet) by reviewing geologic and geotechnical reports and completing a subsurface survey using borings and a CPT survey* (ECINTL, 2000) across the shallow location of the postulated Lincoln Boulevard fault. Davis and Namson have completed a study of

*CPT (core penetrometer technology) surveying, a geologic method of imaging the subsurface.

the

deeper conditions at the site (50 feet below the surface to the top of crystalline basement) and surrounding area. The study used existing geologic literature and unpublished geotechnical reports, constructed new geologic maps and cross sections of the subsurface based on data from oil and gas wells drilled in the area, purchased previously acquired geophysical data, and acquired and interpreted new geophysical data from the Playa Vista site and surrounding area (Figure 1, Plate I). The geophysical data purchased and acquired for this study consist only of seismic reflection data. A good number of maps, cross sections, and seismic lines displayed as large plates are included in this study (8.0 Plates). Most of the plates have been generalized and reduced to page size figures for the ease of reading and copying the report (Figures 7.0).

In order to understand the subsurface structure under the Playa Vista site and its relationship to the nearby oil fields and known geologic structures, two sets of cross sections were constructed for the study (Figure 2, Plate II): 1) Davis and Namson constructed four well to well cross sections across the site, and 2) Mr. Jack West, Petroleum Geologist, was directed to construct two regional cross sections across the site and to nearby oil fields. The maps and cross sections provide a general image of the subsurface structure and stratigraphic framework under and near the Playa Vista site.

Playa Vista purchased the license to an east-west trending Chevron seismic line located south of the site, and the line has been interpreted and integrated with the geologic data set. The Chevron line was oriented in a manner favorable to intersecting the southward projection of the postulated Lincoln Boulevard fault (Plate I).

The new geophysical data consist of one 2D high-resolution seismic line, a 3D seismic survey over the entire site, and an offshore geophysical survey (Figure 2, Plate II). The

2D line has an northeast-southwest direction and runs along the south side of Jefferson Boulevard crossing the northwest trending postulated Lincoln Boulevard fault (ETI, 2000) and the northwest trending postulated Charnock fault (Poland et al., 1959). The 2D high-resolution line has been processed, interpreted, and integrated with the geologic data set and the 3D seismic survey.

The 3D seismic survey was acquired over the entire Playa Vista site (Plate II), a portion of Centinela Creek, along Ballona Creek, the portion of Dockweiler Beach State Park just south of Ballona Creek, and the outer portion of Marina Del Rey Harbor (bay cable). The 3D seismic survey has been processed, interpreted, and integrated with the geologic data set and the 2D seismic survey.

An offshore geophysical survey was conducted to investigate the possibility of faulting along the base of the bluffs that lie along the south side of the Playa Vista site (Ballona escarpment). The offshore survey is located just offshore of the Dockweiler Beach State Park and west and southwest of the Playa Vista site (Figure 2, Plate II). The offshore seismic was acquired, processed, and interpreted by Dr. Dan Francis, California State University Long Beach, and Dr. Mark Legg, Legg Geophysical, and their report is inserted near the end of this report (section 4.0 Offshore Geophysical Survey).

2.0 Subsurface Geology of the Playa Vista Site

2.1 Setting and previous work:

The Playa Vista site lies within the western shelf portion of the Los Angeles basin (Figure 1, Plate I). The western shelf is a northwest trending structural block between the Newport-Inglewood fault zone and the offshore Santa Monica basin (Wright, 1991). The western shelf terminates to the north against the Santa Monica fault zone and the Santa Monica Mountains. To the south, the western shelf terminates against the Palos Verdes Hills fault and the Palos Verdes Hills. Within the western shelf marine sedimentary rocks of middle Miocene to Quaternary age unconformably overlie a basement complex of Catalina Schist. The western shelf is deformed into several

northwest trending anticlines but no major faults traverse the block. The western shelf is only moderately deformed by folds and faults compared to other portions of the Los Angeles basin. The contrast can be appreciated on a regional cross section across the basin (Figure 3, Plate III). In this cross section, note how gently folded and little faulted the western shelf area is in contrast to the highly deformed north side of the Los Angeles basin that is under downtown Los Angeles. The north side of the basin is characterized by abundant steep bedding dips, complex folding, large uplifted basement blocks, and abundant faults some of which are seismically active (Davis, et al., 1989). The earthquake history of the Playa Vista portion of the Los Angeles Basin is described in the ECINTL (2000) report.

The Playa Vista site lies along the Ballona Creek drainage just inland from the Pacific Ocean (Figure 2, Plate II). The surface of the site is nearly level and only a few feet above sea-level. To the south of the site are east-trending bluffs that form the north edge of the Del Rey Hills. Poland et al (1959) refers to the hills as the El Segundo sand hills and the bluffs as the Ballona escarpment. The subsurface stratigraphy and structure of the site and surrounding area is reasonably well understood from numerous oil and gas wells that have been drilled in the area, some water well drilling (Poland et al, 1959; DWR, 1961), and oil-industry seismic reflection data.

Beneath the west end of the Playa Vista site is the eastern edge of the Del Rey Hills Area of the old Playa Del Rey Oil Field. The Playa Del Rey Oil Field is divided into two producing areas: the Venice Area and the Del Rey Hills Area. The Venice Area was discovered in 1929 with oil production from the Schist Conglomerate zone (Figure 4, Plate IV) and oil and gas production from the shallower Upper Zone of the middle and upper Repetto Formation (Barton, 1931). The Del Rey Hills Area was discovered in May, 1931 with oil production from the Schist Conglomerate zone that is just above the Catalina Schist basement (Metzner, 1935). Presently the Southern California Gas Company uses the Del Rey Hills Area as a natural gas storage facility (Riegle, 1953; Hester, 1986).

Both productive areas of the Playa Del Rey Oil Field lie along the Playa Del Rey anticline and the Playa Vista site lies above the east limb of the anticline. The Playa Del Rey anticline is a long, northwest trending basement-cored fold that trends offshore at Venice Beach. The Playa Del Rey anticline is not expressed at the surface and is known from oil and gas wells and geophysical surveys. Well data show the basement core (Catalina Schist) of the anticline is overlain by a thick section of marine strata consisting of sandstone and shale of Miocene, Pliocene and early Quaternary age (Figure 4, Plate IV). Under the Playa Vista site a thick section of Pleistocene and Holocene strata unconformably overlie the older marine rocks and mask the Playa Del Rey anticline (Plate IVB). A detailed description of the geomorphology and Quaternary stratigraphy of the Playa Vista site is presented in the ECINTL (2000) report.

During the initial stages of this study the existing geologic literature and unpublished consultant reports on the area were obtained and studied. There is a fair amount of published and unpublished geologic literature on the Playa Vista site and surrounding area. Of particular interest to this subsurface study are a series of State of California, Division of Oil and Gas Summary of Operations (DOG*) reports on the Playa Del Rey Oil Field. These reports have useful maps, cross sections, and descriptions that provide a good understanding of the subsurface structure and stratigraphy of the oil field. These maps and cross sections were integrated with the Davis and Namson maps and cross sections presented later in this report.

2

Barton (1931) was the first to report on the Playa Del Rey Oil Field, and the report describes drilling activities in the area going back to 1921. Included in the Barton report are a map on top of the Nodular Shale and two cross sections covering the Venice Area of the oil field. Metzner (1935) provides a structure map on top of the Catalina Schist, an isopach map of the Schist Conglomerate

*DOG (now DOGGR-Department of Oil & Gas and Geothermal Resources)

producing zone, and three generalized cross sections over the entire Playa Del Rey Oil Field. The Metzner report also includes a detailed topographic map that becomes the basis for several surface fault interpretations by that author. The Metzner fault interpretations and the mislocation of these interpretations by ETI (2000) are discussed in section 2.3 of this report (The postulated Lincoln Boulevard fault). Hodges (1944) provides a further update of drilling activities mainly in the Del Rey Hills Area, and a description of the beginning of the gas storage activities in the Del Rey Hills that started in 1942. The Hodges report provides structure maps on top of the Catalina Schist and the Upper Bentonite marker in the Repetto Formation, and an isopach map of the Schist Conglomerate producing zone. Riegle (1953) provides a further update of the gas storage operations at the Del Rey Hills Area and presents several small maps and an hysteresis loops of injection and withdrawal cycles of gas. Summaries of the Playa Del Rey Oil field can be found in Metzner (1943) and DOG (1974). Hester (1986) produced a series of subsurface maps and cross sections over the Playa Del Rey Storage Field (old Del Rey Hills Area) for the Southern California Gas Company, and these maps and cross sections were integrated with the Davis and Namson maps and cross sections presented later in this report.

Other studies that were of importance to the Davis and Namson subsurface evaluation of the Playa Vista site are Poland et al (1959), DWR (1961), and Wright (1991). Poland et al (1959) and DWR (1961) are regional ground water studies that provide useful water well data, and maps and cross sections of the Quaternary section in and around the site. These reports are especially important because they provide data on the Quaternary portion of the subsurface that typically is not well recorded in oil and gas well records. Besides the recent ECINTL (2000) report, other recent geotechnical reports on the Playa Vista site were reviewed by Davis and Namson (Converse, et al., 1979; Law/Crandell,1987a,b). Wright (1991) provides a broad tectonic and historical analysis of the Los Angeles basin and the western shelf area that was helpful to this study.

2.2 Stratigraphy of the Playa Vista Site:

Oil and gas drilling within and near the Playa Vista site has penetrated the entire sedimentary column beneath the Playa Vista site (Figure 4, Plate IVA) with a great number of wells having reached the top of the Catalina Schist (crystalline basement complex). On the basis of lithologic similarities the Catalina Schist is generally considered the southern equivalent of the Franciscan Complex of central and northern California. Suppe and Armstrong (1972) obtained some early Cretaceous K-Ar (potassium-argon) ages on the Catalina Schist that are consistent with the late Jurassic to Eocene age of the Franciscan Formation.

Unconformably above the Catalina Schist is a thick section (5,500 to >10,000 feet) of mostly marine sedimentary rocks that range in age from the middle Miocene to the Quaternary (Figure 4, Plate IVA). This marine sedimentary section thins westward onto the crest of the Playa Del Rey anticline. Deposited directly above the Catalina Schist is the Schist Conglomerate zone that is the principal oil reservoir of the old Playa Del Rey Oil Field. This reservoir is now used for gas storage in the Del Rey Hills Area of the oil field. The Schist Conglomerate zone consists of angular clasts to rounded pebbles of Catalina schist set within a Catalina Schist derived sand matrix. The zone varies in thickness from a few feet to nearly 300 feet near the project site as a result of onlap onto the Catalina Schist basement (Hodges, 1944). Pinch-out of the zone across the Playa Del Rey anticline and below a thick section of overlying shale provides the trap for accumulation and storage of hydrocarbons at the Del Rey Hills Area. The Schist Conglomerate zone is most likely equivalent to the upper member of the Topanga Formation (Blake, 1991) that is early to middle Miocene in age, i.e. 17-14 million years old.

Above the Schist Conglomerate is a dark brown shale known as the Nodular shale that here is the basal member of the Puente Formation (Figure 4). The Nodular shale varies in thickness from 50 to 300 feet and the unit contains distinctive tan nodules. The Nodular shale belongs to foraminiferal division E of Wissler (1943, 1958) making the

unit early to late Mohnian (late Miocene) in age or about 14-9 million old.

Overlying the Nodular shale is a dark brown to black shale within the Puente Formation that is consistently about 50 feet thick in the Playa Del Rey Oil Field (Hodges, 1944) and provides an excellent subsurface marker for correlation of well data. The remaining Puente Formation consists of dark brown to black shale and thin sandstone beds. The Puente Formation is a Los Angeles basin facies of the upper Miocene portion of the Monterey Formation (Blake, 1991). The total thickness of the Puente Formation ranges from 650 feet on the crest of the Playa Del Rey anticline to over 1600 feet in the synclinal trough east of the anticline. The black shale marker bed and remaining Puente Formation belong to Wissler's division A-B that is Delmontian in age (latest Miocene) or from 6.5 to 5.0 million years old.

Overlying the Puente Formation is a very thick section of interbedded shale, siltstone and sandstone of the lower Repetto Formation. The Repetto Formation represents the continuation of the deep marine conditions started in the Miocene. The Pliocene age Repetto Formation ranges in thickness from about 2250 feet on the crest of the Playa Vista anticline to about 4400 feet in the synclinal trough east of the anticline. The Repetto ranges in age from 5.0 to 2.5 million years old. The Repetto Formation is divided into three members: a lower member from 5.0 to 4.0 million years old, a middle member from 4.0 to 3.0 million years old, and an upper member from 3.0 to 2.5 million years old. The Repetto Formation contains the "upper zone" of the Venice Area of the Playa Del Rey Oil Field. The "upper zone" is an oil and gas producing zone that was not commercially productive in the Del Rey Hills Area (Figure 4, Plate IVA).

Above the Repetto Formation is the upper Pliocene to lower Quaternary Pico Formation. The Pico Formation consists of interbedded sandstone, siltstone and shale that were deposited as the Los Angeles basin shoaled. The Pico Formation ranges in thickness from about 2150 feet on the crest of the Playa Vista anticline to about 4150 feet in the synclinal trough east of the anticline. The Pico Formation is estimated to from

2.5 to 0.8 million years old (Dr. Dan Ponti, USGS, personal communication). In the Playa Vista area the Pico Formation can be divided into three members: 1) a lower member whose top is equivalent to the Venturian/ Wheelerian stage boundary that is about 2.0 million years old (Blake, 1991), 2) a middle member whose top is poorly constrained but must be from about 1.5 to 1.0 million years (Dr. Dan Ponti, USGS, personal communication), and 3) an upper member whose top is about 0.8 million years old (Dr. Dan Pointi, USGS, personal communication).

The Pico Formation is unconformably overlain by unconsolidated upper Quaternary age strata of the San Pedro Formation, Lakewood Formation and unnamed upper Pleistocene and Holocene strata that include the Ballona aquifer or "50 foot" gravel (Figure 4, Plate IVB). The Quaternary deposits consist of interbedded sandstone, gravel, silt and clay of mostly alluvial, lagoonal, and shallow-marine origin. As a result of the deep down-cutting of Ballona Creek (ancestral Los Angeles River) during the last sea level low stand the Quaternary units at the site are not arranged in a simple layer-cake sequence. Regionally the San Pedro Formation rests above the Pico Formation along an angular unconformity (Poland et al., 1959). The top of the San Pedro Formation in the Playa Del Rey area is estimated to be about 0.3 million years old years (Dr. Dan Ponti, USGS, personal communication). Under the Del Rey Hills, south of the Playa Vista site, the San Pedro Formation is unconformably overlain by the Lakewood Formation that is exposed in the bluffs (Ballona escarpment). North of the hills and under the Playa Vista site most, if not all, of the Lakewood Formation has been removed by the down-cutting of Ballona Creek. Here the uppermost Pleistocene and Holocene section rests unconformably on lower portions of the San Pedro Formation, or possibly Pico Formation. A more detailed discussion of the upper Pleistocene and Holocene stratigraphy and the results of the CPT survey down to the top of the Ballona aquifer are presented in the ECINTL (2000) report.

2.3 The postulated Lincoln Boulevard fault:

The ETI (2000) report proposes a newly discovered fault with a shallow subsurface location

just east of Lincoln Boulevard (Figure 2). A shallow oval-shaped methane anomaly was detected by a four foot soil gas survey and wells monitoring the uppermost Pleistocene and Holocene section above the Ballona aquifer ("50 foot" gravel). The anomaly was mapped by ETI just east of Lincoln Boulevard. In attempting to explain the presence of this anomaly ETI interpreted the anomaly to be the result of a previously unrecognized fault (the Lincoln Boulevard fault). Cross sections in the ETI (2000) report show the postulated Lincoln Boulevard fault dipping westward at 58 degrees and intersecting the top of the Catalina Schist under the eastern part of the Del Rey Hills Area of the Playa Del Rey Oil Field (Figure 5, Plate V). Building on their interpretation ETI states the fault should be considered potentially active. ETI further postulates that the fault could cause large volumes of methane gas to be released to the surface during an earthquake.

It is stated on pg. 1 and 7 of the ETI (2000) report that the position and attitude of the proposed Lincoln Boulevard fault is based on a combination of subsurface geologic data, surface topographic lineations, and a north-south trend of anomalous geochemical data. However, the literature research and well data review of the Playa Vista area conducted by Davis and Namson did not discover any geologic evidence to support the location, geometry and activity of the proposed Lincoln Boulevard fault as will be discussed.

In section 3.1, pg. 7 of the ETI (2000) report, work by Metzner (1935, pg: 7-9) is cited to support the existence of the postulated Lincoln Boulevard fault. Metzner (1935), on the basis of changes in topographic expression, infers several faults in the Del Rey Hills southwest of the Playa Vista project site (Figure 6, Plate VI). However, Metzner never claims there is a fault between his topographic provinces 3 and 4 (this is the only topographic boundary of Metzner's that would lie close to the postulated Lincoln Boulevard fault). Metzner does interpret faults along the western boundary of province 1 (coastline), between provinces 1 and 2, and between provinces 2 and 3. The faults postulated by Metzner have projected surface locations through the far west end of the project site and further west, and not near Lincoln Boulevard or the methane anomaly. The closest of these postulated surface faults are at least 4,000 feet west of the shallow

location of the postulated Lincoln Boulevard. Furthermore, Metzner does not show these faults in his subsurface map (top of Catalina Schist/Schist Conglomerate isopach), indicating that Metzner may not have believed these postulated surface faults extended north of the Del Rey Hills.

The results of oil exploration drilling and geophysical work subsequent to Metzner's work casts doubt on the validity of any of these postulated surface faults. None of the subsurface maps within the DOG Summary of Operations Reports completed subsequent to Metzner (1935) show Metzner's postulated surface faults. The maps made by Hester (1986) do not show subsurface evidence for the postulated surface faults of Metzner. The licensed Chevron seismic line (Figure 17, Plate XVII, and section 3.1 of this report) does not show any of the surface faults postulated by Metzner extending into the subsurface. Interestingly Metzner (1935) interpreted the straight coast line from Ballona Creek south to Redondo Beach to be controlled by a nine mile long fault along the western boundary of his province 1 (Figure 6, Plate VI). There is an enormous body of data and literature (Wright, 1991) to refute such a claim, and this underscores the problem of making fault interpretations based solely on geomorphic features.

The ETI (2000, pg. 8) report also cites Riegle (1953) and Wright (1991) as providing subsurface evidence for the postulated Lincoln Boulevard fault in the Del Rey Hills Area. A small fault is shown cutting the top of the Catalina Schist in the southeast corner of section 27, T2S-R15W in Riegle (1953), Hodges (1944), and Metzner (1935). An examination of the various DOG reports show that the fault shown by Riegle (1953) and Hodges (1944) comes from subsurface mapping by Metzner (1935). The subject fault is northwest trending and about 2800 feet long. Metzner (1935) discusses the fact that he can find no clear evidence for displacement along the fault, but he infers the fault from changes in the amounts of oil and water production between wells. The fact that these types of production variations indicate permeability barriers or changes in the elevation of the oil/water contact and can result from geologic conditions other than

faulting is not considered by Metzner (1935). The trace of the postulated fault is shown on Metzner's (1935) map on top of the Catalina Schist, but he does not show the fault offsetting the top of the Catalina Schist or the isopach contours of the Schist Conglomerate zone. Hodges (1944) work shows the postulated fault offsetting contours on his top of the Catalina Schist map with a maximum displacement of about 150 feet and down to the east. However, he offers no additional evidence for the fault and he does not explain how the amount and sense of displacement were determined. Hodges (1944, pg. 6) states that the subject fault and a number of other smaller faults in Playa Del Rey oil field die-out before reaching the "upper zone" in the middle and upper Repetto Formation.

Hester (1986) states in his report that he could find no evidence for the northwest trending fault in the southeast corner of section 27, and his top of Catalina Schist, top of Schist Conglomerate, and BM-X Point (equivalent to the top of the Nodular Shale) maps show no such fault. Several of Hester's cross sections provide a detailed view of well to well correlation across the postulated fault. Cross section III-III' and Q-Q' show no evidence for faulting where the lines cross the postulated fault (just west of the Joyce #1 well). In addition, Hester (1986) noted that the similarity between well dip data and map data did not suggest a fault. Hester (1986) also cites previous Union Oil Company (original operator) work done in the 1960's that states that the fault postulated by Metzner (1935) in the southeast corner of section 27 is nonexistent.

Davis and Namson could find no evidence for the postulated fault in the southeast corner of section 27 and this is reflected in our subsurface maps (Figures 9-11, Plates IX-XI) . Metzner's (1935) fault interpretation is a non-unique explanation for variations in oil and water production that could result from a variety of geologic factors other than faulting. The postulated fault occurs in an area characterized by complex basement relief and changes in the occurrence and thickness of the overlying Schist Conglomerate zone. The changes in the basement and Schist Conglomerate are occur over a large area and are not aligned in a manner suggestive of faulting. Metzner

(1935) recognized that most of the complexity was the result of middle Miocene uplift and erosion and the subsequent in-filling of channels with erosional debris. Such a complex depositional setting could easily provide the permeability and stratigraphic changes that would give the oil and water production variations noted by Metzner (1935).

Wright's (1991) summary paper of the entire Los Angeles basin is based on an extensive amount of previously published data on the basin. Cross section A-A' in Wright (1991, pg. 50) shows two small faults to either side of the Playa Del Rey Oil Field. These faults do not extend above the Repetto Formation and it is clear that they are based on the prior DOG reports described above and represent no new data on these faults.

Converse, et al. (1979) and LeRoy Crandell and Associates (1987a,b) completed geologic studies along the bluffs just south of the Playa Vista site. Southward projection of the shallow trace of the postulated Lincoln Boulevard fault would intersect the bluffs and the fault should be exposed in the upper Pleistocene Lakewood Formation outcropping along the bluffs. Converse et al (1979) and LeRoy Crandell and Associates (1987a,b) found no evidence of faulting during course of their studies.

During the summer of 2000, Earth Consultants International (ECINTL) completed a fault evaluation of the surface and shallow geologic setting at the Playa Vista site for Playa Vista. This was done by reviewing geologic and geotechnical reports, and completing a subsurface survey using borings and a CPT survey. The CPT study was completed across the shallow location of the postulated Lincoln Boulevard fault just east of Lincoln Boulevard (ECINTL, 2000). The top of the Ballona aquifer (50-foot gravel) and a sequence of finer-grained deposits directly above the aquifer were mapped. From their subsurface survey and geologic literature review, ECINTL (2000, p. 24) concludes that there is no fault cutting the top of the Ballona aquifer ("50 foot" gravel).

In summary, the ETI (2000) report offers no new evidence for the existence of the Lincoln Boulevard fault, and the preexisting geologic evidence cited by ETI does not support the presence of the Lincoln Boulevard fault. ETI has proposed the Lincoln Boulevard fault to explain the presence of the shallow methane anomaly, but ETI fails to consider that methane anomalies and seepages are not uniquely the result of faulting. It is well known that methane anomalies and seepages can result from a variety of subsurface conditions, not all of them requiring faulting (Thrasher, et al., 1996; Matthews, 1996). Therefore the postulated Lincoln Boulevard fault is a possible but not unique interpretation of the methane anomaly, but the fault interpretation is inconsistent with the existing geologic data from the Playa Vista area.

ETI's earthquake scenario of large volumes of methane gas released along the Lincoln Boulevard fault during an earthquake is exaggerated and certainly unprecedented in the seismic history of California where numerous large and moderate earthquakes have occurred under or adjacent to existing oil and gas fields with no catastrophic releases of gas.

2.4 Geology of the Playa Vista site determined from oil and gas wells:

Davis and Namson were requested by Playa Vista to do their own subsurface geologic evaluation of the possibility of the Lincoln Boulevard fault as proposed by ETI (2000), and to evaluate the possibility of subsurface faulting in other portions of the project site and surrounding area. This new subsurface work is based on the correlation and mapping of the geologic formations and markers determined from oil and gas well data. The result is a series of maps and cross sections that yield a good approximation of the subsurface structure of the Playa Vista site and surrounding area.

Well data has two important drawbacks to doing fault evaluations that need to be considered. First, most oil and gas wells are not logged shallower than 1,000 to 1,500 feet and this portion of the geologic record is often very important to fault studies, as is the case at Playa Vista. Second, well data does not provide a continuous image of the subsurface, and it is impossible to use well data to eliminate the possibility of small displacement faults existing between wells. For these reasons Playa Vista decided to

add to the subsurface study by purchasing existing oil industry seismic reflection data (section 3.1 Licensed Chevron seismic line) and by completing their own seismic surveys of the area (section 3.2 2D High resolution seismic line; section 3.3 3D seismic survey; and section 4.0 Offshore Geophysical Survey)

Two regional cross sections using subsurface well data were constructed by Mr. Jack West, Petroleum Geologist, to better the faulting; subsurface structure, and stratigraphic framework within and surrounding the Playa Vista site (Figure 7, Plate VII). The westernmost part of the Playa Vista site overlies the northwest-southeast cross section from the Venice oil field to the Lawndale oil field near Southern California Gas Company Vidor #18. This cross section follows the crest of the Playa Del Rey anticline and shows a number of small faults cutting the top of the Catalina Schist, Schist Conglomerate, Nodular shale member and younger portions of the Modelo Formation (Modelo Formation is equivalent to the Puente Formation used in this report). These faults do no cut the lower Repetto Formation and thus ceased activity at the end of the Miocene (about 5.0 million years ago). The closest of these faults to the Playa Vista site is the down-to-the-south normal fault shown along the crest of the Playa Del Rey anticline between County of Los Angeles DOW R.G.C. #11 well and the Southern California Gas Company Del Rey #10. This fault occurs under the Venice Area of the Playa Del Rey Oil Field and thus north of the Playa Vista site.

The second regional cross section constructed by Jack West is northeast-southwest directed and goes from the Del Rey Hills Area of the Playa Del Rey Oil Field to the Inglewood Oil Field (Figure 7, Plate VII). The cross section follows the southern boundary of the Playa Vista site. The cross section shows that the Playa Vista site lies along the crest and east limb of the Playa Del Rey anticline that is separated by a broad syncline from the Inglewood Oil Field. In the cross section the Inglewood Oil Field lies along the Newport Inglewood fault zone and that oil field is characterized by steep dips and numerous faults. In contrast the Del Rey Hills Area of the Playa Del Rey Oil Field, not adjacent to a major fault zone, is structurally simple with gentle to moderate dips

and a lack of faulting.

The cross section also shows the thickening of the entire sedimentary column towards the east and provides some control over the age of the Playa Del Rey anticline. As previously discussed, the Los Angeles basin subsided during the Miocene and early Pliocene and the eastward thickening of the Schist Conglomerate through the middle Repetto Formation is a result of thickening towards the area of maximum subsidence in the central Los Angeles basin (Figure 3, Plate III). Basinwide compression and fold growth started during the late Pliocene (Davis, et al., 1989) and the eastward thickening of the upper Repetto through upper Pico Formations is the result of syntectonic depositional patterns. The Playa Del Rey anticline probably started to grow in the late Repetto and continued to deform to at least the end of Pico Formation deposition. The overlying San Pedro Formation does not appear involved in the growth of the anticline. From these relationships it appears that the anticline grew between about 3 million and 500,000 years ago. This geometry of the east limb of the Playa Del Rey anticline and the eastward thickening of depositional units is also observed in the Davis and Namson cross sections and seismic reflection surveys (section 3.1 Licensed Chevron seismic line; section 3.2 2D High resolution seismic line; and section 3.3 3D seismic survey).

Davis and Namson constructed a series of subsurface structure contour maps and cross sections (Figures 8-15; Plates VIII-XV) by well to well correlation of the spontaneous potential and resistivity curves of electric logs, and the visual descriptions of rocks encountered while drilling (Figure 4, Plate IVA). These maps also integrate previously discussed subsurface mapping done in the area by the State of California, Division of Oil and Gas (DOG), and the Southern California Gas Company (Hester, 1986).

The deepest map is on the top of the Catalina Schist (Figure 9, Plate IX). The map shows the crest and east limb of the Playa Del Rey anticline, and the projected intersection of the postulated Lincoln Boulevard fault with the top of the crystalline

basement. As can be seen from the contouring there is no abrupt change in the top of the Catalina Schist that would be expected if the surface was offset by the postulated Lincoln Boulevard fault as depicted by ETI (2000) and shown here as Figure 5 and Plate V. It is worth noting that there are a good number of wells penetrating the Catalina Schist near the projected fault intersection, thus significantly reducing the possibility that small displacement faults exist. Given the number of wells, only a very small discontinuous fault, if any, could be interpreted between wells.

The near surface location of the postulated Charnock fault (Poland, et al., 1959) is shown on the eastern end of the map. The projected subsurface intersection of the Charnock and the top of the Catalina Schist would lie directly below the shallow surface location because Poland et al (1959) interprets the fault as having a vertical surface. The wells adjacent to the Charnock fault are too widely spaced to assist in the determination of the existence of this fault.

The next higher map is on top of the Schist Conglomerate zone (Figure 10, Plate X). The map shows the projected intersection of the postulated Lincoln Boulevard fault with the top of the Schist Conglomerate in an area of rather dense well control. As with the Catalina Schist map there is no change in the top of the Schist Conglomerate zone surface that would suggest the postulated Lincoln Boulevard fault as depicted in the ETI (2000) report.

The stratigraphically highest map is on top of the upper Bentonite marker of the upper part of the Repetto Formation (Figure 11, Plate XI). The map does not extend far enough east to intersect the projected fault plane of the postulated Lincoln Boulevard fault as detailed well control is lacking this far east. The map shows the Playa Del Rey anticline and as discussed by Hodges (1944) the regular shape of the fold indicates no faulting is present above -3700 feet subsea depth in the western portion of the Playa Vista site.

The subsurface mapping was supplemented with four cross sections that give a vertical slice view of the subsurface structure under the Playa Vista site. The locations and the cross section lines are shown in Figure 8 and Plate VIII. The locations of the cross section lines were selected to provide a representative view of the subsurface of the Playa Vista site and to avoid well projections into the lines. The postulated Lincoln Boulevard fault has been placed on the cross sections with the position and geometry shown in Figure 5 and Plate V of this report (Plate 1 of the ETI Report).

Cross section #1 (Figure 12, Plate XII) is a northeast directed line along the southern boundary of the Playa Vista site. Section #1 shows the gentle east dip of the Playa Del Rey anticline and the eastward thickening of sedimentary units. There is nothing in the well data or geometry of the subsurface to suggest the postulated Lincoln Boulevard fault. Cross section #1 passes through the University City Syndicate #1 well that had a gas blow-out of about 3.1 MMCF/day at 1821 feet in August 1930. ETI (2000) believe the blow out was due to the well bore intersecting the proposed Lincoln Boulevard fault as depicted in Figure 5 and Plate V of this report. Examination of the well records show the blowout died on its own after twelve hours. A gas blowout is not unique evidence for a fault. Shallow blowouts were a common occurrence in wells drilled in the Los Angeles basin during the early part of 1900's usually as a result of drilling through an isolated sand body and/or poor drilling procedures. The 2D high resolution seismic line (section 3.2) provides an image that suggests the gas blow out was the result of the well drilling into a small pocket of gas trapped by a stratigraphic pinchout within the upper Pico Formation (Figure 20, Plate XX).

Cross section #2 (Figure 13, Plate XIII) is a northerly line across the Playa Vista site and goes from the Del Rey Hills Area to the small Kidson pool. The cross section crosses the east limb of the Playa Del Rey anticline at a high angle and the low dips shown are apparent. Cross section #2 also passes through the University City Syndicate #1 well. In cross section #2 there is nothing in the well data or geometry of the subsurface to suggest the existence of the postulated Lincoln Boulevard fault.

Cross-section #3 (Figure 14, Plate XIV) is a northeast trending cross section across the northern portion of the Playa Vista site. Section #3 is nearly perpendicular to the trend of the Playa Del Rey anticline and shows a steeper limb dip (true dip) to the Playa Vista anticline, but there is nothing in the well data or geometry of the subsurface to suggest the postulated Lincoln Boulevard fault.

Cross-section #4 (Figure 15) is a northeast line along the southern boundary of the Playa Vista site. Cross-section #4 follows the cross-section #1 line, except that the University City Syndicate #1 is replaced by the Co-Operative Development, Community #1 well to make a straighter cross-section line. Within the Del Rey Hills Area the west end of the cross-section #4 goes northwest along the crest of Playa Del Rey anticline. Cross-section #4 shows the crest and gentle east dip of the Playa Del Rey anticline, and there is nothing in the well data or geometry of the subsurface to suggest the postulated Lincoln Boulevard fault.

In the two regional cross-sections constructed by Jack West and the three subsurface maps and four cross-sections constructed by Davis and Namson there is nothing in the geometry of the subsurface or well data to suggest the presence of the Lincoln Boulevard fault under the Playa Vista site. The maps and cross-sections show the general structure under the Playa Vista site and show no significant fault is possible under the entire site. East of the Del Rey Hills Area of the Playa Del Rey oil field (central and eastern portions of the Playa Vista site) the density of wells is low and it would be possible for one to interpret a small fault under the site if some other evidence for a fault became available. For instance, the density of well data adjacent to the Charnock fault is too low to eliminate its existence. Under the western part of the Playa Vista site (Del Rey Hills Area) the density of wells is high and it is very difficult to interpret even a small of fault between the wells as shown by Hester (1986). As previously discussed, the small fault interpreted by Metzner (1935) to offset the top of the Catalina Schist in southeast corner of section 27 probably does not exist based on

subsequent more detailed subsurface work (Hester, 1986). This fault was cited by ETI (2000) as evidence for extension of the postulated Lincoln Boulevard fault into the Southern California Gas Company's Gas Storage reservoir in the Schist Conglomerate zone of the Del Rey Hills Area (Figure 5, Plate V). If small faults are present in the western Part of the Playa Vista site they are confined to the deeper sedimentary units and do cut through the upper Bentonite marker of the Repetto Formation as shown by the subsurface mapping of Hodges (1944) and Jack West cross-sections (Figure 7, Plate VII). This indicates no faulting has occurred in the western part of the Playa Vista during the last 2.5 to 3.0 million years

3.0 Onshore Geophysical Survey

3.1 Licensed Chevron seismic line:

Playa Vista purchased a licensed seismic reflection line from Chevron. Line LAB 85-4 is located about 9,000 to 12,000 feet south of the Playa Vista site and is oriented in an east-west direction (Figure 16, Plate XVI). The Chevron seismic line is licensed data and the wiggle trace presentation cannot be reproduced for this report. Figure 16 and Plate XVI are grayscale plots of the migrated seismic data with a line interpretation of the structure and stratigraphy. Seismic line LAB 85-4 is oriented so that it should intersect the southern projection of the postulated Lincoln Boulevard fault at about shot points 248-254. This portion of the seismic line is characterized by unbroken reflectors through the entire sedimentary section to the top of the crystalline basement -a depth of about 6700 feet. The seismic reflectors are the result of lithologic [density] changes in the rock column with depth and the reflectors provide a continuous subsurface image of sedimentary bedding and contacts. Faults are visible in seismic data because they disrupt and offset the bedding and may produce diffractions at the terminations of reflectors. The unbroken reflectors in the Chevron seismic line and lack of diffractions indicate either the postulated Lincoln Boulevard fault is nonexistent or it dies out before reaching the line.

Line LAB 85-4 is of very high imaging quality for the Los Angeles basin showing a seismic image of the entire sedimentary section to the top of the crystalline basement along the entire seismic line. Above 1.4 sec (approximately 5,000 ft depth) the seismic line shows a number of reflectors that are continuous across the entire line and indicate no faulting has occurred since these layers were deposited. A check shot survey from the nearby Chevron (Shell Oil Co.) Six Companies #1 well (section 2, T3S-R15W, Plate I) was used to constrain the stratigraphy and age of the reflectors. The continuous reflectors belong to the upper Repetto Formation and younger units. Therefore no faulting has occurred along Chevron line LAB 85-4 during the last 3.0 million years (the age of the base of the upper Repetto Formation).

Below 1.4 sec on LAB 85-4 and at about shot point 200 there is evidence for a small fault cutting the top of the Catalina Schist, Topanga Formation, and Puente Formation. This indicates the fault was active during the late Miocene (5-14 ma). The fault dies out within the middle Repetto Formation and therefore the fault has not moved during the last 3.0 million years. This is not the postulated Lincoln Boulevard fault (ETI, 2000) for three reasons: 1)the location of the small fault is much further east than the on-strike projection of the postulated Lincoln Boulevard fault (as discussed above); 2) the small fault does not cut strata younger than middle Repetto (conversely the postulated Lincoln Boulevard fault, if it exists, must cut upper Quaternary deposits to produce the shallow methane anomaly at the Playa Vista site); and 3) most importantly, and discussed later, the new 3D seismic data collected by Playa Vista show no evidence for the postulated Lincoln Boulevard fault or the small Miocene age fault observed in Chevron seismic line LAB 85-4. The small Miocene fault either dies out before reaching the Playa Vista site or trends east of the Playa Vista site and the new seismic data.

3.2 2D High resolution seismic line:

A 2D high-resolution seismic line was acquired for Playa Vista along the south side of Jefferson Boulevard during the last week of July 2000 (Figure 18, Plate XVIII). Seismic acquisition was performed by Subsurface Exploration Company, and during August and

September 2000 Tricon Geophysical did the processing of the 2D seismic data set.

Figure 19 and Plate XIX are the uninterpreted migrated 2D high-resolution seismic line, and Figure 20 and Plate XX are the same data set interpreted. The 2D line transects most of the Playa Vista site in an east-west direction from the eastern edge of Southern California Gas Company's gas storage field to the eastern end of the Playa Vista property. Interpretation and integration of the 2D line with the oil well data was completed by Davis and Namson during September 2000. The 2D seismic data was integrated with the well data and interpreted using SeisX software (Paradigm Geophysical) on a Unix workstation. A check shot survey from the nearby Chevron (Shell Oil Co.) Six Companies #1 well (section 2, T3S-R15W, Plate I) was used for converting the Universal City Syndicate 31 well to time. The Pico Formation stratigraphy shown on the interpreted line was brought in from the 3D seismic interpretation that had the benefit of more well ties. Included in the plates (8.0 Plates) are interpreted the uninterpreted 2D line (Plate XIX), and the interpreted 2D line (Plate XX) that are plotted at 1"=600 feet to be consistent with the subsurface geologic maps. The interpreted lines were plotted from Seis X by Davis & Namson and the uninterpreted lines were plotted by Tricon Geophysical.

Overall the 2D high-resolution line is of good quality with the eastern two thirds having the best quality (from about shot point 600 eastward). Integration of the 3D seismic interpretation shows the 2D line mostly images the middle and upper Pico Formation in the time interval from about 200 to 800 milliseconds (approximately 600 to 2500 feet depth). Deeper than 800 milliseconds there is little useable data as would be expected from a high resolution line. The 3D seismic survey, described next, images the remaining sedimentary section down to the top of the Catalina Schist and the entire Playa Vista site.

The 2D line shows the detailed structural geometry and stratigraphic framework of the east limb of the Playa Del Rey anticline under the Playa Vista site. The 2D line is of

sufficient data quality to show the details of westward stratigraphic thinning along the anticlinal limb. The Playa Vista anticline was growing during deposition of the middle and upper Pico Formation and the westward thinning of beds is a result of the interaction of tectonism and deposition. Of greatest importance to the faulting issues at the Playa Vista site are the set of reflectors from about 400 to 700 milliseconds that are continuous along the entire 2D line. These reflectors belong to the upper portion of the middle Pico Formation.

The seismic reflectors are the result of lithologic [density] changes in the rock column with depth and the reflectors provide a continuous subsurface image of sedimentary bedding and contacts. Faults are visible in seismic data because they disrupt and offset the bedding and may produce diffractions at the terminations of reflectors. Consequently the continuous reflectors in the 2D seismic line show that no faulting has occurred under the Playa Vista site east of the eastern edge of the gas storage field (Del Rey Hills Area) during at least the last 1.0 million years (top of middle Pico Formation is estimated to be from 1.5 to 1.0 million years old). As previously discussed, the area west of the 2D line has subsurface mapping and cross section work based on a high density of well data that show it is unlikely that any faults cut the upper Repetto Formation (Figure 7, Plate VII, and Hodges, 1944). This indicates no faulting in the western part of the Playa Vista site during the last 3.0 to 2.5 million years.

The 2D line crosses the shallow location of the postulated Lincoln Boulevard fault just east of Lincoln Boulevard and about shot point 450 (Figure 20, Plate XX). The middle Pico Formation reflectors cross the subsurface projection of the postulated Lincoln Boulevard fault, and show the fault is nonexistent on the 2D line. The eastern half of the 2D line shows a continual set of reflectors from about 200 to 600 milliseconds (Figure 19, Plate XIX) that cross the mapped position of the postulated Charnock fault of Poland, et al. (1959). The intersection of the postulated Charnock fault and the 2D lines is about shot point 1120, and the continuous reflectors and lack of diffractions show that the Charnock fault is nonexistent in the upper Pico Formation. Deeper reflectors belonging to the upper part of the middle Pico Formation also cross the postulated

Charnock fault unbroken. The Playa Vista site is near the southern end of where Poland et al. (1959) postulated the fault and it is possible the fault has died out, turned east of the site, or, being a fault inferred from variations in the ground water table does not exist.

The 2D line images other subsurface relationships that are important to the Playa Vista project site. The 2D line shows that the westward-thinning wedge of Pico Formation strata on to the east limb of the Playa Del Rey anticline as presented in the cross sections (Figures 7, Plate VI; and Figures 12-15, Plates XII-XV) is valid. The westward thinning is accomplished by stratal thinning, pinchouts and onlap of younger beds on to older beds (Figure 20, Plate XX). Within the upper Pico Formation is an angular unconformity that is imaged across the entire line, and the upper Pico strata above this unconformity are onlapping westward onto the older Pico strata below the unconformity. This relationship is particularly evident where the Universal City Syndicate #1 well crosses the unconformity (Figure 20, Plate XX). It is noteworthy that the location of the unconformity is just below the depth of where the Universal well had a gas blow out in 1931. The stratigraphic relationships shown on the 2D high-resolution line provide a very likely explanation for the blow out. Gas migrating updip became trapped within the onlapping sands just above the unconformity.

Between shot points 300 and 600 and above 400 milliseconds the 2D line is characterized by discontinuous reflectors and overlapping reflectors that are interpreted here to be nested channel deposits possibly related to the downcutting and subsequent filling of the ancestral Ballona Creek during the Pleistocene. As discussed in section 2.2 (Stratigraphy of the Playa Vista Site) extreme down cutting of Ballona Creek and subsidence during the late Pleistocene may have produced nearly 400 feet of local relief on the base of the ancestral Ballona channel (Figure 4, Plate IVB). This area is also characterized by a poor signal to noise ratio and low fold that is probably a result of the high degree of surface modification of the Playa Vista site east of Lincoln Boulevard.

In summary the 2D high-resolution seismic line displays unfaulted reflectors along the entire line. The 2D line covers much of the Playa Vista site as it extends from the join of Jefferson and Culver Boulevards eastward to the end of the Playa Vista site. The continuous reflectors belong to the upper portion of the middle Pico Formation and show there been no faulting of any kind since at least the last 1.0 million years. Subsurface mapping based on well data indicate that no faulting has occurred in the Playa Vista site area west of the 2D line during the last 2.5 to 3.0 million years. In addition the 2D seismic line shows no evidence for either the postulated Lincoln Boulevard fault or the postulated Charnock faults below the upper middle Pico Formation reflectors.

3.3 3D seismic survey:

A 3D seismic line was acquired for Playa Vista over the entire Playa Vista project site, and over additional areas along Centinela and Ballona Creeks, Dockweiler State Beach south of Ballona Creek, and in the entrance to Marina Del Rey Harbor (bay cable) during the latter part of July 2000 (Figure 21, Plate XXI, and Figure 22, Plate XXII). Acquisition was performed by Subsurface Exploration Company, and Tricon Geophysical processed the 3D data set during September and October 2000.

The 3D seismic data was integrated with the well data and interpreted by Davis & Namson during October, 2000 using SeisX software (Paradigm Geophysical) on a SGI Unix workstation. The 3D seismic survey is over an area with abundant well data. Wells adjacent to the Inlines and Crosslines are shown on the lines. Integration of well data into the lines allows for a better understanding of the deeper less definitive seismic data, and for stratigraphic and age determination of seismic reflectors. Depending on the well location with respect to the Playa Del Rey anticline, check shot surveys from either the Chevron (Shell Oil Co.) Six Companies #1 well (section 2, T3S-R15W), or the Shell Oil Company, Baldwin Hills Community #1 (section 9, T2S-R14W) were used for converting the geologic well data to time (Plate I).

The 3D seismic data are processed and displayed as Inlines and Crosslines. The Inlines are roughly parallel to Jefferson Boulevard while the Crosslines are roughly parallel to Lincoln Boulevard (Figures 21 and 22, Plates XXI and XXII). Included in the plates (8.0 Plates) are interpreted and uninterpreted Inlines 15, 20, 25, and 30 (Plates XXIIIA-H), and Crosslines 20, 30, 40, 50, 60, and 70 (Plates XXIVA-L). The interpreted and uninterpreted lines are plotted at 1"=600 feet to be consistent with the subsurface geologic maps. The interpreted lines were plotted from Seis X by Davis & Namson and the uninterpreted lines were plotted by Tricon Geophysical.

Figures 23 and 24 are examples of Inlines of the 3D seismic data set that provide northeast-southwest slices of the subsurface under the Playa Vista site. These lines also cross the crest of the Playa Del Rey anticline, the postulated Lincoln Boulevard fault, and the postulated Charnock fault. The shallow data gaps (above 1000 milliseconds) on the left-hand-side of the lines are the result of the 3D seismic survey being unable to access the wetland areas of the Playa Vista project site and some residential areas in the western portion of the study area which resulted in decreased data recovery (fold). In general the 3D survey has better image quality in the central and eastern portions of the Playa Vista site. Undoubtedly this is due to the lack of source lines in the west compared to areas in the central and eastern parts of the site (Figure 22, Plate XXII).

The 3D Inlines (Figures 23 and 24, Plates XXIII and XIV) show the detailed structural geometry and stratigraphic framework of the east limb of the Playa Del Rey anticline under the Playa Vista site. The Inlines shows that the westward-thinning wedge of Pico Formation strata on to the east limb of the Playa Del Rey anticline as shown in the cross-sections (Figures 7, Plate VI; and Figures 12-15, Plates XII-XV) and in the 2D high-resolution lines (Figures 19 and 20, Plates XIX and XX). Of greatest importance to the faulting issues at the Playa Vista site are the set of reflectors from about 400 to 1000 milliseconds and continuous along the entire 3D seismic survey from about

Crossline 20 eastward. Crosslines 20 intersects Inlines 20 and 25 about 1300 feet west of the join of Culver and Jefferson Boulevards (Plates XXI and XXII) indicating the unfaulted reflectors underlie most of the Playa Vista site. The seismic reflectors are the result of lithologic [density] changes in the rock column with depth and the reflectors provide a continuous subsurface image of sedimentary bedding and contacts. Faults are visible in seismic data because they disrupt and offset the bedding and may produce diffractions at the terminations of reflectors. The continuous reflectors imaged in the Crosslines belong to the middle Pico Formation indicating that no faulting has occurred under most of Playa Vista site during the last 2.0 million years. This conclusion is consistent with the results of the 2D high-resolution seismic line and the subsurface mapping based on well data.

The 3D seismic survey provides additional information of the faulting issues at the Playa Vista site. The Inlines cross the postulated Lincoln Boulevard fault in the central portion of the survey (from about Crosslines 30 to 50), and the postulated Charnock fault in the eastern portion of the survey (from about Crosslines 50 to 90). In the central area of the 3D seismic survey all stratigraphic tops and subsurface survey data have been converted to two-way travel time using velocity data from the Chevron (Shell Oil Co.) Six Companies #1, as this well has a similar depth and stratigraphy to the east limb of the Playa Del Rey anticline.

The Inlines cross the shallow location of the postulated Lincoln Boulevard fault just east of Lincoln Boulevard and about their intersections with Crosslines 44 to 45 (Figure 23 and 24, and Plates XXIIIA-H, Plates XXIVA-L). In this central area the Inlines show sets of continuous reflectors from about 400 to 1400 milliseconds, eliminating the possibility of a Lincoln Boulevard fault, and any other faulting, from this portion of the survey above 1400 milliseconds. Integration of the well data indicates that the continuous reflectors are from the middle and upper Repetto Formation, and the lower and middle Pico Formation. Therefore no faulting has occurred in the central portion of the 3D seismic survey during the last 4.0 million years.

In the central portion of the 3D seismic survey and below 1400 milliseconds to the top of Catalina Schist the seismic image is less definitive as would be expected from the decreasing penetration and return of seismic energy. There, the image is characterized by discontinuous reflectors and somewhat noisy data. Well data indicate that the section imaged consists of the top of the Catalina Schist, Schist Conglomerate, Nodular Shale, Puente Formation and lower Repetto Formation. No evidence for faulting is observed in the seismic record below 1400 milliseconds and portions of the top of the Catalina Schist are obvious on the Inlines and Crosslines. Extrapolation of the top of Catalina Schist from portion to portion argues against any significant faulting below 1400 milliseconds under the Playa Vista site.

The eastern portion of the 3D seismic survey (from Crosslines 50 to 90) nearly reaches the synclinal trough that bounds the east limb of the Playa Del Rey anticline. This syncline is shown on Jack West's Playa Del Rey oil field to Inglewood oil field cross section (Figure 7, Plate VII). The eastern portion of the 3D seismic survey shows the Playa Vista site down to the Catalina Schist (Figures 23 and 24). Well tops and subsurface survey data have been converted to two-way travel time using velocity data from the Shell Oil Company, Baldwin Hills Community #1 as this well has a similar depth and stratigraphy to eastern part of the 3D seismic survey.

The Inlines cross the shallow location of the postulated Charnock fault (Poland, et al., 1959) just east of their intersections with Crossline 83 (Figure 23 and 24, and Plates XXIIIA-H, Plates XXIVA-L). Between about Crosslines 50 and 90 the Inlines show sets of continuous reflectors from about 400 to 1400 milliseconds eliminating the possibility of a Charnock fault, or any other faulting, above 1400 milliseconds. Integration of the well data indicates that the continuous reflectors are from the upper Repetto Formation, and the lower and middle Pico Formation. Therefore there has been no faulting in the eastern portion of the 3D seismic survey during the last 3.0 million years.

In the eastern portion of the 3D seismic survey and below 1400 milliseconds to the top of Catalina Schist the seismic image is less definitive. As with the central portion of survey, the eastern portion is characterized by discontinuous reflectors and somewhat noisy data. Well data indicate that the section imaged consists of the top of the Catalina Schist, Schist Conglomerate, Nodular Shale, Puente Formation, and lower middle Repetto Formation. No evidence for faulting is observed in the 3D seismic survey below 1400 milliseconds.

The western portions of the Inlines provide northeast-southwest subsurface images across the crest of the Playa Del Rey anticline west of the intersections of Crossline 30 (Figure 23 and 24, and Plates XXIIIA-H, Plates XXIVA-L). Crosslines 20 and 30 provide northwest-southeast subsurface images of the crest of the anticline. The Del Rey Hills Area of the old Playa Del Rey oil field is located where the Inlines cross the crest of the anticline. This is an area with abundant well data, and wells adjacent to the Inlines and Crosslines are shown on the lines. Well tops and subsurface survey data have been converted to two-way travel time using velocity data from the Chevron (Shell Oil Co.) Six Companies #1 well that has a similar depth and stratigraphy to the crest and limbs of the Playa Del Rey anticline.

The western portions of the Inlines (Figure 23 and 24, and Plates XXIIIA-H, Plates XXIVA-L) provide good quality images consisting of well defined and continuous reflectors from about 700 to 400 milliseconds that oil well data indicate are from the middle Pico Formation. As a result of the previously mentioned shallow data gaps along the western portion of the 3D seismic survey these well defined reflectors are broken by areas of no data west of Crossline 20 (about 1300 feet west of the join of Culver and Jefferson Boulevards). Where these reflectors are imaged they show no evidence for faulting, however, it was impossible to obtain a complete image of the shallowest portions of the crest of Playa Del Rey anticline west of Crossline 20.

In the western portion of the Inlines and the adjacent Crosslines, moderate quality images of the subsurface were obtained from a zone from 700 to 1400 milliseconds

(about 4500 feet) across the crest of the Playa Del Rey anticline. This zone consists of a stack of discontinuous reflectors that show no evidence for faulting. Imaging is less definitive in this zone than in the shallower section, as would be expected from the decreasing penetration and return of acoustic energy. Integration of well data with the lines also does show any indication of faulting within this zone. The well data also indicate that these discontinuous reflectors are from the middle and upper Repetto Formation and lower Pico Formation. The area of the Playa Vista site west of Crossline 20 has geologic data that assist with the fault evaluation. As previously discussed, subsurface mapping and cross section work based on abundant well data in the Del Rey Hills Area show it is unlikely that any faults cut the upper Repetto Formation (Figure 7, Plate VII, and Hodges, 1944). This indicates no faulting in the westernmost part of the Playa Vista site during the last 3.0 to 2.5 million years.

In the western portion of the 3D seismic survey below 1400 milliseconds (about 4500 feet) a zone of moderate to poor image quality was obtained across the crest of the Playa Del Rey anticline. There the images consist of a stack of discontinuous reflectors and rather noisy data. The data from this zone show no evidence for faulting, however the data is poor enough that one cannot eliminate the possibility of minor faulting. The well data indicate that the seismic image below 1400 milliseconds is from the lower Repetto formation to the top of the Catalina Schist. The western portion of the survey is in an area of abundant well control and correlation of that data by Hester (1986) and this study (section 2.0, Subsurface Geology of the Playa Vista Site) show no evidence for faulting. Integration of well data with the 3D seismic data also supports this conclusion.

In summary the 3D seismic survey shows that nearly the entire Playa Vista site is underlain by continuous reflectors belonging to the middle Pico Formation. The 3D data coverage begins to die out in the westernmost part of the Playa Vista site (about 1300 feet west of the join of Culver and Jefferson Boulevards) and this is the only area of the site where the continuous reflectors were not imaged. The continuous reflectors indicate that no faulting has occurred under the Playa Vista site during the last 2.0

million years with the exception of the small unimaged area at the western end of the project site. Abundant well data show it is unlikely that any faults cut the upper Repetto Formation in the westernmost part of the site and thus that no faulting occurred there during the last 3.0 to 2.5 million years.

The 3D seismic survey revealed no evidence for either the postulated Lincoln Boulevard or the postulated Charnock faults in the data shallower than 1400 milliseconds or about 4500 feet. Above 1400 milliseconds the 3D survey is characterized by sets of continuous reflectors where these postulated faults intersect the 3D survey. Integration of oil well data with the 3D seismic data show these continuous reflectors are from the middle and upper Repetto Formation and the overlying Pico Formation. Thus one can conclude there has been no fault activity under the central and eastern portions of the Playa Vista site during the last 4.0 million years. Below that 1400 milliseconds the seismic image is not clear. The conclusion that there is no Lincoln Boulevard fault is consistent with the results of the 2D High Resolution Survey (section 3.2 2D High Resolution seismic line), and the Earth Consultants International study of the shallow geology of the site (ECINTL, 2000). The conclusion that there is no Charnock fault or other faulting above 1400 milliseconds in the eastern part of the 3D seismic survey area is also consistent with the results of the 2D High Resolution seismic line. The fact that the postulated Lincoln Boulevard is not observed in either the 2D or 3D seismic surveys argues against its presence below the depth of good seismic imaging. The only reason for interpreting the fault is to explain the shallow methane anomaly at the Playa Vista site (ETI, 2000). The postulated fault would have to cut through the upper Pliocene and Quaternary deposits in order to be a conduit for methane. If the seismic surveys show there is no fault above 4500 feet then the methane anomaly must have some other cause and there is no basis for suggesting the presence of the Lincoln Boulevard fault.

4.0 Offshore Geophysical Survey

The offshore geophysical survey (Figure 25) was acquired, processed, and interpreted

by Dr. Dan Francis of California State University Long Beach and Dr. Marc Legg of Legg Geophysical. Their report was written separately from the main report and has been inserted here with only editing modifications.

4.1 Introduction:

An offshore survey was carried out to determine the existence of through going faults that may be of concern to the Playa Vista site (Figure 25). The survey area (Figure 26) was chosen to detect faults that extend from the vicinity of the Playa Vista property to the immediate offshore area. Of particular concern are faults that might connect with the onshore gas storage facility, or hypothetical faults that define or control the bluffs along the north edge of Westchester and Playa Del Rey (Figure 2). The survey area is adjacent to, and compliments, the onshore 2-D and 3-D survey area. In addition to the survey area indicated in Figure 26, two multi-channel seismic profiles were acquired in the Ballona Creek channel, from near the mouth to within 500 feet of the Culver overpass (Figure 27). These profiles parallel one of the geophone spreads in the 3-D land survey, and also parallel a high resolution profile acquired along Jefferson Blvd.

4.2 Methods:

Four acoustic instruments were deployed to provide overlapping data sets that would image the seafloor itself, and subbottom features at various depths and resolutions:

1. *Side scan sonar* provides information on seafloor characteristics such as topography, bottom type (sandy, rocky), and presence of man-made objects. High frequency (150 kHz) sound waves emanate from both sides of a towed instrument; an image of a swath of seafloor 400 m (about 1200 feet) wide is built up as the sound reflects from seafloor features. We have 100% areal coverage of the seafloor in the survey area shown in Figure 26.

2. *3.5 kHz echo sounding* provides high-resolution vertical profiles of sub-bottom characteristics to a depth of up to 50 feet. Vertically incident sound

waves penetrate the seafloor because of their lower frequency (relative to side scan sonar), and reflect from strata and other subsurface geologic features. 3.5 kHz echo soundings were carried out on all of the boat track lines shown in Figure 26.

2. *Single-channel digital uniboom seismic reflection* uses still lower frequency (400-1,200 Hz) but higher energy (300 joules) sound waves to image geological features as deep as 300 feet below the seafloor. Data are digitized and stored in a computer for later processing, which reduces noise and allows plotting of profiles at any desired scale. Uniboom data were collected on every other trackline shown in Figure 26.

3. *Single channel digital sparker seismic reflection* uses a low frequency (70-200 Hz) high energy (1,000 joules) sound source to image, at lower resolution than the uniboom, features as deep as 2,000 feet below the seafloor. Sparker profiles were collected on lines on which uniboom data were not collected.

Because of its lower resolution, the sparker does not provide good images of the upper 50-100 feet, and the uniboom does not adequately image the upper 10-20 feet. This is why three methods, 3.5 kHz, uniboom, and sparker, are needed to provide the most complete overlapping imaging required to detect faulting and determine recency of fault movement. Examples of such imaging in areas other than the Playa Vista survey are depicted in Figures 28, 29 and 30. With the addition of side scan sonar, a three-dimensional imaging (vertical and horizontal) is made possible.

The same sparker sound source was used in Ballona Creek with a 24-channel receiver cable; data from these distributed channels were "stacked" to provide clearer, deeper images. This more costly technique was used in this critical location as a link to the multichannel land seismic survey.

4.3 Results:

The offshore seismic/sonar survey revealed no evidence of faulting related to the bluffs (Ballona escarpment) just south side of the Playa Vista site (Figure 31). Some minor, low-offset faults were found to the north, but none in the location or alignment required for a fault to be associated with the bluffs. The faults

A reflective sedimentary contact (boundary between two layers) 11 to 13 msec below the seafloor was imaged in the uniboom data; this corresponds to a depth of about 40 to 50 feet (Figure 30). The reflector is flat, with only about 5 feet of vertical relief, and extends from south to north across any reasonable extension of the bluffs. The reflector is shown in some uniboom records to be an angular unconformity. The reflector correlates to an unconformable contact in nearby well records; this contact separates 15,000 year old sediments below it from sediments 6,000 years old or younger above. The reflector is offset by a small east-west trending fault just west of the breakwater, well north of any fault that would be related to the bluffs (Figure 31). The vertical separation of this fault is about 4 msec (about 12 feet). This fault is not observed in lines 11, 15, and 17 and the fault is assumed to die out west of the breakwater in the offhsore. A second fault was observed further north with an unknown, but probably small, vertical separation (Figure 31). As with the first fault this fault dies out eastward before reaching lines 15 and 17.

A reflector at about 375 msec (about 1,200-1,400 feet) is imaged in parts of the sparker profiles (Figure 32). This reflector is probably an angular unconformity, as an anticline and other possible structural features are imaged below it. A possible small fault exists well to the south of the bluffs, but it is imaged in only one profile, so its orientation cannot be determined. The reflector is only weakly imaged in the area of the bluffs and farther north (Figure 33). The reason for poor imaging of this reflector in some areas may be due to attenuation or scattering of acoustic energy in seafloor surface sediments; this scattering may be in part controlled by the locations of ancient river channels on the seafloor.

Numerous river channels, formed when sea level was lower, were revealed by side san sonar data (Figure 34). Most of the channels in the northern part of the survey area trend in a southeast direction (bearing approximately 135 degrees). They are crosscut by a younger channel that begins just south of the southern entrance to Marina del Rey, and trends south-southeast (bearing approximately 165 degrees). This younger channel may have been eroded by the Los Angeles River when it flowed out of the present Ballona Creek channel. The channels are evidenced in side scan sonar records by dark (high reflectivity) linear features that may represent rough (for example, gravelly) seafloor. There is no evidence of ridges or other topographic features; any such features more than about 1 foot high would appear in 3.5 kHz profiles (detection of seafloor topography is complicated by sea surface swell of about 3-4 feet at the time of the survey). Thus the high reflectivity is probably from numerous small rocks or other objects on the seafloor that mark the edge of a channel.

The channels show no direct evidence of horizontal (strike-slip) offset that would be due to faulting. The size and sharpness of the imaged linear features in the side scan records limits the maximum horizontal separation of any faults that may exist to no more than about 15 feet.

The younger channel is clearly imaged in two 3.5 kHz profiles (Figure 36); the edges of the channel correlate approximately with the linear features in the side scan sonar records. The channel is only about 10 feet deep in the center, and is backfilled with sediments less than 11,000 year old. This raises the possibility that seafloor sediments in the area of the younger channel are different from those in other parts of the survey area.

The extent of the reflector at 375 msec is almost entirely contained within the confines of the younger channel (Figure 37), suggesting that poor imaging outside the channel is due to loss of energy within shallow sediments. A possible fault is imaged in one profile

within the channel (Figure 33), but the extension of the bluffs is north of the channel. This means that the 375 msec reflector provides no direct evidence for or against faulting associated with the bluffs. On the other hand, a stratigraphic horizon seen in numerous wells in the area, at depths ranging from 800 to 1,200 feet (top of the Pico formation), is the most likely correlation with the 375 msec reflector, and with a reflector at 250 msec in the Ballona Creek 24-channel line (Figure 38). If so, a fault with vertical separation necessary to account for the bluffs is unlikely.

The Ballona Creek 24-channel line shows two areas of poor seismic imaging, one near the river mouth and the other east of the point where the Marina del Rey channel turns north away from Ballona Creek (Figure 38). These two "wipeout" zones could be due to methane gas in the pore spaces of the sediments, or to scattering or energy loss due the character of the Ballona Creek riverbed.

4.4 Conclusions of offshore geophysical survey:

The offshore survey area is a region of relatively flat stratigraphy, with shallow marine and river-deposited (from lower stands of sea level) sediments. At least two unconformities have been imaged in the seismic data. Channels are abundant in the upper 50 feet of the sediments. Seismic imaging in such sediments is often incomplete because of scattering or loss of acoustic energy, especially in sediments at the seafloor. This phenomenon may also have affected the 24-channel seismic profile in Ballona Creek.

The offshore data do not image a fault along the offshore projection of the bluffs just south of the Playa Vista site (Ballona escarpment). The continuous nature of offshore reflectors, as far as they are imaged, provides no evidence for such a fault. The existence of 6,000 year old sediments in the Ballona wetlands and offshore (in the younger river channel, cross cutting any reasonable extension of the bluffs), and 100,000-300,000 (?) year old sediments on top of the bluffs in Westchester, argues for erosion as the causative agent for the bluffs. Any bluff-controlling fault would have to

terminate at or near the shoreline, an unlikely structural feature. Furthermore, no prominent shoreline-parallel structural feature is observed in the offshore or Ballona Creek data that could terminate a west-trending bluff-related structure.

Two east-west trending faults, with vertical separation of 12 feet or less, were imaged further south near the entrance of Marina Del Rey. Near shore north-south lines indicate these fault do not project onshore.

The Ballona Creek 24-channel lines shows two area of poor seismic imaging, one near the river mouth and the other east of the point where the Marina Del Rey Harbor turns north away from Ballona Creek (Figures 27 and 38). These two "wipeout" zones could be due to scattering or energy loss due to the character of the Ballona Creek riverbed, or less possibly to methane gas in the pore spaces of the sediments. Dredging and compaction prior to development of Marina Del Rey Harbor and flood control efforts at Ballona Creek may have created a shallow zone of dense material that reflects seismic energy. Alternatively, there may be a zone of river-deposited gravels, cobbles and boulders that scatter seismic energy. A possible insight into the cause of these wipeout zones is provided by an old (1901 version, 1912 printing) topographic map of the area (Figure 39). The original shape of the Ballona lagoon overlaps the present Ballona Creek channel in the area where seismic imaging is good. At that time Ballona Creek emptied into the lagoon farther to the north. Silty or clayey lagoonal sediments would be more transparent to seismic energy than sandy or gravelly river deposits; the latter may be responsible for the wipeout zones in the seismic data. If the cause of the wipeout zone is shallow gas, then the gas would be localized near Ballona Creek, because gas wipeout zones do not appear in the onshore seismic data acquired by Playa Vista.

5.0 Summary and Conclusions

In May 2000 Davis and Namson Consulting Geologists started a study of the subsurface of the Playa Vista site to determine the possibility of a Lincoln Boulevard fault as proposed in the ETI Report (2000), and to evaluate the possibility of other faults at the site. The Davis

and Namson study took a multiphase approach to the problem. First, the existing geologic literature and unpublished consultant reports on the area were obtained and reviewed. No mention of a Lincoln Boulevard fault exists in the literature before the ETI (2000) report, and the report offers no new geologic or geophysical evidence for the existence of the Lincoln Boulevard fault. The preexisting geologic evidence cited by ETI (2000), i.e. Metzner (1935), does not support the presence of the Lincoln Boulevard fault. ETI has proposed the Lincoln Boulevard fault to explain the presence of the shallow methane anomaly, but ETI fails to consider that methane anomalies and seepages are not uniquely the result of faulting. It is well known that methane anomalies and seepages can result from a variety of subsurface conditions, not all of them requiring faulting (Thrasher, et al., 1996; Matthews, 1996). Therefore the postulated Lincoln Boulevard fault is a possible but not unique interpretation of the methane anomaly, but the fault interpretation is unsupported by the existing geologic literature from the Playa Vista area. ETI's earthquake scenario of large volumes of methane gas released along the Lincoln Boulevard fault during a future earthquake is unprecedented in the seismic history of California where numerous large and moderate earthquakes have occurred under or adjacent to existing oil and gas fields with no catastrophic releases of gas.

Davis and Namson collected an extensive well database, and subsurface maps and cross sections were constructed using these data and previous subsurface work. Mr. Jack West, Petroleum Geologist, constructed two regional cross sections of the Playa Vista area. The maps and cross sections show the general structure under the Playa Vista site and show no significant fault is possible under the entire site. East of the Del Rey Hills Area of the Playa Del Rey Oil Field (central and eastern portions of the Playa Vista site) the density of wells is low and it would be possible for one to interpret a small fault under the site if some other evidence for a fault became available. For instance, the density of well data adjacent to the Charnock fault is too low to support or eliminate its existence. Under the western part of the Playa Vista site (Del Rey Hills Area) the density of wells is high and it is very difficult to interpret even a small fault between the wells as shown by Hester (1986). As previously discussed, the small fault interpreted by Metzner (1935) to offset the top of the Catalina Schist in the southeast corner of section

27 probably does not exist based on subsequent more detailed subsurface work (Hester, 1986). This fault was cited by ETI (2000) as evidence for extension of the postulated Lincoln Boulevard fault into the Southern California Gas Company's Gas Storage reservoir in the Schist Conglomerate zone of the Del Rey Hills Area (Figure 5, Plate V). If small faults are present in the western part of the Playa Vista site they are confined to the deeper sedimentary units and do not cut through the upper Bentonite marker of the Repetto Formation as shown by the subsurface mapping of Hodges (1944), Hodges (1986), and Jack West cross sections (Figure 7, Plate VII). This indicates no faulting has occurred in the western part of the Playa Vista during the last 2.5 to 3.0 million years

During May and June 2000 a search and review was done for existing seismic reflection data near the Playa Vista area. Playa Vista purchased a seismic data license from Pacific Seismic Company for Chevron Line LAB 85-4. This line is east-west trending and located south of the Playa Vista site and in a orientation that would be intersected by the postulated Lincoln Boulevard fault. The postulated Lincoln Boulevard fault is not imaged on the line, and either the postulated Lincoln Boulevard fault is nonexistent or it dies out before reaching the line. Line LAB 85-4 is of very high imaging quality for the Los Angeles basin showing a seismic image of the entire sedimentary section to the top of the crystalline basement along the entire seismic line. Above 1.4 sec (approximately 5,000 ft depth) the seismic line shows a number of reflectors that are continuous across the entire line and indicate no faulting has occurred since these layers were deposited. The continuous reflectors belong to the upper Repetto Formation and younger units. Therefore no faulting has occurred along Chevron line LAB 85-4 during the last 3.0 million years (the age of the base of the upper Repetto Formation).

An extensive seismic reflection study was initiated and completed under the direction of Davis and Namson during July 2000 to better image the subsurface structure between wells, to evaluate the postulated Lincoln Boulevard fault, and to evaluate other faulting questions such as the postulated Charnock fault at the Playa Vista site. New onshore

and offshore geophysical data, mostly seismic reflection, was acquired in a pattern that would image any faulting questions at the Playa Vista site. The onshore seismic surveys consist of a 2D high-resolution line and a 3D survey. The onshore data was processed by Tricon Geophysical during August, September, and the first half of October 2000. Interpretation of the seismic data by Davis and Namson began in early September and was finished at the end of October 2000.

The 2D high-resolution seismic line acquired by Playa Vista is located along Jefferson Boulevard. The 2D line displays unbroken reflectors along the entire line. The 2D line covers much of the Playa Vista site as it extends from the join of Jefferson and Culver Boulevards eastward to the end of the Playa Vista site. The continuous reflectors belong to the upper portion of the middle Pico Formation and show that there has been no faulting of any kind along the 2D line during at least the last 1.0 million years. The 2D seismic line shows no evidence for either the postulated Lincoln Boulevard fault of ETI (2000) or the postulated Charnock fault (Poland et al., 1959).

A 3D seismic line was acquired by Playa Vista over the entire Playa Vista project site, and over additional areas along Centinela and Ballona Creeks, Dockweiler State Beach south of Ballona Creek, and in the entrance to Marina Del Rey Harbor (bay cable). The 3D survey had the same imaging objectives as the 2D high resolution line but the 3D survey covered more of the Playa Vista site and was able to image deeper than the 2D line. The 3D seismic survey shows that nearly the entire Playa Vista site is underlain by continuous reflectors belonging to the middle Pico Formation. The 3D data coverage begins to die out in the westernmost part of the Playa Vista site (about 1300 feet west of the join of Culver and Jefferson Boulevards) and this is the only area of the site where the continuous middle Pico Formation reflectors were not imaged. The continuous reflectors indicate that no faulting has occurred under the Playa Vista site during the last 2.0 million years with the exception of the small unimaged area at the western end of the project site. At the western end of the Playa Vista site abundant well data show it is unlikely that any faults cut the upper Repetto Formation indicating no

faulting there during the last 3.0 to 2.5 million years (Hodges, 1944; Hester, 1986). The continuous middle Pico Formation reflectors
also show that the postulated Lincoln Boulevard and Charnock faults are not present at that or younger stratigraphic levels.

The 3D seismic survey revealed no evidence for either the postulated Lincoln Boulevard or the postulated Charnock faults being present at deeper levels below the middle Pico Formation. Where these postulated faults cross the 3D survey there are continuous seismic reflectors to about 1400 milliseconds or about 4500 feet depth. Oil well data show these continuous reflectors are from the middle and upper Repetto Formation and the overlying Pico Formation. Thus one can conclude there is no evidence for the postulated Lincoln Boulevard or Charnock faults in strata deposited during the last 4.0 million years. The conclusion of no Lincoln Boulevard fault in much of the sedimentary section under the Playa Vista site is consistent with the results of the 2D high resolution seismic line (section 3.2 of this study), and the Earth Consultants International study of the shallow geology of site (ECINTL, 2000). The conclusion of no Charnock fault present in strata younger than 4.0 million years seismic is also consistent with the results of the 2D high-resolution seismic line. The fact that the postulated Lincoln Boulevard is not observed in either the 2D or 3D seismic surveys down to about 4500 feet depth argues against the very existence of the fault at deeper levels. The only reason for interpreting the fault at the Playa Vista site is to explain the shallow methane anomaly at the Playa Vista site (ETI, 2000). The postulated fault would have to cut through upper Pliocene and Quaternary deposits in order to be a conduit for the shallow methane anomaly. As the seismic surveys show, there is no fault above 4500 feet. Consequently, the methane anomaly must have some cause other than a fault and therefore there is no need for a Lincoln Boulevard fault. It is well known that methane anomalies and seepages can result from a variety of subsurface conditions, not all of them requiring faulting (Thrasher, et al., 1996; Matthews, 1996). Therefore the postulated Lincoln Boulevard fault is a possible but not unique interpretation of the methane anomaly, but the Lincoln Boulevard fault interpretation is inconsistent with the existing geophysical and geologic data from the Playa Vista area.

During July 2000 an extensive offshore geophysical survey was conducted southwest of the Playa Vista Project site under the direction of Dr. Dan Francis of California State University at Long Beach and Dr. Marc Legg of Legg Geophysical. Drs. Francis and Legg processed and interpreted the offhsore data during August and September 2000. Their report was written separately from the geologic and onshore geophysical study by Davis and Namson and the offshore report has been inserted here into the main study with only editing modifications.

The purpose of the survey was to better understand the origin of the bluffs (Ballona escarpment) just south of the Playa Vista site. The offshore geophysical data do not image a fault along the offshore projection of the bluffs. The continuous nature of offshore reflectors, as far as they are imaged, provides no evidence for such a fault. The existence of 6,000 year old sediments in the Ballona wetlands and offshore (in the younger river channel, cross cutting any reasonable extension of the bluffs), and 100,000-300,000 (?) year old sediments on top of the bluffs in Westchester, argues for erosion as the causative agent for the bluffs. Any bluff-controlling fault would have to terminate at or near the shoreline, an unlikely structural feature. The results of the offshore survey show that the bluffs are the result of erosion by the ancestral Ballona Creek and not faulting and uplift.

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Plate XXIIID: Playa Vista 3D Seismic Survey Interpreted Inline 30
Plate XXIIIE: Playa Vista 3D Seismic Survey Uninterpreted Inline 15
Plate XXIIIF: Playa Vista 3D Seismic Survey Uninterpreted Inline 20
Plate XXIIIG: Playa Vista 3D Seismic Survey Uninterpreted Inline 25
Plate XXIIIH: Playa Vista 3D Seismic Survey Uninterpreted Inline 30

Plate XXIVA: Playa Vista 3D Seismic Survey Interpreted Crossline 20
Plate XXIVB: Playa Vista 3D Seismic Survey Interpreted Crossline 30
Plate XXIVC: Playa Vista 3D Seismic Survey Interpreted Crossline 40
Plate XXIVD: Playa Vista 3D Seismic Survey Interpreted Crossline 50
Plate XXIVE: Playa Vista 3D Seismic Survey Interpreted Crossline 60
Plate XXIVF: Playa Vista 3D Seismic Survey Interpreted Crossline 70
Plate XXIVG: Playa Vista 3D Seismic Survey Uninterpreted Crossline 20
Plate XXIVH: Playa Vista 3D Seismic Survey Uninterpreted Crossline 30
Plate XXIVI: Playa Vista 3D Seismic Survey Uninterpreted Crossline 40
Plate XXIVJ: Playa Vista 3D Seismic Survey Uninterpreted Crossline 50
Plate XXIVK: Playa Vista 3D Seismic Survey Uninterpreted Crossline 60
Plate XXIVL: Playa Vista 3D Seismic Survey Uninterpreted Crossline 70

8.0 Appendix I-Acquisition Comments, Playa Vista High Resolution 2D, by Dan Hollis, Subsurface Exploration Company (SECO), Pasadena,CA

The purpose of the high resolution, 2D seismic line was to image from a depth of about 2000-ft to the surface. A spread configuration of 2000'-0'-2000' was chosen: the 2000-ft far offset allows for sufficient offsets to image to a 2000-ft depth and a near offset of 0-ft (no gap) allows imaging as close to the surface as muting of the first arrival energy allows. A 10-ft group interval was chosen to provide high spatial resolution and to minimize spatial aliasing of dipping events. Six potted geophones were used for each receiver station. A sand bag was placed over the geophones to improve ground coupling and to reduce noise. One stationary vibrator was used for each source location. A 20-ft source interval was used for the line, except in the area of high noise near Lincoln Boulevard were a 10-ft source interval was used. Sweep testing indicated that the optimal frequency range is between 15 and 120 Hz. A Varisweep of 15-120 Hz bandwidth was used to acquire the data.

9.0 Appendix II-Notes regarding processing of Playa Vista High Resolution 2D survey, by Dan Davidson, Tricon Geophysical, Denver, CO

The data were received in SEG Y format from the field acquisition company on two 8mm magnetic tapes. The data were reformatted to DISCO internal format for further processing. The data were then displayed and the traces were edited to remove "dead" traces and review the data for completeness and overall quality. To process the seismic reflection data from raw field format

(shot domain) to a stacked common depth point (CDP) profile requires that the spatial relationship between shots and receivers be described. This description is called the geometry. The geometry of the line was finalized after thoroughly consulting with the surveyor concerning anomalous group locations, and with the seismic crew observer concerning the cable layout, especially in the area of Lincoln Blvd., and the locations of noisy areas from road crossings, pipeline crossing, and construction crew activity. After finalizing the geometry, it is used by almost all of the following processing steps. Gain tests were performed on selected shot records. Based on these tests a spherical divergence correction was designed and applied to balance the amplitude spectrum of the data. Spectral analyses were performed on selected shot records with and without deconvolution filter operators applied. It was determined that the data had usable frequency content up to approximately 80 Hertz (Hz). A surface consistent spiking deconvolution operator was selected because it balanced the frequency spectrum and improved resolution of the data at frequencies greater than 60 Hz. Datum static corrections were applied to correct for variations in the surface topography. Refraction statics were not applied because the quality of the first break of the refraction event was of insufficient quality to pick reliably. The data were then sorted to CDP order and interactive velocity analyses were performed across the line at intervals of 50 CDPs. Normal moveout (NMO) and surface consistent residual statics were applied and then the seismic data were stacked preliminarily. A second pass of velocities and residual statics were applied and the data were stacked again. The area from station 400-700 approximately was then analyzed a third time as this area of the line had the more serious noise problems in the vicinity of Lincoln Blvd. After

an acceptable velocity and statics models were determined, a CDP consistent statics correction model was calculated and applied to the data to further define the static model and produce a stacked section having higher resolution.

Automatic gain control (AGC) with a small window (250 milliseconds in length) was then applied to the data before stack to better image the shallow data by balancing the trace amplitude. The data were then stacked.

After final stack the data were migrated with a finite difference migration to correct for raypath curvature. A Tau-P spectral enhancement was applied to the data to increase the signal to noise ratio. Finally, a 12-80 Hz bandpass filter and a post-stack trace balance was applied to improve the final display.

SEPICH ASSOCIATES
METHANE SPECIALISTS
located in the walnut adobe
680 WALNUT ST. MOORPARK, CA 93021

TEL (818) 707-3036
(805) 552-0000
FAX (818) 707-3012
(805) 552-0001

January 30, 2001

Mr. David Hsu
Chief Grading Section
City of Los Angeles
Dept. of Building & Safety
201 N. Figueroa Street, 3rd Floor
Los Angeles, CA 90012

Dear Mr. Hsu:

Attached is the Playa Vista Methane Prevention, Detection and Monitoring Program, prepared by Playa Vista in conjunction with Camp Dresser and McKee, Inc., Exploration Technologies Inc. and the Department.

The measures outlined in the Program exceed the Los Angeles Building Code, Division 71 (sections 91.7101 et seq.), Methane Seepage District Regulations and exceed current engineer practices for methane conditions. The Program provides an extra-ordinary level of protection for occupants of the Playa Vista project.



Sincerely,

John Sepich

PLAYA VISTA METHANE PREVENTION, DETECTION AND MONITORING PROGRAM

Playa Vista will implement or cause to be implemented a comprehensive methane prevention, detection and monitoring system for the properties located at Playa Vista. The primary goals of the methane system are to (i) **prevent** the migration of methane into enclosed building spaces through the use of physical building systems in those areas of Playa Vista where there is a potential for migration of methane into enclosed building areas, (ii) **detect** the existence of methane within enclosed building areas and, if methane is present at levels exceeding 25% of the Lower Explosive Limit ("LEL") (i.e. 12,500 parts per million of volume ("ppmv")), to activate an alarm, and (iii) **monitor** the presence of methane in areas of the Playa Vista property where there is a potential of methane gas migrating into buildings in order to provide for contingencies for changing methane levels at the Playa Vista property.

As set forth in Appendix 1-Methane System Requirements, the Playa Vista Methane Prevention, Detection and Monitoring Programs establishes three levels of system requirements for Playa Vista. In addition, in order to ensure the long-term adequacy of the methane systems at Playa Vista, the methane program will include maintenance, reporting, and system responsibility requirements. These requirements are designed to provide residents at Playa Vista with mechanisms to ensure that prevention, detection and monitoring systems are operating correctly and to provide the appropriate City agencies with a method to ensure compliance with all applicable methane system requirements.

Each of the levels will provide a comprehensive program of prevention, detection and monitoring systems along with a maintenance and testing program. These systems will insure adequate and appropriate safety for all building occupants.

The Department of Building and Safety will review and approve the design and implementation of the methane systems. The Department of Building and Safety may utilize one or more independent experts in methane and methane systems (i.e. a Peer Reviewer) in reviewing and approving the design and implementation of the methane systems.

Playa Vista may request modifications or adjustments to this program and the Methane System Requirements based on additional site information, technology changes or changed conditions, with the written approval of the Department of Building and Safety.

Soil Gas Survey Requirements

A baseline methane soil gas site survey for Playa Vista was conducted by and Camp Dresser & McKee Inc., in consultation with Exploration Technologies, Inc. Attached as Appendix 2 is a baseline methane soil gas site survey prepared by Exploration Technologies, Inc. showing the measured methane soil gas levels at Playa Vista (the "Baseline Survey").

The Baseline Survey should be used to determine the areas of Playa Vista in which building methane prevention systems are required for building sites for which building permits are applied for prior to September 1, 2001.

Individual building sites for which building permit applications are submitted after September 1, 2001 shall provide a methane soil gas site survey for the building site (the "Building Site Survey"). The purpose of the Building Site Survey is to determine, to the satisfaction of the Department of Building and Safety, the applicability of methane prevention and monitoring systems requirements in connection with the construction of buildings on the building site which is the subject of the Building Site Survey. The Building Site Survey shall be conducted by a licensed civil engineer or registered geologist in the State of California.

If a building is to be constructed on a building site where (i) prior to September 1, 2001, the Baseline Survey indicates the presence of methane concentrations or (ii) after September 1, 2001, the Building Site Survey indicates the presence of methane concentrations, building methane detection, prevention and monitoring systems shall be required as provided for in this program.

Detection Systems

All buildings at Playa Vista will be equipped with methane gas detection systems within spaces located in the basement levels of the buildings and data collecting sensors below the lowest floor/basement slab, as set forth on the Methane System Requirements attached as Appendix 1. All buildings at Playa Vista located on building sites where measured soil gas concentrations exceed 100 ppmv, as indicated on the applicable methane soil gas site survey, also shall be equipped with data collecting sensors below the impermeable membrane. Methane System Requirements for building sites at Playa Vista are set forth on Appendix 1.

The detectors and sensors shall be approved by the Department of Building and Safety and the Los Angeles Fire Department and shall meet the specifications of the Department of Building and Safety. The quantity and actual location of the detectors and sensors shall be determined by a qualified methane engineer and approved by the Department of Building and Safety.

The detection and sensor systems will be tested for electrical safety pursuant to the Los Angeles Electric Code and tested and approved pursuant to the Los Angeles Fire Department standards.

The detection system will activate a visual and audible building alarm if methane concentrations are detected at 12,500 ppmv within the building (25% of the LEL) or higher. Concurrent with the building alarm activation, an electronic signal will notify the Los Angeles Fire Department of the building alarm activation.

Within ten (10) calendar days following the activation of an alarm, a written report shall be submitted by the building owner or the property owners' association to the Los Angeles Fire Department and the Department of Building and Safety regarding the alarm activation and the cause of the activation and, if needed, providing recommendations and corrective measures.

Building Methane Prevention Systems

Methane Prevention Systems will be required for all buildings located on building sites where methane gas is detected, as indicated on the applicable methane soil gas site survey.

Building system requirements will be determined based on the highest methane concentrations located beneath the building site as indicated on the applicable methane soil gas site survey.

Building prevention systems shall be installed in buildings in accordance with Appendix 1-Methane System Requirements.

As required by Methane System Requirements (Appendix 1), building prevention system elements shall include, as applicable, (i) a methane detection system coupled with an alarm which will provide an audio and visual alarm if methane concentration levels reach or exceed 12,500 ppmv (25% of the LEL) within the building, (ii) a gravel blanket together with perforated methane collection pipes located below the building designed to collect and vent methane gas (passively and/or actively), (iii) a City of Los Angeles approved methane gas membrane designed to prevent methane gas from migrating into enclosed building areas. Active systems shall provide for mechanical ventilation (e.g. fan or blower to remove or reduce methane concentrations in gas venting pipes and/or basement areas), and (iv) a functional subsurface venting system in Level III areas as designated on Appendix I (Methane System Requirements).

The installation of the building prevention system shall be supervised by a qualified methane engineer. The Department of Building and Safety shall perform inspections of the building prevention system installations.

Building Monitoring Systems

Monitoring of methane concentration levels will be provided for as part of the building prevention systems as provided for in the Methane System Requirements (Appendix 1). The timing and method of monitoring will be based on the methane concentrations as indicated on the applicable methane soil gas site survey.

Areas of Methane Greater Than 100 ppmv

In areas of Playa Vista where methane soil gas concentrations, as indicated on the applicable methane soil gas site survey, are above 100 ppmv, methane concentrations within the building system shall be monitored continuously by an electronic monitoring system. The methane concentration data shall be accessible (read only) over a secure Internet connection to the Los Angeles Fire Department, the Department of Building and Safety and the property owners' homeowner association (or building owner, as applicable). In addition, an annual written report of the data together with any recommendations from a qualified methane engineer will be provided by the property owners' association (or building owner, as applicable) to the Department of Building and Safety and the Los Angeles Fire Department. Copies of the written reports also shall be provided to the Playa Vista Master Association.

If the monitoring data indicates that methane concentrations below the impermeable membrane exceed 37,500 ppmv, the mechanical ventilation system shall be automatically activated. If subsequent monitoring data indicates methane concentrations below 37,500 ppmv, the mechanical ventilation system may be deactivated.

Methane sensors above and below the methane membrane may also be utilized to assist the qualified methane engineer in determining the integrity of the methane membrane. If the qualified methane engineer determines that the methane sensors indicate that the methane

membrane has lost its integrity, in whole or in part, the qualified methane engineer shall submit a report of findings and any required corrective measures to the building owner or the property owners' association and building owner or property owners' association shall submit to the Department of Building and Safety a copy of the findings and any required corrective measures for review and approval prior to any such corrective measures being undertaken. The building owner or property owners' association shall undertake such corrective actions in a timely manner and shall provide a report to the Department of Building and Safety of compliance such corrective measures.

If methane concentrations change over time, methane monitoring may be modified (increased or decreased) based on recommendations of a qualified methane engineer, as approved by the Department of Building and Safety.

Areas of Methane Below 100 ppmv

In areas of Playa Vista where methane concentrations, as indicated in the applicable methane soil gas site survey, are less than 100 ppmv, methane concentrations within the building prevention systems will be manually sampled. Sampling will be conducted quarterly, provided that the methane concentrations remain below 100 ppmv. In addition, an annual written report of the data shall be submitted by the property owners' association (or building owner, as applicable) to the Department of Building and Safety and the Los Angeles Fire Department. Copies of the written reports also shall be provided to the Playa Vista Master Association.

If in any quarter, the monitoring data indicates that methane concentrations exceed 100 ppmv or if the monitoring data is highly variable, the Department of Building and Safety or the qualified methane engineer may require additional manual sampling or electronic monitoring of the methane concentrations. A quarterly written report of the monitoring data shall be provided by the property owners' association (or building owner, as applicable) to the Department of Building and Safety and the Los Angeles Fire Department. Copies of the written report also shall be provided to the Playa Vista Master Association.

Methane sensors above and below the methane membrane may also be utilized to assist the qualified methane engineer in determining the integrity of the methane membrane. If the qualified methane engineer determines that the methane sensors indicate that the methane membrane has lost its integrity, in whole or in part, the qualified methane engineer shall submit a report of findings and any required corrective measures to the building owner or the property owners' association and building owner or property owners' association shall submit to the Department of Building and Safety a copy of the findings and any required corrective measures for review and approval prior to any such corrective measures being undertaken. The building owner or property owners' association shall undertake such corrective actions in a timely manner and shall provide a report to the Department of Building and Safety of compliance with such corrective measures.

If methane concentrations change over time, methane monitoring may be modified (increased or decreased) based on recommendations of a qualified methane engineer, as approved by the Department of Building and Safety.

Maintenance and Reporting

Individual building systems will be tested, maintained, and serviced at least annually by the building owner or property owners' association pursuant to the manufacturer's specifications and to the satisfaction of the Los Angeles Fire Department and the Department of Building and Safety. The building owner or property owners' association, as applicable, shall be responsible for any required repairs of the methane systems, including without limitation any required repairs to the methane membrane, gas vent pipes or ventilation systems.

The property owners' association (or building owners, as applicable) shall maintain records of such service and repair. Copies of all service and repair records shall be sent to the Playa Vista Master Association within thirty (30) calendar days of service.

For buildings that are located on Playa Vista common areas (i.e. not owned or controlled by an individual building owner or property owners' association), the Playa Vista Master Association shall have responsibility for testing, maintenance, repair and service.

Individual building owners and/or property owners' associations shall complete any required service of the systems and shall keep the system in good working order and fully operational. The individual building owners and/or property owners' association shall be responsible for any required repairs and replacements.

On or before July 1 of each calendar year, the building owner or the property owners' association shall submit a certification to the Los Angeles Fire Department and the Department of Building and Safety that the annual testing, maintenance and service has been completed and certifying that the system is operational.

System Responsibility

The developer/builder will have primary responsibility for the design and construction of the building methane prevention systems and the building monitoring systems. The design of the building methane prevention systems and monitoring systems shall be incorporated into the design of the buildings. The design of the systems shall be consistent with this program and shall be subject to review and approval by the Department of Building and Safety. A qualified methane system engineer shall prepare the plans and specifications for the systems.

The systems shall be made operational by the project developer/builder. A report as to its operational status shall be signed by the qualified methane system engineer and submitted to the Department of Building and Safety and the Los Angeles Fire Department. A copy of the report shall be provided to the building owner or the property owners' association and to the Playa Vista Master Association. No certificate of occupancy shall be issued for any building until the methane systems, as required by Methane System Requirements attached as Appendix 1, are operational and a qualified methane engineer has certified the systems to be operational.

Upon the certification of the operational status of the building methane system and monitoring system, the building owner or the property owners' association shall have responsibility for the continued operation, maintenance, repair and replacement of the systems.

The building owner or property owners' association, as applicable, shall develop and submit for approval by the Department of Building and Safety and the Los Angeles Fire

Department an evacuation plan for the building. A copy of the evacuation plan shall be available to residents and tenants.

The building owner or the property owners' association, as applicable, shall have financial responsibility for all costs and expenses associated with the building methane system and the monitoring system, including without limitation all costs associated with testing, maintaining, servicing and repairing the systems and any cost incurred in preparing and submitting required reports to be provided to the City and the Master Association.

Appendix I

Building Methane Prevention System Requirements

DRAFT METHANE SYSTEM REQUIREMENTS

A baseline soil gas survey shall be conducted for each building site to determine the areas of Playa Vista Phase I in which building methane prevention systems are required.[1]

Mitigation Measure	Methane Concentration Level		
	Level I[2] White: <10ppmv Blue: 10-<30ppmv Lt. Blue: 30-<100ppmv	Level II[2] Green: 100-<1000ppmv Yellow: 1000-<12,500ppmv	Level III[2] Orange: 12,500-<150,000ppmv Red: 150,000ppmv or >
Methane Prevention System[3]			
Passive - Underneath the Building			
• 12" gravel blanket	Required	Required	Required
• gas collection vent pipe	Required	Required	Required
• impermeable membrane	Required	Required	Required
Active - Mechanical Ventilation			
• ventilation triggered with elevated methane concentrations	None	Required[4]	Required[4]
Subsurface Ventilation	None	None	Required
Methane Detection System			
Within the Building			
detectors in spaces located in the basement/lowest level in the building[5]	Required	Required	Required
• audible alarm[6]	Required	Required	Required
• visual alarm[6]	Required	Required	Required
• automatic notification of LAFD[6]	Required	Required	Required
Underneath the Building	None	Required	Required
• data collecting sensors below impermeable membrane[5]	Required	Required	Required
• data collecting sensors between impermeable membrane and lowest floor/basement slab[5]			
Methane Monitoring System			
• manual quarterly assessment	Required[7]	None	None
• continuous methane sampling and data collection accessible by the homeowners' association, LADBS and LAFD via the Internet	None	Required[8]	Required[8]
Maintenance of the Prevention, Detection and Monitoring Systems			
• annual testing to the satisfaction of LADBS and LAFD	Required	Required	Required
• homeowners' association to have financial responsibilities	Required	Required	Required

Contingency Plan			
• when high methane concentration are detected within a building	Required	Required	Required
• when methane system components fail	Required	Required	Required

Footnotes:

1. Projects for which building permit applications were received by LADBS prior to January 1, 2002 may use as baseline methane concentration data the soil gas survey data prepared by CDM/ETI at Appendix 1. After January 1, 2002, all projects shall submit for approval to the satisfaction of LADBS, individual soil gas site assessments that characterize methane soil gas concentrations for the building site.
2. Levels of methane concentrations and corresponding colors on the methane concentration maps are identified in the Appendix 2 or individual building site soil gas assessments.
3. LADBS may reduce on requirements in areas where the methane concentrations in the area of building sites is non-detect.
4. When methane concentrations are detected at 37,500 ppmv by the sensors in the ventilation system below the impervious membrane, a mechanical ventilation system shall be automatically activated.
5. Number, type and location of detectors (or approved equivalents) to be determined by a qualified methane engineer, as approved by LADBS.
6. Audible alarm, visual alarm and notification of LAFD shall be triggered when methane concentrations are detected at 12,500 ppmv.
7. Sampling data reviewed by a qualified methane engineer shall be approved by LADBS. When such data is determined to be highly variable, additional manual sampling or electronic sampling may be required by LADBS. A qualified methane engineer shall submit a report to LADBS with conclusions and recommendations.
8. When the methane concentration data indicates significant changes in methane concentrations below the membrane, then a report by a qualified methane engineer shall be submitted to LADBS characterizing the reasons for such changes.

Appendix 2

Baseline Methane Soil Gas Site Survey

Exploration Technologies, Inc.
3698 Westchase Dr. • Houston, Texas 77042 • (713) 785-0393 • FAX (713) 785-1550

ATTACHMENT 10

January 31, 2001

Mr. David Hsu
Chief, Grading Section
City of Los Angeles
Dept. of Building and Safety
201 North Figueroa Street
Los Angeles, CA 90012-2827

Dear David:

We have reviewed the proposed plan for the methane prevention, detection and monitoring systems from Methane Specialist and CDM, as defined in their report of January 30th, 2001 and outlined by their matrix table "METHANE SYSTEM REQUIREMENTS," and find that the proposed systems meet our recommendations, provided that the systems meet, or exceed all detail specifications as required by Department of Building and Safety.

One of the proposed methane prevention systems, the subsurface venting for the Level III areas which overlay the methane soil gas anomalies, is currently in the research and design stages. The subsurface venting system, which primarily targets the 50-foot gravel aquifer, provides a necessary level of protection, supplementing the building systems, for development of the Level III areas. Building in Level III areas is contingent upon a functional subsurface venting system to the satisfaction of the Department of Building and Safety in consultation with the peer review team.

If you have any questions or require additional information, please contact me.

Sincerely,
Exploration Technologies, Inc.

V.T. Jones III

Victor T. Jones, III, Ph.D.
Peer Reviewer for LADBS
President, Exploration Technologies, Inc.

FORM GEN. 160 (Rev. 7-98)

CITY OF LOS ANGELES
INTER-DEPARTMENTAL CORRESPONDENCE

Date: October 24, 2000

To: Ronald F. Deaton,
Chief Legislative Analyst

Attention: Barbara Garrett, Analyst

From: Vitaly B. Troyan, P.E.
City Engineer

By: Michael P. Brown, Manager
Geotechnical Engineering Division

Subject: **PLAYA VISTA - INVESTIGATION OF POTENTIAL OIL FIELD SUBSIDENCE**

Per a request from your office, attached are the results of the survey of the Playa Vista area.

The survey was performed by the Bureau of Engineering's Survey Division in October, 2000. The survey recorded the current elevations of benchmarks in the area and compared them to the elevations of those same benchmarks in 1975, 1980, and 1985. These elevations were adjusted using a National Geodetic Survey (NGS) benchmark as the baseline. Not all of the benchmarks had data for 1975 and 1980, in those cases the partial data was provided. The survey met the tolerances for National Geodetic Survey, Second Order Class II, which means that loop closures were very small (8mm's times the square root of the loop distance in km). Therefore, the survey was completed to a very high degree of accuracy. The attached survey report describes the survey methods, and equipment used, in greater detail.

The elevation change measured in the area over the 25 year period ranged from –2.66 inches (subsidence) to +0.81 inches (uplift). In order to interpret the data more easily, our office has prepared a map depicting the location of each of the benchmarks as well as the elevation change from the earliest available date. The map also shows the approximate limits of the oil field.

If you have any questions regarding this information please contact Michael Mulhern or Ted Allen of my staff at (213) 847-4011 or (213) 847-4028, respectively.

Attachments: 1) Playa Vista Area Bench Mark Data report from BOE Survey Division
2) Playa Vista Development Survey Data Map from BOE Geotechnical Division

MPB/MEMO Q:\PROJECT\No File Number\Playa Vista\Survey Files\Conclusions of the Survey Data.IDC.doc

CITY OF LOS ANGELES

INTER-DEPARTMENTAL CORRESPONDENCE

Date: October 23, 2000

To: Vitaly B. Troyan, P. E.
City Engineer

From: Erich Ziebarth, Chief Surveyor

Subject: Playa Vista area Bench Mark Data

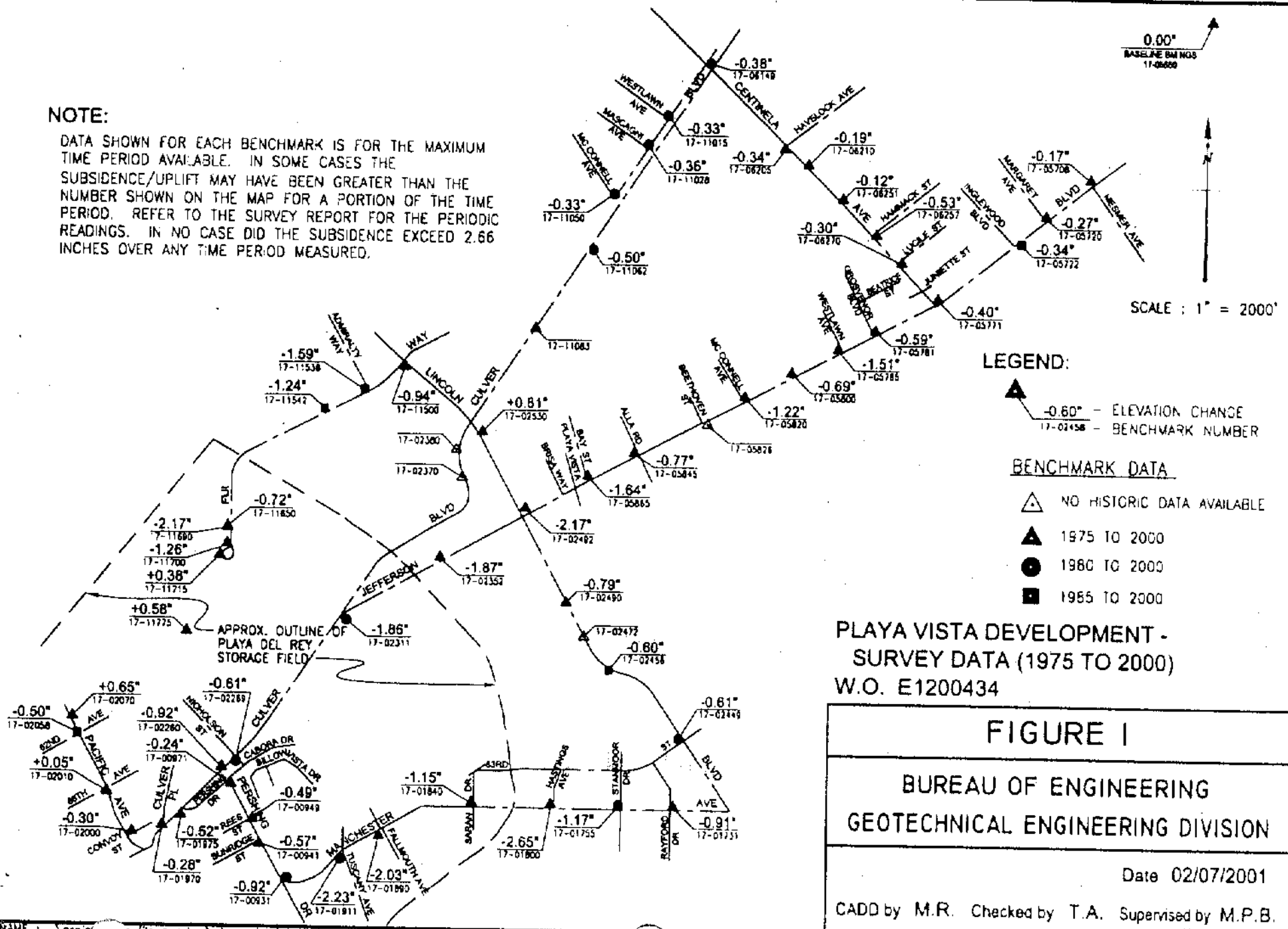
The attached spreadsheet was prepared in response to your request for evidence of settlement or uplift in the Playa Vista area.

Following is a synopsis of the Playa Vista area precise leveling that the Survey Division conducted:

Initially the published primary levels through the area were identified and leveling courses run. Additional leveling courses were run to form closed loops to check closure tolerances. A bench mark outside the area of influence was needed to establish a baseline for comparison. The bench mark selected (#17-05650) provided a tie into the leveling courses done by NGS (National Geodetic Survey) in 1997. The leveling procedures and methods used complied with, and all loop closures fell well within, the tolerances published by NGS for Second Order Class II precision criteria. The Leica Digital level used was calibrated before, during and after the leveling courses were run. There were no anomalies detected.

After collecting the field data, it was adjusted using STAR*LEV least squares adjustment software. Finally, all bench marks were placed on the same reference datum because a simple difference in published elevations of existing bench marks between subsequent years could not be used. A shift in the datum used between the 1975 and 1980 level runs, and again between the 1980 and 1985 level runs, made it impossible to do this. Therefore by placing all bench marks on the same reference datum (NGS, 1997), the difference in elevations will reflect any vertical movement.

PROFESSIONAL LAND SURVEYOR
ERICH A. ZIEBARTH
EXP. 12/31/01
NO. 5037
STATE OF CALIFORNIA


NOTE:
DATA SHOWN FOR EACH BENCHMARK IS FOR THE MAXIMUM TIME PERIOD AVAILABLE. IN SOME CASES THE SUBSIDENCE/UPLIFT MAY HAVE BEEN GREATER THAN THE NUMBER SHOWN ON THE MAP FOR A PORTION OF THE TIME PERIOD. REFER TO THE SURVEY REPORT FOR THE PERIODIC READINGS. IN NO CASE DID THE SUBSIDENCE EXCEED 2.66 INCHES OVER ANY TIME PERIOD MEASURED.
0.00" BASELINE BM NO5 17-05050
SCALE : 1" = 2000'
LEGEND:
-0.60" 17-02456 - ELEVATION CHANGE - BENCHMARK NUMBER
BENCHMARK DATA
NO HISTORIC DATA AVAILABLE
1975 TO 2000
1980 TO 2000
1985 TO 2000
APPROX. OUTLINE OF PLAYA DEL REY STORAGE FIELD
PLAYA VISTA DEVELOPMENT - SURVEY DATA (1975 TO 2000)
W.O. E1200434
FIGURE 1
BUREAU OF ENGINEERING
GEOTECHNICAL ENGINEERING DIVISION
Date 02/07/2001
CADD by M.R. Checked by T.A. Supervised by M.P.B.
FILENAME : ..\proje file number\playa vista\1plan1.dwg

Playa Vista Bench Mark Data

Street	Run	BM#	1975	1980	1985	2000	adj'd 75	adj'd 80	adj'd 85	2000	75-80 feet	75-80 inch	80-85 feet	80-85 inch	85-00 feet	85-00 inch
Baseline BM NGS	306	17-05650	27 [illegible]	27 [illegible]	27 221	27 329	0.012	0 190	0 108	0.000						
Culver_Blvd	306															
		17-06149		28 199	28 264	28 327		28 359	28 372	28 327			0 013	0 156	-0.045	-0.540
		17-11015		22 772	22 871	22 934		22 962	22 979	22 934			0 017	0 204	-0 045	-0 535
		17-11028		19 347	19 445	19 507		19 537	19 553	19 507			0 016	0.192	-0 046	-0 552
		17-11050		14 947	15 043	15 110		15 137	15 151	15 110			0 014	0 168	-0 041	0 495
		17-11052		13 077	13 173	13 226		13 267	13 281	13 226			0 014	0 168	-0 055	-0 664
		17-11083		12 526	12 615	GONE		12 716	12 723	GONE			0 007	0 084	n/a	n/a
		17-02530		19 521	19 610	19 669		19 711	19 718	19 669			0 007	0.084	-0 049	-0 592
		17-02380	27 852	27 654	27 730	GONE	27 864	27 844	27 838	GONE	0 020	-0 240	-0 006	-0.072	n/a	n/a
		17-02370	20 181	19 977	20 033	GONE	20 193	20 167	20 141	GONE	-0 026	-0 312	-0 026	-0 312	n/a	n/a
* dup Jefferson		17-02352	11 188	10 984	11 043	11 044	11 200	11 174	11 151	11 044	0 026	-0 312	-0 023	-0.276	-0 107	-1 284
Jefferson_Blvd	306															
		17-05771	13 941	13 757	13 848	13 920	13 953	13 947	13 956	13 920	-0 006	-0 072	0 009	0.108	-0 036	-0 435
		17-05781	13 514	13 323	13 415	13 477	13 526	13 513	13 523	13 477	-0 013	-0 156	0 010	0 120	-0 046	-0 555
		17-05785	14 326	14 111	14 183	14 212	14 338	14 301	14 291	14 212	-0 037	-0 444	-0 010	-0 120	-0 079	-0 949
		17 05800	13 826	13 648	13 727	13 780	13 838	13 838	13 835	13 780	0 000	0 000	-0 003	-0.036	-0 055	-0 656
		17-05820	12 506	12 310	12 385	12 416	12 518	12 500	12 493	12 416	0 018	-0 216	-0 007	-0 084	-0 077	-0 919
		17-05826	14 154	13 967	13 963	GONE	14 166	14 157	14 071	GONE	0 009	-0 108	-0 086	-1 032	n/a	n/a
		17-05845	12 388	12 208	12 287	12 336	12 400	12 398	12 395	12 336	-0 002	-0 024	0 003	-0 036	-0 059	-0 714
		17-05865	12 883	12 694	12 746	12 758	12 895	12 884	12 854	12 758	0 011	-0 132	-0 030	-0 360	-0 096	-1 151
* dup Lincoln		17-02492	12 008	11 811	11 841	11 840	12 020	12 001	11 949	11 840	-0 019	-0 228	-0 052	-0 624	-0 109	-1 313
* dup Culver		17-02352	11 188	10 984	11 043	11 044	11 200	11 174	11 151	11 044	-0 026	-0 312	0 023	-0 276	-0 107	-1 284
		17-02311		5 492	5 548	5 517		5 672	5 656	5 517			-0 016	-0 192	-0 139	-1 665
		17-02269		3 868	3 973	4 007		4 058	4 081	4 007			0 023	0 276	-0 074	-0 889
		17-02260	4 110	3 947	4 042	4 045	4 122	4 137	4 150	4 045	0 015	0 180	0 013	0 156	-0 105	-1 256
		17-01975	10 527	10 374	10 469	10 496	10 539	10 564	10 577	10 496	0 025	0 300	0 013	0 156	-0 081	-0 971
Lincoln_Blvd	284															
		17-11500	9 030	8 848	8 940	8 964	9 042	9 036	9 048	8 964	-0 004	-0 048	0 010	0 120	-0 084	-1 012
		17-02530	19 589	19 521	19 610	19 669	19 601	19 711	19 718	19 669	0 110	1 320	0 007	0 084	-0 049	-0 592
* dup Jefferson	217	17-02492	12 008	11 811	11 841	11 840	12 020	12 001	11 949	11 840	-0 019	-0 228	-0 052	-0 624	-0 109	-1 313
Lincoln@Jefferson		17-02490	7 094	6 913	6 988	7 040	7 106	7 103	7 096	7 043	-0 003	-0 036	-0 007	-0 084	-0 056	-0 673
		17-02472	46 502	46 316	46 381	GONE	46 514	46 506	46 489	GONE	0 008	-0 096	-0 017	-0 204	n/a	n/a
		17-02458			94 787	94 845			94 895	94 845					0 050	-0 595
		17-02449		134 937	135 026	135 076		135 127	135 134	135 076			0 007	0 084	-0 058	-0 691

9/29/00

Street	Run	BM#	1975	1980	1985	2000	adj'd 75	adj'd 80	85	2000	75-80 feet	75-80 inch	80-85 feet	80-85 inch	85-00 feet	00 inch
Baseline BM NGS	306	17-05650	27 317	27 139	27 221	27 329	0.012	0.190	0.108	0.000						
Manchester Ave	206	17-00931		65 564	65 643	65 678		65.754	65 751	65 678			-0.003	-0.036	-0.073	-0.881
		17-01911		110 321	110 331	110.325		110 511	110 439	110.325			-0.072	-0 864	-0.114	-1.357
		17-01890	109 06	108 881	108 927	108 901	109 07	109.071	109.035	108 901	0.001	0 012	-0 036	-0 432	-0.134	-1.608
		17-01840	143 4	143 225	143 29	143 320	143 416	143 415	143 398	143.320	-0 001	-0 012	-0 017	-0.204	-0 078	-0 933
		17-01800	137 29	137 109	137 159	137 078	137 298	137 299	137.267	137.078	0 001	0 012	-0 032	-0 384	-0 189	-2.273
		17-01755		127 857	127 923	127 950		128 047	128 031	127.950			-0.016	-0 192	-0.081	-0 977
		17-01731	161 09	160 908	160 99	161 029	161 105	161 098	161 098	161.029	-0 007	-0.084	0 000	0 000	-0 069	-0 829
Lincoln Blvd (S)	217	17-01713				131 288				131 288						
Pershing Dr	216	17-01975	10 527	10 374	10 469	10 496	10 539	10 564	10 577	10 496	0 025	0 300	0 013	0 156	-0.081	-0 971
		17-00971	35 57	35 417	35 515	35 562	35 582	35 607	35 623	35.562	0 025	0 300	0 016	0.192	-0.061	-0 731
		17-00949	57 073	56 916	57 004	57 044	57.085	57.106	57 112	57 044	0 021	0.252	0.006	0 072	-0.068	-0.815
		17-00941	64 242	64 085	64 17	64 207	64 254	64.275	64.278	64 207	0 021	0 252	0 003	0 036	-0 071	-0.856
Pacific Ave	318	17-02070	16 946	16 791	16 942	17 012	16 958	16 981	17.05	17.012	0 023	0 276	0 069	0 828	-0.038	-0 457
		17-02058			14 902	14.968			15.01	14 968					-0.042	-0.502
		17-02010	13 644	13 481	13.606	13 660	13 656	13.671	13 714	13.660	0 015	0 180	0 043	0 516	-0 054	-0 645
		17-02000	11 796	11 637	11 742	11 783	11 808	11 827	11 85	11 783	0 019	0 228	0 023	0 276	-0 067	-0 801
		17-01970	10 892	10 738	10 843	10 881	10 904	10 928	10 951	10 881	0 024	0 288	0 023	0 276	-0 070	-0 843
Jefferson	306	17-05671				23 697				23 697						
		17-05693				21 228				21 228						
		17-05708	20 741	20 541	20 646	20 739	20 753	20 731	20 754	20 739	-0 022	-0 264	0 023	0 276	-0 015	-0 184
		17-05720	18 167	17 982	18 077	18 156	18 179	18 172	18 185	18 156	-0 007	-0 084	0 013	0 156	-0 029	-0 345
		17-05722			16 453	16 533			16 561	16 533					-0 028	-0 339
		17-05771	13 941	13 757	13 848	13 920	13 953	13 947	13 955	13 920	-0 006	-0 072	0 009	0 103	-0 035	-0 435
Centinela Ave	282	17-06149		28 169	28 264	28 327		28 399	28 372	28 327			0 013	0 156	-0 045	-0 540
		17-06205	17 877	17 694	17 792	17 860	17 889	17 884	17 9	17 860	-0 005	-0 060	0 016	0 192	-0 040	-0 476
		17-06210	28 379	28 195	28 297	28 375	28 391	28 385	28 405	28 375	-0 006	-0 072	0 020	0 240	-0 030	-0 360
		17-06251	22 071	21 89	21 991	22 073	22 083	22 08	22 099	22 073	-0 003	-0 036	0 019	0 228	-0 026	-0 307
		17-06257	16 264	16 079	16 165	16 232	16 276	16 269	16 273	16 232	-0 007	-0 084	0 004	0 048	-0 041	-0 498
		17-06270	15 234	15 052	15 144	15.221	15 246	15 242	15 252	15.221	-0 004	-0 048	0 010	0 120	-0 031	-0 368

9/29/00

Playa Vista Bench Mark Data

Street	Run	BM#	1975	1980	1985	2000	adj'd 75	adj'd 80	adj'd 85	2000	75-80 feet	75-80 inch	80-85 feet	80-85 inch	85-00 feet	85-00 inch
Baseline BM NGS	[illegible]	17-05650	27.121	27.139	27.321	27.329	0.012	0.190	0.108	0.000						
Culver Bl	256	17-02381				29.109				29.109						
		17-06145		28.169	28.264	28.327		28.359	28.372	28.327			0.013	0.156	-0.045	-0.540
Fiji Way	257	17-11556			16.44	16.416			16.548	16.416						
		17-11642			14.137	14.142			14.245	14.142					-0.132	-1.589
		17-11650	12.79	12.615	12.713	12.742	12.802	12.805	12.821	12.742	0.003	0.036	0.016	0.192	-0.103	-1.239
		17-11690	14.869	14.695	14.774	14.700	14.881	14.885	14.882	14.700	0.004	0.048	-0.003	-0.036	-0.079	-0.944
		17-11700	15.31	15.131	15.226	15.217	15.322	15.321	15.334	15.217	-0.001	-0.012	0.013	0.156	-0.182	-2.182
		17-11715	14.759	14.593	14.728	14.602	14.771	14.783	14.836	14.802	0.012	0.144	0.053	0.636	-0.117	-1.407
		17-11756				15.087				15.087					-0.034	-0.405
		17-11775	11.71	11.552	11.693	11.770	11.722	11.742	11.801	11.770	0.020	0.240	0.059	0.709	-0.031	-0.371

9/29/00

CITY OF LOS ANGELES
INTER-DEPARTMENTAL CORRESPONDENCE

Date: February 26, 2001

To: Ronald Deaton
Chief Legislative Officer

Attn.: Barbara Garrett

From: P.J. (Mike) Michalski, Engineering Geologist III
Bureau of Engineering

Subject: INTERPRETATION OF SURVEY DATA RELATING TO POTENTIAL SUSBSIDENCE
PLAYA VISTA PROJECT - (File 96-092) WO E1200434

On October 24, 2000, the Department of Public Works, Geotechnical Engineering Division (GED) provided a memo describing the benchmarks used and the degree of accuracy of the data and map summarizing the City of Los Angeles survey data. Per your request, this memo provides interpretation and conclusions of the data.

The maximum subsidence observed at one location in the area over the period from 1975 to 2000 was 2.66 inches. No significant or clearly defined trend of increased subsidence with the Playa Del Rey Oil Field or any other specific area was observed. The location with the greatest level of subsidence is an elevation marker placed on the curb of Manchester Boulevard at the intersection of Hastings Avenue. Another one of the markers displaying a greater than 2-inch settlement is in a sidewalk of Lincoln Boulevard at Jefferson Boulevard, a distance of approximately four-fifths of a mile from the previously-noted marker. This suggests that settlement is localized and may be associated with curb, sidewalk and gutter settlement along major streets.

Current building codes are adequate to address the minimal level of subsidence and uplift observed in the area. There is no evidence that proposed methane mitigation measures will result in increased potential for subsidence in the area.

If you have any questions with this review, please contact Mike Mulhern, CEG 1507, HG 306 at (213) 847-4011 or Ted Allen, CE, at 847-4028.

c: Clark Robins, Deputy City Engineer
Susan Pfann, Deputy City Attorney

Earth Consultants International

Geologic Study to Evaluate the Potential for Active Faulting Near the Intersection of Lincoln and Jefferson Boulevards, at the Playa Vista Site, in the City of Los Angeles, California

July, 2000
Project No. 800130-001

Prepared for:

Playa Capital Company, LLC
12555 Jefferson Boulevard, Suite 300
Los Angeles, California 90066

Prepared by:

Earth Consultants International, Inc.
2522 North Santiago Boulevard, Suite B
Orange, California 92867

Earth Consultants International

Project No. 800130-0001
July 25, 2000

To: **Playa Capital Company, LLC**
12555 Jefferson Boulevard, Suite 300
Los Angeles, California 90066

Attention: **Mr. David Nelson, Sr. Vice-President**

Subject: **Geologic Study to Evaluate the Potential for Active Faulting Near the Intersection of Lincoln and Jefferson Boulevards, at the Playa Vista Site, in the City of Los Angeles, California**

At the request of Playa Vista, LLC, Earth Consultants International, Inc. (ECI) have conducted a geologic study of that portion of the Playa Vista property to the southwest of the intersection of Lincoln and Jefferson Boulevards to evaluate whether or not the near-surface sediments in this area are offset by a northwest-trending fault. This study was prompted by a report by Exploration Technologies, Inc. (ETI, 2000) which conducted a subsurface assessment of methane gas at the site, and suggested that methane is migrating to the shallow subsurface along a previously unrecognized, potentially active fault east of and parallel to Lincoln Boulevard.

As part of our investigation we reviewed previously published geologic maps and reports covering this area, and unpublished geologic and geotechnical reports prepared by other investigators for the Playa Vista site. We also conducted a subsurface study consisting of drilling borings and CPTs across the area where this fault is proposed. The data obtained from our literature review and our field investigation have been reviewed and analyzed. The data indicate that there are no north to northwest-trending faults in this area that offset the Pleistocene-age sediments that form the bluffs to the south of the site, nor the Pleistocene-age sediments underlying the Ballona Creek floodplain. Lateral continuity of shallower Holocene-age sediments underlying the site also indicates that the younger section is not offset by faulting.

From all our data, we cannot find evidence to support the existence of a supposed "Lincoln Boulevard fault" across the property. Our study found no reason to interpret a fault through any of the alluvial units we correlated from CPTs and borings in four transects of the Playa Vista site, nor in the older sediments forming the bluffs south of the site. While a fault might lie deeper than our investigation was designed to explore, it has not had a displacement-producing earthquake in tens to hundreds of thousands of years (as evidenced by the unfaulted Pleistocene sediments forming the bluffs), and likely does not exist at all. Therefore, in accordance with the California definitions of active faulting, there are no faults that meet the criteria of sufficiently active and well-defined to preclude development of this area.

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We hope that this report provides you with the information you need at this time. Should you have any questions regarding our report, please do not hesitate to contact us.

Respectfully submitted,

EARTH CONSULTANTS INTERNATIONAL, INC.

Tania Gonzalez, CEG 1859
Project Consultant

Eldon Gath, CEG 1292
Principal Consultant

Kerry Sieh, PhD., RG 506
Sr. Project Consultant

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Geologic Study to Evaluate the Potential for Active Faulting Near the Intersection of Lincoln and Jefferson Boulevards, at the Playa Vista Site, in the City of Los Angeles, California

1.0 Introduction

1.1 Purpose of the Study

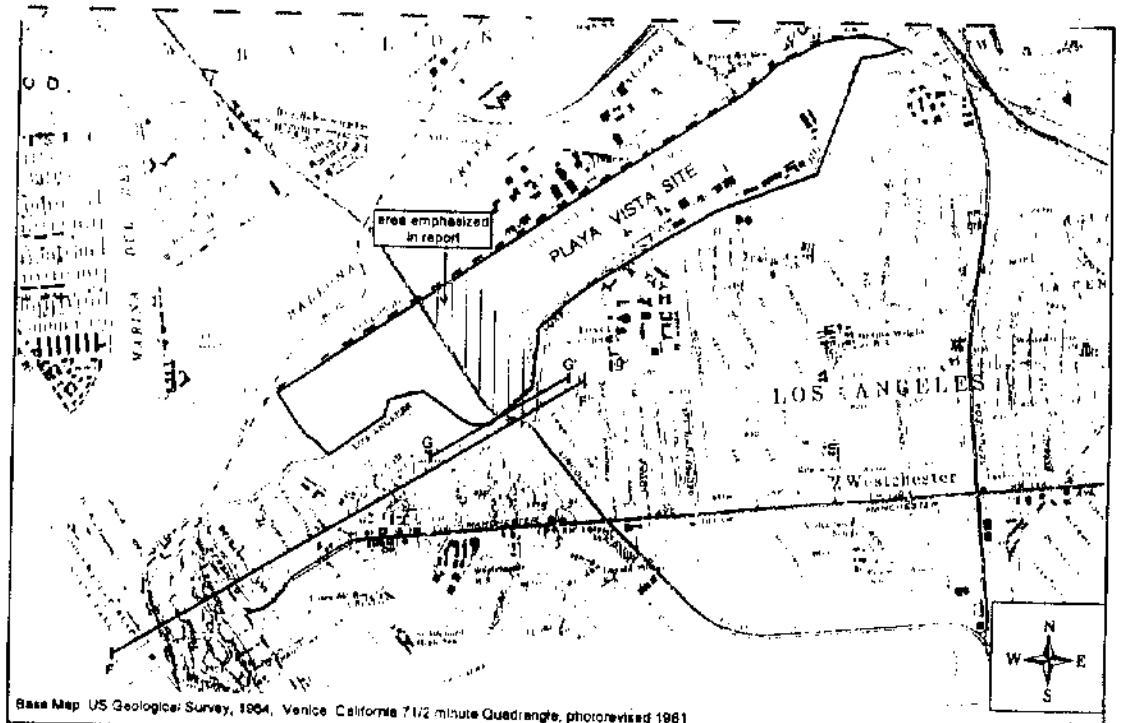
This report presents the results of a fault rupture hazard investigation conducted for the west-central portion of the Playa Vista site, southwest of the intersection of Lincoln and Jefferson Boulevards, in the City of Los Angeles (see Figure 1). The purpose of our study was to evaluate whether or not a fault underlies that area of the Playa Vista site where the Lincoln Boulevard fault has been proposed by Exploration Technologies Inc (ETI, 2000). If the data suggest that indeed there is a fault in this area, we would further assess whether or not the fault is an active structure, using the California definitions of fault activity for residential projects.

1.2 Site Description

The Playa Vista site consists of approximately 1,000 acres of developed and undeveloped land in the city of Los Angeles. The site is approximately 1,500 to 2,500 feet wide (in a north-south direction), and nearly 4 miles long (in an east-west direction). The property is accessed off of Centinela Avenue by Teale Street, a road that extends westward through the property, providing access to several of the former Hughes facility buildings still present on the east side of the site. The site is bounded to the north by West Jefferson Boulevard, to the east by Centinela Avenue, to the south by steep bluffs, and to the west by the Ballona wetlands and the community of Playa del Rey (see Site Location Map, Figure 1). The area discussed in this report is primarily (but not limited to) that portion of the site southwest of the intersection of Jefferson and Lincoln Boulevards.

It is our understanding that the eastern and central portions of the property, east of Lincoln Boulevard, will be developed into a residential, industrial, entertainment and technology district. Some of the former Hughes facility buildings are considered of historical value and will remain onsite. Other buildings will be demolished as part of the re-development and development process. The designated wetlands on the western portion of the site will remain undeveloped as protected wildlife habitat.

Geomorphically, the Playa Vista site is located on the south side of the Ballona Creek floodplain, in the western portion of the Los Angeles Basin (see Figure 2). Prior to grading, the site was nearly level, with a regional gentle slope to the west-southwest, toward the Pacific Ocean. Pre-development elevations at the site varied from approximately 15 feet above mean sea level along its eastern end, near Centinela Avenue, to approximately 5 feet above mean sea level along its western end. Recently, however, as a result of extensive grading that has been conducted in the area that is the focus of this study, the original topography has been modified locally. For example, the project's geotechnical engineers recommended that the soils in the area proposed for development be surcharged (buried under a thick section of artificial fill) to increase their in-situ densities and decrease their potential to liquefy. In addition, large cuts below design street level that will be the parking sub-levels to various buildings have already been excavated in this area. These excavations are reflected in the topographic map of the site that we used as a base map (see Plate 1).



Base Map: US Geological Survey, 1964, Venice California 7 1/2 minute Quadrangle, photorevised 1981

Earth Consultants International

Project No. 800130-001

Date July, 2000

Site Location Map
Playa Vista Property

showing location of cross-sections F-F' and G-G'

1 2000
Scale in Feet

Figure No. 1

The site is underlain in the near surface by alluvial (stream-lain) sediments associated with Ballona Creek and other drainages, including an ancestral Los Angeles River, that have flowed out to sea through this area for hundreds to thousands of years. Locally, the alluvium has been buried with as much as 20 feet of artificial fill associated with the surcharge and grading operations described above. Based on extensive subsurface exploration of the site, we know that the alluvial sequence is underlain by Holocene-age, fine-grained lagoonal and alluvial sediments that are in turn underlain by a gravel-sand sequence of possibly late Pleistocene age. The top of the gravel sand sequence is approximately 40 to 50 feet below the original ground surface. Additional information regarding these geologic units and stratigraphy at the site is provided in Sections 2 and 3 below.

1.3 Scope of Work

Specific tasks that we completed as part of this study are listed below.

- We reviewed older topographic maps of the Playa Vista area to observe pre-development landforms in this part of the Los Angeles basin that would be analogues to the landforms interpreted from the subsurface data, and to look for landforms at the surface that could be indicative of active faulting.

- We reviewed other published and unpublished reports and maps to obtain data on the geologic units, faults, ground-water barriers and geomorphic characteristics of the site, with emphasis on site-specific geological reports prepared by previous investigators for the study area. We specifically looked for geological data on the bluffs to the south of the Playa Vista site that would show whether or not faulting has been previously observed in this area. Refer to Appendix A for a list of references.

- We ran historical earthquake and deterministic seismic analyses for the site using Blake's (1990, 1995) EQSEARCH and EQFAULT software to locate historical earthquakes of magnitude greater than 4 reported within 20 miles of the site, and to estimate the peak ground accelerations that could be expected at the site from the closest known seismic sources. Refer to Appendices B and C for the computer outputs.

- We reviewed borehole and cone penetrometer test (CPT) data available for the site provided to us by Group Delta Consultants and Playa Vista. The borings that encountered the gravelly layer were located on the maps provided to us, and their locations were plotted on a GIS based map of the Playa Vista site. Then the elevation of the gravelly layer (relative to mean sea level) was calculated for each point by subtracting the depth of the gravel (as reported in the boring or CPT) from the elevation of that boring. The elevations of the top of the gravel layer were then plotted and the top of the gravel layer was contoured using these data points.

- We prepared cross-sections using borehole data collected by previous investigators for the bluffs south of the site. In the borehole data we looked for discrete units, such as geologic contacts between discernible units, that can be used to determine whether or not these deposits have been faulted.

- We reviewed vintage aerial photographs of the site and vicinity from our in-house library, and at Playa Vista to look for landforms that could be indicative of faulting in this area. Vertical pairs of photographs from our in-house library were reviewed with a stereoscope to look for fault-related topography, vegetation and soil contrasts, or other



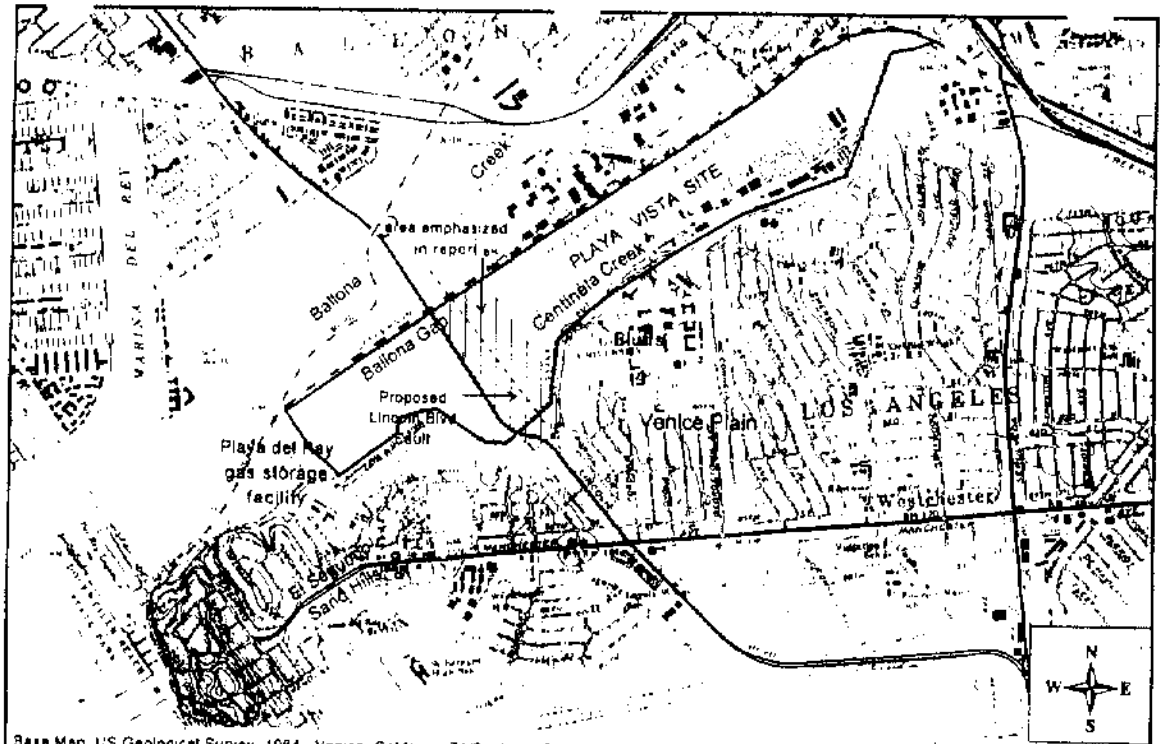
lineaments of possible fault origin. The in-house library photos reviewed are listed in Appendix A.

- We conducted a subsurface investigation that consisted of drilling 57 CPT soundings and 5 hollow stem auger borings (their logs are included in Appendices D and E, respectively). The CPTs and borings were drilled roughly perpendicular to the trend of the proposed Lincoln Boulevard fault, along three 800-feet long lines and one 300 feet long line trending east-west, east of Lincoln Boulevard and south of Jefferson Boulevard, within the area of concern. The CPTs were drilled to refusal in the gravelly sand layer that underlies the site. The hollow stem borings were drilled and sampled continuously to confirm and correlate the subsurface data obtained with the CPTs. The borings were generally drilled at least 5 feet into the gravelly sand layer. All of the borings and CPTs were backfilled with a grout slurry to the surface. Their locations were surveyed by GPS Landworks, Inc. who provided us with the survey data in digital format. The subsurface data obtained from our field study were used to image in more detail the top of the gravelly sand layer and other, more shallow soil layers in the area where the Lincoln Boulevard fault has been proposed.

  The CPT and borehole program described above was conducted in lieu of trenching, because, even though trenching is the most common and preferred method to assess the presence or absence of faulting, this investigative method was not feasible at this site. At the Playa Vista site, ground water generally occurs within 5 feet of the original ground surface, and the Holocene (less than 10,000 years old) section of sediments is relatively thick (approximately 40 to 50 feet thick), making trenching extremely expensive, if not impossible, at this site.

- We compiled the data obtained from our literature review and subsurface investigation, analyzed it, and prepared this report summarizing our findings and conclusions. As part of this task, we prepared cross-sections perpendicular to and parallel to the proposed Lincoln Boulevard fault on which we projected the CPT and borehole data available for the area. These cross-sections are critical to our analysis of whether or not the sediments in the area of this study are vertically offset by a fault.

Geophysical survey studies to image the older sediments at depth, from approximately 1,000 feet below the ground surface down to the basement rock, has been conducted by a separate group of consultants at about the same time as this report was being prepared. The results of the geophysical studies will be summarized and combined with our findings under separate cover, once the geophysical data have been processed and interpreted by Davis and Namson's team.



Base Map: US Geological Survey, 1964, Venice, California 7 1/2 minute Quadrangle, photorevised 1981

Earth Consultants International

Project No. 800130-001

Date July, 2000

Geomorphic Map Showing Features Discussed in the Text

2000 Scale in Feet

Figure No. 2

2.0 Background Information and Review of the Literature

2.1 Tectonic Setting

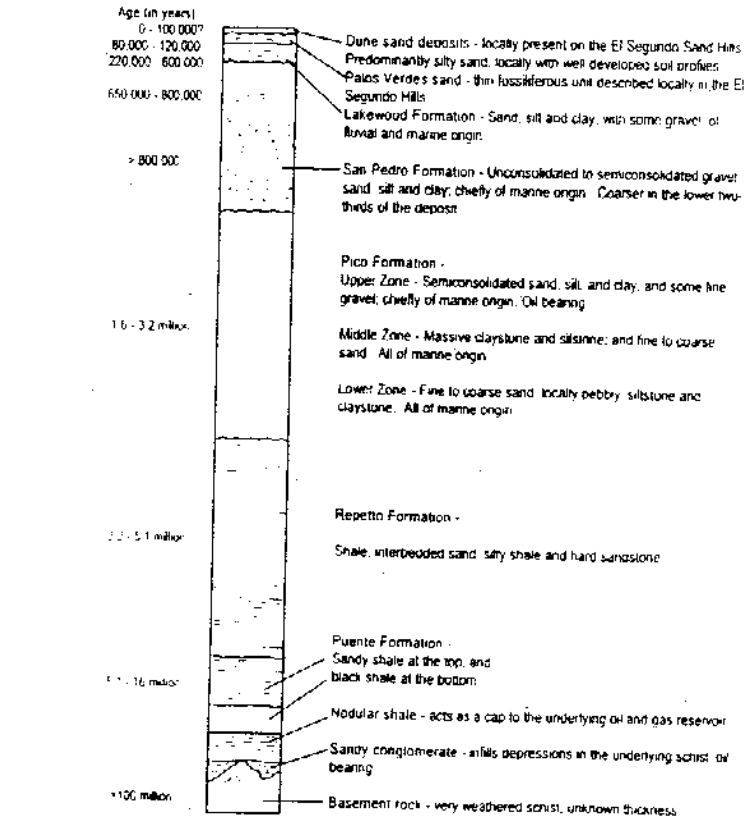
The Playa Vista site is located near the northwestern end of the Peninsular Ranges province of southern California, just south of its intersection with the Transverse Ranges province. The Peninsular Ranges province is characterized by a northwest-southeast grain that is reflected in the orientation of its major faults and folds. The Transverse Ranges is characterized by an east-west grain that is "transverse" to the predominant grain of the Peninsular Ranges. Three major fault systems are located about 5 miles from the site: 1) the Newport-Inglewood fault zone, 2) the Palos Verdes fault, and 3) the Santa Monica fault. The first two fault zones are located within the Peninsular Ranges province, and consist of predominantly right-lateral strike-slip faults that trend northwesterly. The Santa Monica fault forms the southern boundary to the Transverse Ranges province, trends east-west, and is considered responsible for uplift of the Santa Monica mountains. This fault is believed to have a left-lateral, north-side-up dip-slip component of movement.

Historical seismicity in the vicinity correlates with the mapped traces of the Newport-Inglewood fault to the east and the Santa Monica fault to the north, but there is no recognizable pattern in the microseismicity immediately below the site that would suggest there is a seismically active fault in this area (Hanksson, 1987, 1992a, 1992b). A review of past earthquake history for this area shows that in the last 200 years, approximately 74 earthquakes of magnitude 4 and above have occurred within 20 miles of the site (see Appendix B). Of these, 14 earthquakes have occurred within 5 miles of the site, with the closest occurring about 2 miles to the north, in Santa Monica. The largest of these earthquakes is a magnitude 5 event that occurred on November 19, 1918 just off the coast of Santa Monica, 5 miles to the northwest of the Playa Vista site. This earthquake is estimated to have caused peak ground accelerations at the site of about 0.14g.

All three of the faults within 5 miles of the site have the potential to generate significant earthquakes that would have an impact at the site. Other active faults farther away can also generate earthquakes that would be felt at the site. Peak ground accelerations at the site as a result of the worst-case scenario, a magnitude ~7 on the Palos Verdes fault are estimated at about 0.42g, where g is the acceleration of gravity (see Appendix C).

2.2 Geologic Setting

This area of the Los Angeles Basin has been studied geologically in quite some detail since the earlier part of the 20th century, when oil exploration in this area began in earnest. Wildcat wells (boreholes drilled for the intent of discovering an oil field) were drilled through the area, including in the Playa Vista site, eventually leading to the discovery of the Playa del Rey Oil Field in 1929. Once the oil field was discovered, development was very rapid, so that by the end of 1930, more than 140 wells had been drilled in the area (Riegle, 1953). The drillers' notes, oil well cuttings and cores, and geophysical logs of these wells have been used by oil field geologists to interpret the subsurface geology. (For a diagram showing the stratigraphic units in this portion of the Los Angeles Basin, refer to Figure 3).



Approximate Scale: 1 inch = 1,000 feet

Project No. 800130-00*
July, 2000

Stratigraphic Column for the West Portion of the Los Angeles Basin

Figure 3

The first to describe the subsurface geology in the Playa del Rey area was Mozner (1935). His work was later superseded by Hodges (1944). Basement rock, the igneous and/or metamorphic hard rock that is exposed in the Santa Monica Mountains to the north (Hoots, 1931), was reached in the oil wells at depths of between 6,000 and 6,500 feet. The basement rock, a schist, is extensively weathered and forms a very irregular upper surface that consists of a topographic high from which several depressions (or valleys) descend both to the northeast and southwest. These depressions were eroded into the bedrock surface when it was exposed at the surface hundreds of millions of years ago. The valleys were filled with a detrital deposit of sandy conglomerate that in turn is overlain by a layer of nodular shale that formed an effective cap, trapping large concentrations of oil and gas at depth. This conglomerate was the principal oil-bearing unit in the Playa del Rey area, producing approximately two-thirds of the oil from this field (Wright, 1991). The gas currently stored in the Playa del Rey field is stored in this sand-conglomerate unit (Riegle, 1953).

The nodular shale is overlain by sediments assigned to the Upper Miocene Puente Formation that include approximately 250 feet of a black shale and 425 feet of sandy shale. The Puente Formation is overlain by 2,500 feet of sediments assigned to the Lower Pliocene Repetto Formation, and approximately 2,000 feet of sediments assigned to the Pico Formation. Oil sands within the Repetto Formation produced the remaining one-third of the oil produced from this field. The Puente, Repetto and Pico sediments are thought to be of marine origin.

These marine sediments are overlain by 400 to 1,000 feet of sediments of Pleistocene age (1.6 million to 10,000 year old). These Pleistocene sediments have been studied extensively because they contain nearly all of the fresh ground water tapped by wells in this portion of the Los Angeles Basin. The principal source of water is the San Pedro Formation, the oldest Pleistocene unit, which consists primarily of unconsolidated gravel and sand, locally capped with silt and clay. The coarse, bottom two-thirds of the San Pedro sediments are thought to be more than 800,000 years old in the Torrance Plain (Ponti and Lajoie, 1992). The upper, fine-grained section was probably deposited between 650,000 and 800,000 years ago.

The San Pedro Formation is overlain by the Lakewood Formation, which was previously referred to as Unnamed Pleistocene Terrace Deposits (Poland and others, 1959; California Department of Water Resources, 1961). Ponti and Lajoie (1992) estimate that this unit was deposited between 220,000 and 600,000 years ago. The Palos Verdes sand described by Hoots (1931), Poland and others (1959), and Cooper (1967), among others, is a fossiliferous layer that locally occurs near the top of the Lakewood Formation. In the Palos Verdes Hills area, this deposit is estimated to be between 80,000 and 120,000 years old (Ponti and Lajoie, 1992). This fossiliferous layer is covered by reddish brown sand of primarily non-marine origin that typically has a well-developed soil profile.

The geologic history of the area in the last 18,000 to 20,000 years is fairly well understood. During the last glacial maximum, large amounts of water were locked in glaciers and ice-sheets that covered extensive areas of the continents. Sea level was approximately 130 meters (400 feet) lower than its present level, and therefore the coastline was many miles offshore from its present position. Rivers draining the mountains to the east carved deep trenches on their way to sea, probably removing all of the Lakewood sediments within the Ballona Gap area, and cutting into the San Pedro Formation. Then, as world-wide temperatures rose and the glaciers

melted, sea level began to rise very quickly, at a rate of about 1 meter (3 feet) in 100 years. The deep trenches began to infill with sediment as the rivers tried to establish a new base level with the rising coastline. The sediments infilling these trenches consisted primarily of gravel, sand and silt. Sea level continued to rise rapidly until about 7,000 to 6,000 years ago. At some point, the Ballona Gap was flooded by the rising sea water, and was cut off from the sea, probably by longshore sediment drift. The alluvial sediments were replaced with finer-grained marsh and lagoonal sediments. As the fine-grained sediments infilled the basin, sea water retreated. More recently, the lagoonal deposits were overlain by a thin veneer of alluvial sediments deposited by an ancestral Los Angeles River and Ballona and Centinela creeks.

Radiocarbon dating of sediments collected by the project archaeologists from cores drilled at various locations on the Playa Vista site provide age control on this process of sedimentation (Brevik and others, undated). Two samples collected near the bottom of the fine-grained alluvial sediments overlying the gravelly sand, at depths of 39 and 46 feet, were dated at 15,640 ± 50 years before present (BP) and 14,770 ± 120 years BP, respectively. The first sample was from a peat deposit, and the second was wood. It seems that infilling by fine-grained alluvial sediments continued until approximately 6,000 years ago, when Brevik and others suggest that a spit of sand formed across the mouth of the coastal inlet, creating the Ballona lagoon.

2.3 Geomorphic Setting

The Playa Vista site is located in the southern half of the Ballona Creek floodplain. The floodplain itself is a nearly level to very gently sloping surface that drains to the west. "Original", pre-development elevations at the site range from about 15 feet above mean sea-level near the eastern boundary of the site, to about 5 feet above mean sea level in the area of this study. The channelized Ballona Creek is located north of the site, while Centinela Creek flows along the southern portion of the site near the bluffs that rise about 150 feet to the Venice Plain and the El Segundo sand hills (Figure 2).

The bluffs form a rather straight east-west profile in the area of Playa Vista, except for the big "bite" formed by the valley along which Lincoln Boulevard rises toward Manchester Avenue (see Figure 2). The bluffs on both sides of this "bite" however, are fairly straight and continuous, and neither side extends out onto the Ballona floodplain more than the other does. This suggests that the bluffs are not laterally offset in this area, as would be expected if a fault extended in a northerly direction through the area.

Several early investigators studied the El Segundo sand hills before they were extensively disturbed by development. Hoots (1931) briefly mentions that the bluffs overlooking the Ballona Plain are underlain by a sand unit that contains fossils of upper San Pedro age, and probably correlative with the Palos Verdes sand. Cooper (1967), in part based on Merriam's (1949) work, describes the sand dunes as underlain by a terrace cover that includes the marine Palos Verdes sand, and a non-marine section. According to Cooper, the dune section itself includes three and possibly four dune sand layers, each layer followed by a stabilization period during which a distinct soil profile developed.

In 1935 Metzner described the hills southeast of the Playa del Rey Oil Field, and divided them into four separate "provinces" on the basis of their topography. Metzner argued that the two provinces closer to the coastline are controlled by faulting, as evidenced by the abrupt escarpments at their margins. The eastern margin of Metzner's third province coincides with Lincoln Boulevard. According to Metzner, this third province is characterized by features nearly perpendicular (rather than parallel) to the coastline, and by closed drainages. Metzner suggests that these features could be the result of faulting, tilting or wind action, but offers no evidence from which to discriminate a case.

Poland and others (1959) and Cooper (1967) describe two main zones rather than four, within the sand dune complex, but disagree about the origin of the inland section. Both Poland and others (1959) and Cooper (1967) describe the zone adjacent to the coast as a dune field of Holocene age. However Poland and others interpret the inland zone as a series of ancient offshore bars modified by wind and stream action, while Cooper considers this section a field of subdued dunes of much greater age. Within these zones, Cooper describes several ridges and depressions parallel to the coast line and explains them as superposed dune surfaces (Figure 4a). Unlike Metzner, neither Poland and others (1959) nor Cooper (1967) identify a topographic lineament coincident with Lincoln Boulevard.

Lajoie and others (1992) also identify two zones and explain them as strandline terraces cut onto the Venice Plain, and then overlain by sand dunes. Based on fossils they assign an age of 124,000 years to the top of the Venice Plain, below the dune sediments, and a tentative age of 320,000 years for older sediments exposed lower in the bluffs. According to Lajoie and others (1992), the terrace closest to the present shoreline is approximately 80,000 years old, and the other is about 102,000 years old, although it could be even older (Figure 4b).

The bluffs facing the Playa Vista site have also been mapped previously by at least two consultants (Converse Ward Davis Dixon, 1979; LeRoy Crandall and Associates, 1991). The geologic maps prepared by both consultants were done with sufficient care to note geologic contacts, bedding attitudes, shallow landslides and erosional gullies. Neither map shows any faulting anywhere on the bluffs (Figures 5a and 5b).

2.4 Local Faulting

Metzner (1945) identified and mapped several faults in the subsurface in the Playa del Rey oil field, to the southwest of the Playa Vista site. The faults were identified approximately 6,000 feet below the ground surface, within the basement bedrock, and oriented primarily east-west. According to Hodges (1944), "these faults cut the oil sand-conglomerate zone and the Nodular shale of the Miocene but are not known to be reflected [i.e., present] in the Upper Zone". The "Upper Zone" is more than 2,000 feet below the ground surface. A map accompanying Hodges (1944) report also shows a bentonite (clay) layer approximately 3,300 to 4,000 feet below the ground surface that is not faulted.

More recently, Yeats and Beall (1991) prepared an east-west cross-section from the Inglewood field to the Playa del Rey oil field that extends from the Pleistocene-age San Pedro Formation at the top down to the basement schist. Yeats and Beall interpret no faulting west of the Inglewood field within the sedimentary section (Figure 6a). Hummon and others (1992) mapped the base of the Pleistocene

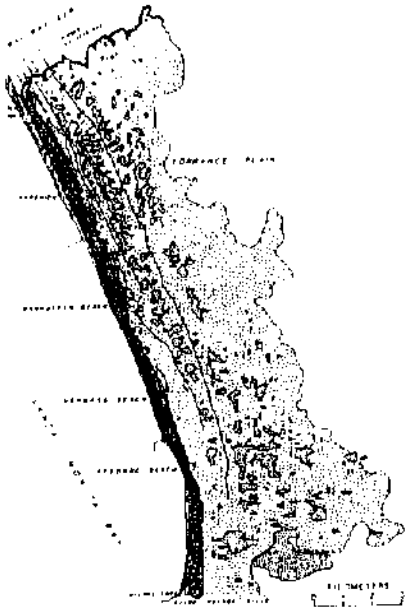


marine gravels (the bottom of the San Pedro Formation) and found that this surface forms a syncline (a bowl-shaped fold) that extends southwesterly from the Newport-Inglewood fault zone on the east toward the coastline (Figure 6b). The data from which Hummon and others (1992) prepared this structural contour map do not support the presence of a northwest-trending fault in the area of the "Lincoln Boulevard fault" west of the Newport-Inglewood fault zone.

None of the published geologic maps, cross-sections and geologic reports that cover this portion of the Los Angeles Basin show any faults or reasons to suspect a fault underlying the area southwest of Lincoln and Jefferson Boulevards, in the area of the proposed "Lincoln Boulevard fault" (Poland et al., 1967; Yeats and Beall, 1991; Wright, 1991). The site is also not located within an Alquist-Priolo Earthquake Fault Zone (Hart and Bryant, 1997). The Newport-Inglewood fault is the closest fault to the site that has been zoned by the State as active (CDMG, 1986, Bryant, 1988; Hart and Bryant, 1997). The Charnock fault, a fault inferred from groundwater level anomalies (Poland and others, 1959; California Department of Water Resources, 1961), has been mapped as underlying the eastern portion of the Playa Vista site, but has not been found near the surface at or near the site (Kovacs-Byer and Associates, 1987; LeRoy Crandall and Associates, 1987a; 1987b).

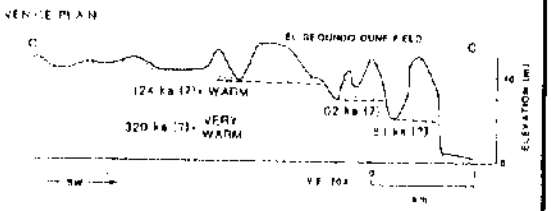
Figure 4a

Lines connect the high points on ridge crests, they are not faults



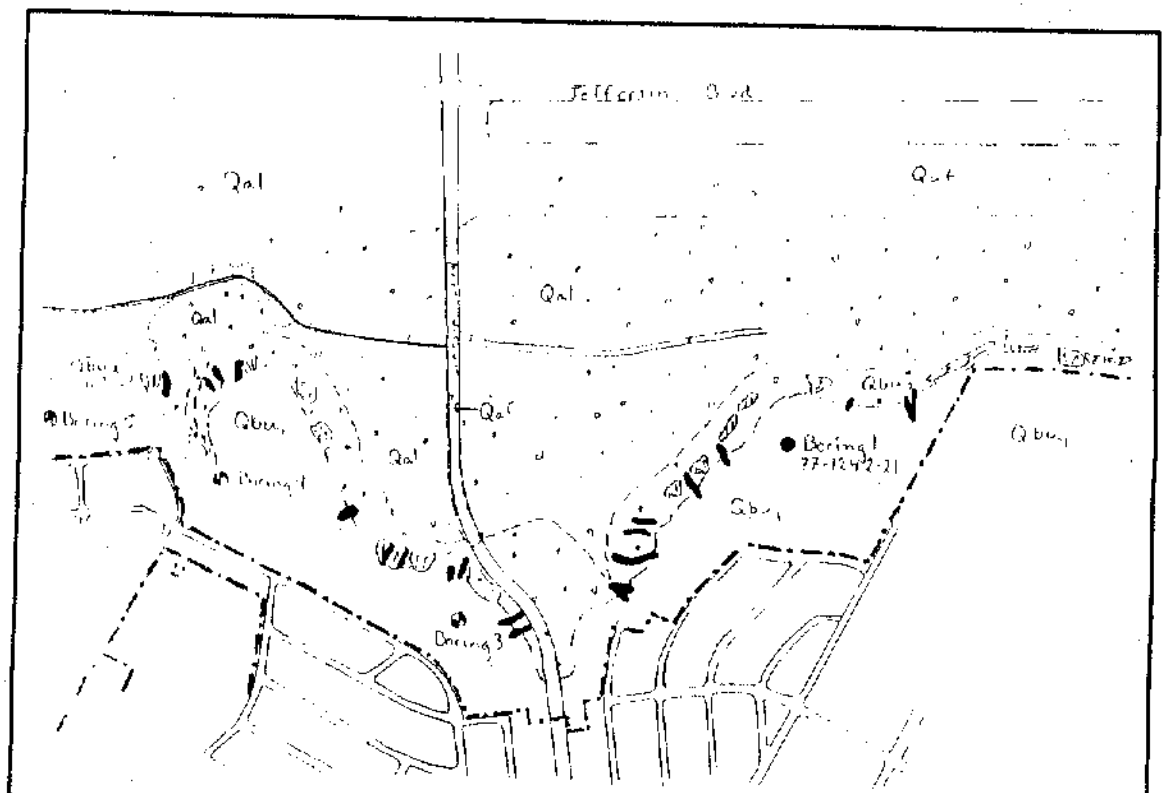
From Cooper, 1967

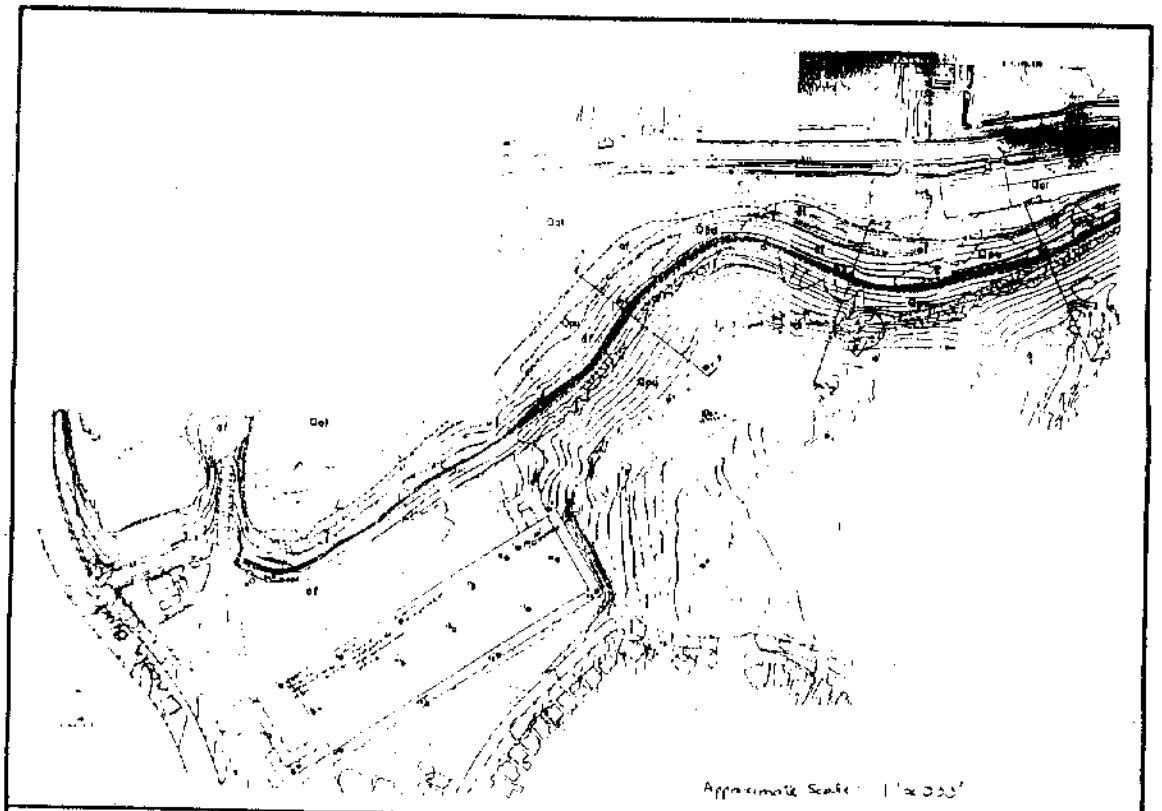
Figure 4b



From Lajoie and others, 1992

Fugro Consultants International	Date: July, 2000 Project: 800130-001	Coastal Dunes Mapped by Cooper (4a) and East-West Cross-Section Through the El Segundo Dune Hill (4b)	Figure 4


Jefferson Blvd.
Qal
Qal
Qal
Qal
Qal
Qbu
Qbu
Qbu
Boring 1
77-1242-21
Boring 2
Boring 3
Earth Consultants International
Date: July, 2000
Project: 600130-001
Geologic Map of the Bluffs
Adjacent to Lincoln Boulevard
(by Converse Ward Davis Dixon, 1979)
Figure 5a



Date: July, 2000
Project: 800130-001

Geologic Map of the Bluffs
Adjacent to Lincoln Boulevard
(by LeRoy Crandall and Associates, 1991)

Figure 5b

Figure 6a (from Yeats and Beall, 1991)

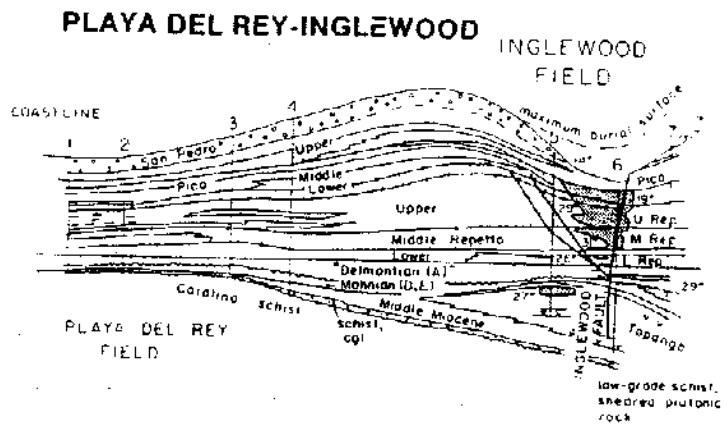
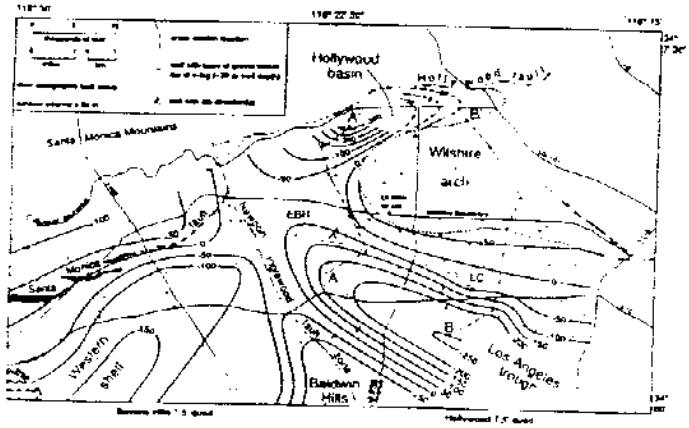


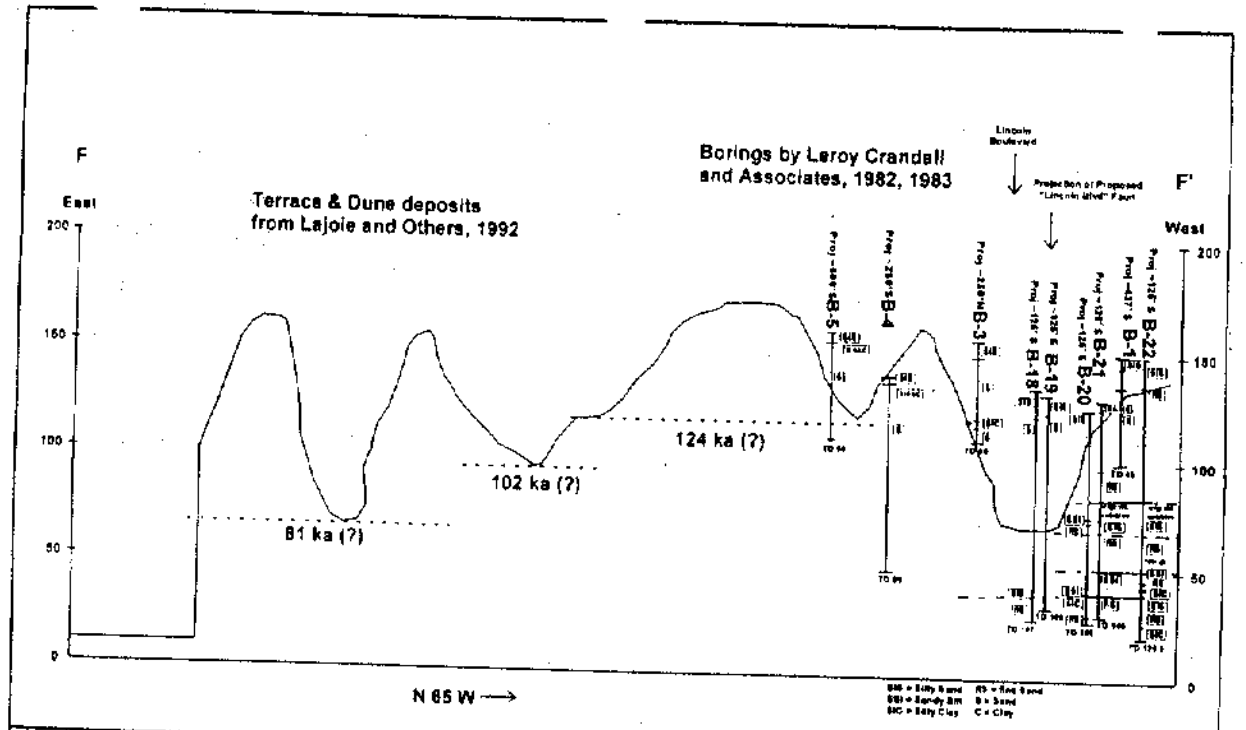
Figure 6b (from Hummon and others, 1992)



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July 2001

Cross-Section from the Inglewood Field to the Playa del Rey Field (6a) and Structural Contour Map at the Base of the Pleistocene Gravel (6b)

Figure 6



Earth Consultants International

Project No. 800130-001

Date July, 2000

Cross-Section F-F'

horizontal

1 50

Scale in Feet

Figure No. 7

3.0 Site-Specific Geologic Studies

3.1 Borehole and CPT Data by Other Investigators

Subsurface exploration of the Playa Vista site has been extensive; hundreds of borings and CPT soundings have been drilled onsite in the last 20 to 25 years. As part of this study we attempted to utilize this extensive data set to correlate stratigraphic units across the area and evaluate whether or not the stratigraphy has been offset by faulting. To do this, we concentrated on the gravelly sand layer that underlies the site, as this layer seems to represent the contact between Pleistocene (greater than 10,000 years old) and Holocene (less than 10,000 years old) sediments. This sandy gravel layer is referred to by Poland and others (1959) as the "50-foot" gravel, named so because on average, this unit occurs about 50 feet below the ground surface. Poland and others (1959) suggest that this unit was laid down by an ancestral Los Angeles River that extended in a westerly direction across the central portion of the study area. Poland and others (1959) recognized from water well data that although the top of the gravel layer slopes to the west, its surface is very irregular.

The borings that encountered the gravelly layer were plotted on a GIS-based map of the Playa Vista site (see Plate 1). Then, the elevation of the gravelly layer (relative to mean sea level) was calculated for each point by subtracting the depth of the gravel (as reported in the boring or CPT) from the elevation of that boring. The elevations of the top of the gravel layer were then plotted (Plate 3) and the top of the gravel layer was contoured using these data points. Unfortunately, some of the earlier borings were not surveyed, so their elevations were either missing or were unreliable. For example, most of the borings and CPTs conducted by Pacific Soils in the 1980s were ultimately dropped from the analysis, either because they were not deep enough to intercept the gravelly sand layer, or because their elevation was unknown. Many of the "MWW" borings by ETI (2000) and "R" borings by Group Delta Consultants (1998) were also dropped because these borings were reportedly drilled very quickly, and the reported depth to the sandy gravel layer could not be verified.

After these questionable borings were identified and dropped from the analysis, the sandy gravel layer elevations provided by the rest of the data were contoured using two foot spacings. The contours show that the top of the gravelly sand deposits forms an irregular surface that has received sediment input from two sources, one to the south, and one to the north-northeast. To the south, the source of this sediment appears to be the escarpment south of the site with gravelly sand deposited at the base of the slope. The sediments to the north appear to emanate from the large fan that cuts a gap through the elevated surface south of Santa Monica. This fan can be seen in the older topographic maps of the area.

3.2 Subsurface Studies by Earth Consultants International

After careful review of the existing data it became clear that we had insufficient points at the top of the sandy gravel layer to image the top of this deposit in the area where the "Lincoln Boulevard fault" was proposed. Therefore, to obtain more closely spaced data in this area we conducted a detailed CPT and boring program in the area east of Lincoln Boulevard and south of Jefferson Boulevard. Three 800-foot long lines of CPTs and borings were drilled perpendicular to Lincoln Boulevard (lines A, C and D in Plate 1). Another line of CPTs approximately 300 feet long was drilled between lines A and C (line B in Plate 1). On each line, the CPTs and borings are spaced on average between 20 and 40 feet apart, although some are less than 10 feet apart. The CPTs were driven until refusal in the dense gravelly sand layer. The borings were drilled adjacent to some of the CPTs to confirm the stratigraphy interpreted from the CPTs.

The geologic units encountered in our borings and CPTs are described below, from youngest to oldest (top to bottom).

3.2.1 Modern Artificial Fill

Artificial fill locally covers the site by as much as 15 to 20 feet. These materials were placed by mechanical means in the last few years, typically for the purpose of surcharging the underlying loose sediments thereby increasing their in-situ densities. The artificial fill typically consists of layered gravelly sand, fine to coarse sand, and silty sand. Scattered pieces of glass and wood were observed locally in the borings and basement excavations, within the artificial fill section.

3.2.2 Modern Alluvial Sediments

A thin (2- to 4-foot thick) section of alluvium typically covers the site in those areas where the ground has not been covered with artificial fill. The alluvium generally consists of sand and silty sand with no soil development.

3.2.3 Holocene Marsh and Lagoonal and Alluvial Sediments

The Holocene section is usually about 40 feet thick and typically consists of two distinct sediment packages separated by a silty sand to sand layer at an elevation of between 25 and 30 feet below current sea level. The upper package consists primarily of silt with thin silty clay interbeds. The unit gets finer-grained up-section (fining upward), so that at the top it is capped with a layer of clay 2 to 4 feet thick. This clay layer is referred in other publications and reports as an "adobe" layer. This fining-upward sequence was probably deposited when the area was a closed-in marsh or lagoon, in the last about 6,000 years.

The bottom of the Holocene sediment package consists primarily of silty clay with thin interbeds of silty sand and sandy silt. This unit generally coarsens upward from a silty clay at the bottom to a silt at the top. Thin sand layers that probably represent pulses of alluvial sedimentation were observed locally. These deposits were probably deposited between 14,000 and 7,000 years ago. In the southern portion of the area investigated, there is a series of nested channels that incise vertically and laterally into each other. The sediments in these channels consist of gravelly sand, sand and silty sand (see Cross-Section D-D'), that most likely emanated from the bluffs to the south.

3.2.4 Late Pleistocene Alluvial Sediments

Dense sand and gravel deposits were encountered at the bottom of the CPTs and in our borings. These sediments are considerably denser than the overlying deposits, with equivalent SPT blow counts of more than 50 for 6 inches of core. The top of this layer is shown in all of our cross-sections (see Plates 5 through 8), and in the structural contour map (Plate 4). As observed by Poland and others (1959), this layer has a regional dip to the west, but is vertically variable. Undulations in the top of this layer, typically in the order of 2 to 4 feet, are reflective of the natural bar and pool riffle morphology of active streams.

From the cross sections prepared with the CPT and borehole data available next to lines A-A' through D-D' (Plates 5 through 8), we can identify those areas where the gravelly sand layer is irregular. In Section A-A', there is a change in elevation of the top of the gravel layer between ECI-44 and ECI-1, and between ECI-53 and ECI-10. In Section B-B', between ECI-50 and ECI-30. In Section C-C', between ECI-26 and ECI-03, and in Section D-D', between ECI-41 and ECI-21. In all these cases, however, the overlying layers go straight across the area where the gravelly sand layer steps, indicating that even if the gravelly sand layer were faulted, the overlying Holocene sediments are not.

3.3 Cross-Sections of the Bluffs South of the Site

In order to extend back the ages of the sediments across the "Lincoln Boulevard fault", we also looked at the Pleistocene bluffs to the south of the site for evidence as to whether or not a fault extends through the area.

To that end we constructed two cross-sections, F-F' and G-G' (see Figures 7 and 8) parallel to the bluffs using borehole data obtained by Converse Ward Davis Dixon (CWDD, 1979) and LeRoy Crandall and Associates (1982 and 1983, 1991) for the former Hughes facility off of Lincoln Boulevard. The borings drilled by CWDD separated a silty sand unit (probably dune deposits), from a light brown sand at depth (probably terrace deposits). The light brown sand is locally covered with reddish brown clay-rich section that is most likely a soil profile. Ground water was measured in some of the borings. Most of the borings drilled by LeRoy Crandall and Associates were located on a bench in the bluffs that is generally below the contact between the dune deposits and the underlying terraces. Because these borings were drilled in most cases with a mud rotary rig, groundwater levels were not obtained. Although the borehole logs are very generalized, gravelly or silty sections within the sand were identified.

Some of these layers are laterally extensive from one borehole to the next (see Sections F-F' and G-G', Figures 7 and 8, respectively). Although none of the layers extends laterally along the entire width of the cross-section, by using several of these layers we can show that there is no offset in the Pleistocene sediments underlying the bluffs to suggest a fault in this area.



4.0 Summary and Conclusions

Geochemical data were used by ETI (2000) to propose that the area of the Playa Vista site immediately east of Lincoln Boulevard is underlain by a fault. The proposed fault reportedly trends north-northwesterly, and dips to the west with a normal sense of slip (the west side of the structure has moved down relative to the east side of the structure). According to ETI (2000), this fault acts as a pathway for thermogenic methane gas to reach the surface. The gas presumably originates at depths of between approximately 500 and 3,400 feet.

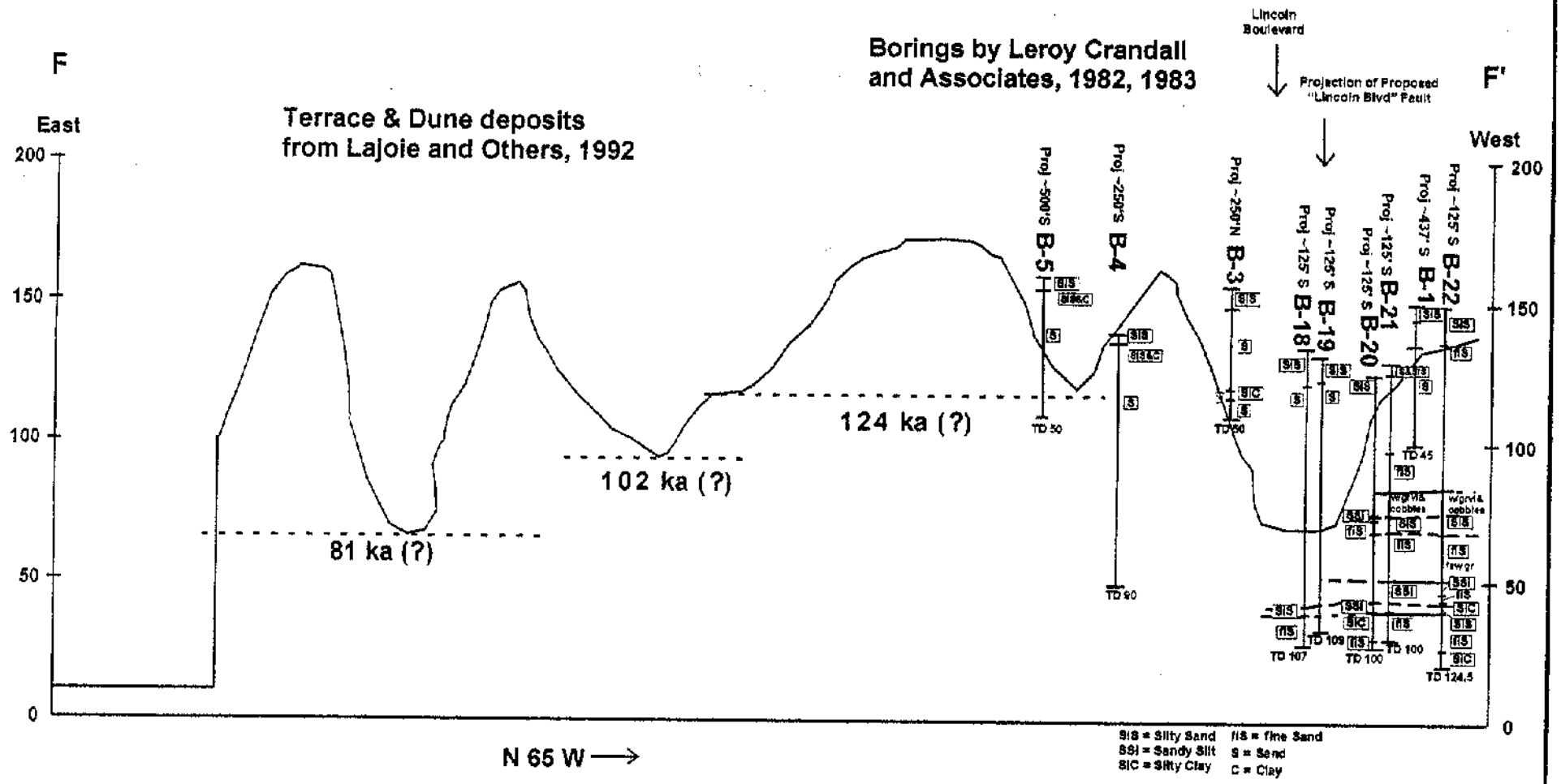
To evaluate whether or not this fault does underlie the area, we undertook a multi-phased geological study. As with much of the Los Angeles Basin, this area has been the subject of several oil and ground water studies. Wildcat oil exploration wells drilled across the area eventually led to the discovery of the Playa del Rey oil field to the west-southwest. Ground water has been produced from several shallow aquifers, including the 50-foot gravel that was the subject of our field studies. A review of these published data shows that no faults have been mapped in the subsurface in this area. Historical seismicity in the vicinity corresponds with the mapped traces of the Newport-Inglewood fault to the east and the Santa Monica fault to the north, and there is no recognizable pattern in the microseismicity immediately below the site that would suggest there is a seismically active fault in this area.

Although the extensive subsurface data from oil well and groundwater well records do not show a fault in this area, we undertook a site-specific study that looked at the extensive near-surface data that has been obtained from the various geotechnical studies conducted at the site. Realizing that the data available were insufficient to image the top of the 50-foot gravel layer, we drilled 57 new CPTs and 5 borings in the area. Using these data we refined the structural contour map of the top of the Pleistocene gravel surface, and prepared several cross-sections. These graphics show that the top of the sandy gravel layer is irregular in the order of 2 to 4 feet, and could conceivable obscure a fault offset of that small magnitude.

To compensate for this, we then looked at the overlying, fine-grained sediments, which since they were deposited in a low-energy environment, would be better expressed as laterally continuous, regular surfaces that would more readily show whether or not they have been faulted. Those areas above where the gravelly sand layer made small vertical changes were in all cases overlain by laterally extensive, unbroken fine grained sediments. This indicates that although we cannot preclude the possibility of a small vertical offset of the top of the gravel, the overlying Holocene sediments are not faulted. The sandy gravel is thought to be approximately 15,000 years old, while the overlying fine-grained sediments were probably deposited less than about 6,000 years ago.

Furthermore, we also looked for geologic reports that had mapped the Pleistocene-age bluffs south of the site. Two geotechnical studies in this area mapped the bluffs and did not find any faults. Cross-sections parallel to the bluffs show that layers in the underlying terrace (or Lakewood sediments) are generally laterally continuous across the area where the "Lincoln Boulevard fault" would project through.

Our studies indicate that there is no fault in this area that has ruptured the ground surface in at least the past several tens to hundred thousand years. Therefore, it is our conclusion that the potential for surface fault rupture hazard in this area is nil, and development constraints to mitigate the potential for surface fault rupture are not warranted.



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Project No. 800130-001

Date July, 2000

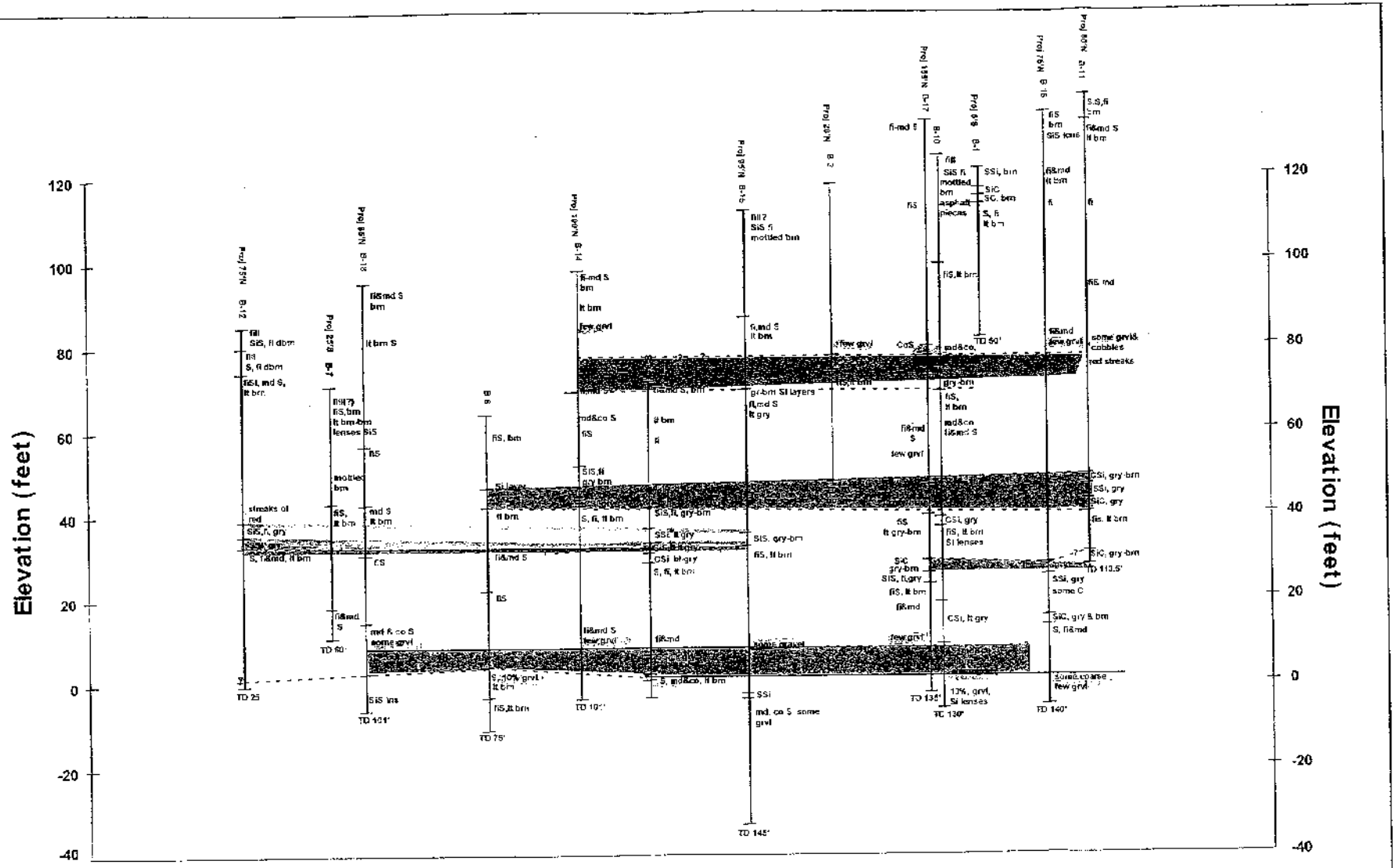
Cross-Section F-F'

horizontal

1 50

Scale in Feet

Figure No. 7



Earth Consultants International

Project No. 800130-001

Cross-Section G-G'

1 20 40

Scale in Feet

Elevation (feet)
Elevation (feet)
Cross-Section
H-H'

Appendix A
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References and Reports Reviewed

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In-House Aerial Photographs Reviewed

Date	Flight No.	Frame No.	Scale	Source
11/4/1952	AXJ-4K	71 74	1:20,000	USDA
11/19/1953	AXJ 14K	67-70	1:20,000	USDA
11/22/1974	389	14, 16, 17, 22, 24, 25	1:6,000	Metrex Aerial Surveys Inc

Appendix B
Earthquake History Analysis



Appendix B
Search for Past Earthquakes in the Site Vicinity

Software Used: EQSEARCH Version [illegible]
Estimation of Peak Horizontal Acceleration From California Earthquake Catalogs

SITE COORDINATES: LATITUDE: 33.9715 N LONGITUDE: 118.428 W
SEARCH RADIUS: 20 mi
SEARCH MAGNITUDE: 4 TO 9.0
SEARCH DATES: 1800 TO 2000
ATTENUATION RELATION: [illegible] Campbell (1993, Horiz. - 0=Soil, 1=Rock
FAULT TYPE ASSUMED: DS=Reverse, SS=Strike-Slip: DS
EARTHQUAKE-DATA FILE USED: ALLQUAKE.DAT
TIME PERIOD OF EXPOSURE FOR STATISTICAL COMPARISON: 25 years
SOURCE OF DEPTH VALUES (A=Attenuation File, E=Earthquake Catalog): A

FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (GMT) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi	(km)
T-A	34.000	118.250	9/[illegible]/1857	[illegible]	33.0	5.00	0.0[illegible]	VII	10	[illegible]
T-A	34.000	118.250	[illegible]/10/1856	0 3 0.0	33.0	5.00	0.07[illegible]	VII	10	[illegible]
T-A	34.000	118.250	5/ 2/1856	8 15 0.0	33.0	4.30	0.048	VI	10	[illegible]
T-A	34.000	118.250	[illegible]/[illegible]/1855	1 0 0.0	33.0	4.30	0.048	VI	10	[illegible]
T-A	34.000	118.250	5/ 4/1855	6 0 0.0	33.0	4.30	0.048	VI	10	[illegible]
MOI	34.000	118.200	[illegible]/[illegible]/1855	830 0.0	33.0	4.30	0.030	V	16	25
T-A	34.000	118.250	3/26/1854	0 0 0.0	33.0	5.00	0.07[illegible]	VII	10	[illegible]
T-A	34.000	118.250	3/21/1880	1425 0.0	33.0	4.80	0.068	VI	10	17
MOI	34.000	118.300	9/ 3/1905	540 0.0	6.5	5.30	0.130	VII	8	12
DMG	34.000	118.500	11/ 8/1914	2140 0.0	7.3	4.50	0.104	VII	5	7
MOI	33.900	118.500	6/18/1915	125 5 0.0	33.0	4.80	0.032	V	19	29
MOI	34.100	118.200	5/ 2/1916	1437 0 0	33.0	4.00	0.024	V	16	25
MOI	34.000	118.200	5/13/1917	13 5 0.0	33.0	4.60	0.046	VI	13	21
MOI	34.000	118.200	6/26/1917	424 0.0	33.0	4.80	0.030	V	12	21
MOI	34.000	118.200	6/26/1917	2115 0 0	33.0	4.60	0.046	VI	13	21
MOI	34.000	118.200	6/26/1917	2120 0.0	33.0	4.60	0.046	VI	13	21
MOI	34.000	118.200	6/26/1917	2130 0.0	33.0	4.60	0.046	VI	13	21
DMG	34.000	118.500	3/ 6/1918	1820 0.0	7.3	4.00	0.024	VII	5	7
MOI	34.000	118.500	3/ 8/1918	1230 0.0	7.3	4.80	0.074	VII	5	7
MOI	34.000	118.500	11/19/1918	2016 0.0	7.3	5.00	0.146	VIII	5	7
MOI	34.000	118.400	2/22/1920	1610 0.0	7.3	4.60	0.140	VIII	3	4
DMG	34.000	118.500	6/22/1920	248 0.0	7.3	4.90	0.137	VIII	5	7
MOI	34.000	118.300	6/22/1920	2035 0.0	33.0	4.00	0.052	VI	8	12
MOI	34.000	118.500	6/23/1920	2220 0.0	7.3	4.80	0.074	VII	5	7
MOI	34.000	118.300	6/30/1920	350 0.0	33.0	4.00	0.052	VI	8	12
MOI	34.000	118.260	7/16/1920	16 9 0.0	33.0	5.00	0.068	VII	10	16
MOI	34.100	118.300	7/16/1920	2022 0.0	33.0	4.60	0.053	VI	12	19
MOI	34.100	118.300	7/16/1920	2037 0.0	33.0	4.60	0.053	VI	12	19
MOI	34.100	118.300	7/16/1920	2038 0.0	33.0	4.60	0.053	VI	12	19
MOI	34.100	118.300	7/26/1920	2244 0.0	33.0	4.60	0.045	VI	12	19
MOI	34.100	118.250	4/21/1921	1536 0.0	33.0	4.60	0.024	V	16	25
MOI	34.000	118.400	1/29/1923	2326 0.0	7.3	4.00	0.093	VII	3	4
MOI	34.000	118.400	2/ 7/1923	429 0.0	7.3	4.60	0.140	VIII	3	4
DMG	34.000	118.500	4/ 4/1923	1026 0.0	7.3	5.00	0.146	VIII	5	7
MOI	33.97	[illegible]	[illegible] 8 1923	15.4 [illegible]	33.0	4.60	0.046	VI	14	22
MOI	33.97	118.300	[illegible] 1923	[illegible]	33.0	4.[illegible]	[illegible]	V	14	[illegible]
[illegible]	[illegible]	118.[illegible]	[illegible] 5 1923	1844 6 [illegible]	[illegible]	4.[illegible]	0.031	V	19	31
DMG	33.97	[illegible]	8 21 1923	2[illegible]	[illegible]	[illegible]	0.[illegible]	VII	22	19
MOI	34.[illegible]	118.400	[illegible] [illegible]/1924	049 0.0	7.3	4.6	0.140	VIII	3	4
[illegible]	[illegible]	118.481	4 24 1931	1807[illegible]	[illegible]	4.41	0.036	[illegible]	14	23

FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (GMT) h m Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	MMI	APPROX. DISTANCE mi	(km)
DMG	33.800	118.300	11/ 7/1931	16 5 0.0	7.3	4.00	0.026	V	14	22
DMG	33.850	118.267	3/11/1933	1 629 0.0	7.3	4.40	0.042	V	11	17
DMG	33.850	118.267	3/11/1933	1455 0.0	7.3	5.00	0.064	VI	11	17
DMG	33.883	118.317	3/11/1933	1457 0.0	7.3	4.90	0.059	VI	8	14
DMG	33.950	118.033	10/25/1933	7 846.0	7.3	4.30	0.028	IV	25	40
DMG	33.867	118.200	11/11/1933	12126 0.0	7.3	4.00	0.026	V	14	22
DMG	33.759	118.253	8/31/1938	1 31814.2	7.3	4.50	0.030	V	16	26
DMG	33.903	118.433	11/29/1938	192115.8	7.3	4.00	0.072	VII	5	8
DMG	34.000	118.433	12/ 7/1938	1 338 0.0	7.3	4.00	0.097	VIII	2	3
DMG	34.783	118.200	12/27/1939	192845 0	7.3	4.70	0.033	V	25	38
DMG	33.983	118.300	2/11/1940	192410.0	7.3	4.00	0.053	VI	7	11
DMG	33.767	118.450	10/11/1940	55712.2	7.3	4.70	0.044	VI	16	25
DMG	33.783	118.417	10/12/1940	1 024 0.0	7.3	4.00	0.030	V	13	21
DMG	33.783	118.433	10/14/1940	205111.0	7.3	4.00	0.030	V	13	21
DMG	33.783	118.417	11/ 1/1940	1 725 3.0	7.3	4.00	0.030	V	13	21
DMG	33.783	118.417	11/ 4/1940	25826.0	7.3	4.00	0.030	V	13	21
DMG	33.617	118.117	10/22/1941	65718.5	7.3	4.90	0.065	VI	16	26
DMG	33.783	118.250	11/18/1941	84036.3	6.2	5.40	0.060	VI	11	18
DMG	33.867	118.217	6/15/1944	0 333.0	7.3	4.50	0.039	V	14	23
DMG	33.867	118.217	6/19/1944	3 6 7.6	7.3	4.40	0.037	V	14	23
DMG	33.939	118.208	5 11/1950	224135.0	7.3	4.40	0.036	V	13	21
PAS	33.944	118.667	1 ...1975	231438.9	7.3	5.00	0.064	VI	14	24
PAS	33.933	118.667	10/17/1979	205237.3	7.3	4.20	0.032	V	14	23
PAS	34.046	118.201	10/ 1/1987	144541.5	7.3	4.70	0.041	V	19	31
PAS	34.060	118.100	10/ 1/1987	1449 5.9	7.3	4.70	0.038	V	20	32
PAS	33.919	118.627	1/19/1989	65328.6	7.3	5.00	0.067	VI	12	19
GSP	34.030	118.180	6/12/1989	165738.4	7.3	4.40	0.035	V	15	24
GSP	34.020	118.180	6/17/1989	172225.5	7.3	4.10	0.029	V	15	25
GSP	34.213	118.592	1/17/1994	123055.4	9.0	6.70	0.148	VIII	18	29
GSP	34.27W	118.573	1/17/1994	175608.2	7.9	4.60	0.029	V	22	36
GSP	34.218	118.605	1/18/1994	113509.9	7.3	4.20	0.021	IV	20	32
GSP	34.245	118.473	1/18/1994	155144.9	7.3	4.00	0.019	IV	19	31
GSP	34.215	118.595	1/19/1994	140514.8	7.3	4.50	0.031	V	17	28
GSP	34.231	118.475	9/20/1994	2012012.3	6.4	5.00	0.052	VI	18	29

END OF SEARCH 74 RECORDS FOUND

MAXIMUM SITE ACCELERATION DURING TIME PERIOD 1800 TO 2020: 0.148g
MAXIMUM SITE INTENSITY (MM) DURING TIME PERIOD 1800 TO 2020: VIII
MAXIMUM MAGNITUDE ENCOUNTERED IN SEARCH: 6.7
NEAREST HISTORICAL EARTHQUAKE WAS ABOUT 2 MILES AWAY FROM 1994
NUMBER OF YEARS REPRESENTED BY SEARCH: 201 years

RESULTS OF PROBABILITY ANALYSES

TIME PERIOD OF SEARCH: 1800 TO 2000
LENGTH OF SEARCH TIME: 201 years
ATTENUATION RELATION: 1: Campbell (1993) Horiz. - 0=Soil 1=Rock
*** TIME PERIOD OF EXPOSURE FOR PROBABILITY: 15 years

PROBABILITY OF EXCEEDANCE FOR ACCELERATION

ACC. g	NO. OF TIMES EXCEED	AVE. OCCUR. #/yr	RECURR. INTERV. years	COMPUTED PROBABILITY OF EXCEEDANCE 15 yr.	10 yr.	5 yr.	2 yr.	1 yr.	0.5 yr.	0.2 yr.
0.01	74	0.368	2.716	0.1661	0.3088	0.9748	1.0000	1.0000	1.0000	0.9999
0.02	73	0.363	2.753	0.1661	0.3045	0.9735	1.0000	1.0000	1.0000	0.9999
0.03	69	0.343	2.913	0.1581	0.2891	0.9565	1.0000	1.0000	1.0000	0.9998
0.04	56	0.279	3.586	0.1037	0.1966	0.8820	1.0000	1.0000	1.0000	0.9958
0.05	32	0.159	6.281	0.0765	0.1472	0.7965	0.9997	1.0000	1.0000	0.9813
0.06	24	0.119	8.375	0.0586	0.1125	0.6970	0.9974	0.9999	1.0000	0.9495
0.07	20	0.100	10.050	0.0483	0.0947	0.6309	0.9931	0.9994	1.0000	0.9167
0.08	12	0.060	16.750	0.0294	0.0580	0.4495	0.9495	0.9886	0.9974	0.7750
0.09	11	0.055	18.273	0.0270	0.0533	0.4215	0.9352	0.9859	0.9956	0.7450
0.10	9	0.045	22.333	0.0221	0.0438	0.3609	0.9034	0.9802	0.9886	0.6735
0.11	8	0.040	25.125	0.0197	0.0390	0.3283	0.8833	0.9765	0.9845	0.6323
0.12	8	0.040	25.125	0.0197	0.0390	0.3283	0.8833	0.9765	0.9845	0.6323
0.13	8	0.040	25.125	0.0197	0.0390	0.3283	0.8833	0.9765	0.9845	0.6323
0.14	6	0.030	33.500	0.0148	0.0294	0.2561	0.8352	0.9694	0.9769	0.5259

PROBABILITY OF EXCEEDANCE FOR MAGNITUDE

MAG.	NO. OF TIMES EXCEED	AVE. OCCUR. #/yr	RECURR. INTERV. years	COMPUTED PROBABILITY OF EXCEEDANCE 15 yr.	10 yr.	5 yr.	2 yr.	1 yr.	0.5 yr.	0.2 yr.
4.00	74	0.368	2.716	0.1661	0.3088	0.9748	1.0000	1.0000	1.0000	0.9999
4.50	38	0.189	5.289	0.0911	0.1723	0.8492	0.9999	1.0000	1.0000	0.9961
5.00	14	0.070	14.357	0.0347	0.0673	0.5017	0.9864	0.9996	0.9998	0.8247
5.50	1	0.005	201.000	0.0025	0.0050	0.0485	0.2202	0.3114	0.3621	0.1115
6.00	1	0.005	201.000	0.0025	0.0050	0.0485	0.2202	0.3114	0.3621	0.1115
6.50	1	0.005	201.000	0.0025	0.0050	0.0485	0.2202	0.3114	0.3621	0.1115

GUTENBERG & RICHTER RECURRENCE RELATIONSHIP

a-value= 3.934
b-value= 1.364

Beta-value= 2.449

Appendix C
Deterministic Seismic Analysis



Appendix C
Deterministic Seismic Analysis

Run with EQFAULT Version 2.20
Estimation of Peak Horizontal Acceleration from digitized California faults

SITE COORDINATES: LATITUDE: 33.9715 N LONGITUDE: 118.4281 W
SEARCH RADIUS: 100 km (62 mil
ATTENUATION RELATION: 11 Campbell & Bozorgnia (1994) Horiz. Alluvium
FAULT-DATA FILE USED: COMOSCE.DAT

ABBREVIATED FAULT NAME	APPROX. DISTANCE (km)	MAX CREDIBLE EVENT MAG.	MAX CREDIBLE EVENT PEAK SITE ACC. g	MAX CREDIBLE EVENT SITE INTENS. MM	MAX PROBABLE EVENT MAG.	MAX PROBABLE EVENT PEAK SITE ACC. g	MAX PROBABLE EVENT SITE INTENS. MM
SAN ANDREAS - San Bernardi	56	7.30	0.054	VI	7.30	0.054	VI
SAN ANDREAS - Southern	56	7.40	0.059	VI	7.30	0.054	VI
SAN ANDREAS - Mojave	44	7.20	0.067	VI	7.20	0.062	VI
SAN ANDREAS - Carrizo	80	7.20	0.057	VI	7.20	0.057	VI
SAN ANDREAS - 1857 Rupture	44	7.80	0.113	VII	7.80	0.086	VII
SAN JACINTO SAN BERNARDINO	56	6.70	0.032	V	6.70	0.027	V
ELSINORE GLEN IVY	46	6.80	0.045	VI	6.80	0.039	VI
WHITTIER	24	6.80	0.104	VII	5.90	0.068	VI
NEWPORT-INGLEWOOD (Offshore)	39	6.70	0.051	VI	5.50	0.026	IV
CUCAMONGA	56	7.40	0.059	VI	6.30	0.022	IV
NEWPORT-INGLEWOOD (Offshore)	39	6.90	0.060	VI	5.80	0.029	IV
CHINO-CENTRAL AVE. (Elsino	39	6.70	0.051	VI	5.50	0.026	IV
CUCAMONGA	56	7.40	0.059	VI	6.30	0.022	IV
NEWPORT-INGLEWOOD (Offshore)	39	6.90	0.060	VI	5.80	0.029	IV
CHINO-CENTRAL AVE. (Elsino	39	6.70	0.051	VI	5.50	0.026	IV
CAMPBELL-SARGENT	28	6.50	0.069	VI	5.00	0.021	IV
CUCAMONGA	64	7.00	0.060	VI	6.00	0.030	V
HOLLYWOOD	8	6.40	0.310	IX	5.30	0.148	VIII
HOUSER	35	6.50	0.060	VI	4.90	0.017	IV
MALIBU COAST	7	6.90	0.376	IX	4.90	0.126	V
RAYMOND-ARROYO PARTIDA-SANT	54	6.70	0.055	V	5.40	0.027	IV
NEWPORT-INGLEWOOD (L.A.Bas	9	6.90	0.355	IX	5.60	0.164	VIII
SAN PEDRO (Onshore	36	6.90	0.074	VII	6.00	0.043	VI
PALOS VERDES	5	7.10	0.424	X	6.20	0.304	IX
RAYMOND	16	6.50	0.152	VIII	5.00	0.067	VI
SIERRA MADRE	17	6.80	0.087	VI	5.60	0.026	IV
SAN FERNANDO	2	6.60	0.262	VII	4.40	0.044	VI
SAN GABRIEL	24	7.20	0.113	VII	5.60	0.034	V
HOLLYWOOD	10	6.50	0.250	VII	5.20	0.106	VI

Page 2

ABBREVIATED FAULT NAME	APPROX. DISTANCE (KM)	MAX. CREDIBLE EVENT: MAG.	PEAK SITE ACC. g	SITE INTENS. MM	MAX. PROBABLE EVENT: MAG.	PEAK SITE ACC. g	SITE INTENS. MM
SANTA MONICA	2	6.60	0.414	X	5.50	0.233	VIII
SANTA YNEZ (East)	50	7.00	0.048	VI	5.90	0.019	IV
SANTA SUSANA	20	6.60	0.096	VII	6.30	0.077	VII
SIERRA MADRE (San Fernando)	22	6.70	0.135	VII	5.60	0.049	VI
SIERRA MADRE	20	7.00	0.153	VIII	6.20	0.086	VII
SIMI-SANTA ROSA	10	6.70	0.073	VII	5.50	0.026	V
VENTURA - PITAS POINT	48	6.80	0.042	VI	5.50	0.015	IV
VERDUGO	17	6.70	0.157	VIII	5.20	0.046	VI
WILSHIRE PARK THRUST	22	6.70	0.356	IX	5.80	0.192	VIII
NORTHRIDGE (E. Oak Ridge)	21	6.90	0.207	VIII	5.80	0.097	VII
ANACAPA-DUME	25	7	0.25	IX	6.30	0.136	VIII
TRANSV. TF THRUST (Eastern	48	7.40	0.101	VII	6.00	0.033	V
MONTALVO OAK RIDGE TREND	52	6.60	0.048	VI	5.50	0.020	IV
OAK RIDGE(Blind Thrust Off	20	6.90	0.061	VI	6.10	0.035	V
ELSMORN	60	6.50	0.024	V	6.00	0.016	IV

END OF SEARCH- 41 FAULTS FOUND WITHIN THE SPECIFIED SEARCH RADIUS

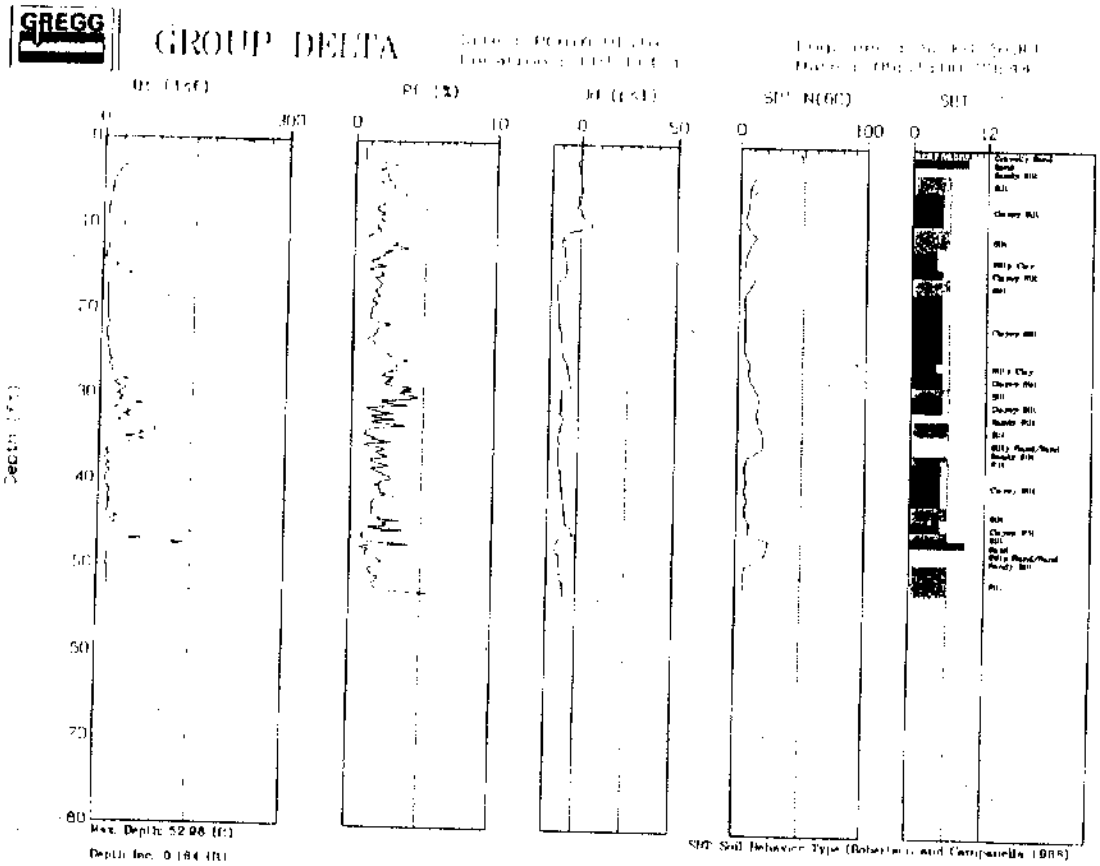
THE PALOS VERDES and the NEWPORT-INGLEWOOD FAULTS ARE CLOSEST TO THE SITE
BOTH FAULTS ARE LOCATED ABOUT 5.0 MILES AWAY

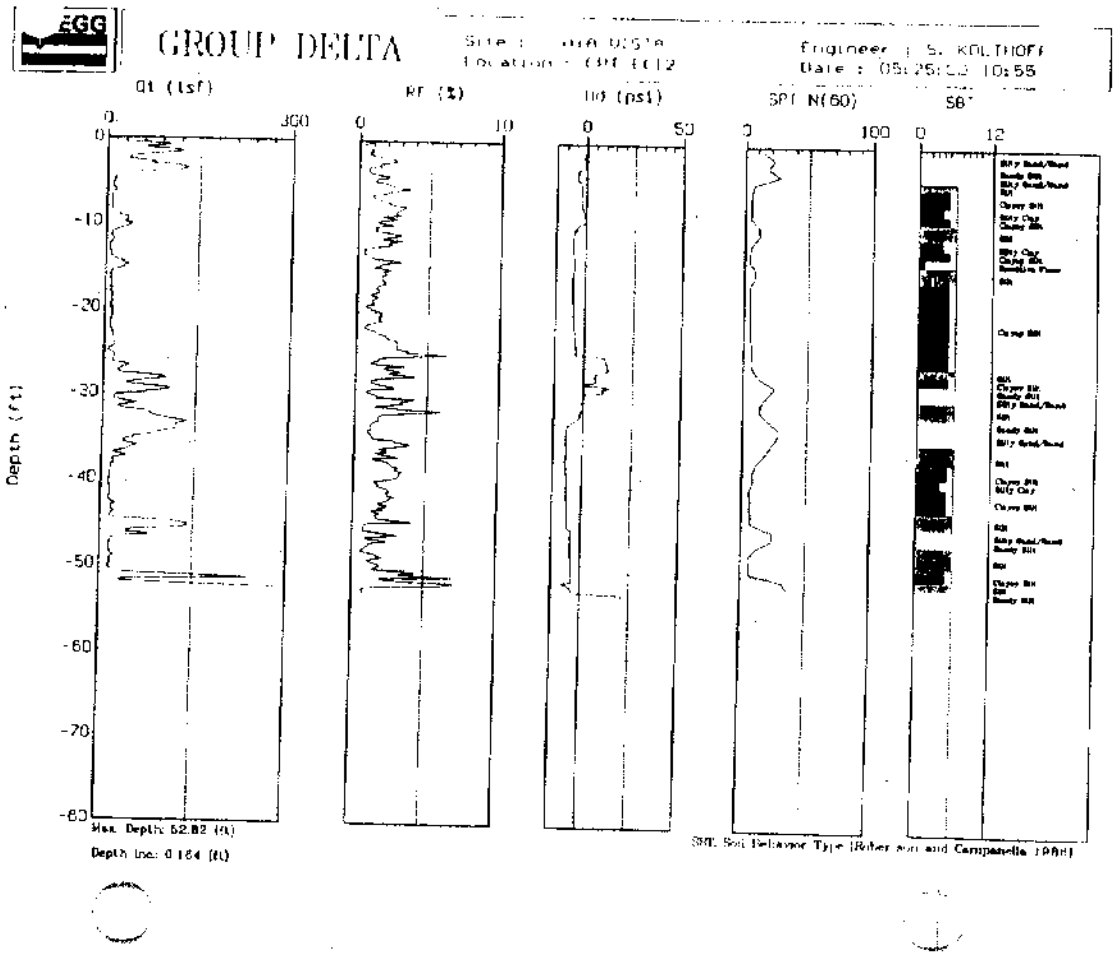
LARGEST MAXIMUM-CREDIBLE SITE ACCELERATION: 0.67 g

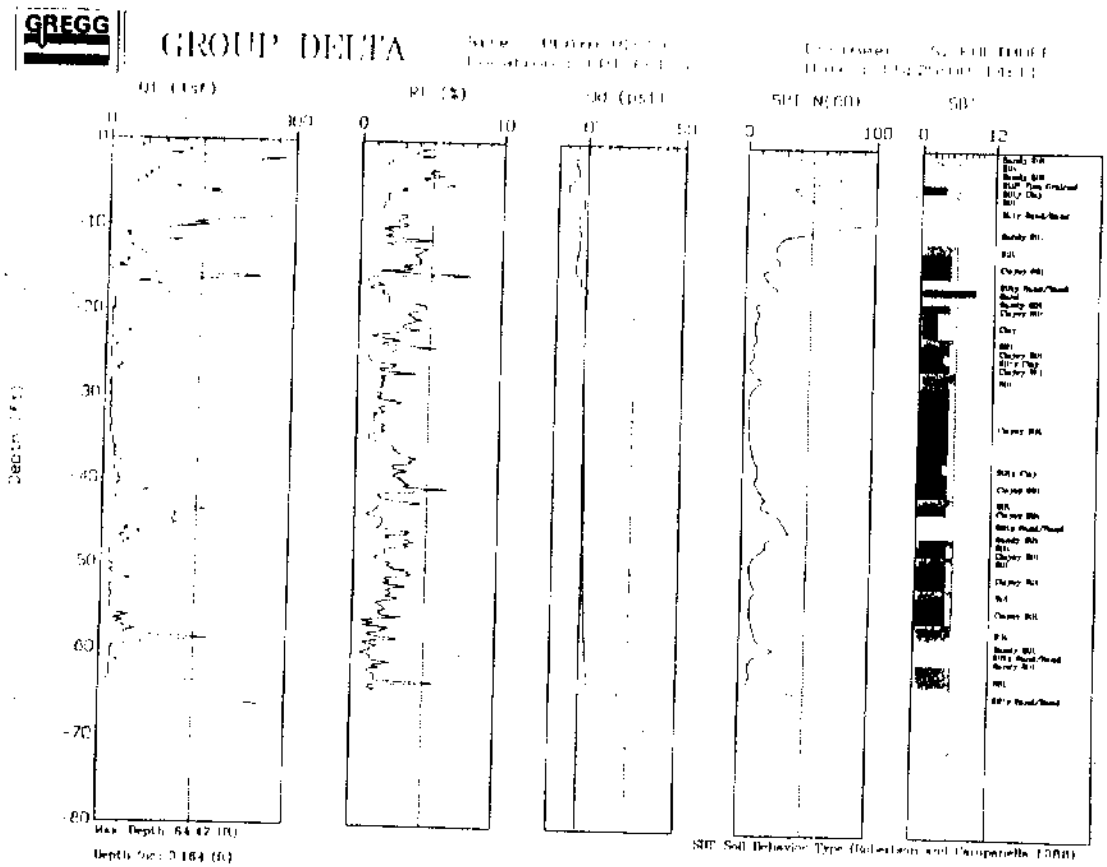
LARGEST MAXIMUM-PROBABLE SITE ACCELERATION: 0.30 g

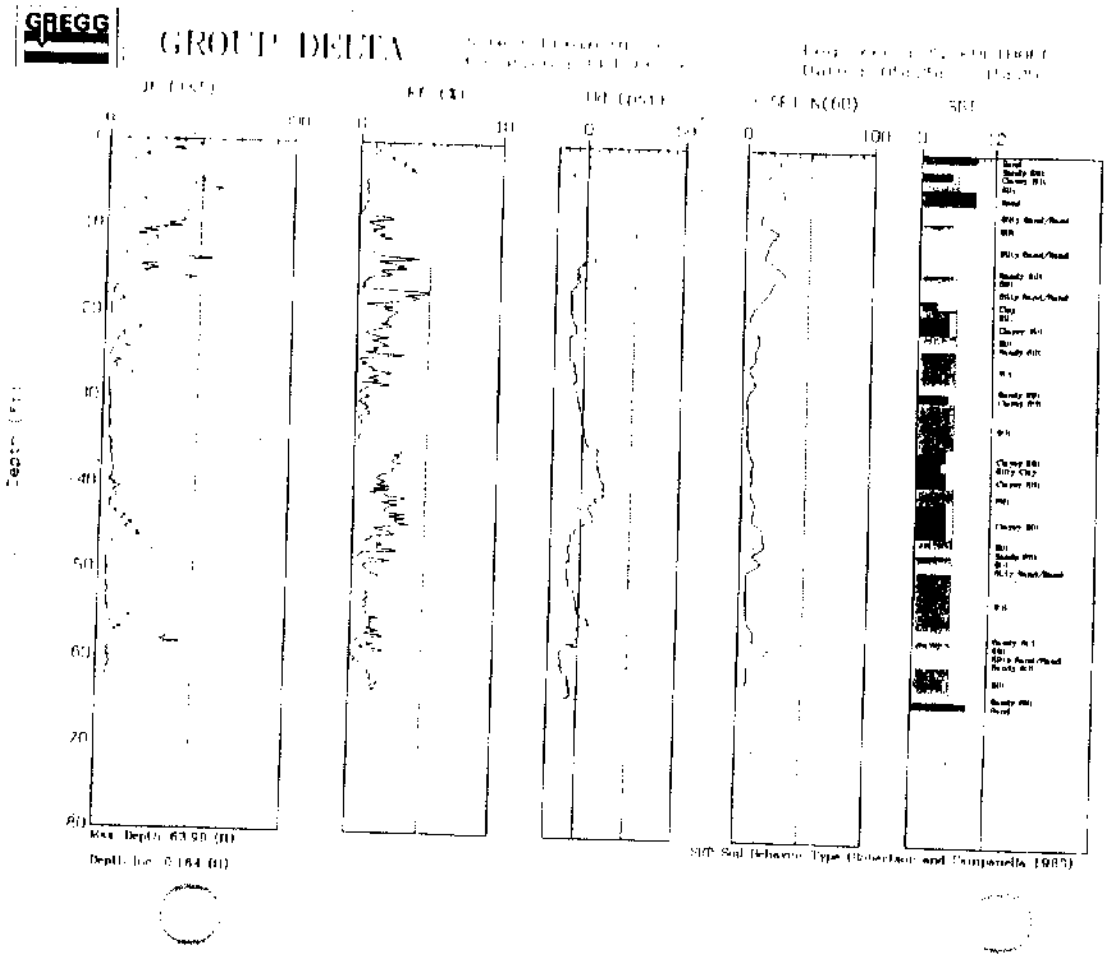
Appendix D
CPT Logs

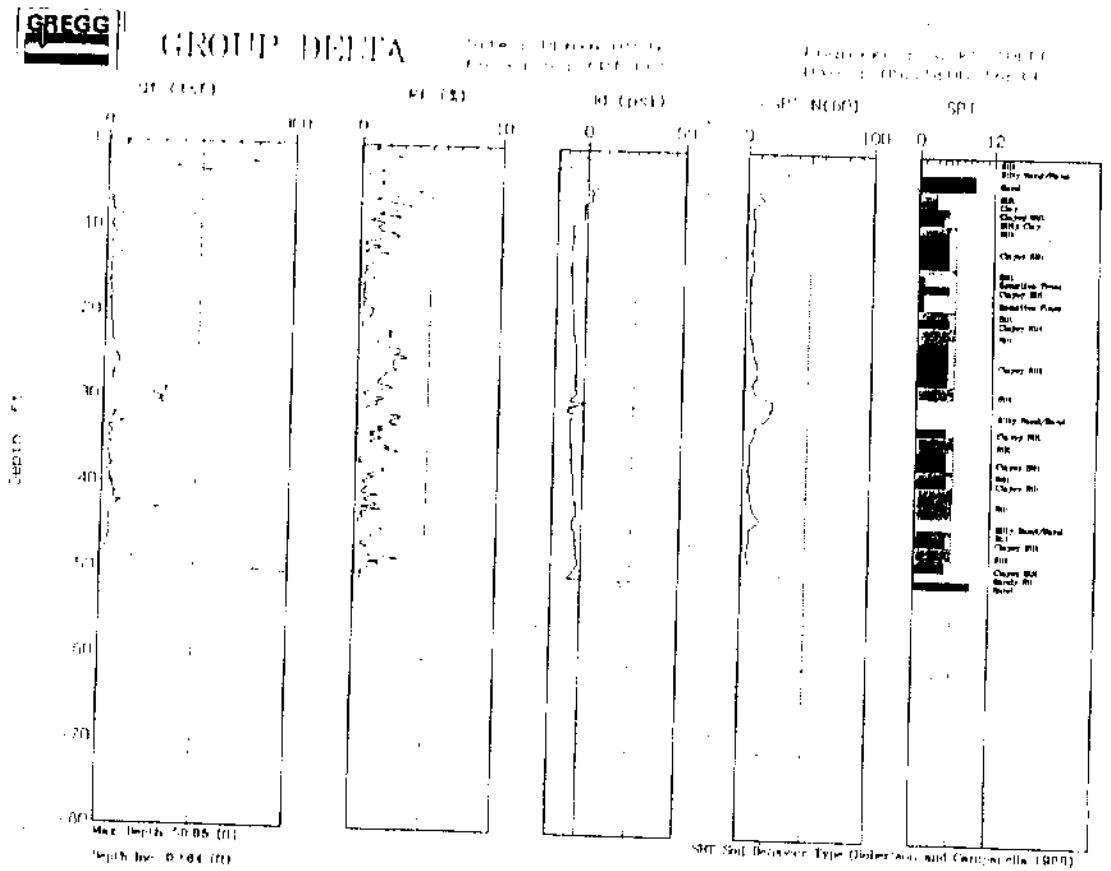


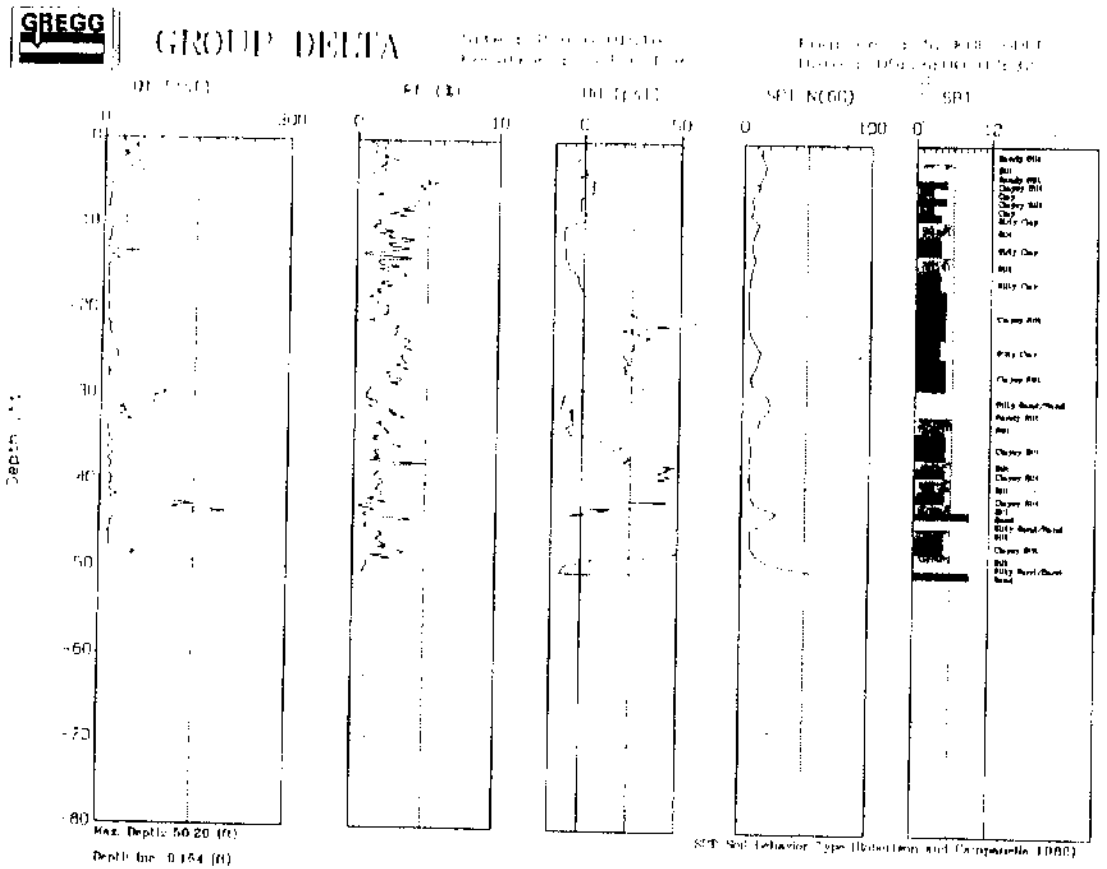

GREGG
GROUP DELTA
Qc (MPa)
Fs (MPa)
Rf (%)
SPT N(60)
SBT
0
300
10
20
30
40
50
60
70
80
Depth (m)
Max. Depth 52.98 (ft)
Depth Inc. 0.164 (ft)
SBT Soil Behavior Type (Robertson and Campanella 1988)

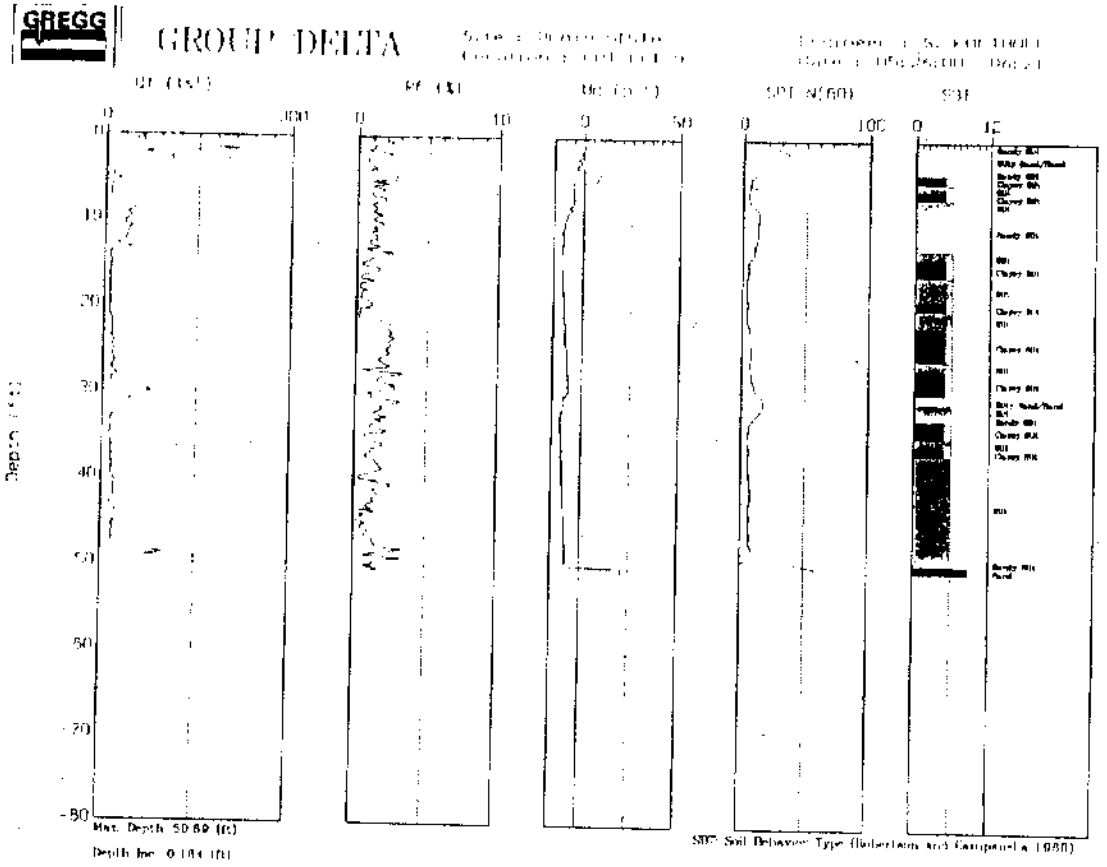

EGG
GROUP DELTA
Site : HIA DOSTA
Location : CPT EC12
Engineer : S. KOLTHOFF
Date : 05:25:00 10:55
Qt (tsf)
RF (%)
u0 (psi)
SPT N(60)
SBT
0
300
10
50
100
12
-10
-20
-30
-40
-50
-60
-70
-80
Depth (ft)
Max. Depth: 52.82 (ft)
Depth Inc: 0.164 (ft)
SBT: Soil Behavior Type (Robertson and Campanella, 1988)

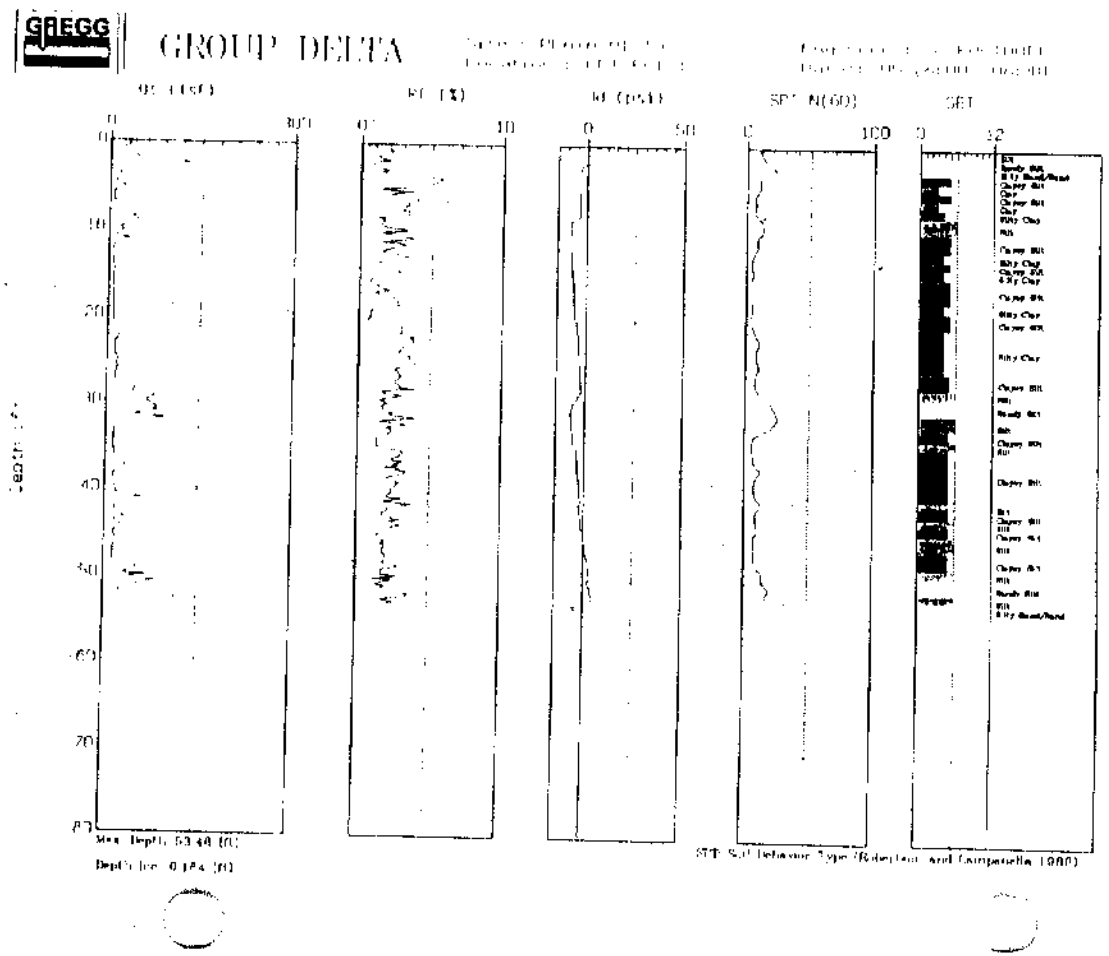

GREGG
GROUP DELTA
Qc (tsf)
Rf (%)
Su (psf)
SPT N(60)
SBT Soil Behavior Type (Robertson and Campanella 1988)

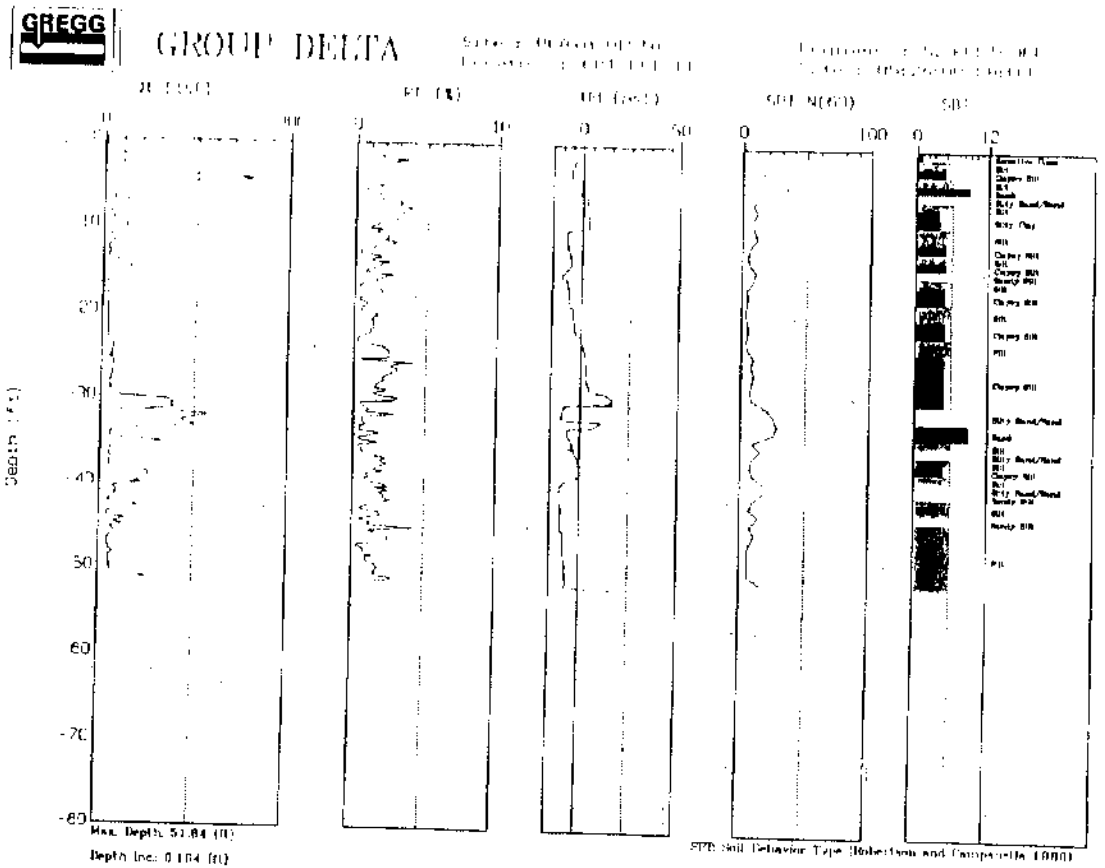

GREGG
GROUT DELTA
Depth (ft)
0
10
20
30
40
50
60
70
80
100
SPT Soil Behavior Type (Robertson and Campanella, 1983)


GREGG
GROUP DELTA
SPT (BLOW)
SPT
Depth (ft)
10
20
30
40
50
60
70
80
0
100
12
Max Depth 79.85 (ft)
Depth Inc 0.164 (ft)
SPT Soil Recovery Type Distribution and Composite (SPT)


GREGG
GROUP DELTA
SPT N(60)
SBT
Max. Depth: 50.20 (ft)
Depth Inc: 0.164 (ft)

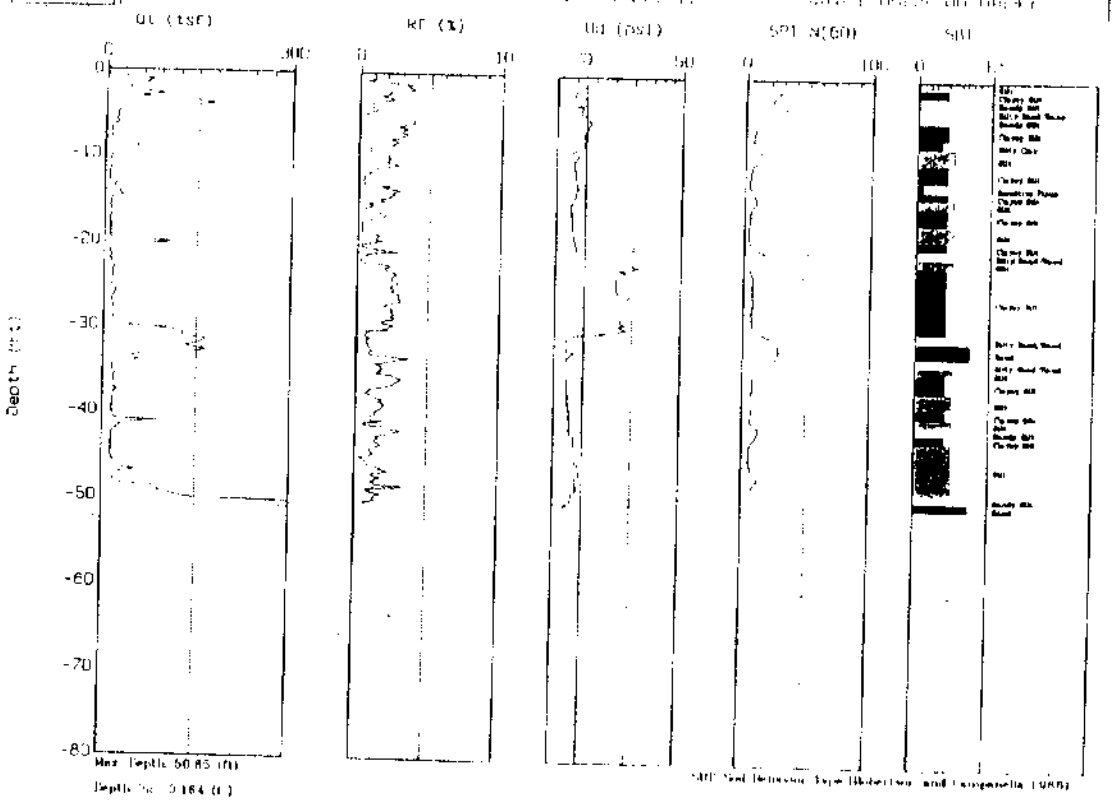

GREGG
GROUP DELTA
0
100
0
10
0
50
0
100
0
15
10
20
30
40
50
70
80
Max. Depth 50.69 (ft)
SBT Soil Behavior Type (Robertson and Campanella 1988)

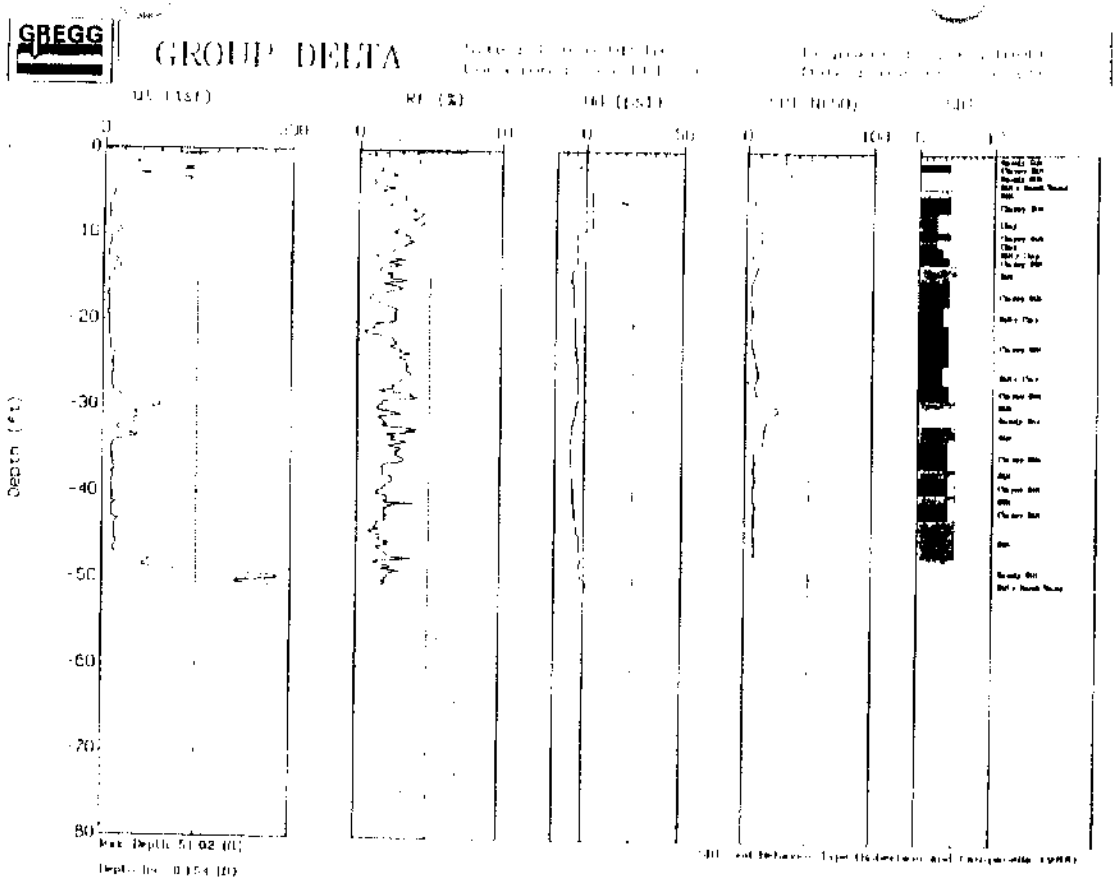

GREGG
GROUP DELTA
Qc (psi)
FR (%)
U (psi)
SPT N(60)
SBT
0
800
10
50
100
12
Max Depth 53.48 (ft)
SBT Soil Behavior Type (Robertson and Campanella 1988)

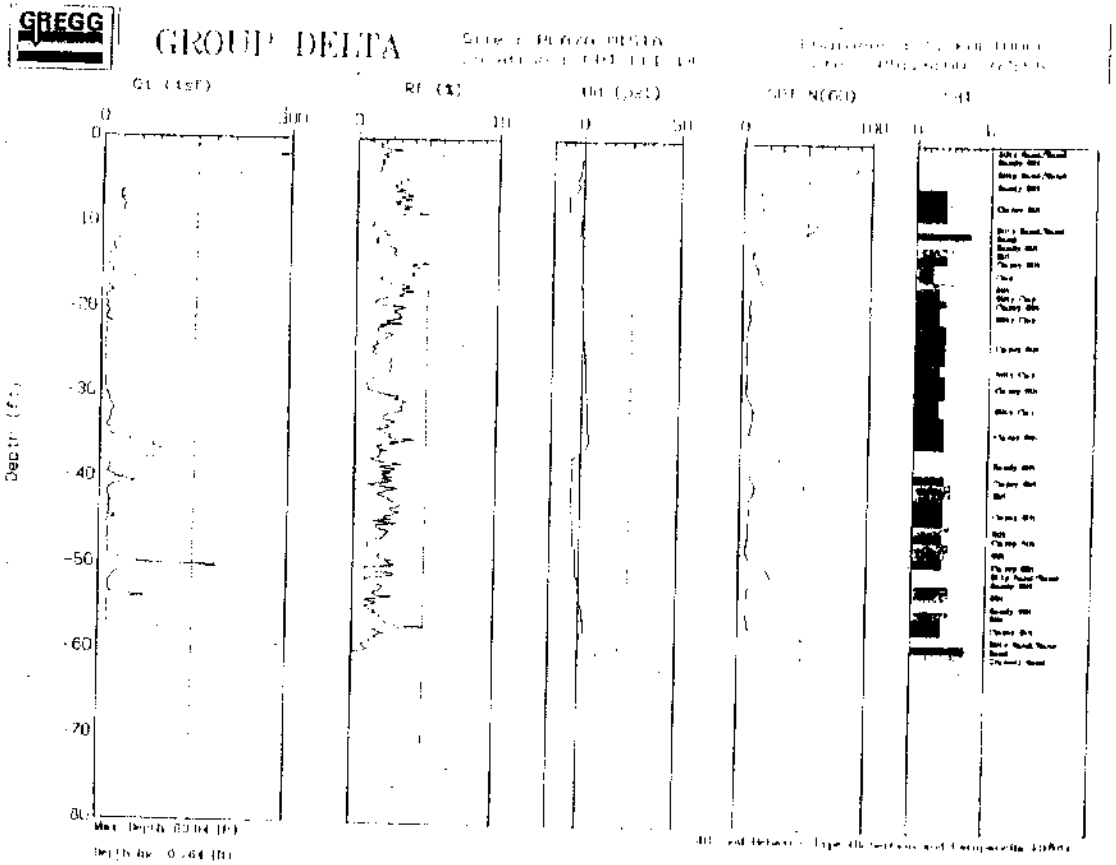

GREGG
GROUP DELTA
Depth (ft)
0
10
20
30
40
50
60
70
80
0
100
0
12
Max. Depth: 51.84 (ft)
Depth Inc: 0.164 (ft)

GREGG

GROUP DELTA

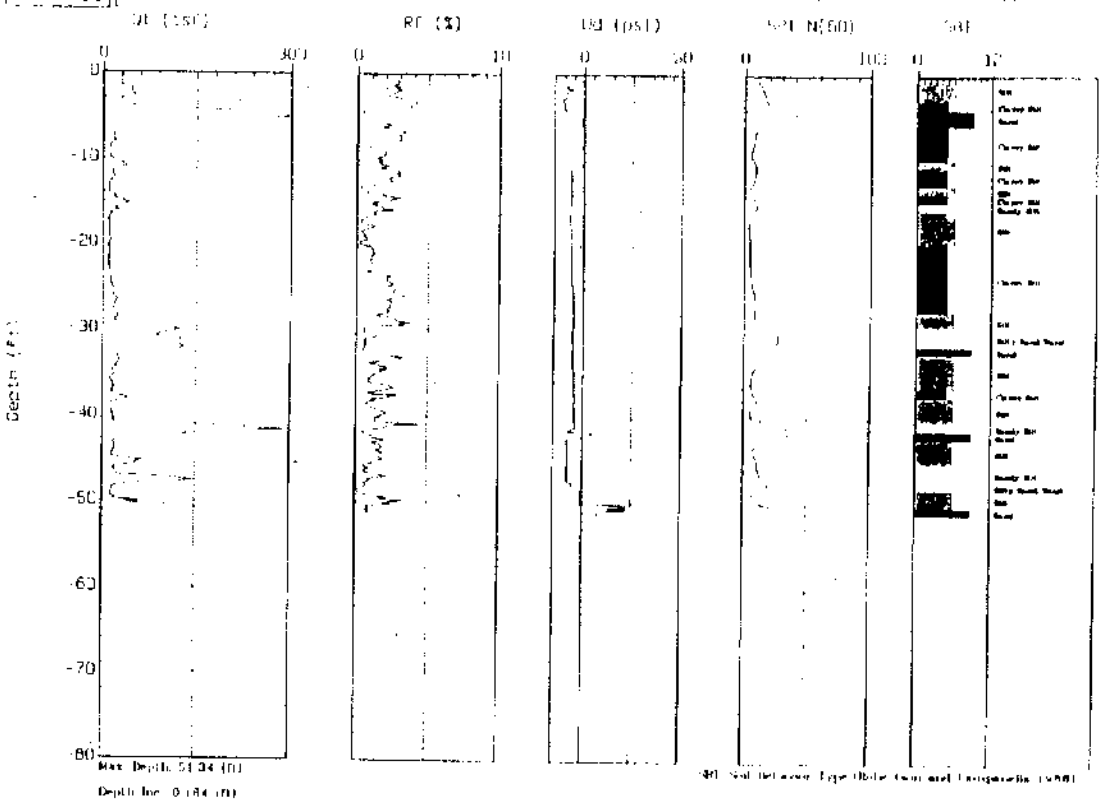



GREGG
GROUP DELTA
Depth (m)
0
10
20
30
40
50
60
70
80


GREGG
GROUP DELTA
Qc (tsf)
Rf (%)
Qbt (psi)
SPT N(60)
0
300
10
20
30
40
50
60
70
80
Depth (ft)

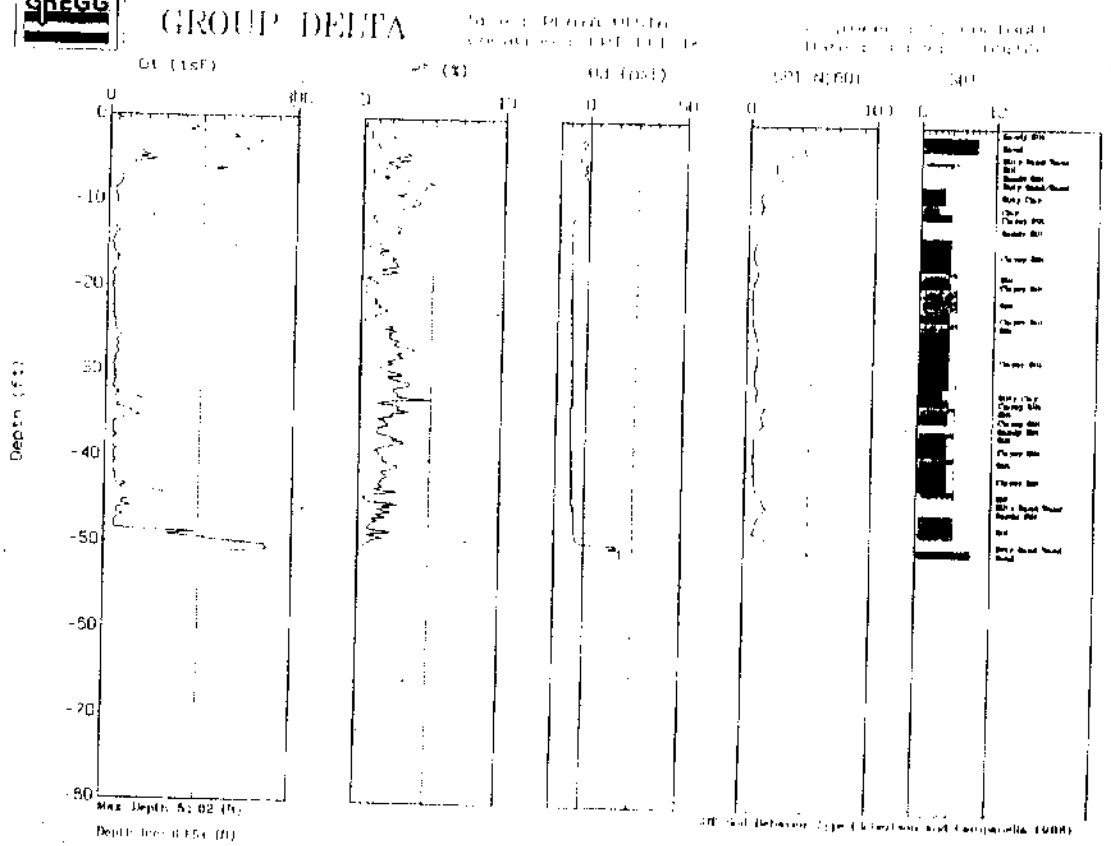
GREGG

GROUP DELTA



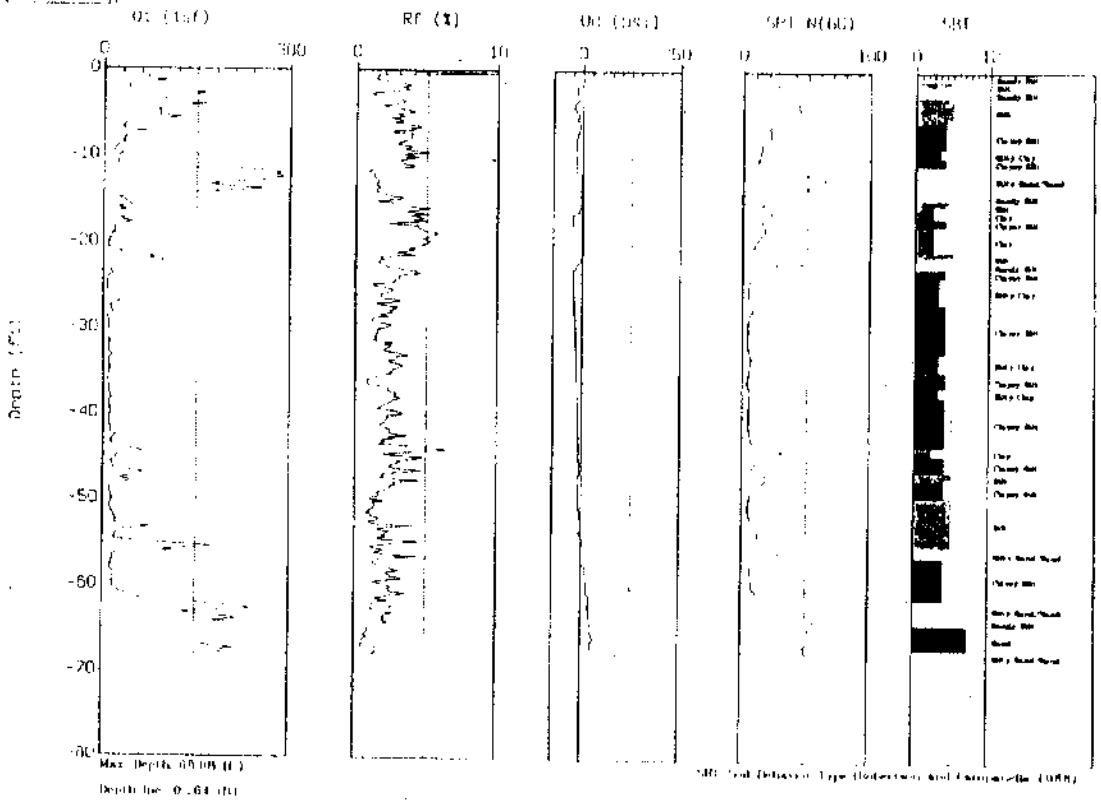
GREGG

GROUP DELTA



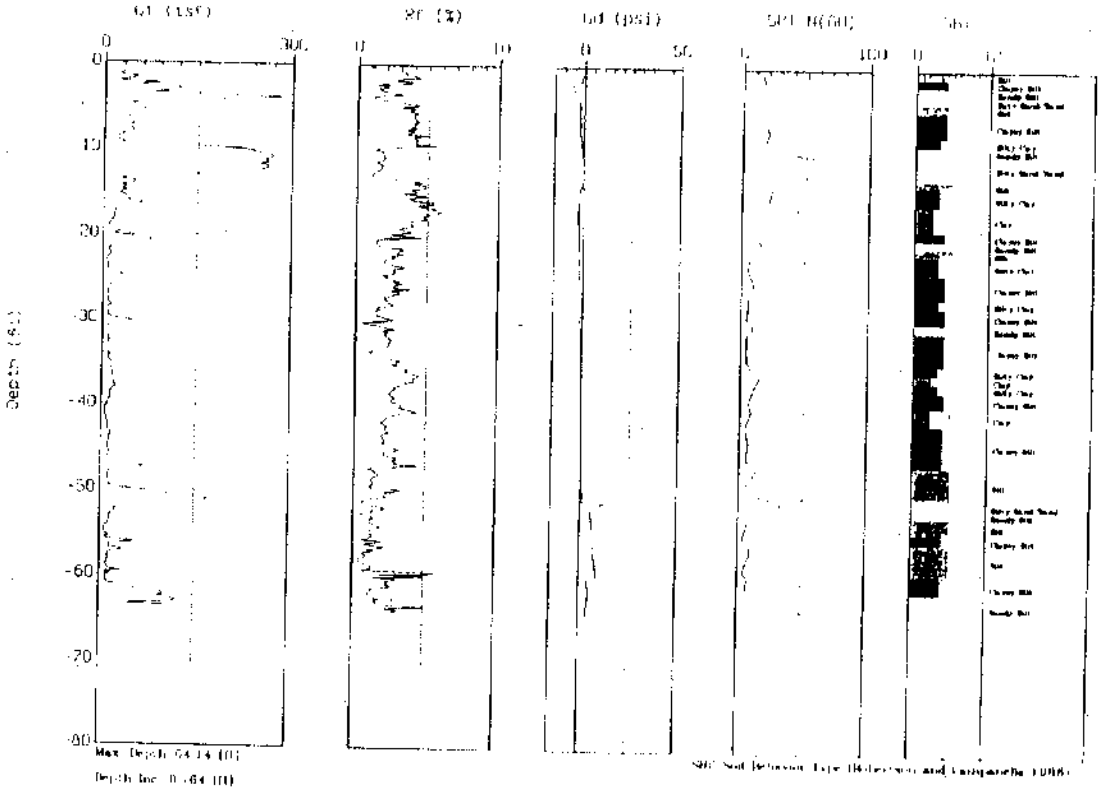
GREGG

GROUP DELTA



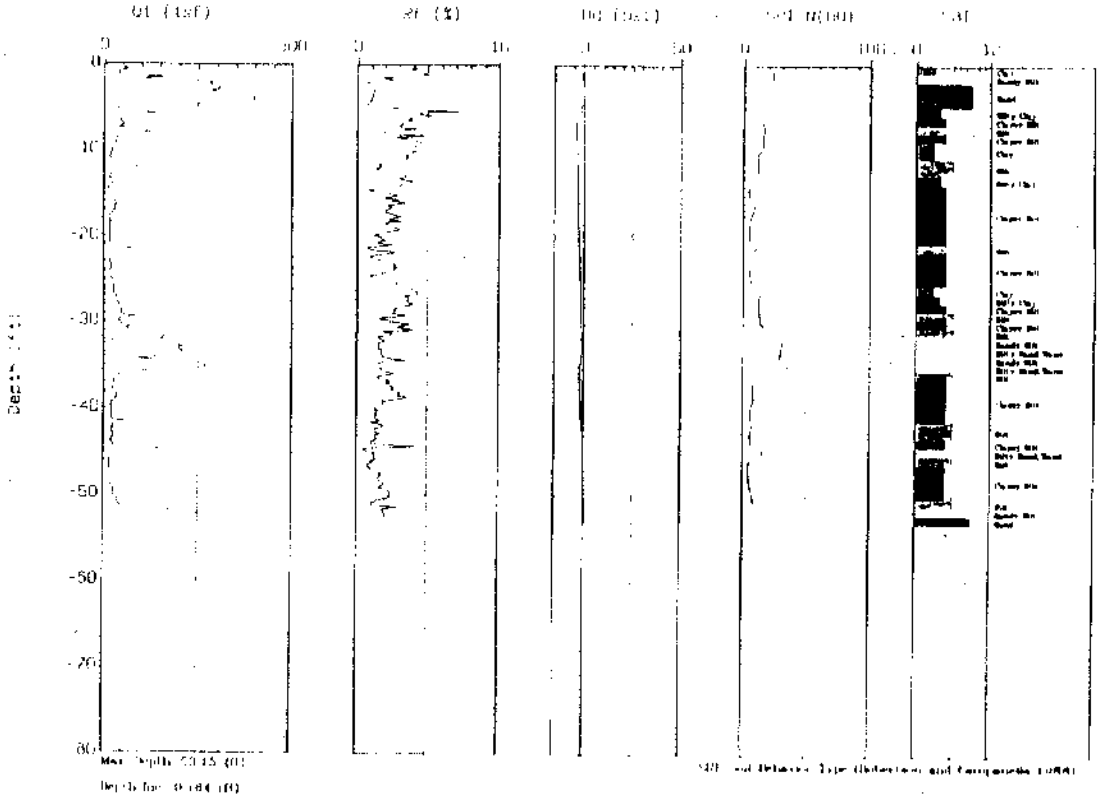
GREGG

GROUP DELTA



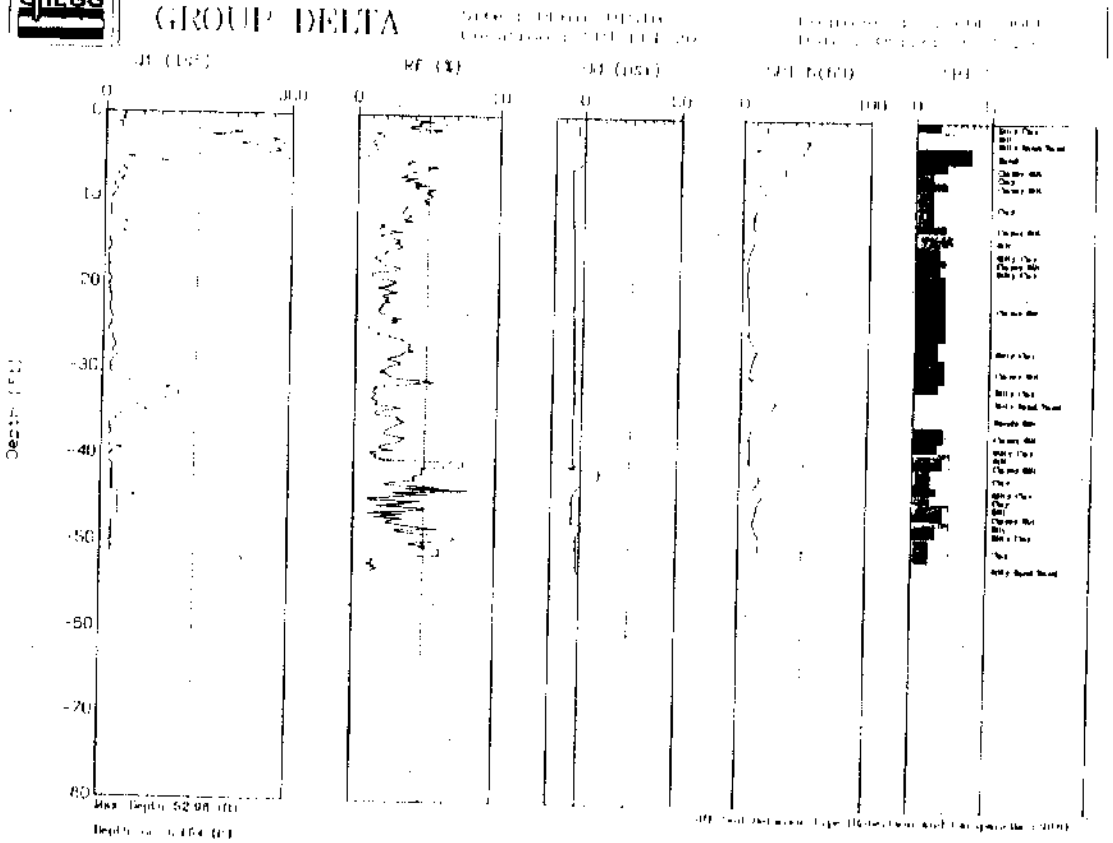
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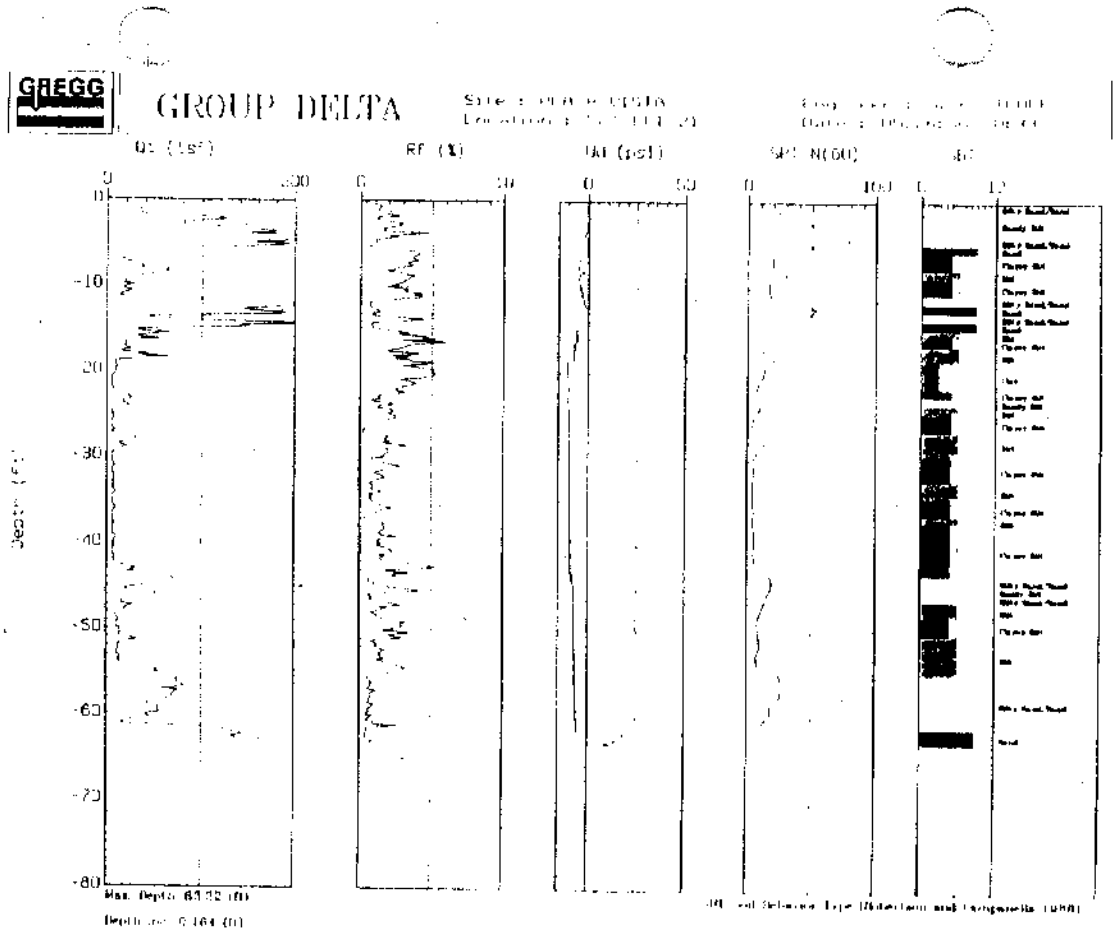
GROUP DELTA



GREGG

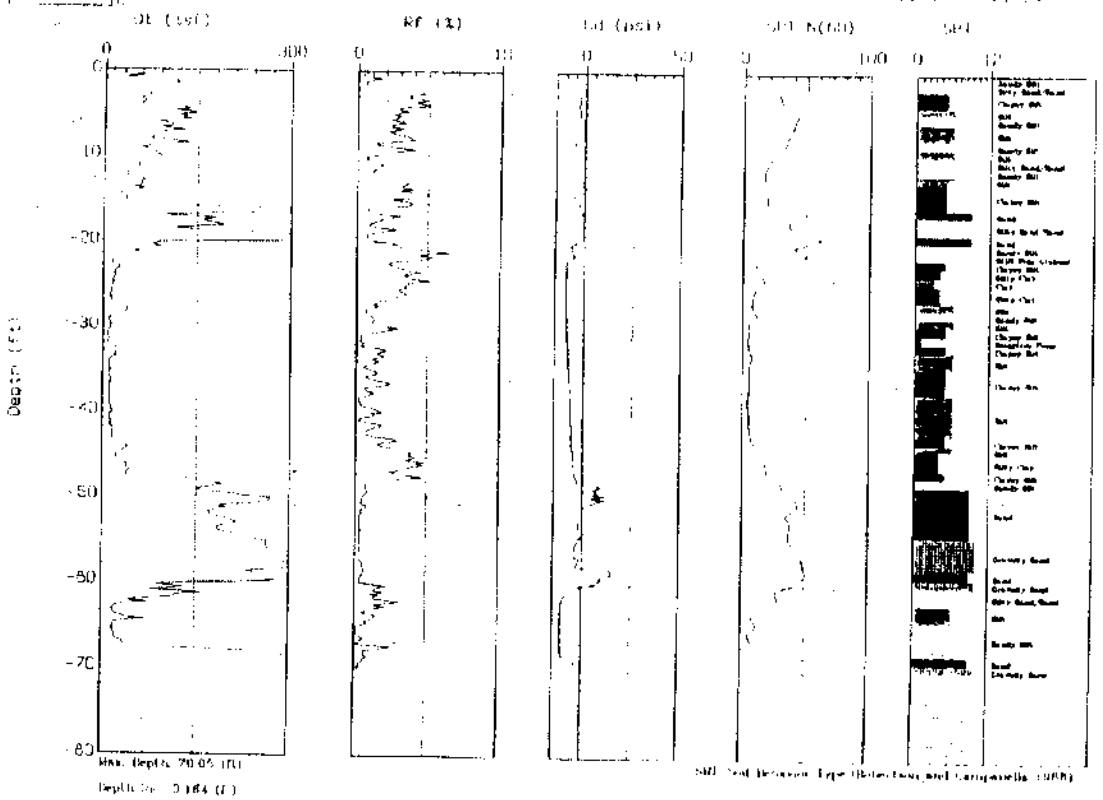
GROUP DELTA




GREGG
GROUP DELTA
Qc (tsf)
Rf (%)
0
300
0
10
0
50
0
100
0
10
-10
-20
-30
-40
-50
-60
-70
-80

GREGG

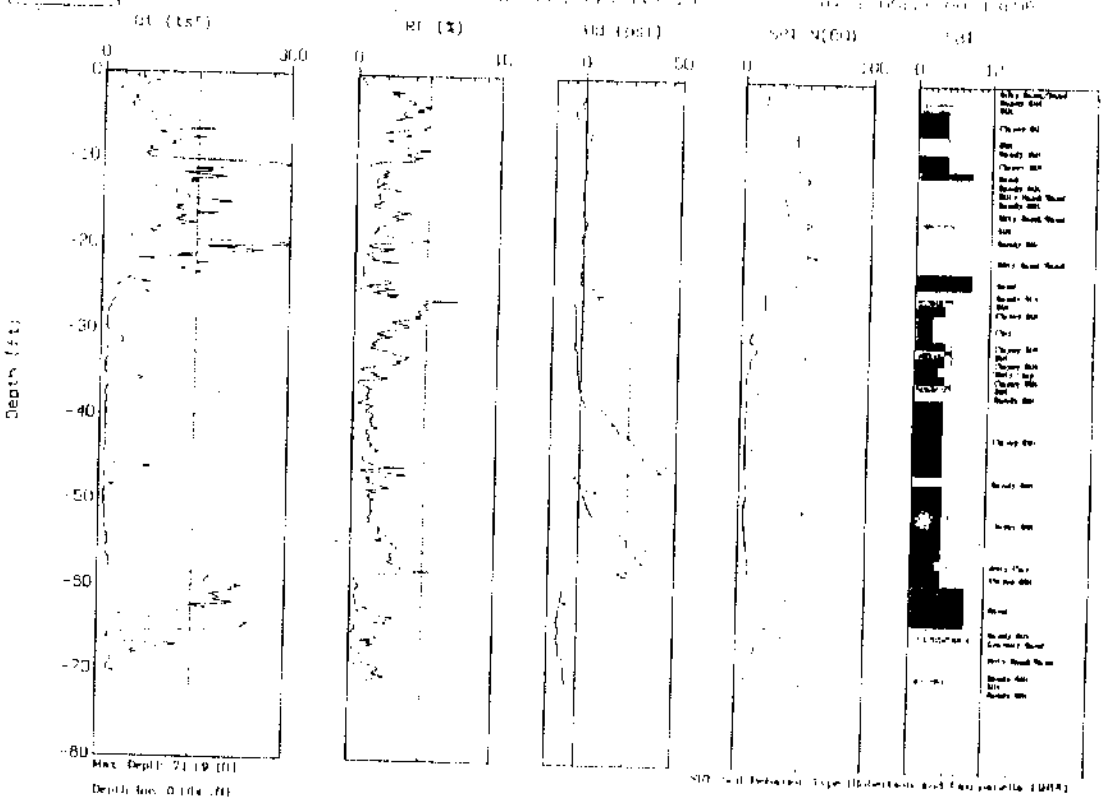
GROUP DELTA



GREGG
GROUP DELTA
Depth (ft)
-90
-70
-60
-50
-40
-30
-20
-10
0

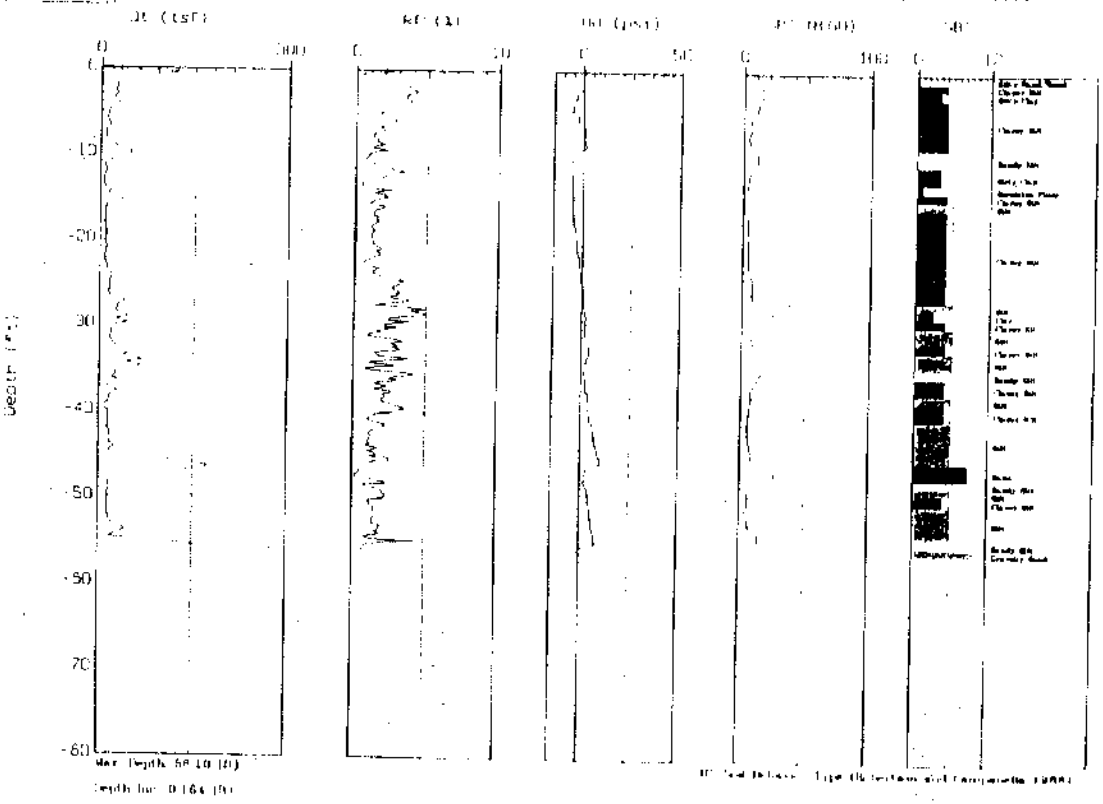
GREGG

GROUP DELTA



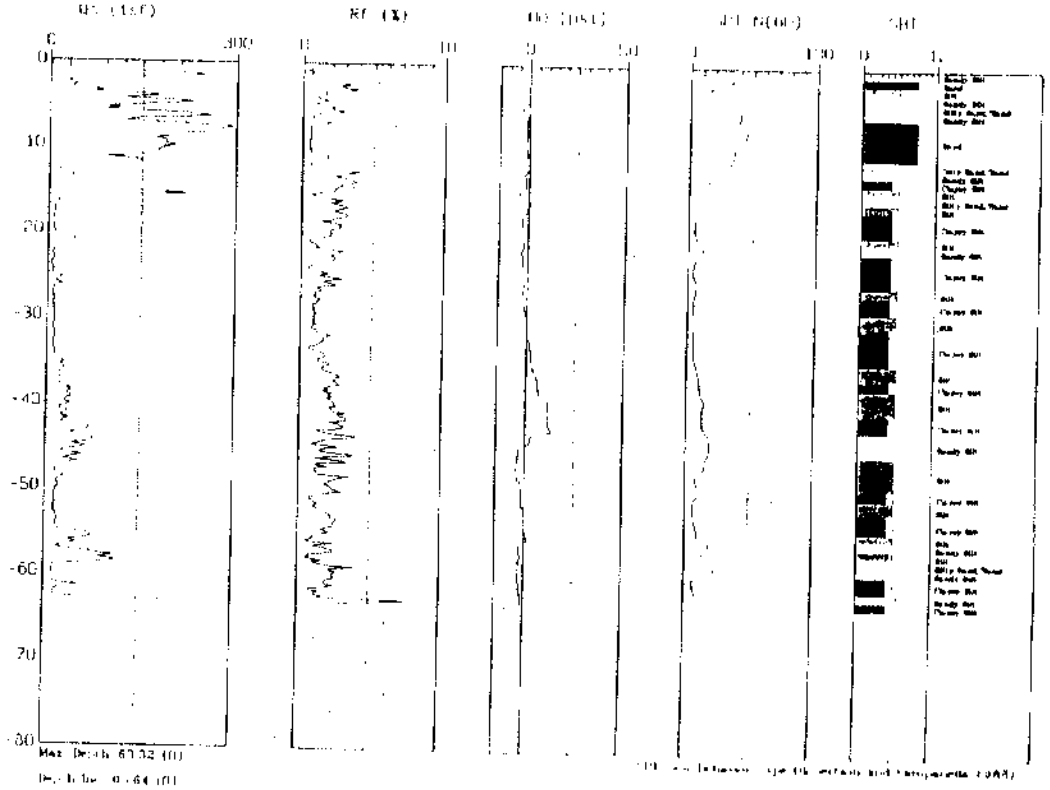
GREGG

GROUP DELTA



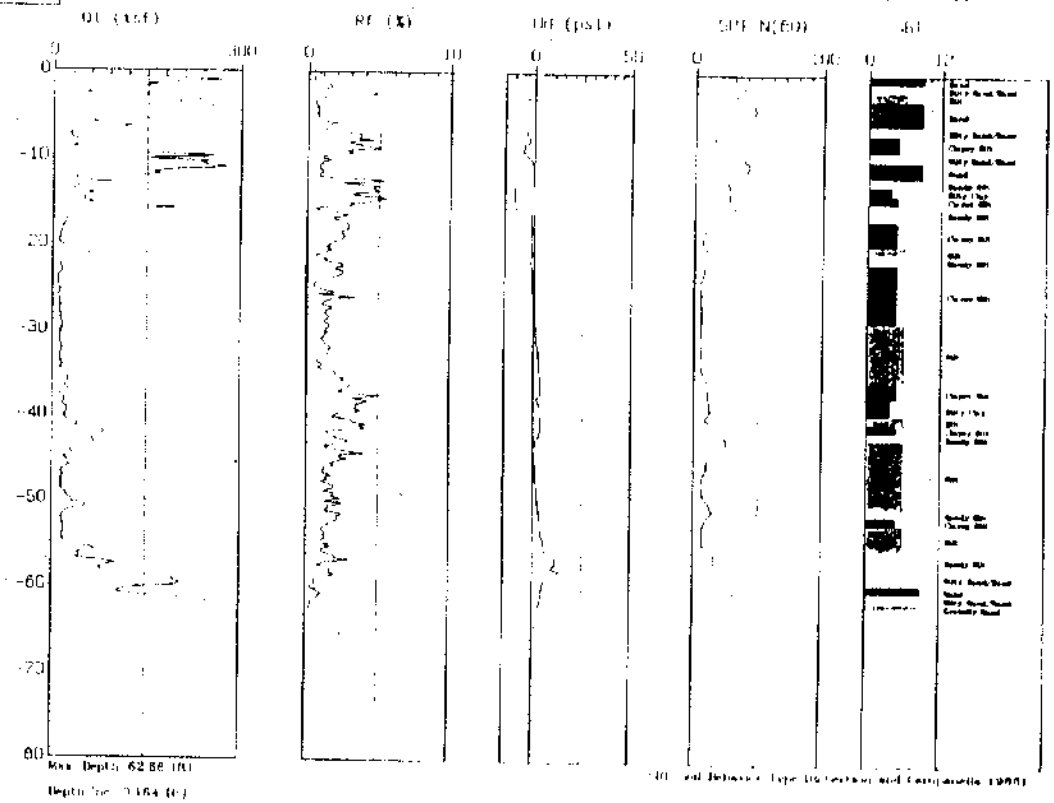
GREGG

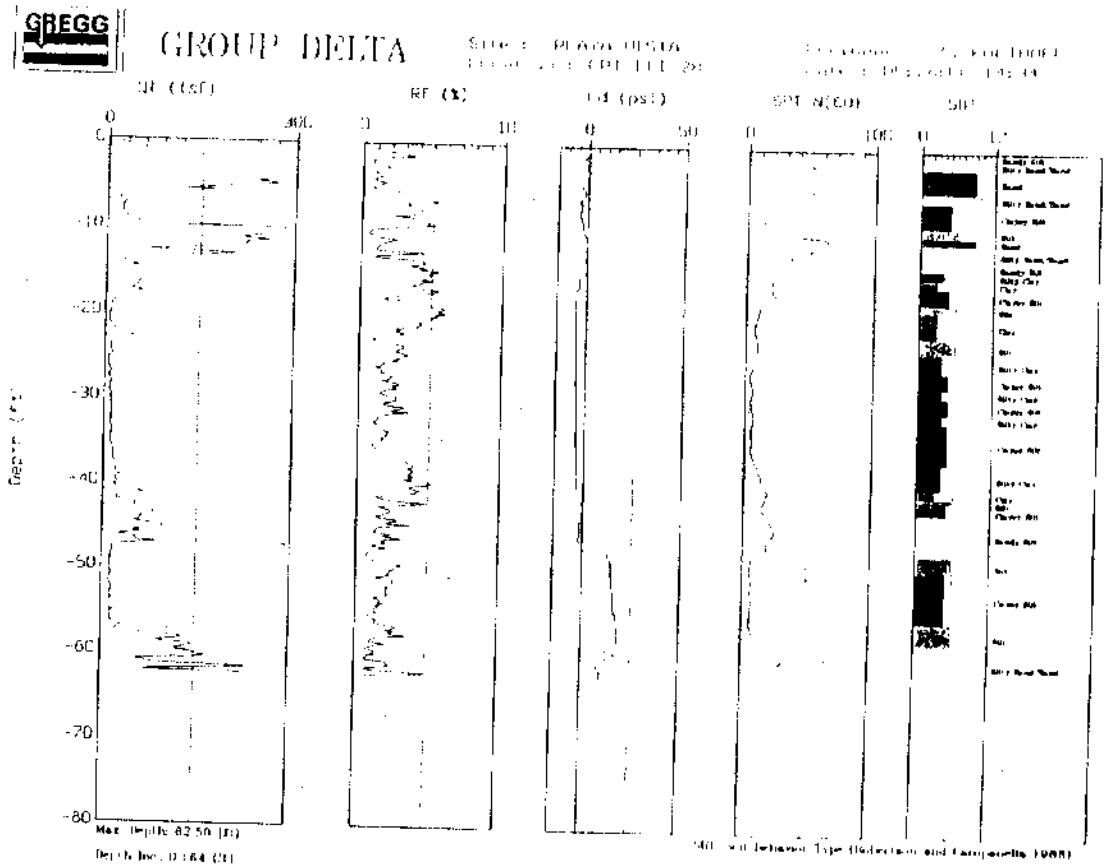
GROUP DELTA



GREGG

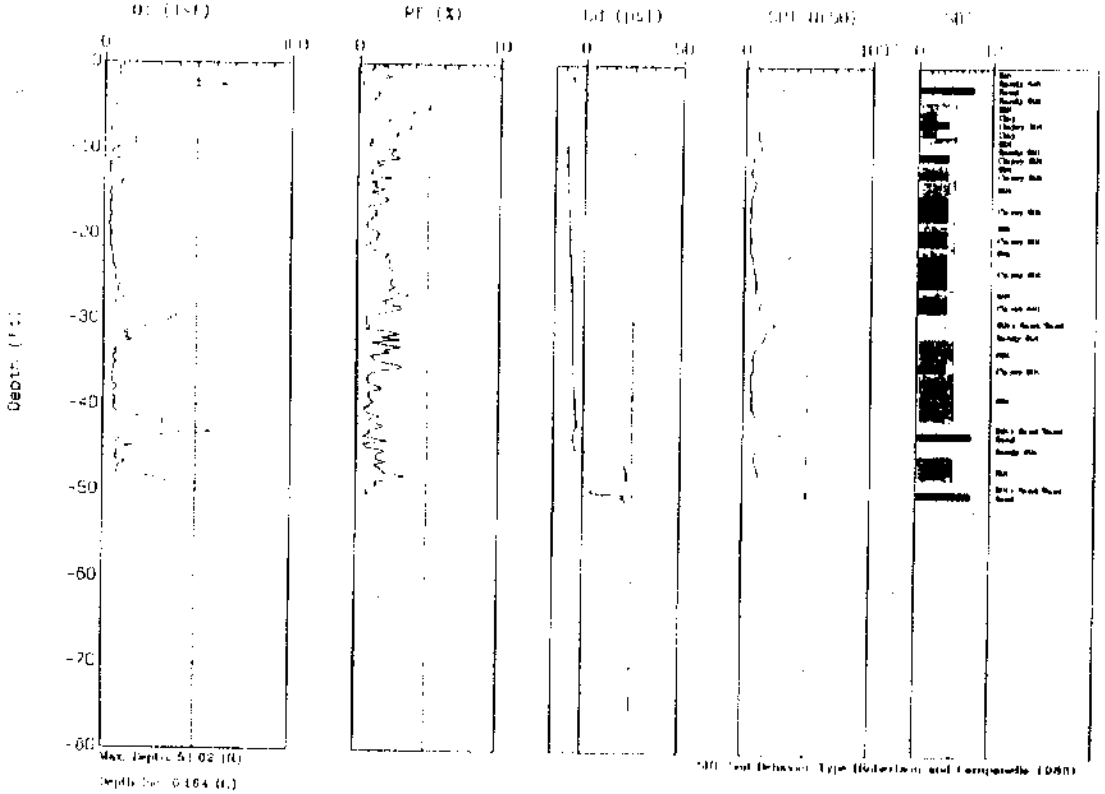
GROUP DELTA




GREGG
GROUP DELTA
QC (tsf)
FR (%)
u4 (psi)
SPT N(60)
Depth (ft)
0
400
10
50
100
-10
-20
-30
-40
-50
-60
-70
-80
Max Depth: 82.50 (ft)

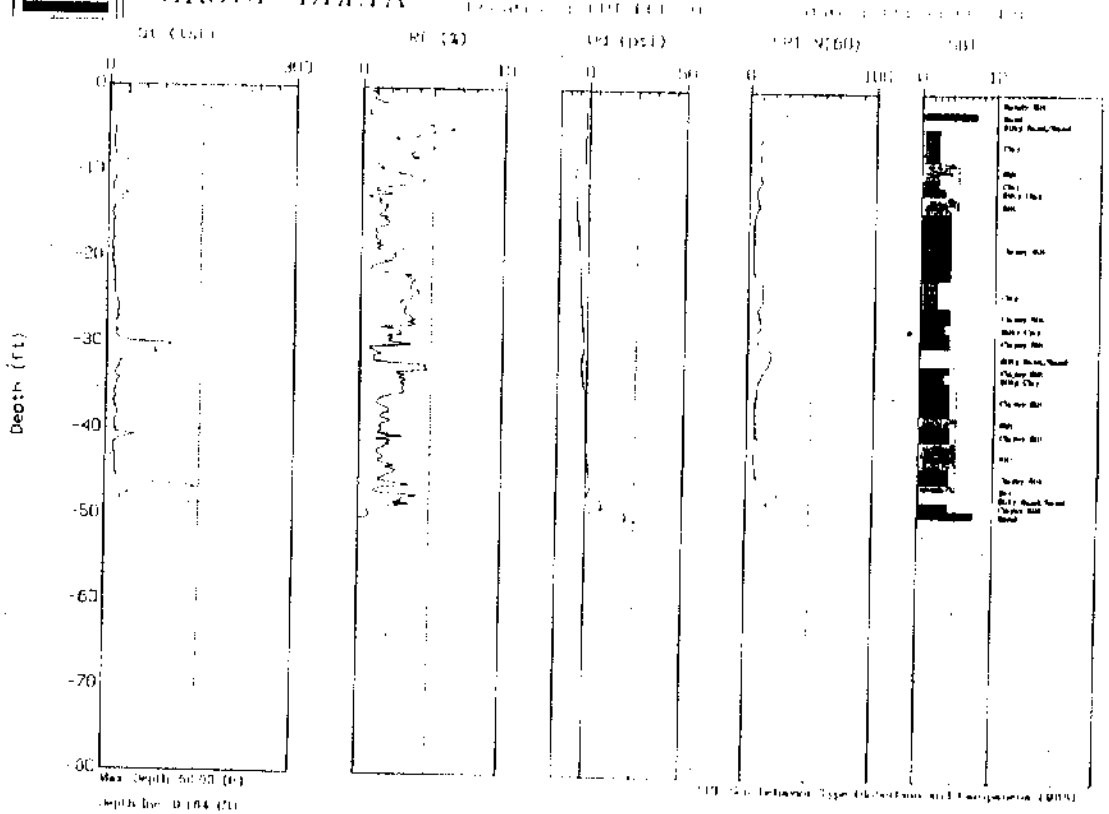
GREGG

GROUP DELTA



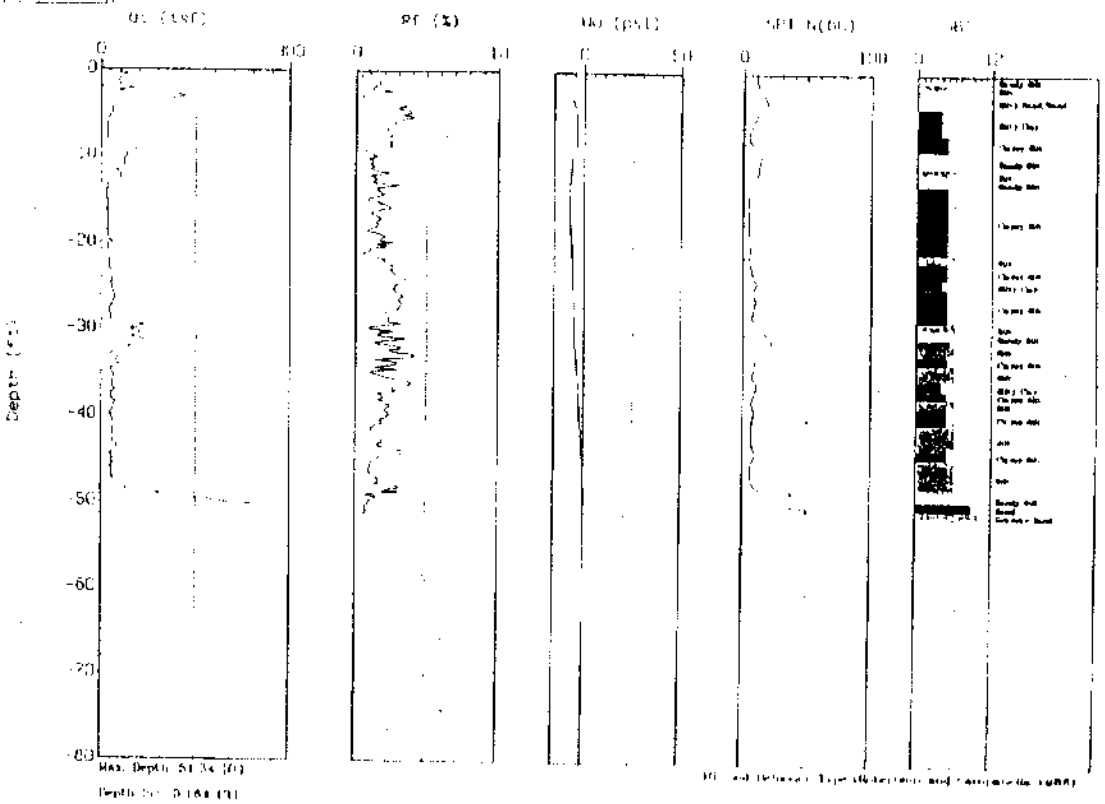
GREGG

GROUP DELTA



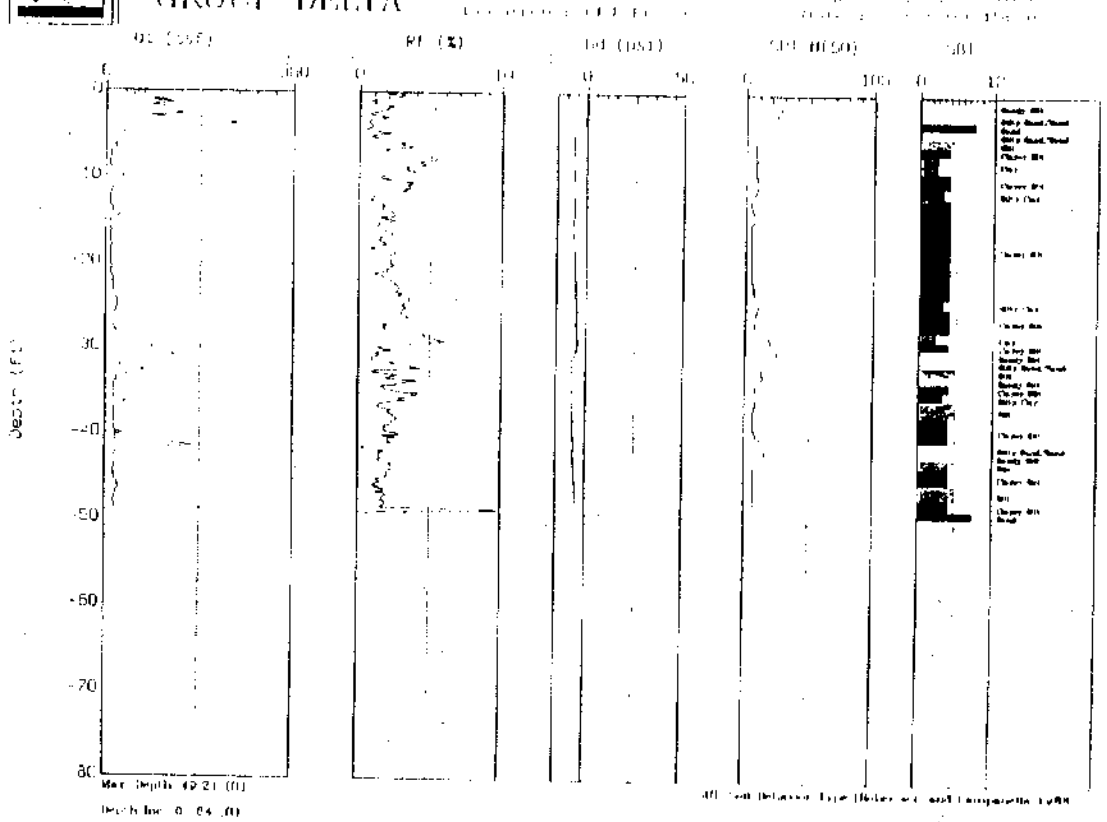
GREGG

GROUP DELTA



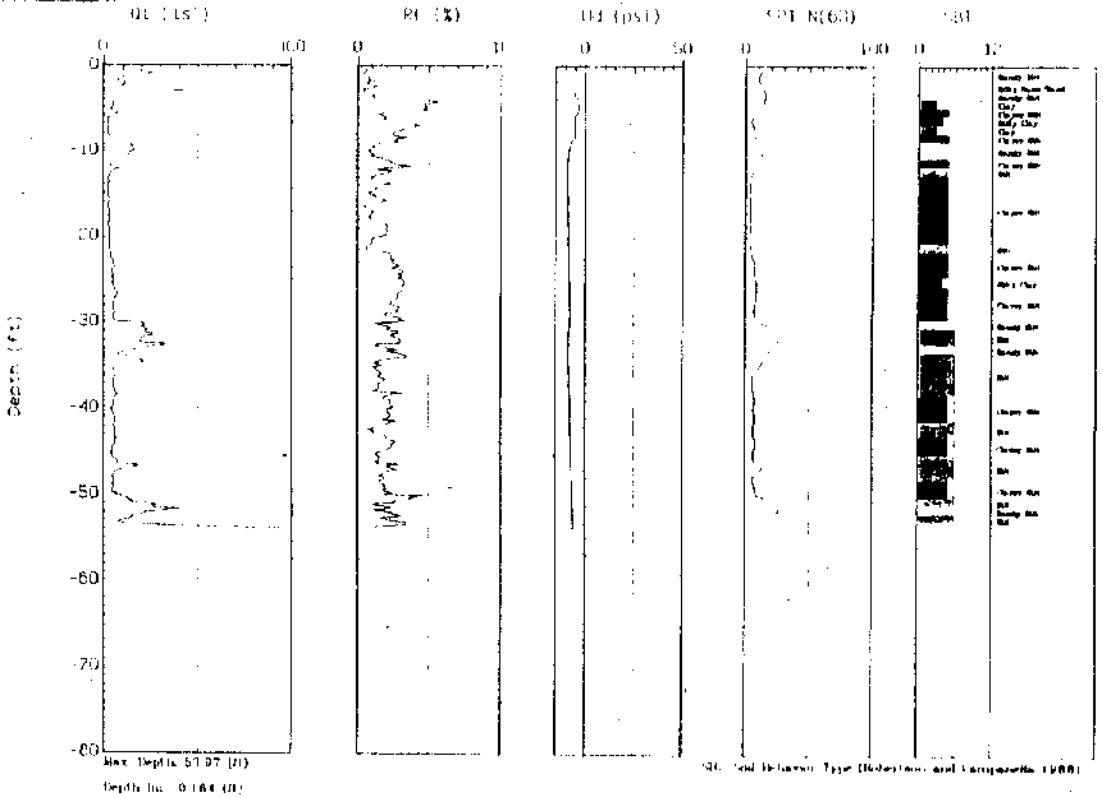
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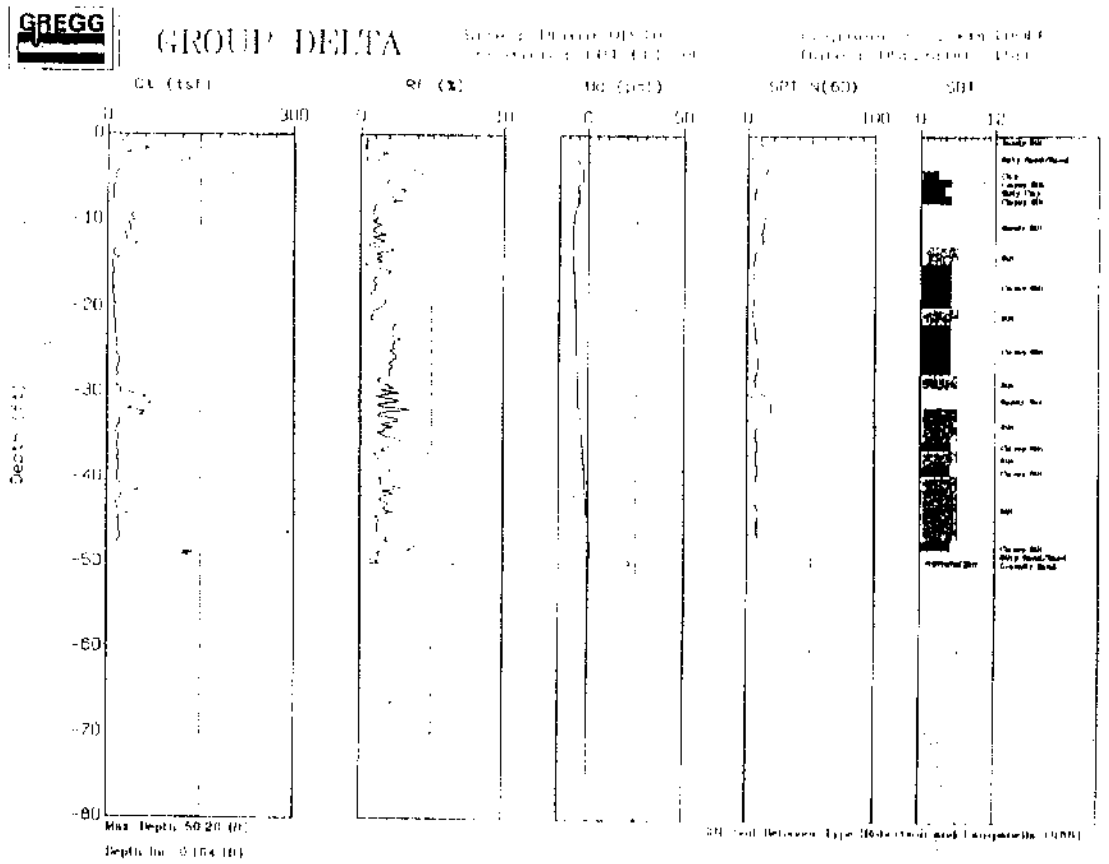
GROUP DELTA



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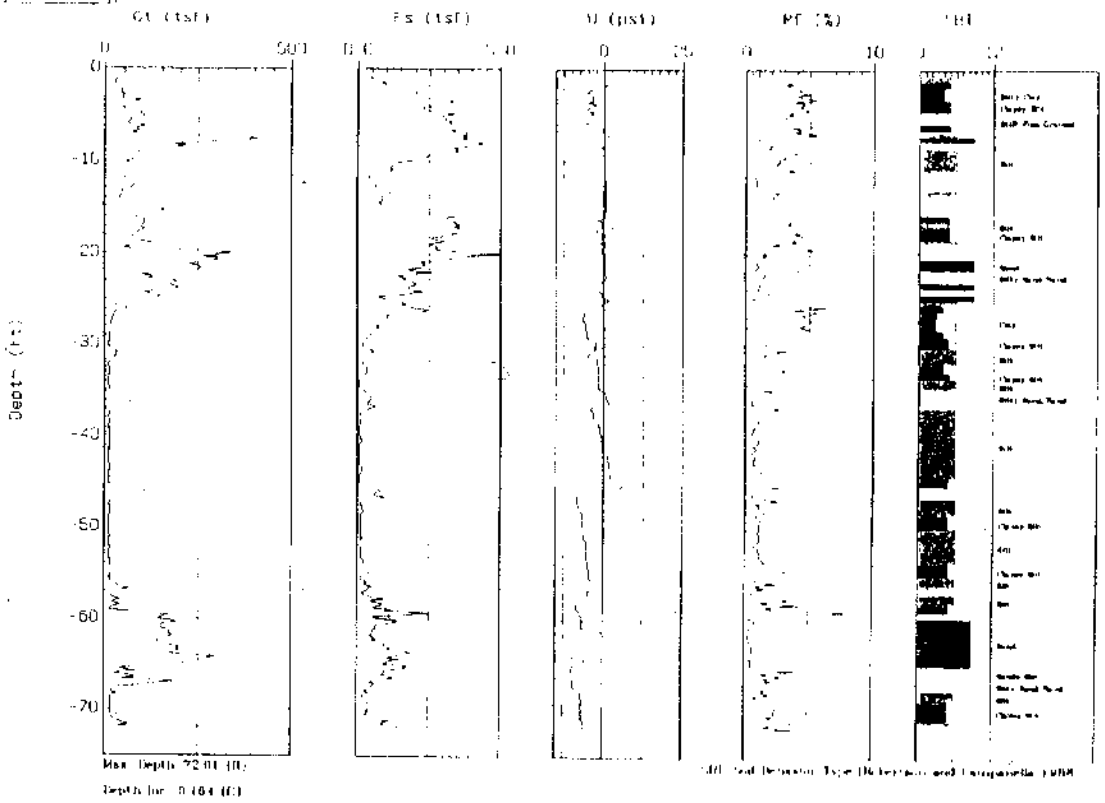
GROUP DELTA




GREGG
GROUP DELTA
qc (tsf)
fs (tsf)
Rf (%)
Ic (unit)
SPT N(60)
SBT
Depth (ft)
0
10
20
30
40
50
60
70
80
300
100
12

GREGG

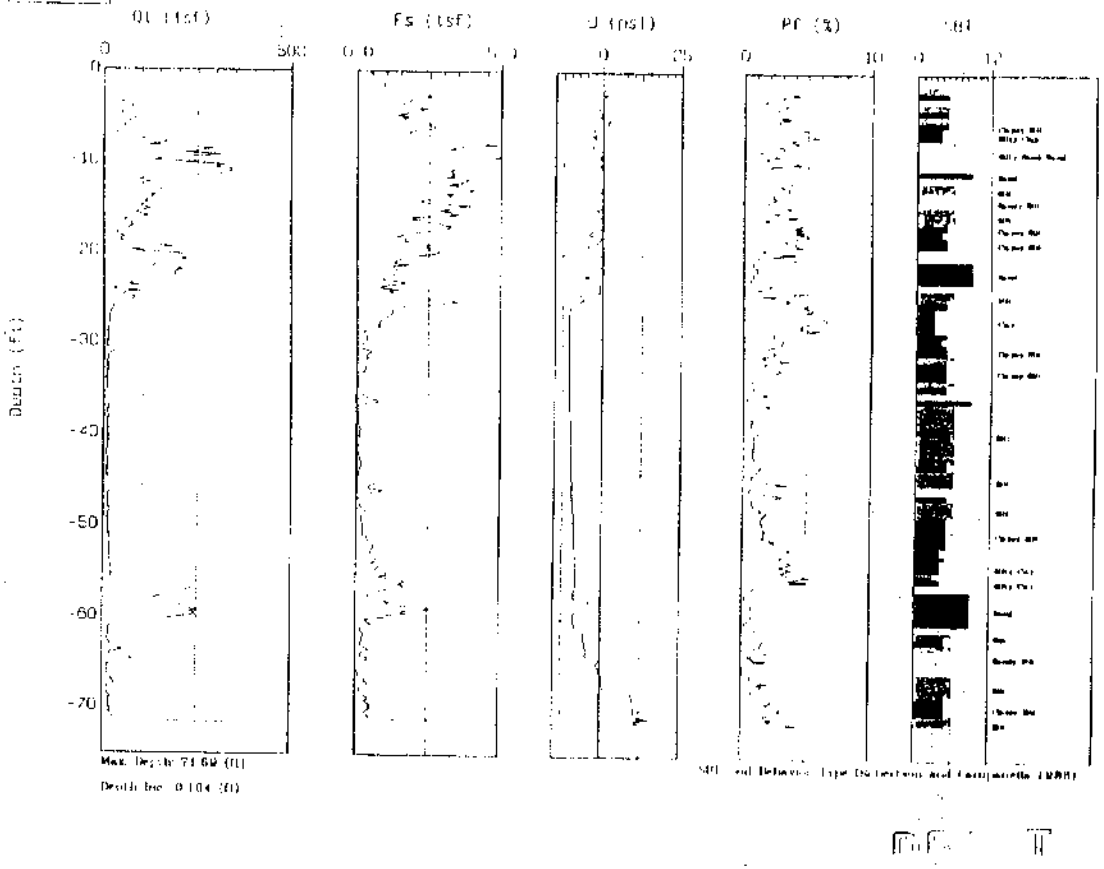
GROUP DELTA



DRAFT

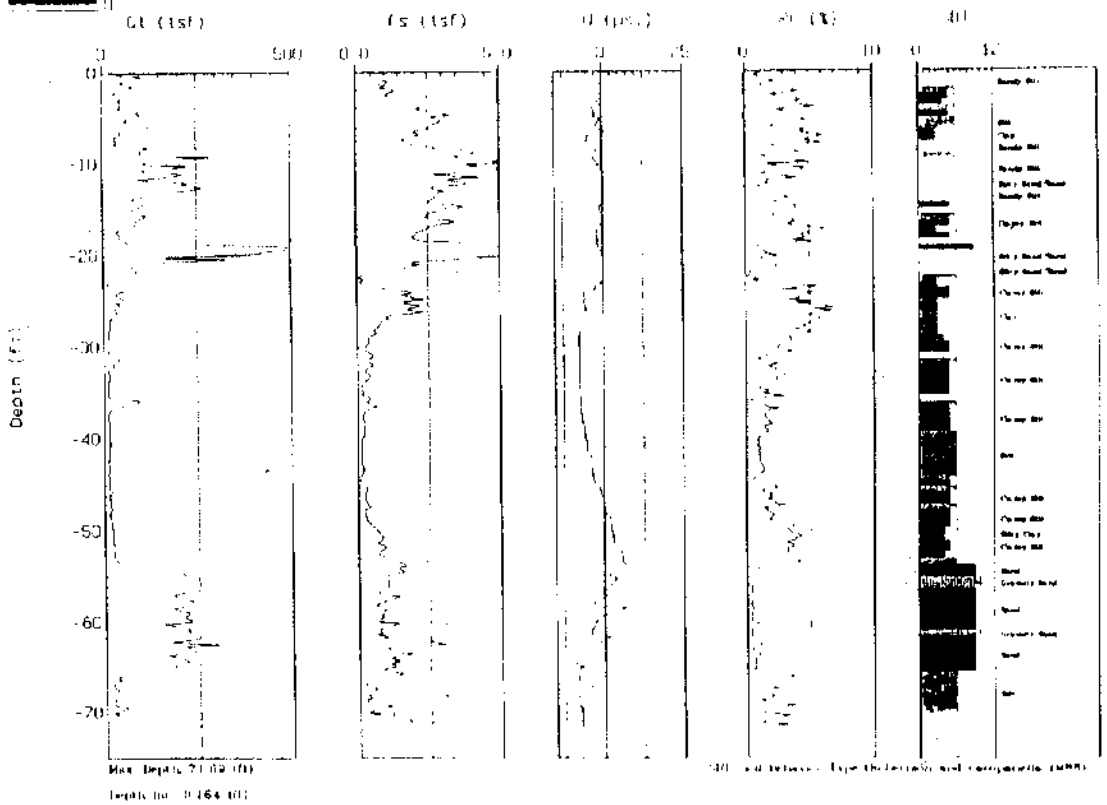
GREGG

GROUP DELTA



GREGG

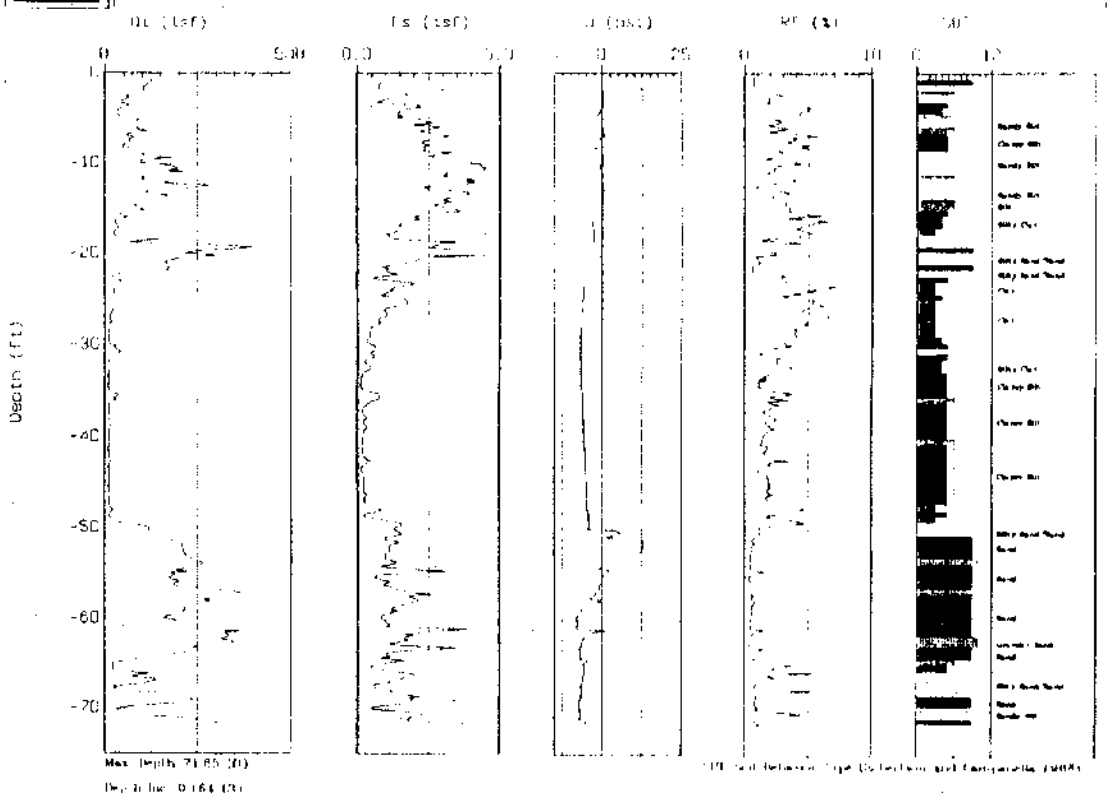
GROUP DELTA



DRAFT

GREGG

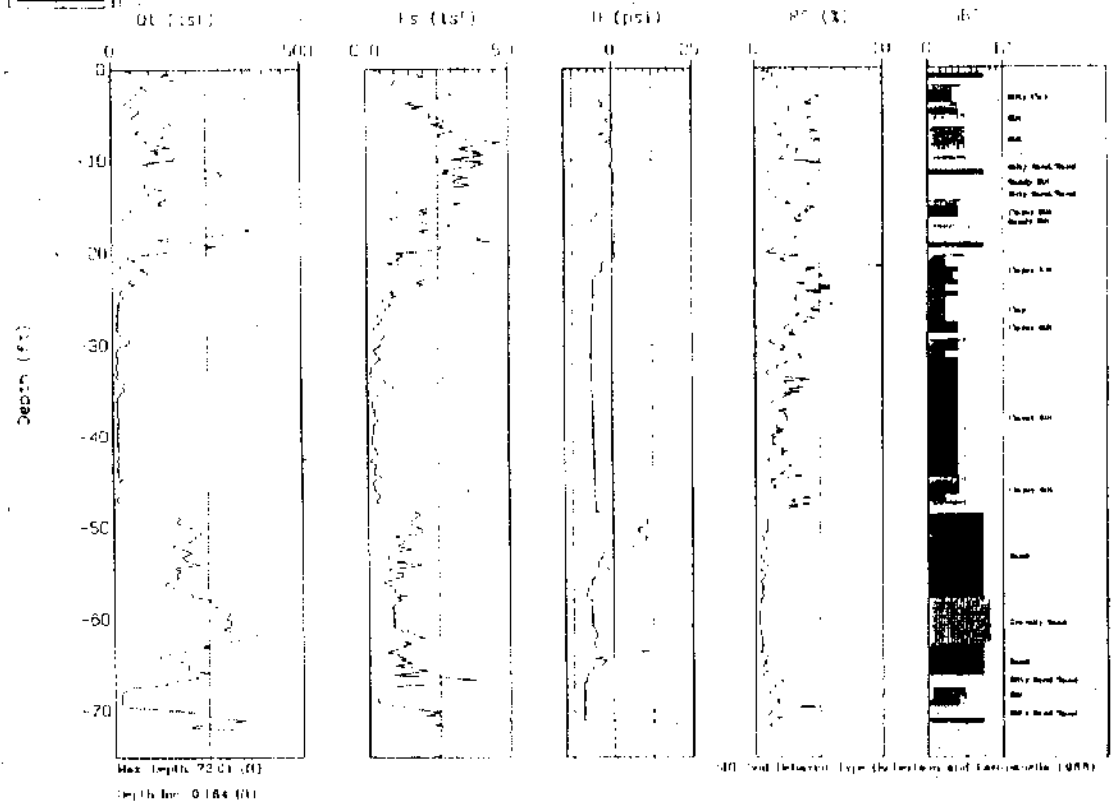
GROUP DELTA



DRAFT

GREGG

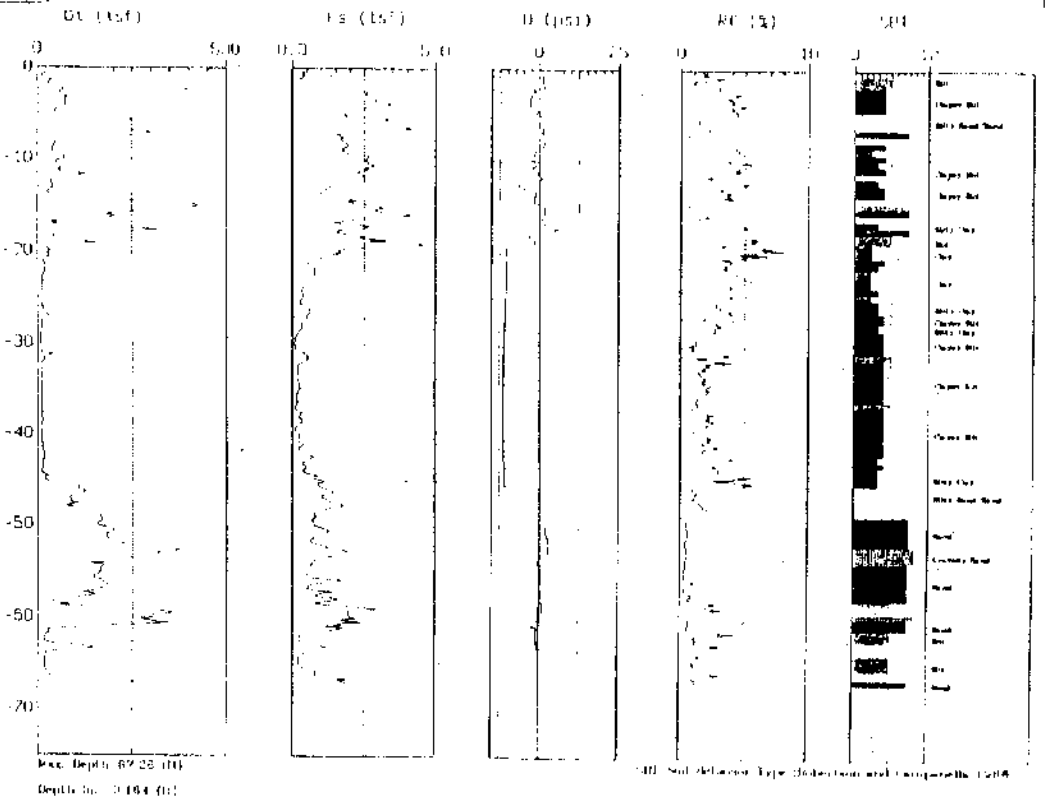
GROUP DELTA



DRAFT

GREGG

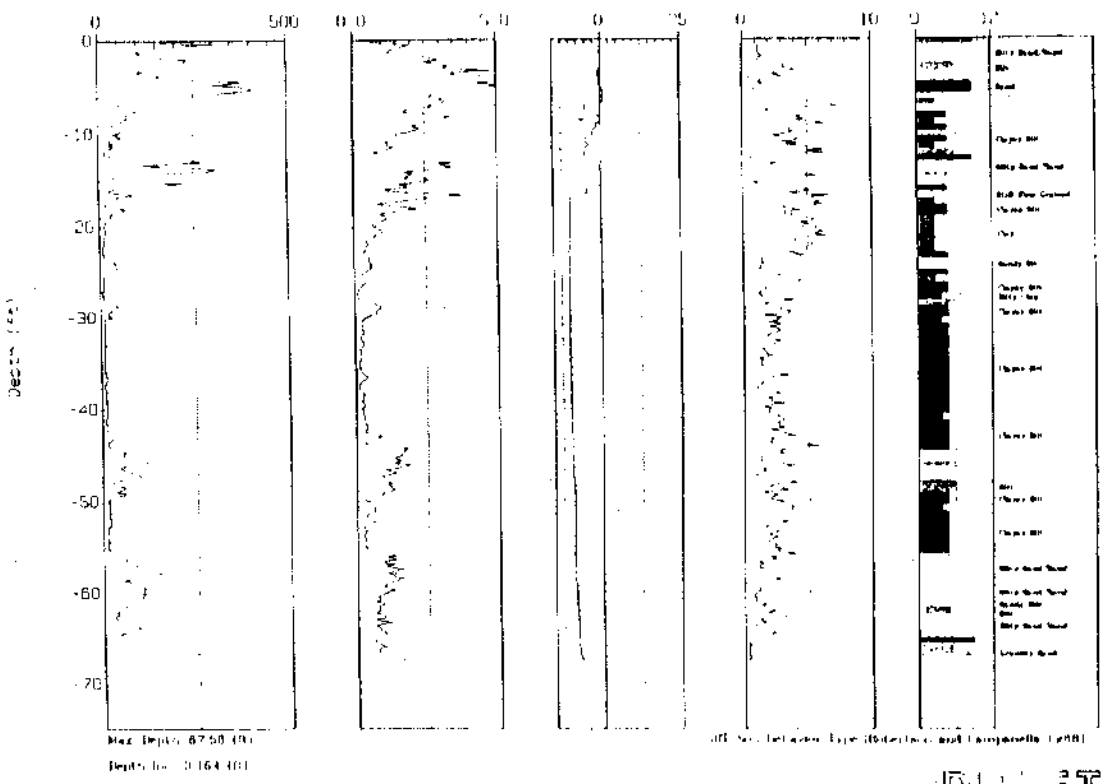
GROUP DELTA



DRAFT

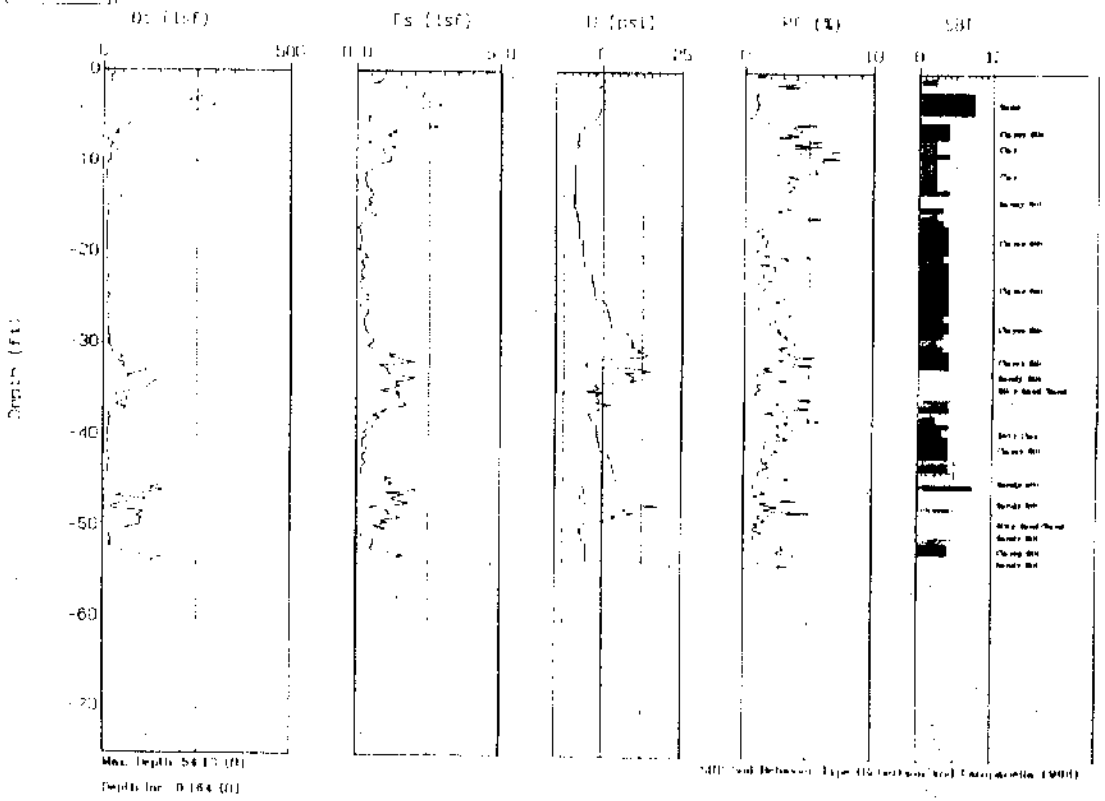
GREGG

GROUP DELTA



GREGG

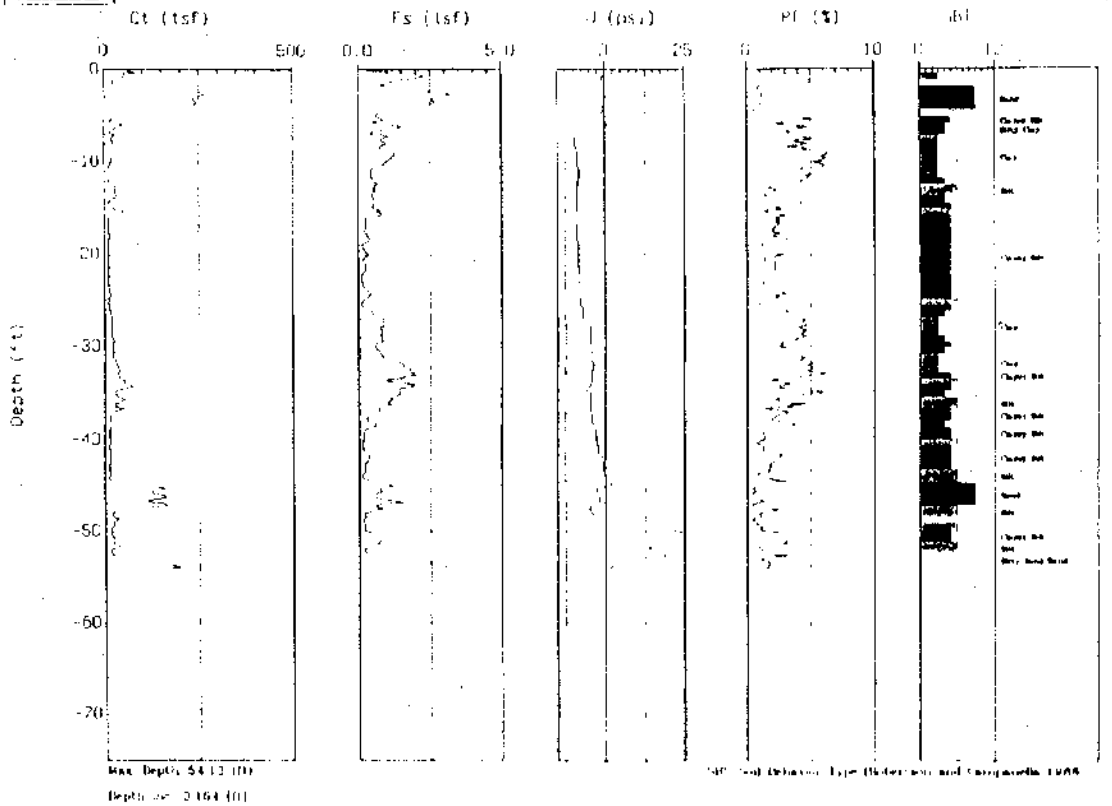
GROUP DELTA



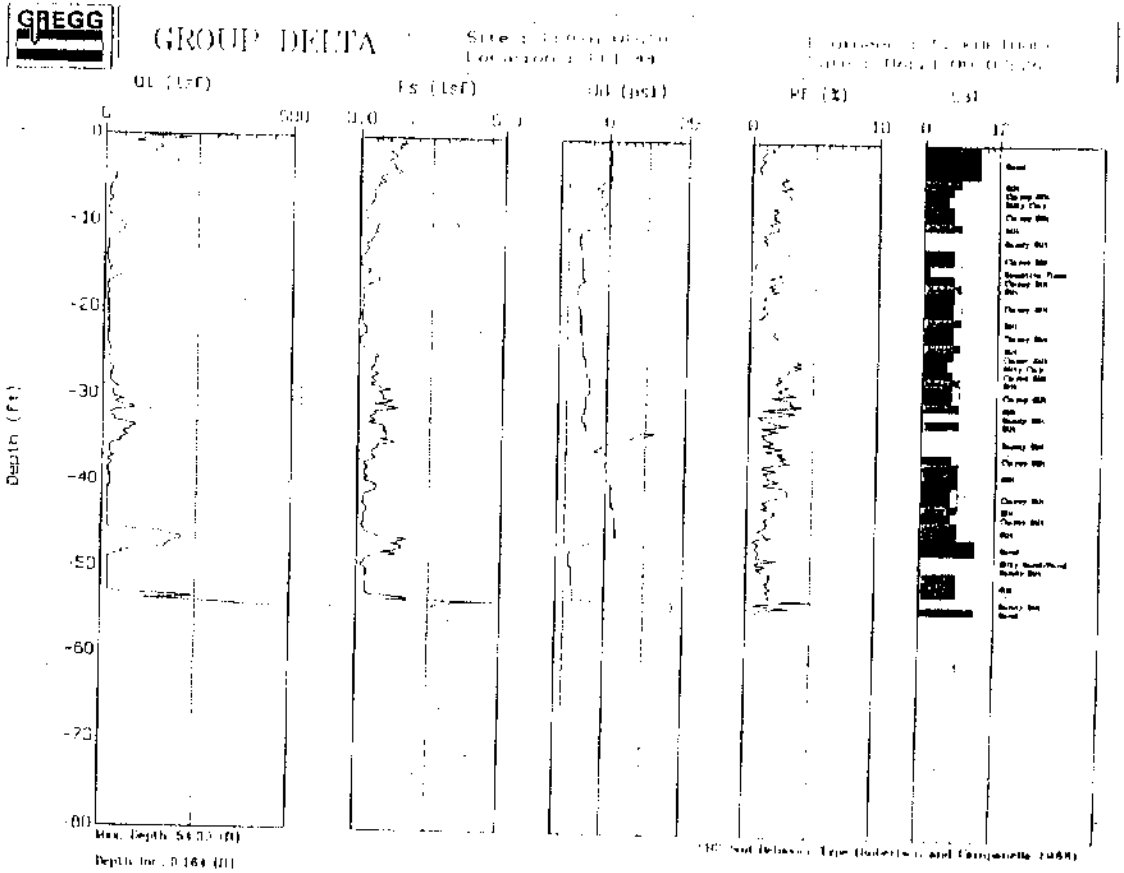
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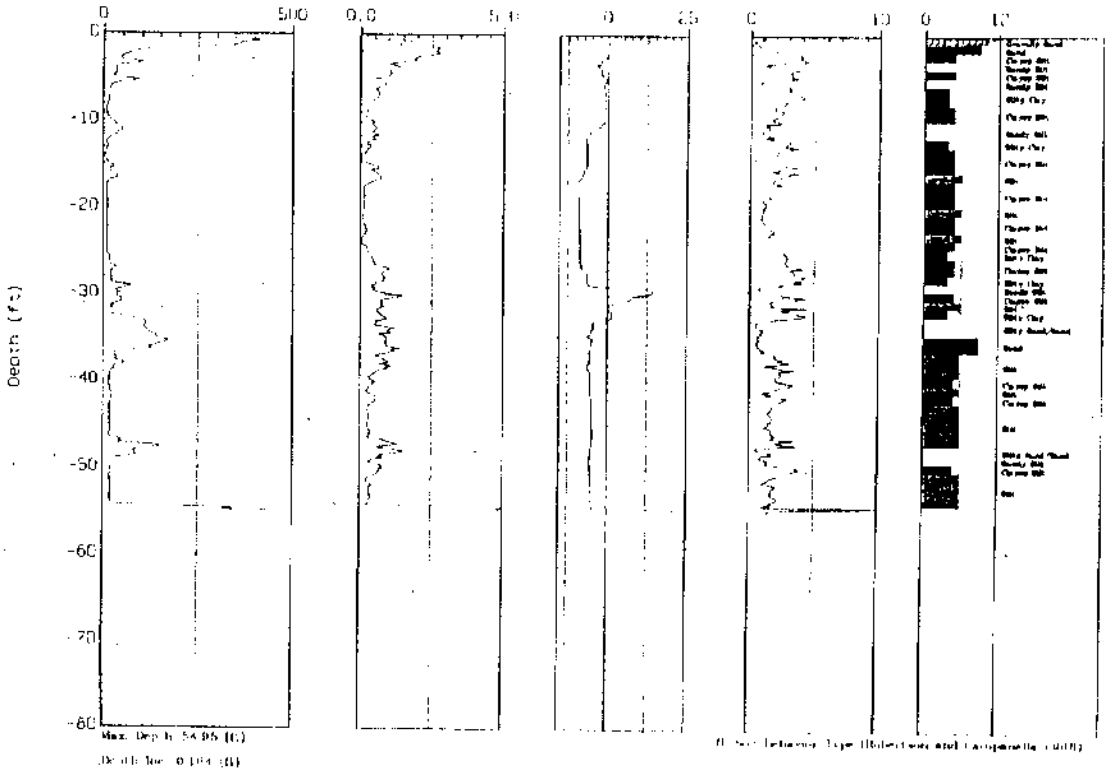


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GROUP DELTA
Qt (tsf)
Fs (tsf)
Qbt (psi)
Rf (%)
Depth (Ft)
0
10
20
30
40
50
60
70
80
500
5.0
25
10
12

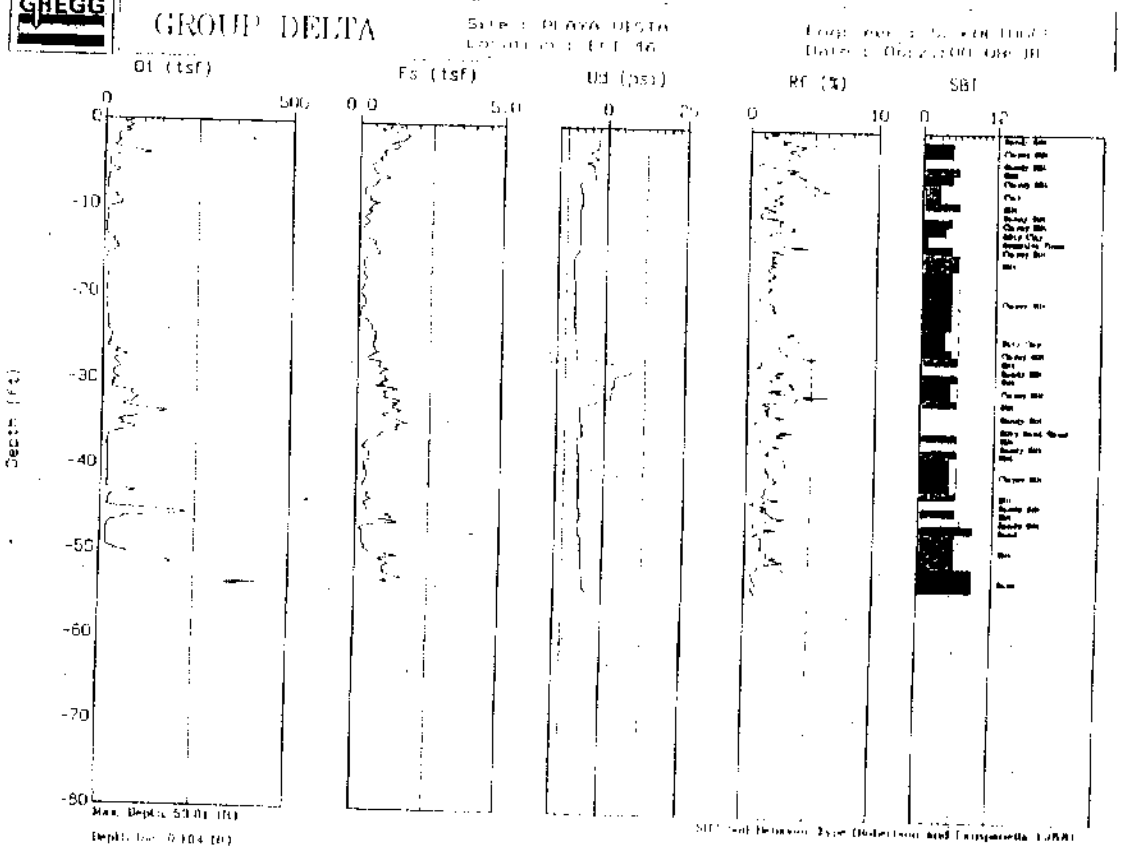
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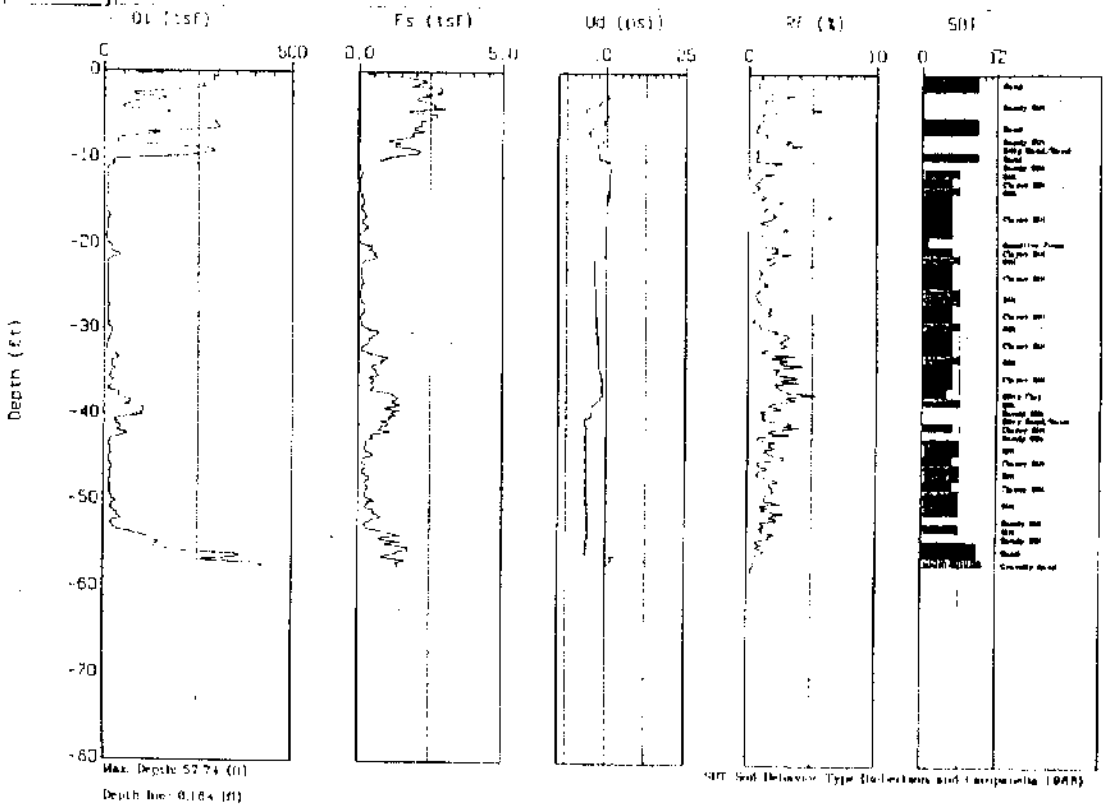
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GROUP DELTA



CITY INVESTIGATION OF POTENTIAL ISSUES OF CONCERN FOR THE COMMUNITY FACILITIES DISTRICT NO. 4 PLAYA VISTA DEVELOPMENT PROJECT

PURPOSE

The purpose of this investigation is to provide information to the Planning and Land Use and Budget and Finance Committees and the City Council, so that Councilmembers can decide whether, as a policy issue, the City should provide Mello Roos financing for some of the infrastructure and ecological components of the Playa Vista Development Project.

COMMUNITY FACILITIES DISTRICT NO. 4 PLAYA VISTA DEVELOPMENT PROJECT DESCRIPTION

The Community Facilities District No. 4 (CFD4) is a portion of the master planned community known as Playa Vista (Playa Vista Development Project). The Playa Vista Development Project has an approximate area of 1,087 gross acres and is over three miles long and one mile wide. It is located on the west side of the City, approximately 11 miles west of downtown, four miles south of the City of Santa Monica and three miles north of the Los Angeles World Airport. The overall Playa Vista Development Project includes residential units, office space, retail, media and technology facilities, community serving facilities (i.e. school, day-care, etc), wetland and habitat restoration, open space and recreational areas, and infrastructure.

CFD4 is a portion of Phase I of the Playa Vista Development Project. CFD4 is located immediately east of Lincoln Boulevard on both sides of Jefferson Boulevard and consists of approximately 169 gross acres, of which 79.4 acres are expected to be subject to the Mello-Roos Special Tax. The Developer's plans calls for development of dwelling units, retail and commercial facilities, library, school, other community-serving facilities, open-space, habitat improvements/enhancements, and infrastructure development and improvements. Exhibit A illustrates the boundaries of CFD4. Exhibit B illustrates the CFD4 proposed development within the context of the Playa Vista Phase I Development Project area.

A. STUDY DESIGN

The Study will investigate the potential public health and safety impacts, and appropriate mitigations if any, associated with methane, hydrogen sulfide, and air toxic (benzene, toluene, ethyl-benzene, and xylene (BTEX)) emissions in the CFD4 area of the Playa Vista Development Project. The public health and safety impacts/risks identified through the study, if any, will be evaluated based upon comparison of risk levels within the City and regulatory standards, as appropriate.

The Study will be completed in a three steps, with Steps II and III being contingent upon the results and findings of Step I. This stepped approach is intended to maximize resources and avoid

unnecessary duplication of data/information collection. The study steps will be applied to each of the four issue areas identified as requiring investigation: 1) Methane, 2) Subsidence, 3) Potential Fault Impacts on the Playa Del Rey Gas Storage Facility, and 4) Air Emission Health Risk Assessment. Specific detail of issue investigations are provided in Section B "Study Scope" below.

The study results will be released for public review and comment.

Step I - Issues Investigation

Step I in each of the three issue areas will consist of a review of existing studies and information and/or studies currently underway. Independent review of data and information and resolution of issues will involve City staff review, responsible regulatory agencies, academia, and consultants as appropriate. To maximize resources, regulatory and responsible regional and state agency and educational institution participation will be sought to the maximum extent possible. However, the availability of staff resources of such agencies and institutions are uncertain, and therefore consultants with expertise in the areas of concern, and not found within the City, may be hired.

If an area of concern is resolved through the Step I investigation and no impacts are identified, that issue will be closed and no further work regarding that issue will be undertaken. If, through the Step I investigation, impacts are identified and adequately characterized, that issue will be addressed through Step III - Identification of Mitigations. If the Step I investigation results in the identification of data/information gaps essential to resolving issues or the better characterize impacts to allow for mitigation development, additional information will be obtained through Step II - Additional Data/Information Gathering.

Step II - Additional Data/Information Gathering

If the Step I investigation identifies data gaps essential to resolving issues or the need to better characterize impacts to allow for mitigation development, such information and data will be collected through Step II. It is anticipated that additional data and site investigation work would require consultants with the expertise and certification in the appropriate field.

If an area of concern is resolved through the additional/information obtained through the Step II investigation and no impacts are identified, that issue will be closed and no further work regarding that issue will undertaken. If, through the Step II investigation, impacts are identified and characterized, that issue will be addressed through Step III - Identification of Mitigations.

The City intends to hire a consulting engineer, certified in the State of California, who has particular expertise in methane mitigation, to provide advice relative to the information

obtained through both Step I and Step II investigations so that the focus of the investigations are on gathering data material to the feasibility and design of mitigations.

Step III - Mitigation Development

For all substantial impacts identified through Step I and II investigations, mitigations will be investigated, evaluated, and recommended for implementation. The study will document any issues of concern for which adequate mitigations cannot be identified.

B. STUDY SCOPE

The study steps outlined above will be applied to each of the four issue areas identified as requiring investigation: 1) Methane, 2) Subsidence, 3) Potential Fault Impacts on the Playa Del Rey Gas Storage Facility, and 4) Air Emission Health Risk Assessment. This Scope of Study Section provides information on the planned scope of each issue investigation. As information is obtained and reviewed and regulatory agency input received the scope of study for each issue area may need to be modified. Therefore, the work plans outlined below should be viewed as dynamic, with the scope of the study "evolving," as appropriate, in response to data obtained throughout the study process.

1) Methane

General Background

Methane gas is a colorless, odorless gas which is combustible.

In spring/summer 1999, Exploration Technologies, Inc. (ETI) designed and supervised the collection and analysis of gas vapor surveys at the Playa Vista Development Project site to better document and understand the subsurface methane gas levels in the project area. The ETI report, dated April 17, 2000, summarizing the results of that effort, identifies areas of methane concentrations of concern in the CFD4 area.

Step I

The Department of Building and Safety, in coordination with the Bureau of Engineering as appropriate, will review the extensive data currently available regarding methane concentrations identified in groundwater and soils collected at the Playa Vista Development Project site by ETI and Playa Capital.

In addition, data/information on the Gas Company's Playa Del Rey Gas Storage Facility and abandoned oil wells will be reviewed in order to determine if there is any relationship between the gases at the CFD4 project site and the gas in the storage facility or potentially associated with abandoned oil wells. Data and information regarding the Playa Del Rey Gas Storage Facility will be obtained from the Gas Company and the State of California Department of Conservation Division of Oil, Gas, and Geothermal Resources. Information

regarding abandoned oils wells will be obtained from the State of California Department of Conservation Division of Oil, Gas, and Geothermal Resources.

The Subsidence study (outlined below) results will be considered as appropriate as part of the Methane Study, Step I.

The State of California Department of Conservation Division of Oil, Gas, and Geothermal Resources, the State agency responsible for oversight of gas storage facilities and oil well installation, maintenance, and abandonment throughout the State, will be consulted as part of the Methane Step I Study review process.

Step II

The need for additional methane testing/drilling will be evaluated based upon the Methane Step I, Subsidence Step II, and the Potential Fault Impacts on the Playa Del Rey Gas Storage Facility Step I (see below) study results.

In the event additional methane testing/drilling is required, the City would utilize one of the Bureau of Engineering's five "On-Call" contractors with the appropriate capabilities and certifications, and which has no conflict of interest with the Playa Vista Development project. The Department of Building and Safety, in consultation with the Bureau of Engineering and other City departments as appropriate, would be responsible for the additional methane data collection study design and oversight.

Step III

Once the issue of methane gas at the CFD4 of the Playa Vista Development project site has been adequately characterized, appropriate mitigation criteria will be investigated, identified, and recommended. The Department of Building and Safety and the Los Angeles Fire Department, in consultation with the City's consultant, will be involved in methane mitigation criteria review and development.

2) Subsidence

General Background

Subsidence is the sinking of the ground to a lower level. Subsidence can be associated with sediment compaction, groundwater withdraw, and gas and oil production. Concern has been expressed that subsidence has occurred in the development area and may be an indicator of methane gas migration.

Step I

The City will review its records for the previous elevation survey readings obtained at various benchmarks within the area of the CFD4 project.

Step II

The Survey Division of the Bureau of Engineering will document the current elevation of the various benchmarks located within the area of the CFD4 project. The current elevation readings will be compared to the previous readings for the same benchmarks (Step I data).

Any level of subsidence will be documented and considered and evaluated as part of the Methane Study (outlined above).

Step III

In the event that the Subsidence Study indicates that subsidence could substantially impact the project or proposed methane mitigations, methods to appropriately address subsidence will be investigated, evaluated, and recommended.

3) Potential Fault Impacts on the Playa Del Rey Gas Storage Facility

General Background

The ETI report identifies the possibility of a potential subsurface fault (called the Lincoln Boulevard Fault in the report) that with respect to seismicity, would be considered as a potentially active low potential fault. There is concern that if such a fault does exist, a future earthquake with an epicenter close to the CFD4 site could potentially cause a rapid release of large volumes of gas from the Playa Del Rey Gas Storage Facility to the surface along the purported Lincoln Boulevard Fault plane.

Step I

The ETI Study and the results of the seismic reflection 3D imaging and cone penetration study currently being performed by Playa Vista and the Gas Company, and other existing studies as appropriate, will be reviewed to determine the likelihood of a fault in the Lincoln Boulevard area. The State of California Department of Conservation Division of Mines and Geology, the State Agency responsible for developing guidelines and methodology for mapping faults, will be requested to participate in the review of the various fault studies. Experts from academia and/or outside consultants may also be sought to assist the City in its review of this issue.

If a fault is identified in the Lincoln Boulevard area, the potential impacts to the Playa Del Rey Gas Storage Facility and associated risks to life and property, if any, will be evaluated. Such an evaluation will include the resources utilized in the review of the fault and would be expanded to include the State of California Department of Conservation Division of Oil, Gas, and Geothermal Resources.

Step II

Step I results will allow the development of conclusions regarding impacts of the potential Lincoln Boulevard fault on the Playa Del Rey Gas Storage Facility. No additional technical work would be called for under Step II of the Study design.

Step III

In the event a fault which could substantially impact the Playa Del Rey Gas Storage Facility is identified, mitigations will be investigated, evaluated, and recommended. The resources utilized in Step I and Gas Company representative will be utilized in the development of mitigations.

4) Air Emission Health Risk Assessment

General Background

Methane gas is not a toxic air contaminant (TAC). However, some TACs, such as benzene, toluene, ethyl-benzene, and xylene (BTEX) and hydrogen sulfide maybe associated with methane emissions. The primary health risk of concern due to exposure to benzene is a potential increased risk of cancer. Non-cancer chronic and acute health effects are associated with BTEX and hydrogen sulfide. Potential non-cancer health effects of these pollutants of concern include eye and respiratory irritation, central nervous system, and reproductive concerns.

Potential health impacts associated with BTEX and hydrogen sulfide are dependant upon pollutant concentration and duration of exposure. To understand the potential public health impacts, if any, posed by BTEX and hydrogen sulfide levels identified at the CFD4 site, a Health Risk Assessment will be performed. Health Risk Assessment methodology is well established by various state regulatory agencies.

Step I

The investigation will focus on BTEX and hydrogen sulfide emissions. The City will contract for outside consultant services to assist in reviewing existing health risk analyses for the site and if necessary to perform a health risk assessment for BTEX and hydrogen sulfide emissions found at the CFD4 site.

City staff and the selected consultant will review health risk analyses prepared by/for Playa Vista and ambient air quality and soil vapor information/data gathered by ETI, Playa Vista, or other sources. Health risk assessment(s) and associated data will be reviewed for adequacy. If existing information is adequate to determine relative health risks, no further work will be undertaken.

In the event existing health risk assessment(s) are determined inadequate, but the underlying data is determined to be adequate, a risk assessment, utilizing methodologies established by appropriate regulatory agencies, will be prepared. If additional data for the risk assessment is required, it will be collected through Step II.

The CFD4 site does include development of a school. State of California Department of Toxic Substance Control is working closely with the Los Angeles Unified School District

regarding school site review/evaluations. Both agencies will be requested to participate in the health risk assessment review process.

Step II

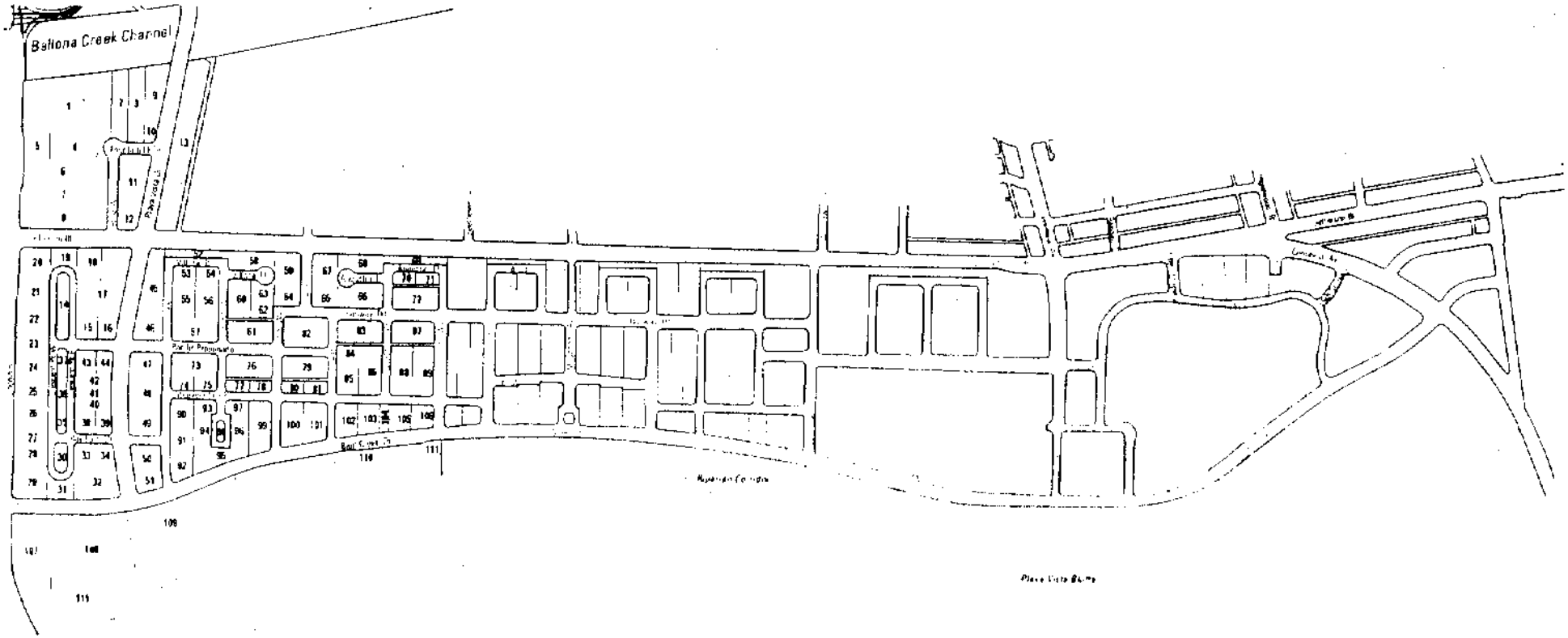
Any information necessary to conduct a health risk assessment for BTEX and hydrogen sulfide will be collected. The consultant contracted for Step I work will be used for Step II data collection as well. Appropriate regulatory agencies (i.e. South Coast Air Quality Management District for ambient air quality monitoring and the State of California Department of Toxic Substance Control and/or the Regional Water Quality Control Board for soil vapor sampling) will be requested to review monitoring/data collection protocols developed by the City/consultant.

The data identified in Step I and additional data collected through Step II will be used to prepare a risk assessment for the project site, utilizing methodologies established by appropriate regulatory agencies, and consistent with Los Angeles Unified School District procedures. Any health risks identified will be, compared with other areas of the City and regulatory standards as appropriate.

Step III

If required, mitigation measures to reduce health risks identified through the Health Risk Assessment Steps I and II will be investigated, evaluated, and recommended by City staff. Responsible regulatory agencies such as the South Coast Air Quality Management District, California Air Resources Board, and the California Department of Toxic Substance Control will be consulted during mitigation development. The Los Angeles Unified School District will also be consulted as appropriate. Services of the consultant utilized in Steps I and II will also be utilized.

Exhibit A

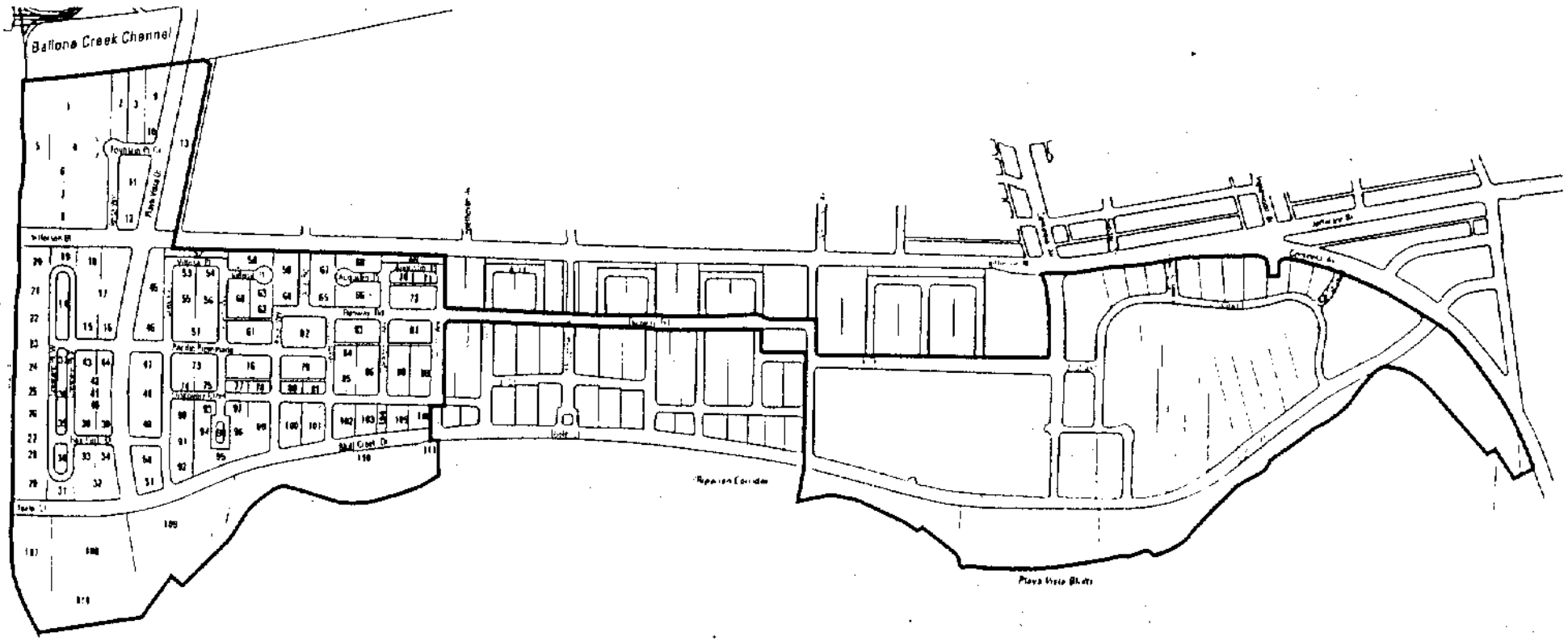


Community Facility District (CFD) 4

Playa Vista Los Angeles, California

Prepared by City of Los Angeles Planning Department • Graphic Services Section • July 2000

Exhibit B



Community Facility District (CFD) 4

Phase 1 Development Area

Playa Vista Los Angeles, California

Prepared by City of Los Angeles Planning Department • Graphic Services Section • July 2000



CITY HALL
LOS ANGELES, CALIFORNIA 90012

July 11, 2000

TO: Interested Agencies
Homeowners Associations within the Community Plan Areas
Interested Parties and Organizations Who Testified before City Council Committees and the City Council

Public Meeting on Tuesday, July 18, 2000

SUBJECT: Notice of Public Meeting on (1) Methane Gas, (2) Potential Fault Impacts on the Playa Del Rey Gas Storage Facility, and (3) Air Emission Health Risk Assessment in the Community Facility District No. 4 (CFD 4) area of the Playa Vista Phase I Development area

The entire Playa Vista Development Project encompasses approximately 1,087 acres situated at the western edge of the City of Los Angeles, generally south of Santa Monica, west of Culver City, and north of Los Angeles International Airport. The Playa Vista Development Project is proposed in two phases of which Phase I entitlement was approved on approximately 337 acres for residential, office, retail, community serving, open-space, habitat improvements, and infrastructure development and improvements.

The CFD 4 is a westerly portion of the Playa Vista Phase I Development area located immediately east of Lincoln Boulevard on both sides of Jefferson Boulevard, and consists of approximately 169 gross acres, of which 79.4 acres are expected to be subject to the Mello-Ross Special Tax. In connection with its consideration of the issuance of Mello-Roos bonds for CFD4, the City Council instructed that further analysis occur on issues relative to Methane and other gas contamination on the site, the impacts of such contamination on the health and

Los Angeles City - Department of Public Works - Bureau of Sanitation

Contact: Bureau of Sanitation - (213) 485-5886
Cases where it appears that toxic waste has been dumped directly into the sewer or storm drain system. This would include ground water discharge containing petroleum products.

State of California - Division of Oil and Gas (DOG)

Contact: (213)590-5311
Abandoned oil wells and contamination caused by an abandoned oil well.

State of California - Air Quality Management District (AQMD)

Contact: (818) 572-6195 or 572-6306 (24 hr)
Volatile Organic Compounds (VOC) - contaminated soil where the VOC equals or exceeds minimum levels established by (AQMD) In general, when you can smell contamination.

of discolored soils near seepage pits are handled by the Department for fire, health or stability hazards and may require technical review.

CONTACT AGENCIES

Los Angeles County - Department of Health Services (LADHS) - Hazardous Waste Control Program

Contact: Erlinda Macalintal - (213) 744-3223

All known or suspected contaminated soil except gasoline Leakage and underground tank removal subsequent to January 1, 1984 done under permit and inspection by the Fire Department

Los Angeles City Fire Department - Underground Tank Unit

Contact: Captain Mack - (213) 485-7543
Gasoline leakage and underground tank removal subsequent to January 1, 1984 done under permit and inspection by the Fire Department; possibility of explosive gas condition or similar Imminent hazard.

Los Angeles City - Department of Building and Safety - Grading Division

Contact: D. H Su
W. Cobarrubias - (213) 485-3435
Methane Hazard Districts and other design precautions Pertaining to Division 15 of the Building Code.

Los Angeles City - Department of Building and Safety Structural Plan Check Division.

Contact: Ron Shigeta - (213) 485-2321
Construction design standards for use in Methane Hazard Districts

Los Angeles City - Police Department - Toxic Materials Unit

Contact: (213) 485-4011
Enforcement and criminal investigation related to Contamination problems. (Note: Other agencies are also involved in enforcement and criminal investigation related to contamination problems.)

the lead agency to determine the proper procedures to follow to remediate the situation. When geotechnical reports have been submitted to the Department for review and the reports indicate the presence of contaminated soils, the notification should be included in the Department's review letter. If the contamination is discovered after construction has started, the Department inspector should issued issue an order to stop work in the vicinity of the contamination and to immediately contact the appropriate lead agency. The Department should also contact the lead agency. This contact can be done by sending the lead agency a copy of the Department review letter, or if the job is under construction, by the inspector phoning the lead agency to describe the nature and possible extent of the suspected contamination.

SPECIAL PROCEDURES

In the event Department inspection discloses the possibility of explosive gas conditions or similar eminent hazards, the inspector should stop the job and immediately notify the Los Angeles City Fire Department. If an abandoned oil well is discovered the Department is to immediately notify the State Division of Oil and Gas (DOG) for their inspection and guidance. In either case the area should be cordoned off to prevent injury to workmen or the public. This condition will prevail until a clearance is received in writing from the appropriate agency.

When the Department inspector suspects the presence of volatile organic compounds (VOC) from soil contamination which equal or exceed 50 parts per million (ppm), the inspector should contact the State Air Quality Management District (AQMD). Upon notification, the AQMD will dispatch personnel to test the level of VOC. If the level of VOC is in excess of allowable limits, AQMD will require that appropriate action be taken. VOV levels will usually equal or exceed 50 ppm when they are detectable by smell.

EXCEPTIONS

The legal classification of contaminated soils refers to unnatural substances found in the ground. Some of these substances are toxic while others are not. Their treatment or disposal is required. Naturally occurring contamination such as crude oil or methane gas may pose foundation, health or fire hazards. For naturally occurring contamination, the Department will be the lead agency and will be responsible for approval of the treatment of the contamination. The Department will in most cases require the owner to obtain the services of a private consultant to provide recommendations for treatment. In cases involving crude oil seepage associated with an abandoned oil well, the Department may require treatment in accordance with DOG standards. An uncovered abandoned oil well requires clearance from DOG that the well was abandoned, or reabandoned, as required by State law. Explosive concentrations of methane gas (.5≥15% LEL) requires shielding, venting and gas detectors to be installed to eliminate the methane hazard in accordance with Division 15 of the Building Code. The Grading Division will continue to review reports submitted by qualified gas control specialists on these matters.

Landfill gases are similar methane-based substances which are controlled much the same as oil field methane gas. Occurrences of ground water that smell of sewage, rotting eggs (H_2S), or

City of Los Angeles BASEC (Building and Safety's Electronic Catalog) - information is for reference only

DATE: 02/06/89

TO: All Plan Check Engineers, Geologists and Inspectors

FROM: James D Kapnelian, Chief Grading Division

RE: CONTAMINATED SOILS (SUPERSEDES MEMO OF JANUARY 3, 1989)

State environmental protection laws require the removal of identified contaminated soils. Once contamination is detected on a site a process of contamination identification and required clean - up treatment will be needed for remediation of the problem. To accomplish this various State and local agencies, private hazardous waste experts and the Department must provide a cooperative effort to evaluate the problem and determine the type of remediation needed.

Possible sources of contamination may yield various substances and levels of hazard. The type and extent of the contamination will dictate the remediation appropriate for the site and agencies to be contacted. Experts in the yield of toxic waste clean - up must work with the appropriate lead agency to classify the type and level of hazard as well as the source, and areal extent of suspected contamination.

LEAD AGENCY DESIGNATION

In the vast majority of contamination soil case handled by this Department, the lead charged to oversee the remediation process is the Los Angeles County Department of Health Services (LADHS). If LADHS suspects contamination of the ground water may be a possibility, it may refer the mater to the State Regional Water Quality Control Board who would then become the lead agency If the contamination is caused by an underground storage tank, or by a tank which was removed subsequent to January 1, 1984 and under permit and inspection by the Los Angeles City Fire Department, the Fire Department will be the lead agency

DETECTION PROCEDURES

The identification of contaminants is a specialized chemical technology that is beyond the scope of the Department's expertise. Evidence of contamination will normally be detected by visual or olfactory observations made during site exploration by the geotechnical consultants or during excavation of the site (In general, by discoloration of the soils or by odor). Less frequently, hazardous vapors are not detected until construction is underway and explosion occurs or workers are overcome by fumes Not all discolored or odorous soils falls within the legal definition of chemically contaminated soils The soil surrounding and associated with a private sewage disposal system is not considered contaminated unless the system has been used to dispose of something other than human waste

DEPARTMENT ACTION

Department personnel upon becoming aware of contaminated soil at a site should not allow a job to commence, or continue , until written clearance of remediation is received from the lead agency Until this clearance is obtained the site should be considered potentially unhealthful and unsafe The Department should notify the owner and/or contractor to immediately contact

California Regional Water Quality Control Board

Los Angeles Region

(50 Years Serving Coastal Los Angeles and Ventura Counties)

320 W. 4th Street, Suite 200, Los Angeles, California 90013
Phone (213) 576-6600 FAX (213) 576-6640
Internet Address: http://www.swrcb.ca.gov/rwqcb4

Winston H. Hickox
Secretary for Environmental Protection

Gray Davis
Governor

July 7, 2000

David Chernik
Environmental Project Manager
Playa Capital Company
12555 W. Jefferson Boulevard, Suite 300
Los Angeles, CA 90066

APPROVAL OF HEALTH-BASED CLEANUP LEVELS—PLAYA VISTA SITE, 6775 CENTINELA AVENUE, LOS ANGELES
(CLEANUP AND ABATEMENT ORDER NO. 98-125, FILE NO. 98-192)

Dear Mr. Chernik:

The RWQCB requested Playa Capital, LLC (Playa) conduct a health risk assessment to evaluate the need for additional soil and/or groundwater remediation for the protection of human health, in addition to the required investigation/remediation of soil and groundwater for the protection of groundwater resources.

We have reviewed the "Health-Based Remediation Goals, Playa Vista, Los Angeles, California" (Report) prepared by Integrated Environmental Services, Inc., dated February 2000, and approve of its implementation. A copy of the memorandum from the Office of Environmental Health Hazard Assessment providing a detailed technical review of the HBRGs will be provided once the hard copy has been received by Board staff.

Please call me at (213) 576-6737 if you have any questions.

Sincerely,

John Geroch
Associate Engineering Geologist
Site Cleanup Unit

cc: Derrick Willis, Integrated Environmental Services

California Regional Water Quality Control Board
Los Angeles Region

Winston H. Hickox
Secretary for Environmental Protection

320 W. 4th Street, Suite 200, Los Angeles, California 90013
Phone (213) 576-6600 FAX (213) 576-6640
Internet Address: http://www.swrcb.ca.gov/~rwqcb4

Gray Davis
Governor

December 27, 1999

David Chernik
Environmental Project Manager
Playa Capital Company
12555 W. Jefferson Boulevard, Suite 300
Los Angeles, CA 90066

COMMENTS ON HEALTH BASED REMEDIAL GOALS —PLAYA VISTA SITE, 6775 CENTINELA AVENUE, LOS ANGELES (CLEANUP AND ABATEMENT ORDER NO. 98-125, FILE NO. 98-192)

Dear Mr. Chernik:

The Office of Environmental Health Hazard Assessment (OEHHA) previously reviewed and commented on the "Draft Protocol for Health-Based Remediation Goal Calculations for the Playa Vista Area D." (Draft Protocols) dated May 11, 1999, prepared by Integrated Environmental Services (IES). Subsequently, IES revised some of its formulae and input values and submitted "Revised Exposure Parameters for Playa Vista Health-Based Remediation Goal Calculations" (Revised Protocols) dated July 14, 1999, prepared by IES. OEHHA has completed its review of the Revised Protocols (copy attached). We have reviewed OEHHA's recommendations and have the following comments:

Construction Worker Inhalation Rate

OEHHA recommends a construction worker inhalation rate of 1.5 m^3/hour, which is the recommended mean value for moderate activities among outdoor workers. We concur with OEHHA's recommendation.

Construction Worker Exposure Duration

IES proposes a one-year exposure duration scenario based on the fact that the site has been divided into tracts, subtracts and parcels and each parcel is owned or will be owned by different parties and construction at each parcel will be arranged by individual owners according to various schedules. We concur with IES's one-year exposure scenario.

Operations/Office Personnel Inhalation Rate

OEHHA recommends an inhalation rate of 1.25 m^3/hour for office personnel. We concur with OEHHA's recommended value of 1.25 m^3/hour.

Expected Land Use

We concur with OEHHA that the health risk assessment shall include an exposure scenario for the residual risk for the areas that will be developed for onsite residential use.

Please call me at 9213) 576-6737 if you have any questions.

Sincerely,

JOHN GEROCH
Associate Engineering Geologist
Site Cleanup Unit

David Hsu, Chief, Grading Engineering Section, Department of Building and Safety, City of Los Angeles
Con How, Director of Planning, City of Los Angeles
Ed Santiago, Division of Oil, Gas and Geothermal Resources
Michael Young, Integrated Environmental Services
Tim Connors, Playa Capital

- The proposed value of 1.0 m^3/hour is a *mean* value (not an upper percentile) for *short-term* exposures (not long-term exposures). For these reasons, it would not be consistent with the RME exposure scenario described in the Draft Protocol for HBRGs. As discussed before, there is no distributional data available in support of this scenario.
- I would like to suggest to use a default value of **10 m^3/8h** "occupational" exposure for the indoor office work. This assumed value would be more consistent with a conservative exposure scenario and is still within the values reported by the U.S. EPA.

Expected Land Use

The DreamWorks Project originally intended for the Playa Vista Area D site, has been abandoned. The Revision does not explain what the new intended land use of the Playa Vista Area D will be. However, it can be reasonably assumed that it could consist of high-density residential and commercial uses. If this is the case, the health risk assessment should include an exposure scenario for the residual risk of *on-site residents*. As previously commented, the residential exposure assessment and HBRGs should be based on on-site residents, including children, which would likely result in lower HBRGs

Conservative Exposure Scenario

The U.S. EPA recommends that use of upper percentile values be limited to the exposure pathways that contribute the bulk of the overall risk. The rationale is that in a *deterministic* risk assessment, it cannot be expected that *all* high-end exposure factors contribute *simultaneously* to exposure and risks. Therefore, once the Conceptual Site Model is developed, and the Chemicals of Potential Concern, exposure pathways, and receptors of concern have been appropriately identified, then the most sensitive exposure factors should be verified that they have been assigned upper-end values.

Comments provided by HWTS/OEHHA in the June 8, 1999 memorandum still remain in effect. It is not necessary to revise the Draft Protocol.

We appreciate the opportunity to comment on this report and look forward to assist the LA-RWQCB in the review of the final risk assessment report.

FEB-05-2001 20:42 FROM:CRWQB LAR 2137566717 TO:213 6800085 P.03

Office of Environmental Health Hazard Assessment

Joan E. Denton, Ph.D., Director
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Oakland Office • Mailing Address: 1515 Clay Street, 16th Floor • Oakland, California 94612

Winston H. Hickox
Agency Secretary

Gray Davis
Governor

MEMORANDUM

TO: John Geroch
California Regional Water Quality Control Board
Los Angeles Region
320 W. 4th Street, Suite 200
Los Angeles, California 90013

VIA: David M. Siegel, Ph D., Chief
Hazardous Waste Toxicology Section

FROM: Julio A. Salinas, Ph.D., Biochem.D.
Hazardous Waste Toxicology Section

DATE: December 9, 1999

SUBJECT: REVISED EXPOSURE PARAMETERS FOR PLAYA VISTA HEALTH-BASED REMEDIATION GOAL CALCULATIONS

Upon your request, I reviewed the document entitled "Revised Exposure Parameters for Playa Vista Health-Based Remediation Goal Calculations" (hereinafter the Revision) prepared by Integrated Environmental Services, Inc. (Integrated), and dated July 14, 1999.

Background

The Hazardous Waste Toxicology Section had previously reviewed the Draft Protocol for Health-Based Remediation Goals (the Draft Protocol) for the Playa Vista Area D site, dated May 11, 1999. The document was intended for the remediation of the area where the Playa Vista DreamWorks Parcels project would be located.

Purpose of the Revision to the Protocol

In the Revision, Integrated proposes to modify some of the human exposure factor values described in the Protocol. Integrated considers the new values to be more representative of the activities to be conducted at the Playa Vista site, than the original values.

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Comments

Construction Worker Inhalation Rate

Integrated proposes the use of 1.3 m^3/hour as representative respiration rate for construction workers, instead of 3.3 m^3/hour originally proposed. Integrated states that 3.3 m^3/hour is an inhalation rate that is unlikely to be sustained for long term. I concur with Integrated in their assessment. I can only make the following comments:

- According to the U.S. EPA Exposure Factors Handbook (EFH, 1997), 1.3 m^3/hour is a mean value for *hourly average* for *short-term* exposure in outdoor workers. The use of central tendency (average) values would be consistent for a "typical" or average exposure scenario, but not for the Reasonable Maximum Exposure (RME) scenario proposed in the Draft Protocol. A higher value would be more appropriate for a conservative exposure scenario.
- The U.S. EPA EFH recommends 3.3 m^3/h as the upper percentile for "*hourly average* for *short-term* exposure in outdoors workers" (EFH, Table 5-23). Neither California nor U.S. EPA have developed probability density functions for respiration rates for *long-term* work regimen (8 h/day for 40 h/week, for extended period).
- In view of the unavailable information, I would like to suggest the use of **1.5 m^3/hour**. This is the recommended *mean* value for *moderate* activities among outdoor workers. Assuming an average regimen of 8 hours/day, this results in an inhalation rate of **12 m^3/8-h**, which would account for most (i.e., conservative) of the 20 m^3/day value assumed to be "typical" respiration rate

Construction Worker Exposure Duration

Integrated proposes the use of a one-year duration of exposure for construction workers, instead of the three-years as originally proposed. The 1-year exposure would seem reasonable if *all* construction activities in the 47 acres Area D site can be achieved within one year. In the new Playa Vista project the type and extent of construction (residential, commercial, industrial) are not defined. It would be more reasonable to assume that the same team of construction workers would be involved in construction activities for one year at one location and then moving to another location for the next year, for probably several years. It should be kept in mind that the overall exposure scenario is conservative for the purpose of remediation. Based on the later rationale, I believe that the original assumption of three-year duration of exposure among workers is more appropriate.

Operations/Office Personnel Inhalation Rate

Integrated proposes the use of 1.0 m^3/hour as inhalation rate for indoor office personnel, instead of the 1.6 m^3/hour originally proposed. The new figure is based on the U.S. EPA Exposure Factors Handbook (1997), Table 5-23

Appendix B. Summary of Soil Gas Survey Analytical Results

	Benzene	Toluene	Ethylbenzene	m-, p-Xylene	o-Xylene	H_2S
Samples	1,155	1,155	1,155	1,155	1,155	1,199
Detects	34	267	18	49	71	10
Frequency	3%	23%	2%	4%	6%	<1%
Minimum	0.07	0.07	0.07	0.07	0.07	0
Maximum	3.85	5.09	1.50	3.12	1.39	41.00
Average	0.24	0.18	0.29	0.25	0.16	0.11
Standard Deviation	0.66	0.35	0.39	0.45	0.18	1.25

Sources: ETI (2000), CDM (2000a), CDM (2000b)

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	Benzene	Toluene	Ethylbenzene	m-, p-Xylene	o-Xylene	H_2S
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Sources: ETI (2000), CDM (2000a), CDM (2000b)

Appendix B. Summary of Soil Gas Survey Analytical Results

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Average	0.24	0.18	0.29	0.25	0.16	0.11
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Sources: ETI (2000), CDM (2000a), CDM (2000b)

APPENDIX B
SOIL GAS SURVEY ANALYTICAL RESULTS

Appendix B. Summary of Soil Gas Survey Analytical Results

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Samples	1,155	1,155	1,155	1,155	1,155	1,199
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Minimum	0.07	0.07	0.07	0.07	0.07	0
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Sources: ETI (2000), CDM (2000a), CDM (2000b)

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RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	NA	NA	2.07E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	5.1E-02

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September, 1996

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

ENTER Chemical CAS No (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
7783064	24.3	Hydrogen sulfide

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to top of contamination, L_T (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	121.92	18	SIC		

ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^v (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^v (cm^3/cm^3)	ENTER Vadose zone soil organic carbon fraction, f_{oc}^v (unitless)
1.5	0.43	0.3	0.002

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-05	1
				Used to calculate risk-based soil concentration.	

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RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	NA	NA	2.07E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	1.4E-04

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CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

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YES	

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES	X

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
7783064	0.0654	Hydrogen sulfide

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	121.92	18	SIC		

ENTER Vadose zone soil dry bulk density ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Vadose zone soil organic carbon fraction, f_{oc}^V (unitless)
1.5	0.43	0.3	0.002

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based soil concentration.	

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RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	NA	NA	1.67E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	6.5E-07

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CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
95476	39.6	o-Xylene

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	121.92	18	SIC		

ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^v (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^v (cm^3/cm^3)	ENTER Vadose zone soil organic carbon fraction, f_{oc}^v (unitless)
1.5	0.43	0.3	0.002

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based soil concentration.	

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RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	NA	NA	1.67E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	7.5E-08

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CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES	

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES	X

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_A (µg/kg)	Chemical
95476	4.56	o-Xylene

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	121.92	18	SIC		

ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^v (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^v (cm^3/cm^3)	ENTER Vadose zone soil organic carbon fraction, f_{oc}^v (unitless)
1.5	0.43	0.3	0.002

ENTER Averaging time for carcinogens, AT_c (yrs)	ENTER Averaging time for noncarcinogens, AT_{nc} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based soil concentration	

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RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	NA	NA	1.67E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	1.5E-08

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CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES	

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES	X

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
95476	88.5	o-Xylene

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	121.92	13	SIC		

ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Vadose zone soil organic carbon fraction, f_{oc}^V (unitless)
1.5	0.43	0.3	0.002

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based soil concentration.

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RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	NA	NA	1.67E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	1.2E-07

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CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES	

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES	X

ENTER Chemical CAS No. (numbers only no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
95476	7.1	o-Xylene

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to top of contamination, L_1 (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	121.92	18	SIC		

ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Vadose zone soil organic carbon fraction, f_{oc}^V (unitless)
1.5	0.43	0.3	0.002

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based soil concentration.	

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RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	NA	NA	1.60E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	4.8E-06

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CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
100414	28.15	Ethylbenzene

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Average soil temperature, T_s (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	121.92	18	SIC		

ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Vadose zone soil organic carbon fraction, f_{oc}^V (unitless)
1.5	0.43	0.3	0.002

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based soil concentration.	

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RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	NA	NA	1.60E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	9.4E-07

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September, 1998

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

ENTER Chemical CAS No (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
100414	5.45	Ethylbenzene

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to top of contamination, L_1 (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	121.92	18	SIC		

ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Vadose zone soil organic carbon fraction, f_{oc}^V (unitless)
1.5	0.43	0.3	0.002

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based soil concentration.	

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	NA	NA	3.05E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	3.6E-05

DATA [illegible]Y SHEET

VERSION 1.2
September, 1998

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_K (µg/kg)	Chemical
108883	57.6	Toluene

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to top of contamination, L_1 (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	121.92	18	SIC		

ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^v (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^v (cm^3/cm^3)	ENTER Vadose zone soil organic carbon fraction, f_{oc}^v (unitless)
1.5	0.43	0.3	0.002

ENTER Averaging time for carcinogens, AT_c (yrs)	ENTER Averaging time for noncarcinogens, AT_{nc} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based soil concentration.	

KLEINFELDER

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RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	NA	NA	3.05E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	1.3E-06

DATA Y SHEET

VERSION 1.2
September, 1998

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES	

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES	X

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_A (µg/kg)	Chemical
108883	2.041	Toluene

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Average soil temperature, T_s (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	121.92	18	SIC		

ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Vadose zone soil organic carbon fraction, f_{oc}^V (unitless)
1.5	0.43	0.3	0.002

ENTER Averaging time for carcinogens, AT_c (yrs)	ENTER Averaging time for noncarcinogens, AT_{nc} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based soil concentration.	

KLEINFELDER

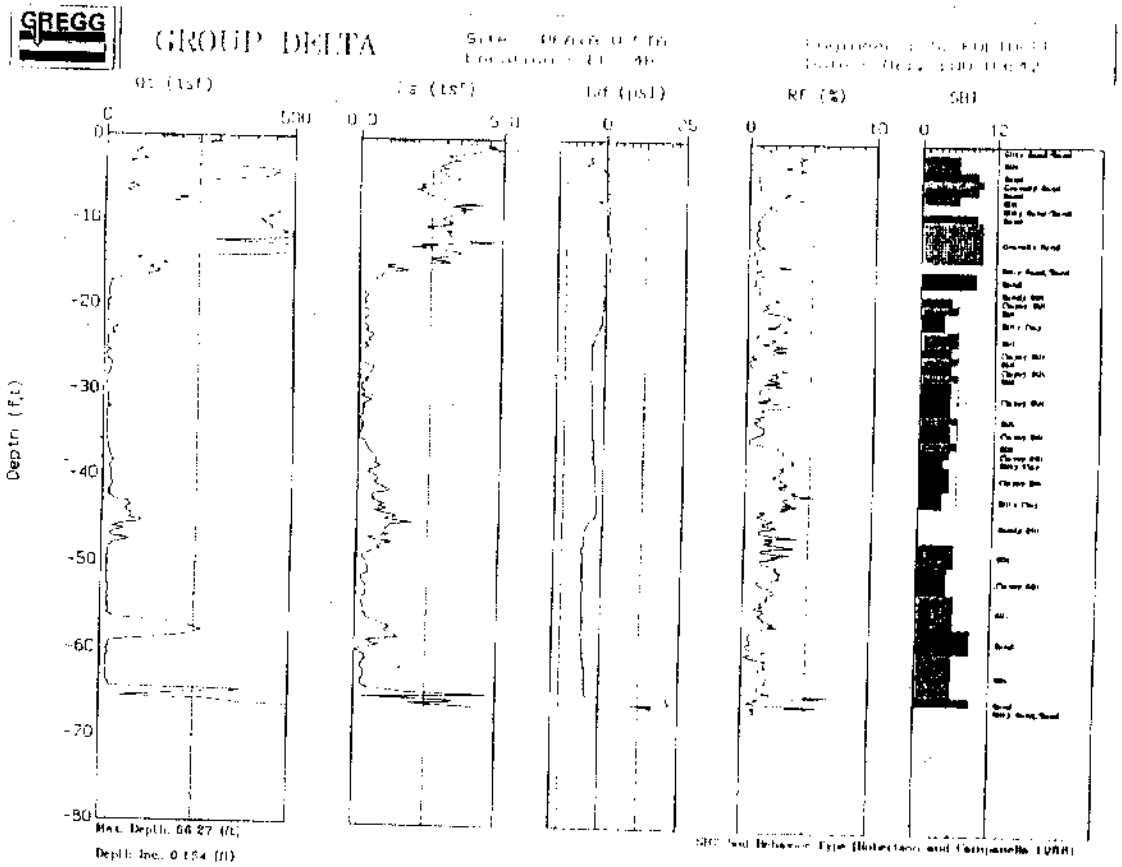
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RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	NA	NA	5.82E+05	NA

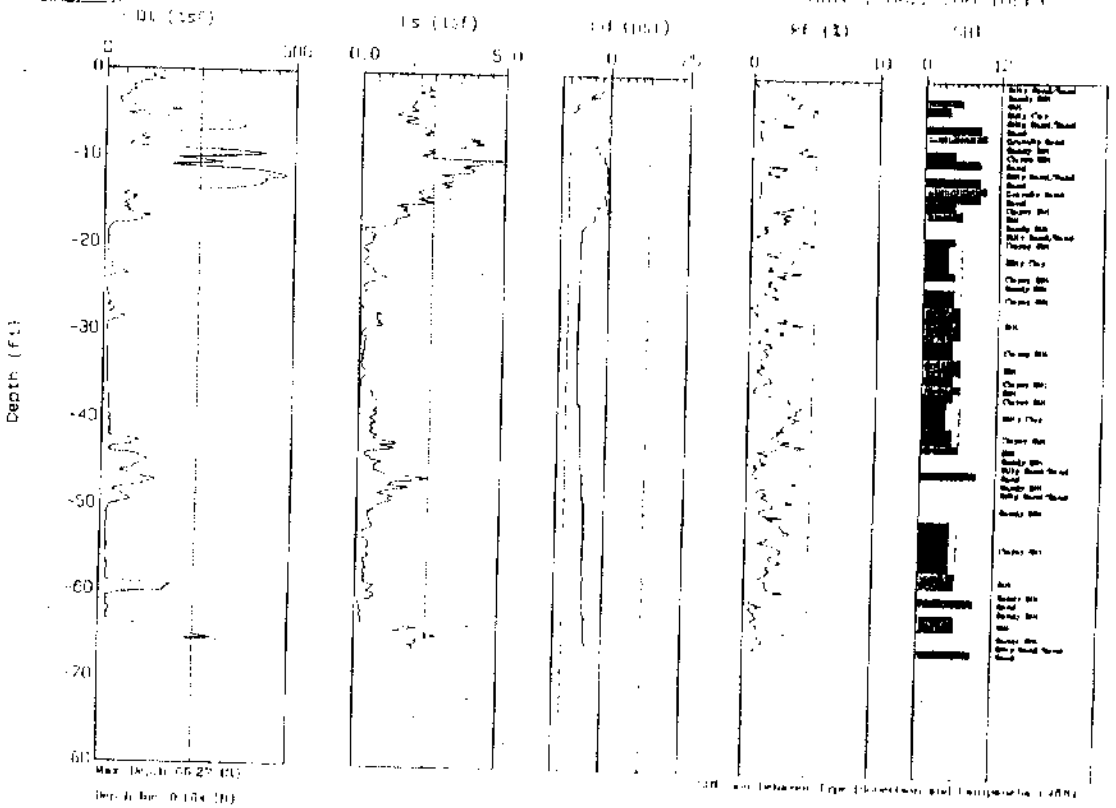
INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.2E-07	1.6E-04


GREGG
GROUP DELTA
Qc (tsf)
Fs (tsf)
Rf (%)
SBT
Depth (ft)
Max. Depth: 66.27 (ft)
Depth Inc.: 0.164 (ft)

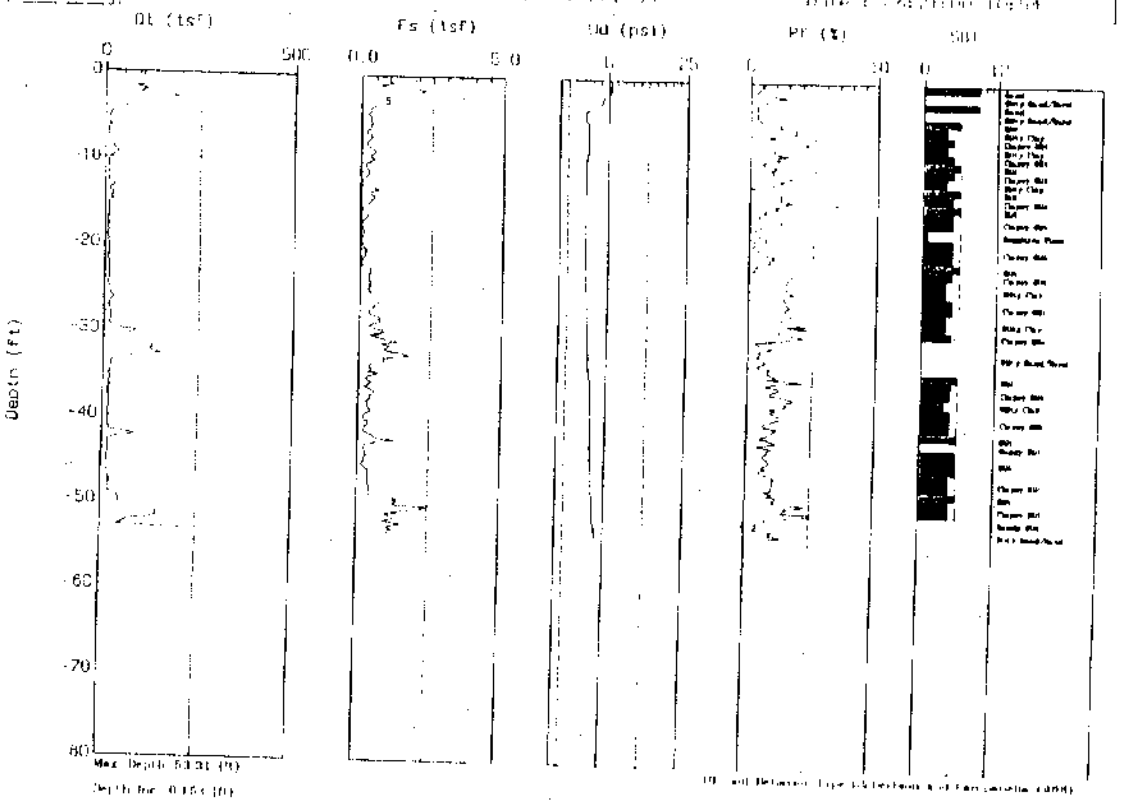
GREGG

GROUP DELTA



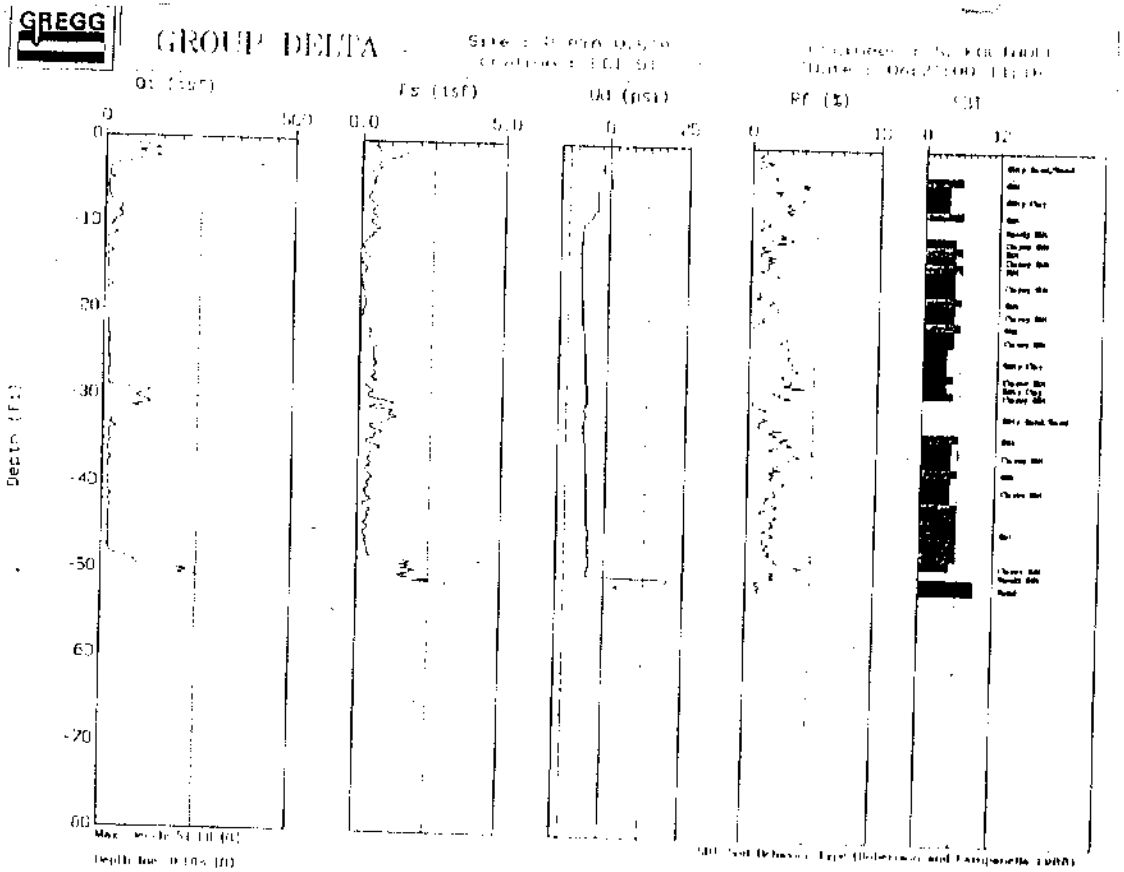
GREGG

GROUP DELTA



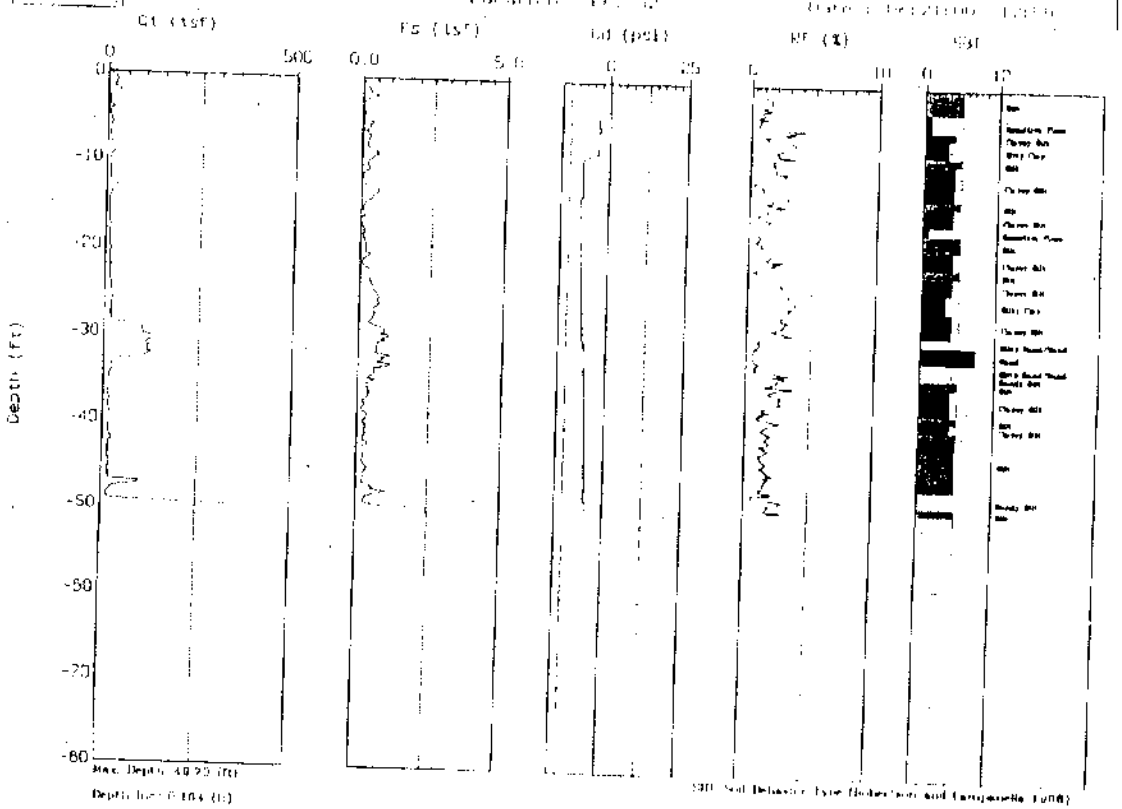
GREGG

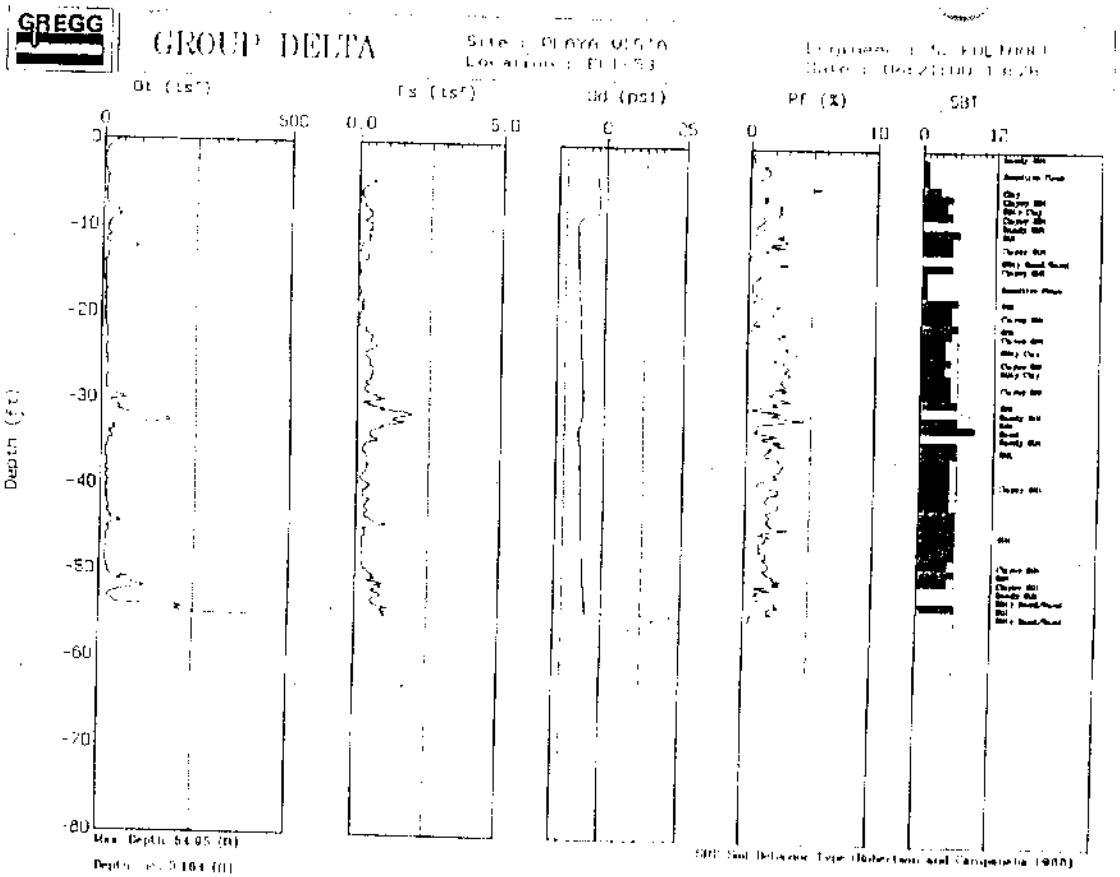
GROUP DELTA



GREGG

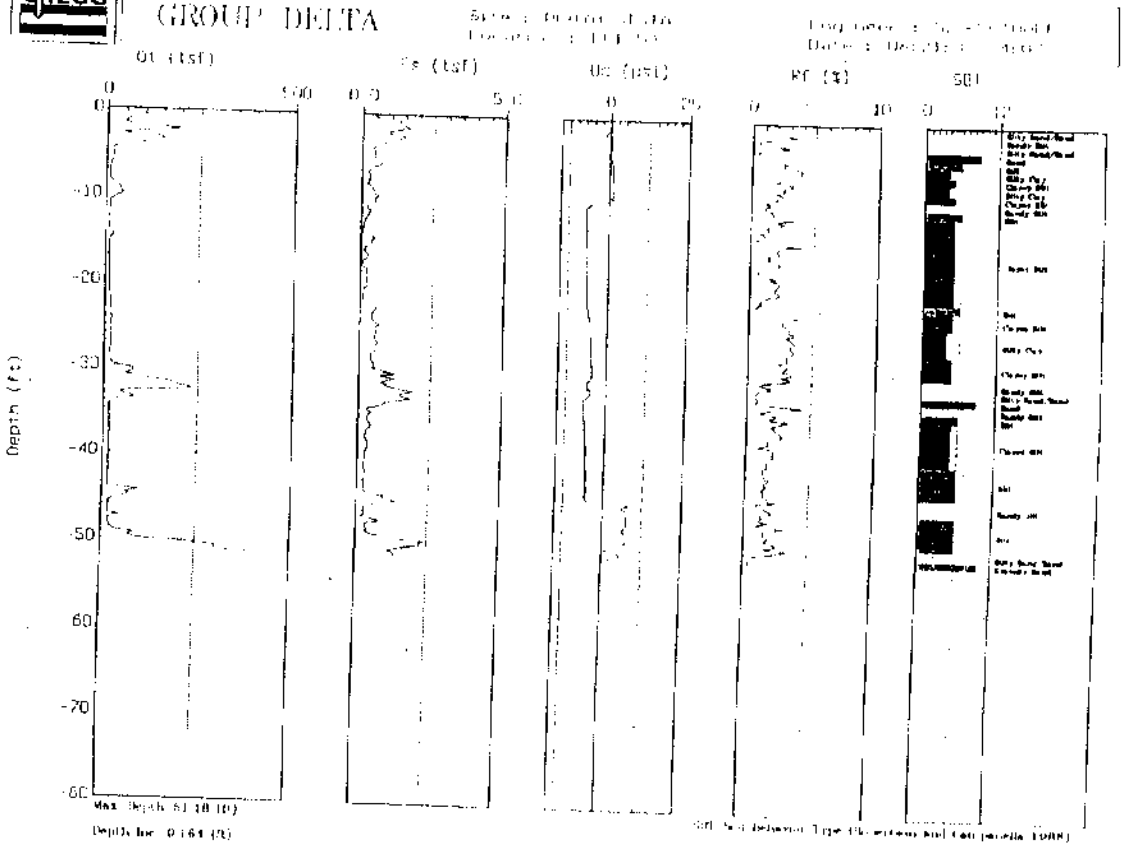
GROUP DELTA




GREGG
GROUP DELTA
Qt (tsf)
Fs (tsf)
Δu (psi)
Pf (%)
SBT
Depth (ft)
0
500
0.0
5.0
0
25
0
10
0
12
-10
-20
-30
-40
-50
-60
-70
-80

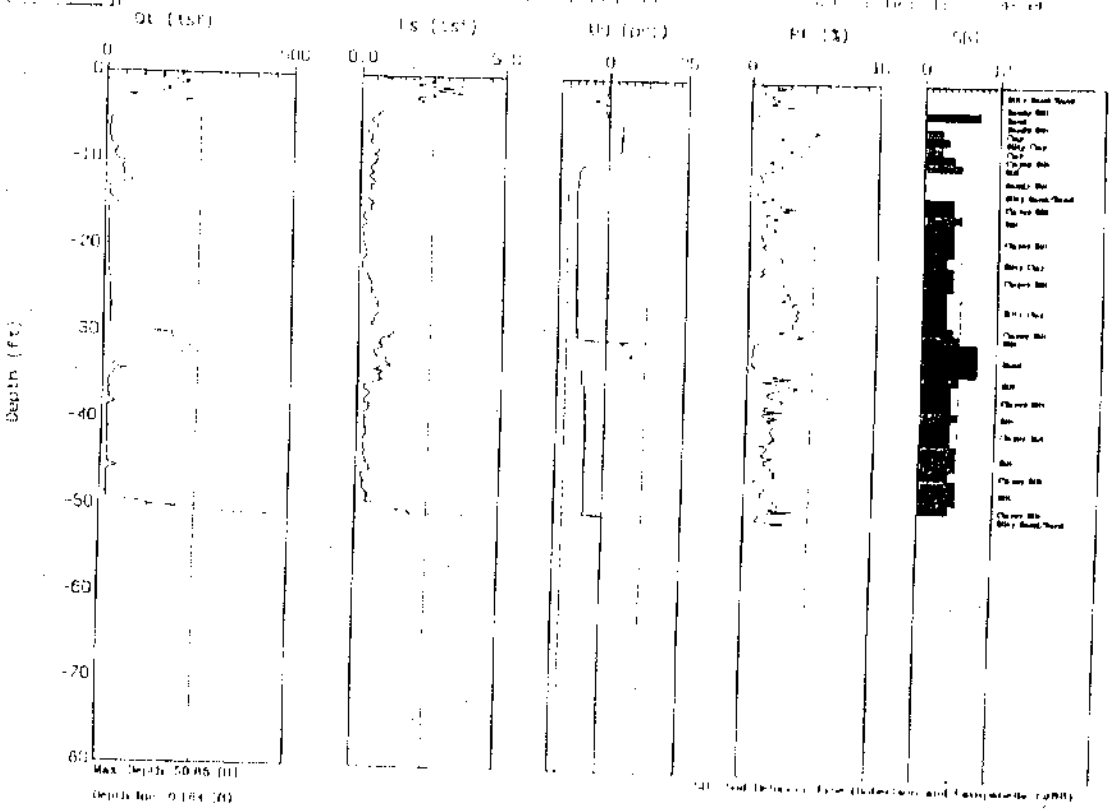
GREGG

GROUP DELTA



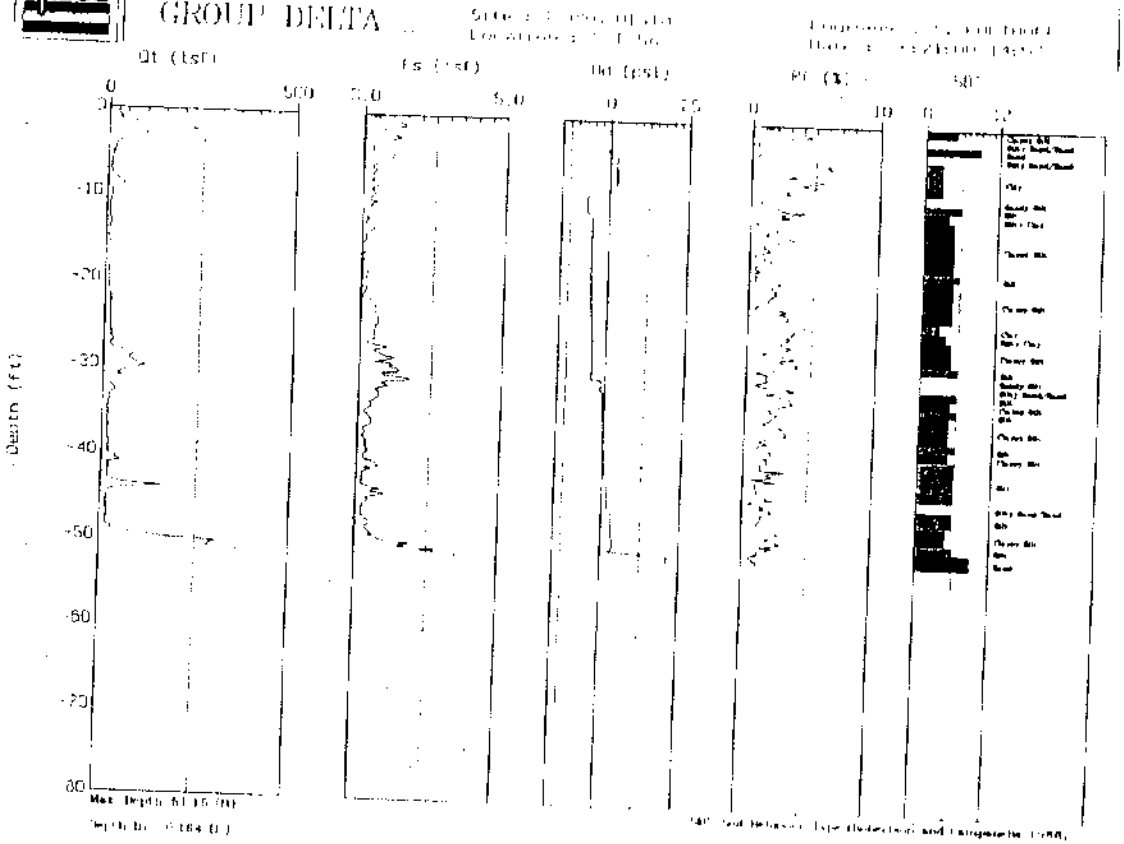
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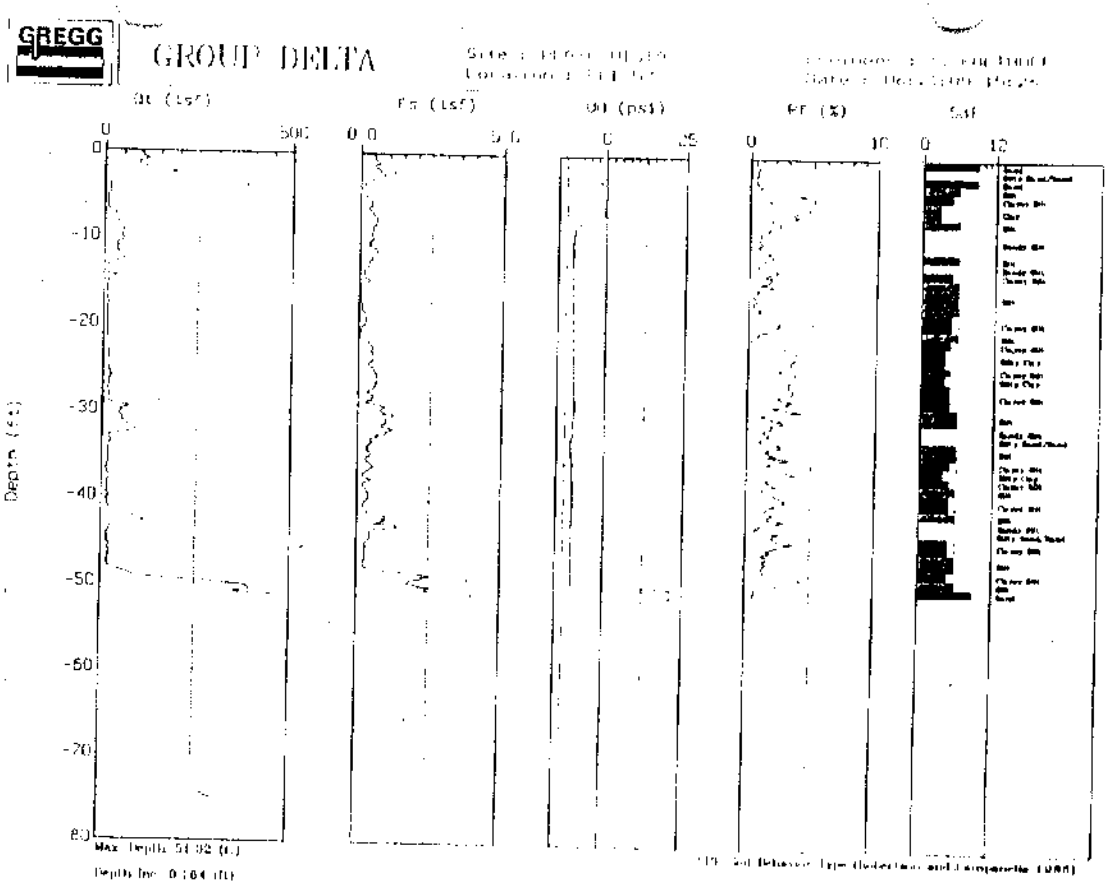
GROUP DELTA



GREGG

GROUP DELTA




GREGG
GROUP DELTA
Qc (tsf)
Fs (tsf)
u2 (psi)
Rf (%)
Sat
Depth (ft)
0
-10
-20
-30
-40
-50
-60
-70
-80
500
5.0
25
10
12
Max Depth 51.82 (ft)
Depth Inc 0.164 (ft)

Appendix E
Boring Logs



GEOTECHNICAL BORING LOG

Date 5-31-00 Drill Hole No. B-1 Sheet 1 of 2

Project [illegible] Job No. [illegible]

Drilling Co. [illegible] Type of Rig [illegible]

Hole Diameter [illegible] Drive Weight [illegible] Drop [illegible] in.

Elevation Top of Hole [illegible] Ref. or Datum [illegible]

Depth Feet	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION
								Logged by [illegible]
								Sampled by [illegible]
								@ 0-5' [illegible]
								@ 5' - 10' [illegible]
								@ 10' [illegible]
								@ 15' [illegible]
								@ 18' [illegible]
								@ 20 [illegible]
								@ 25' [illegible]

GEOTECHNICAL BORING LOG

Date _____ Drill Hole No. _____ Sheet _____ of _____

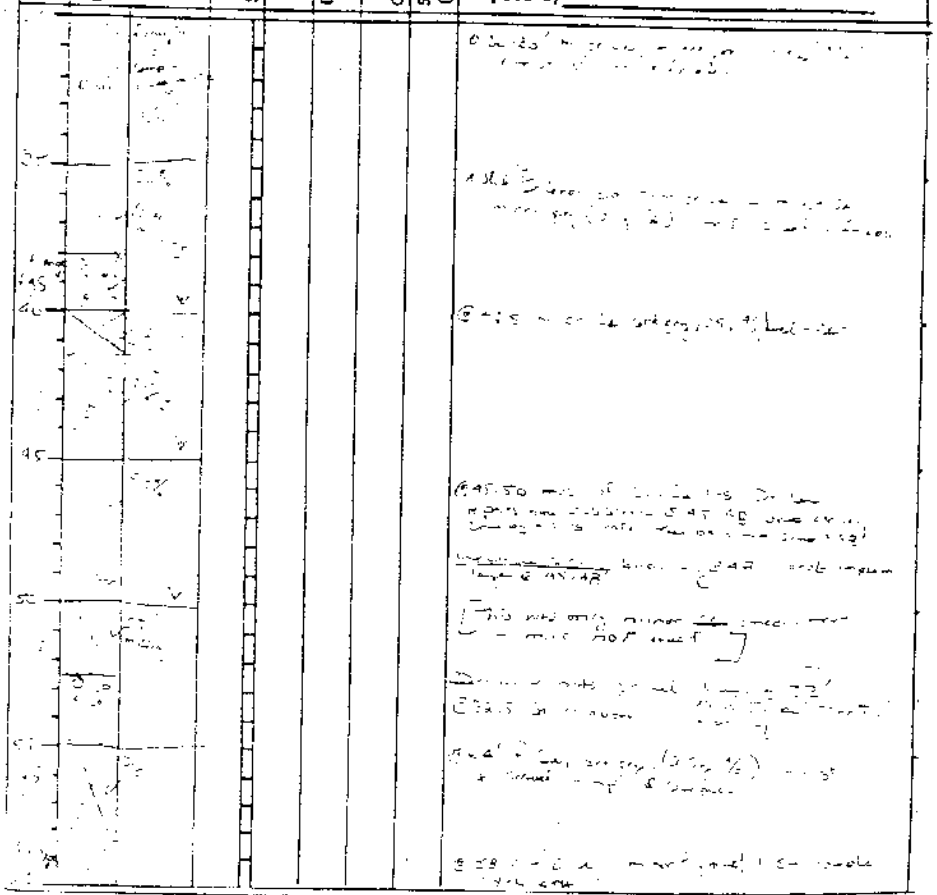
Project _____ Job No. _____

Drilling Co. _____ Type of Rig _____

Hole Diameter _____ Drive Weight _____ Drop _____ in.

Elevation Top of Hole _____ Ref. or Datum _____

Depth Feet	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION Logged by _____ Sampled by _____



Backfilled w/ slurry

GEOTECHNICAL BORING LOG

Date _____ Drill Hole No. _____ Sheet ___ of ___

Project _____ Job No. _____

Drilling Co. _____ Type of Rig _____

Hole Diameter _____ Drive Weight _____ Drop _____ in.

Elevation Top of Hole _____ Ref. or Datum _____

Depth Feet	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION
								Logged by _____
								Sampled by _____
0								
5								
10								
15								
20								
25								

GEOTECHNICAL BORING LOG

Date 5-31-00 Drill Hole No. B-2 Sheet 1 of 1

Project Pinole Point

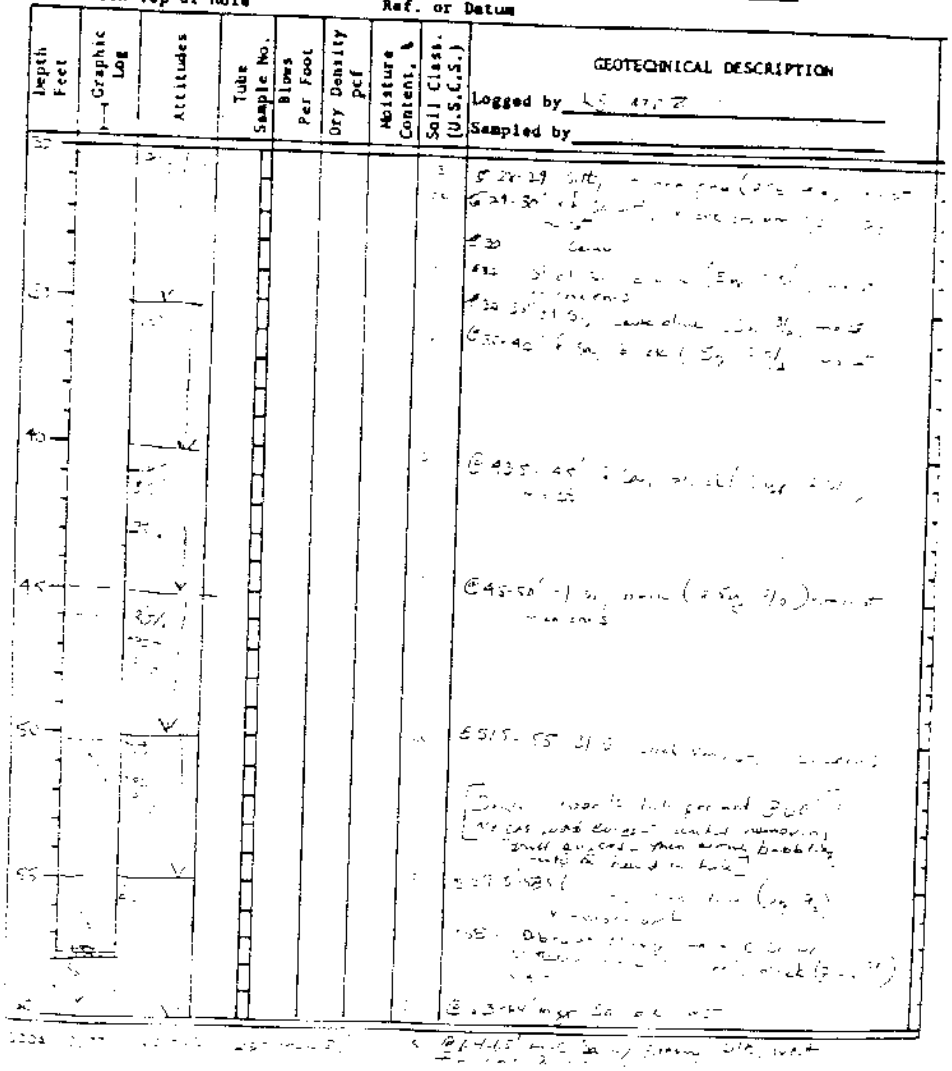
Job No. 700-32-001

Drilling Co. Taber

Type of Rig CME

Hole Diameter 8" Drive Weight Drop in.

Elevation Top of Hole Ref. or Datum



GEOTECHNICAL BORING LOG

Date _____ Drill Hole No. B-3 Sheet 1 of 1

Project _____ Job No. _____

Drilling Co. _____ Type of Rig _____

Hole Diameter _____ Drive Weight _____ Drop _____ in.

Elevation Top of Hole _____ Ref. or Datum _____

Depth Feet	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION
								Logged by _____
								Sampled by _____
0								@ 0'-2' no recovery
								@ 2'-5' [illegible]
								@ 5' [illegible]
								@ 5'-6.5' [illegible]
								@ 6.5'-6.5' [illegible]
								@ 6.5'-9.0' [illegible]
								@ 9.0'-10' [illegible]
10								@ 10' no recovery
								@ 11'-12.5' [illegible]
								@ 12.5' [illegible]
								@ 13.5' [illegible]
								@ 14'-15' [illegible]
								@ 15' [illegible]
								@ 15'-18' [illegible]
								@ 18'-20' [illegible]
								@ 20'-20.8' [illegible]
								@ 20.8'-21' [illegible]
								@ 21'-22' [illegible]
20								@ 22'-23' [illegible]
								@ 23'-25' [illegible]
								@ 25'-30' [illegible]

GEOTECHNICAL BORING LOG

Date _____ Drill Hole No. _____ Sheet _____ of _____

Project _____ Job No. _____

Drilling Co. _____ Type of Rig _____

Hole Diameter _____ Drive Weight _____ Drop _____ in.

Elevation Top of Hole _____ Ref. or Datum _____

Depth Feet	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION
								Logged by _____ Sampled by _____
30								@30-32.5 no recovery
32.5								@32-35 S to mS with gravel
35								@35-37.5 mS with gravel
								@37.5-39.2 C with (2.5Y 5/1)
								39.2-40 C with (2.5Y 5/1)
40								@40-41 no recovery
								@41-44.5 mS with (2.5Y 5/1)
								@44.5-45 C with (2.5Y 5/1)
45								@45-46 no recovery
								@46-47.5 mS with (2.5Y 5/1)
								@47.5-48 C with (2.5Y 5/1)
								@48-49.2 mS with (2.5Y 5/1)
								@49.2-49.5 C with (2.5Y 5/1)
								@49.5-50 mS with (2.5Y 5/1)
50								@50-52 no recovery
								@52-54 mS with (2.5Y 5/1)
								GRAVEL @ 54'
								@54-55' Gravel max size to 2cm, (range ranges to gravel), most are subrounded (2.5Y 5/1)
								TD 55' backfilled w/ slurry

CGA

GEOTECHNICAL BORING LOG

Date _____ Drill Hole No. _____ Sheet ___ of ___

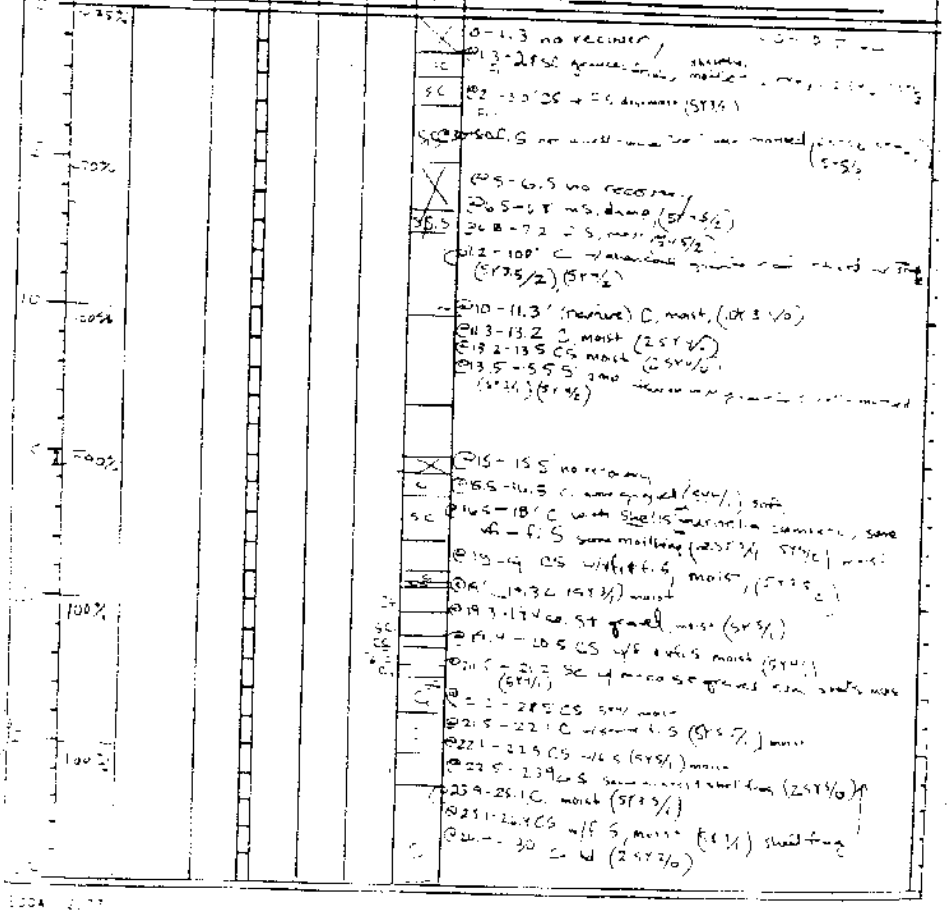
Project _____ Job No. _____

Drilling Co. _____ Type of Rig _____

Hole Diameter _____ Drive Weight _____ Drop _____ in.

Elevation Top of Hole _____ Ref. or Datum _____

Depth Feet	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density pcf	Moisture Content, %	Soil Class (U.S.C.S.)	GEOTECHNICAL DESCRIPTION Logged by _____ Sampled by _____



GEOTECHNICAL BORING LOG

Date _____ Drill Hole No. B-4

Project _____ Sheet _____ of _____

Drilling Co. _____ Job No. _____

Hole Diameter _____ Drive Weight _____ Type of Rig _____

Elevation Top of Hole _____ Ref. or Datum _____ Drop _____ in.

Depth Feet	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION
								Logged by N.S. MSZ
								Sampled by
30								@30-31' no recovery
								@31-33.5 CS w/ trace - S damp (2.5Y 5/6)
								@33.5-35' S w/ CS, moist (2.5Y 5/6)
								@35-36 no recovery
35								@36-38 3' S w/ CS moist (2.5Y 5/6)
								@38 3-39.5' -, moist (5Y 3/1)
								@39-40' CS w/ S (2.5-5Y 3/1)
40								@40-41 no recovery
								@41-41.5 damp-wet, S (2.5Y 5/6)
								@41.5-43.5 CS w/ S (2.5Y 5/6) moist
								@43.5-45 CS w/ S damp-moist (2.5Y 5/6)
								@45-48 no recovery
								@48-48.5 f. S. w/ moist- wet (2.5Y 5/6)
								@48.5-50 S. - m S, damp - wet (2.5Y 5/6)
50								@50-54' no recovery
								@54-55 mS, damp (2.5Y 5/6)
								@55-56 same as 54-55'
								@56-57' gravel round submround max 4 to 2.5 in diam damp-wet 2.5Y 5/6
								TD 57

Backfilled w/ Slurry

GEOTECHNICAL BORING LOG

Date 5-20 Drill Hole No. 2-5 Sheet __ of 3

Project [illegible] Job No. [illegible]

Drilling Co. [illegible] Type of Rig CME [illegible]

Hole Diameter [illegible] Drive Weight [illegible] Drop [illegible] in.

Elevation Top of Hole [illegible] Ref. or Datum

Depth Feet	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION
								Logged by [illegible]
								Sampled by [illegible]
								@ 0 - 2.5 no recovery
								@ 2.5 - 5.0 f-mS moist (10YR 3/3) [illegible]
								@ 5 - 5.6 no recovery
								@ 5.5 - 6.8' CS, mst. (2.5Y 4/4) [illegible]
								@ 6.8 - 8.5 SC mst. f-mS, (10YR 3/2.5)
								@ 8.5 - 9.9' CS w/gravels, moist (10YR 3/2) [illegible]
								@ 9.9 - 11.9' SC f-mS gravels up to 2" [illegible]
								@ 11.9 - 12.3' CS mst gravels (10YR 3/3)
								@ 12.3 - 14' f-S w/ gravels (10YR 4/4)
								@ 14 - 17 CS dry - moist bld, w/gravels [illegible]
								@ 17 - 18.5 (2.5Y 6/2) [illegible]
								@ 18.8 - 19.5C
								@ 19.5 - 20' f-S (10YR 4/4) moist-dr
								@ 20 - 23 no recovery
								@ 23 - 24.2 f-S some clay (2.5Y 4/3) moist
								@ 24.2 - 24.9 m-f S, dmp. (2.5Y 3.5/2)

GEOTECHNICAL BORING LOG

Date 1-15-25 Drill Hole No. B-5 Sheet 1 of 3

Project Phase 1 Site Job No. [illegible]

Drilling Co. Cascade Type of Rig CME [illegible]

Hole Diameter [illegible] Drive Weight [illegible] Drop [illegible] in.

Elevation Top of Hole [illegible] Ref. or Datum [illegible]

Depth Feet	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION
								Logged by CS, TDC
								Sampled by [illegible]
30								@ 30' SS to recovery
35								
40								
45								
50								@ 50-53.5' wet mS, 2.5Y 3/1
55								@ 53-60' sat mS 12.5Y 5/1

GEOTECHNICAL BORING LOG

Date 6-5-00 Drill Hole No. B-5 Sheet 1 of 2

Project Plaza 156 Job No. 340-30-50

Drilling Co. Cascade Type of Rig CME Hollow Stem Auger

Hole Diameter 8" Drive Weight _____ Drop _____ in.

Elevation Top of Hole _____ Ref. or Datum _____

Depth Feet	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION
								Logged by _____ Sampled by _____
50								@50-53 SM reddish brown
								@53-54.5 Sat. SM (2.5Y3/0)
								@54.5-55 SM
								@55-65 no recovery
								@65-70.5 wet SM, SAND (2.5Y3/0)
								@70.5-71 F.S. dense (2.5Y3/0)
75								@71.5 Gravel layer, moist (2.5Y4/2)

T.D. 71.5

PLATES WILL BE PROVIDED
UPON REQUEST

CITY OF LOS ANGELES
INTER-DEPARTMENTAL CORRESPONDENCE

Date: February 21, 2001

To: Ronald Deaton
Chief Legislative Officer

Attn.: Barbara Garrett

From: P.J. (Mike) Michalski, Engineering Geologist III
Bureau of Engineering

Subject: PUBLIC WORKS VISIT WITH CALIFORMIA DIVISION OF MINES & GEOLOGY, SACRAMENTO REGARDING FAULT POTENTIAL
PLAYA VISTA PROJECT - (File 96-092) WO E1200434

On February 6, 2001, two engineering geologists with the Department of Public Works, Geotechnical Engineering Division (GED) and two representatives from your office met in Sacramento with State geologists who have responsibility to study and classify faults as to their recency and potential for causing property damage. Michael Reichle, Ph.D., Supervising Geologist, and William Bryant, Senior Geologist in the Alquist-Priolo fault classification program, were in attendance. The purpose of the visit was to determine if the studies submitted by Playa Vista Capital were adequate to assess the potential presence of a fault or faults on or adjacent to the project site.

The studies submitted to and reviewed by the State included a July 2000 report by Earth Consultants International Inc. titled "Geologic Study to Evaluate the Potential for Active Faulting Near the Intersection of Lincoln and Jefferson Boulevards, at the Playa Vista Site, in he City of Los Angeles, California" This report, signed by California-registered geologists of international reputation, reviewed extensive published geologic reports and maps covering the area, unpublished geologic and geotechnical reports and incorporated the results of numerous drilling and cone penetrometer tests (CPTs) to provide detailed correlations of Pleistocene strata which may have been offset by any faulting. Another study reviewed by the State was the November 10,2001 report by Davis & Namson Consulting Geologists titled "An Evaluation of the Subsurface Structure of the Playa Vista Project Site and Adjacent Area". This report, also signed by California registered geologists who are widely published in the industry, reviewed extensive subsurface data and cross-sections, existing seismic lines, and acquired extensive new onshore and offshore geophysical data, chiefly seismic reflection. No offsets are visible in sediments deposited during the last 2.5 to 3.0 million years or older, including in areas of the proposed "Lincoln Boulevard Fault" nor of the Charnock Fault.

CONCLUSION

The State geologists, reviewing these two reports and two boxes of supporting data and references agree with the conclusions of the reports, that there is no evidence for the "Lincoln Park Fault" or any other recent faulting on the Playa Vista site. They stated that they will prepare a letter to this effect, pending review of a few more pieces of data to be provided by Dr. Davis and after a discussion with Mr. Mark Zoback at Stanford University. They are also reviewing additional data from offshore which may indicate two small faults (or other interpretations of the shallow seismic data), and which, even if present, most likely will not affect the project site.

If you have any questions with this review, please contact Mike Mulhern, CEG 1507, HG 306 at (213) 847-4011.

c: Clark Robins, Deputy City Engineer
Susan Pfann, Deputy City Attorney

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LOS ANGELES, CA 90012

ANDREW A. ADELMAN
GENERAL MANAGER

WALT KRUKOW
EXECUTIVE OFFICER

December 19, 2000

ATTACHMENT 7

Mr. David Nelson
Senior Vice President
Playa Capital Company
12555 W. Jefferson Bl., #300
Los Angeles, CA 90066

CURRENT REFERENCE REPORT/LETTER(S)	REPORT NO.	DATE(S) OF DOCUMENT	PREPARED BY
Review letter	-	12/07/00	ETI
Geologic Report	-	11/16/00	Davis & Namson

The referenced review letter and geologic report concerning an evaluation of the subsurface geologic structure of the Playa Vista project site have been received by the Grading Section of the Department of Building and Safety. The purpose of the geologic report was to evaluate the possibility of a Lincoln Boulevard fault, as postulated in the report of April, 2000 by Exploration Technologies, Inc. The conclusion of the report is that no evidence was found for the postulated Lincoln Boulevard fault. Exploration Technologies, Inc has reviewed the data and agrees that a postulated Lincoln Boulevard fault that would provide a pathway for gas from the Southern California Gas Co. storage field to the Playa Vista site is unsubstantiated. The Department accepts these conclusions.

DAVID H. SU
Chief of Grading Section

(213) 977-6329

cc: Exploration Technologies, Inc
Davis & Namson

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HUMAN HEALTH RISK ASSESSMENT
PLAYA VISTA DEVELOPMENT
LOS ANGELES, CALIFORNIA

February 6, 2001

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HUMAN HEALTH RISK ASSESSMENT
PLAYA VISTA DEVELOPMENT
LOS ANGELES, CALIFORNIA

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EXECUTIVE SUMMARY

Kleinfelder conducted a human health risk assessment of chemicals present in soil gas on the Playa Vista development in Los Angeles, California. A widely-used computer model approved and published by U.S. EPA (EQM 1997) for subsurface vapor intrusion into buildings was used to assess potential exposures of future residents of the Playa Vista development to benzene, ethylbenzene, toluene, xylenes (collectively known as the BTEX compounds), and hydrogen sulfide vapors that may migrate from subsurface soil to indoor air. Migration of these vapors into indoor spaces constitutes a potential inhalation exposure. The computer model was used to estimate the excess lifetime cancer risk and the noncancer hazard that may be associated with inhalation of organic soil vapors that migrate aboveground from the subsurface. Only the inhalation exposure pathway was quantitatively evaluated because the chemicals of concern are present as vapors and other exposure pathways, such as skin contact, do not pose a hazard at the concentrations measured.

CHEMICALS OF CONCERN

The soil gas survey data upon which the model runs were based were developed from the results of three surveys conducted in 1999 and 2000 on the subject property (ETI 2000; CDM 2000a; CDM 2000b). Measurable levels of methane, hydrogen sulfide, and BTEX compounds have been detected in soil gas samples collected in these surveys.

The three soil gas surveys evaluated the presence of methane, which was measured at the survey depths of 4 to 4.5 feet below ground surface at concentrations of up to 891,543 ppmv. The health hazards associated with methane were not quantified in this risk assessment because methane does not cause systemic effects like lung, liver, or kidney damage. At high concentrations, methane is an asphyxiant. Concentrations of methane much lower than those of concern for asphyxiation pose an explosion hazard. Therefore, methane mitigation measures required for this project by the City of Los Angeles, Department of Building and Safety are more than adequate to address the potential health hazards associated with this gas.

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Of the more than 1,000 soil gas samples analyzed for BTEX compounds and hydrogen sulfide, benzene and ethylbenzene were positively detected in less than 5% of the samples. Chemicals detected in less than 5% of the samples analyzed do not necessarily warrant evaluation in a risk assessment and, with regulatory agency approval, can be omitted from a risk assessment (EPA 1989). However, to ensure that risk calculations performed in support of this analysis are conservative, the cancer risk and noncancer hazard that may be associated with chemicals detected in fewer than 5% of the samples were quantified and incorporated into the total cancer risk and noncancer hazard estimated for the site.

EXPOSURE ASSUMPTIONS

The estimates of cancer risk and noncancer hazard developed in this risk assessment were based on an individual who lives on the subject site 24 hours per day, 350 days per year, for 30 years, averaged over a 70 year period (U.S. EPA 1989; OEHHA 1994; and DTSC 1999) and is exposed to the chemicals of concern that have migrated above ground. Separate estimates of cancer risk and noncancer hazard were developed from the average and the maximum soil gas concentration of each of the chemicals of concern.

This human health risk assessment is based on EPA's *reasonable maximum exposure* (RME) assumptions (EPA 1989). The RME is defined as the highest exposure that is reasonably expected to occur at a site. The intent of the RME is to estimate a conservative exposure case (i.e., well above the average case) that is still within the range of possible exposures. The key RME assumptions applied in this risk assessment are as follows:

- Exposure frequency – 350 days per year, 24 hours per day, which assumes that the receptor does not leave the home except for a two-week vacation each year;
- Exposure duration – 30 years (U.S. EPA 1989; OEHHA 1994; and DTSC 1999), which represents the 90th percentile based on the 1990 census (EPA 1997);
- Exposures to carcinogens were averaged over a 70 year lifetime (U.S. EPA 1989; OEHHA 1994; and DTSC 1999).

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- Exposure point concentration – includes the maximum measured concentration although the maximum concentration occurred at only one of 1,155 locations sampled. For benzene (the chemical that poses the greatest health hazard based on this risk assessment) the maximum concentration was almost four times greater than the next highest concentration and benzene was detected in fewer than 5% of the 1,155 samples analyzed;
- Protective of children – longer exposure duration (30 years vs. 6 years) and greater magnitude of exposure (inhalation rate of 20 m^3/day vs. 10 m^3/day) were assumed;
- Cancer risk and noncancer hazard were quantified for chemicals present in less than 5% of samples analyzed (i.e., benzene and ethylbenzene). Chemicals detected with low frequency do not necessarily require evaluation. With regulatory agency approval, chemicals detected in less than 5% of samples analyzed can be omitted from a risk assessment; and
- This risk assessment evaluated all soil vapor measurements, regardless of the potential source of the vapors (i.e., thermogenic releases, near-surface releases of contaminants in soils, or volatilization of contaminants in groundwater).
- The California cancer risk factor for benzene, which is more health protective than the U.S. EPA Cancer risk factor, was used in this risk assessment.
- No mitigation measures (e.g., vapor barriers, vapor collection systems) were incorporated into the assessment of health risk.

Vapor migration to outdoor air was not evaluated because migration to indoor air poses a more significant hazard. The indoor air hazard estimated in this risk assessment was below regulatory limits, therefore, an evaluation of outdoor air was not necessary. Commercial exposure was not evaluated because the exposed individuals spend more time at home than they do at work; therefore, the potential health risks associated with residential exposure exceeds those of commercial exposure.

CANCER RISK THRESHOLD

Cancer risk was quantified as the excess lifetime cancer risk, which is the probability that an individual exposed, under the conditions defined in the risk assessment, to the chemicals of concern will develop cancer as a result of that exposure over and above the background rate of cancer in the US population. The background rate of cancer in the US is about 1 in 3 (American

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Cancer Society 1993). Therefore, of the roughly 300,000,000 citizens of the US, 100,000,000 can expect to develop some form of cancer at some time in their lives. If the entire population of the US were to reside on a site where, due to chemical contamination, the excess lifetime cancer risk was 1×10^{-6} (1 chance in 1,000,000), then an additional 300 citizens might develop some form of cancer as a result, and the total number of cancer cases would be 100,000,300.

For the development of cancer, the California Office of Environmental Health Hazard Assessment (OEHHA) has developed "No Significant Risk Levels" for carcinogens that are based on an excess lifetime cancer risk of 1×10^{-5} (OEHHA 1994). EPA has recommended that a cancer risk range of 10^{-6} to 10^{-4} be used for making decisions about whether further investigation or remediation is warranted (EPA 1986). Thus, when the cumulative cancer risk for a given site is less than 1×10^{-6}, further investigation and remediation are generally not warranted. A cumulative cancer risk of 1×10^{-6} means that there is a 1 in 1,000,000 chance that cancer will develop in an exposed individual at some time in their life as a result of exposure to the chemicals of concern. Of the chemicals of concern evaluated in this risk assessment, only benzene is classified as a carcinogen.

NONCANCER HAZARD THRESHOLD

Noncancer hazard is quantified based on an estimated dose to which a resident may be exposed, under the conditions defined in the risk assessment, compared to a reference dose (RfD) developed by the U.S. EPA. The RfD is a dose that is not expected to result in adverse health effects. If the ratio of the estimated dose and the RfD is less than 1.0, then adverse health effects are not expected. The ratio of the estimated dose and the RfD is called the hazard quotient.

For noncancer hazards, EPA has recommended a hazard quotient of 1 as the point of departure for making decisions about further investigation or remediation. The hazard quotient is the result of dividing an estimated intake of a chemical through soil ingestion, inhalation, or dermal contact, or all three by a daily dose of a chemical that is expected to be without harm, the reference dose. When total intake exceeds the reference dose, the hazard quotient is greater than 1 and there is an increased likelihood that noncancerous adverse health effects will develop in the exposed population.

RESULTS AND CONCLUSIONS

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Based on the risk assessment described in this report, the cancer risk that may be associated with exposure to soil gas (BTEX and hydrogen sulfide) that has migrated aboveground is 7×10^{-9} for average soil gas concentrations and 1×10^{-7} for maximum concentrations. These cancer risk estimates are well below the 1×10^{-6} cancer risk that DTSC, EPA, and other regulatory agencies consider to be acceptable and does not require further investigation or remediation.

The noncancer hazard quotient was estimated to be 0.0001 for average soil gas concentrations and 0.051 for maximum concentrations. DTSC and EPA consider a noncancer hazard quotient below 1.0 to be acceptable and does not require further investigation or remediation.

On the basis of these risk assessment results, Kleinfelder recommends that no further investigation or remediation are necessary to adequately protect commercial workers; adult and child residents; and school children from soil gas vapors that may migrate from the subsurface environment into the outdoor air or structures built on the subject property.

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1.0 INTRODUCTION

A human health risk assessment was conducted to evaluate the potential exposure of hypothetical future residents of the Playa Vista development to benzene, ethylbenzene, toluene, xylenes, and hydrogen sulfide vapors that may migrate aboveground from subsurface soil. Migration of these vapors into indoor spaces constitutes a potential inhalation exposure and may pose a health hazard. An EPA-approved computer model, the Johnson and Ettinger Model, was used to estimate the excess lifetime cancer risk and the noncancer hazard that may be associated with inhalation of organic vapors that migrate from the subsurface into a home.

1.1 RISK ASSESSMENT PURPOSE AND PROCESS

A risk assessment helps to answer two key questions about a site that has been contaminated by chemical releases: does the contamination pose a hazard to human health, and, if so, what level of hazard does it pose? To answer these questions the risk assessor:

- Identifies chemicals of concern,
- Evaluates how a receptor group may come into contact with those chemicals,
- Estimates the magnitude of exposure during that contact, and based on what is known about the toxicity of the chemicals of concern,
- Seeks to qualitatively and quantitatively estimate the level of hazard posed.

Simplifying assumptions are made throughout the development of the risk assessment. These assumptions tend to result in an overestimate of the actual risk at a given site. Therefore, it is highly unlikely that the risk assessment will result in a "false negative." That is to say, it is highly unlikely that an unacceptable health hazard would be overlooked.

The exposure scenario evaluated in this risk assessment was based on highly conservative and health-protective assumptions. The maximally-exposed individual was assumed to be a future onsite resident who will live in a home constructed on the subject site at the location of the

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highest concentrations of the chemicals of concern for 350 days per year for 30 years averaged over a 70 year period. (U.S. EPA 1989, 1997; OEHHA 1994; and DTSC 1999). These assumptions are also protective of children because they are based on an adult exposure period that is longer (30 years vs. 6 years) and of greater magnitude (inhalation rate of 20 m^3/day vs. 10 m^3/day) than those for a child. In other words, the child exposure used in these analyses was a factor of 10 higher than actual exposure conditions.

The onsite resident exposure scenario is also likely to be a substantial overestimation of the true residential exposure situation. The onsite resident was assumed to remain in a single location (where the highest concentrations of the chemicals of concern occur) for 350 days per year over 30 years, averaged over 70 years (U.S. EPA 1989; OEHHA 1994; and DTSC 1999). Furthermore, exposures were modeled based on the assumption that the maximum source vapor concentration occurred across the site although the maximum concentration occurred at only one of the 1,155 locations sampled. For example, the cancer risk that may be associated with the maximum soil gas concentration of benzene was based on the assumption that the maximum concentration of benzene occurred throughout the site, not only at the location where that measurement was made.

Of the more than 1,000 soil gas samples analyzed for BTEX compounds and hydrogen sulfide, benzene and ethylbenzene were positively detected in less than 5% of the samples. Chemicals detected in less than 5% of the samples analyzed do not necessarily warrant evaluation in a risk assessment and, with regulatory agency approval, can be omitted from a risk assessment (EPA 1989). However, to ensure that risk calculations performed in support of this analysis are conservative, the cancer risk and noncancer hazard that may be associated with chemicals detected in fewer than 5% of the samples were quantified and incorporated into the total cancer risk and noncancer hazard estimated for the site. In spite of these conservative, health-protective, assumptions, the cancer risk and noncancer hazard based on the average and maximum soil gas concentrations are much less than EPA's point of departure discussed below.

The quantitative assessment criteria applied in a human health risk assessment are based on the probability that cancer will develop in an exposed population or the likelihood that noncancerous effects will develop in that population as a result of exposure to the chemicals of concern. For the

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development of cancer, the California Office of Environmental Health Hazard Assessment (OEHHA) has developed "No Significant Risk Levels" for carcinogens that are based on an excess lifetime cancer risk of 1×10^{-5} (OEHHA 1994). EPA has recommended that a cancer risk range of 10^{-6} to 10^{-4} be used for making decisions about whether further investigation or remediation is warranted (EPA 1986). Thus, when the cumulative cancer risk for a given site is less than 1×10^{-6}, further investigation and remediation are generally not warranted. A cumulative cancer risk of 1×10^{-6} means that there is a 1 in 1,000,000 chance that cancer will develop in an exposed individual at some time in their life as a result of exposure to the chemicals of concern. To put this cancer risk in perspective, the background rate of cancer in the United States is about 1 in 3 (American Cancer Society 1993). Therefore, of the roughly 300,000,000 citizens of the United States, 100,000,000 can expect to develop some form of cancer at some time in their lives. If the entire population of the United States were to reside on a site where, due to chemical contamination, the excess lifetime cancer risk was 1×10^{-6}, then an additional 300 citizens might develop some form of cancer as a result and the total number of cancer cases would be 100,000,300. Of the chemicals of concern evaluated in this risk assessment, only benzene is classified as a carcinogen.

For noncancer hazards, EPA has recommended a hazard quotient of 1 as the point of departure for making decisions about further investigation or remediation. The hazard quotient is the result of dividing an estimated intake of a chemical through soil ingestion, inhalation, or dermal contact, or all three by a daily dose of a chemical that is expected to be without harm, the reference dose. When total intake exceeds the reference dose, the hazard quotient is greater than 1 and there is an increased likelihood that noncancerous adverse health effects will develop in the exposed population.

The three soil gas surveys also evaluated the presence of methane, which was present at the survey depths of 4 to 4.5 feet below ground surface at concentrations of up to 891,543 ppmv. The health hazards associated with methane were not quantified in this risk assessment because it is a simple asphyxiant without any systemic effects like lung, liver, or kidney damage. An asphyxiant simply replaces oxygen in breathable air. The health hazards associated with methane can be successfully managed with engineering controls, including vapor barriers and collection systems that are required in the building code of the City of Los Angeles.

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1.2 THE JOHNSON AND ETTINGER MODEL

Johnson and Ettinger (1991, cited in EQM 1997) introduced a screening-level model which incorporates both convective and diffusive mechanisms for estimating the transport of contaminant vapors emanating from groundwater into indoor spaces located directly above or near the source of contamination. Johnson and Ettinger reported that the results of the model were in qualitative agreement with published experimental case histories and in good qualitative and quantitative agreement with detailed three-dimensional numerical modeling of radon transport into houses (Loureiro, et al. 1990, cited in EQM 1997).

The Johnson and Ettinger Model is a one-dimensional analytical solution to convective and diffusive vapor transport into indoor spaces and provides an estimated attenuation coefficient that relates the vapor concentration in the indoor space to the vapor concentration at the source of contamination. The model can provide a steady-state solution to vapor transport (infinite or nondiminishing source) and a quasi-steady-state solution (finite or diminishing source). Inputs to the model include chemical properties of the contaminants, saturated and unsaturated zone soil properties, and structural properties of the building.

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2.0 JOHNSON AND ETTINGER MODEL INPUTS

The Johnson and Ettinger model requires several input variables for estimating excess lifetime cancer risk and noncancer hazard. Table 2-1 provides a summary of the model inputs used to evaluate the health hazards that may be associated with benzene, ethylbenzene, toluene, xylenes, and hydrogen sulfide present as soil gas at the Playa Vista site. The Data Entry Numbers identified in Table 2-1 correspond to the inputs in the model data entry sheets (Appendix A). Land use at the subject site was assumed to be residential, therefore, the model inputs for exposure duration and exposure frequency were consistent with California Department of Toxic Substances Control (DTSC) (DTSC 1999) and U.S. EPA default assumptions for a residential exposure scenario (EPA 1989, 1997).

TABLE 2-1
SUMMARY OF JOHNSON AND ETTINGER MODEL ASSUMPTIONS - SOIL

Data Entry Number	Parameter	Comment
1	Depth below grade to bottom of enclosed space floor	15 cm, default value for slab-on-grade construction.
2	Depth below grade to location of soil gas measurement	*Soil* – Four feet (122 cm) based on shallowest soil sampling depth.
3	Average soil temperature	18°C, estimated for Southern California (EQM 1997).
4	Vadose zone SCS soil type	Soil type "silty clay" selected based on boring log observations.
5	Vadose zone soil dry bulk density	1.5 g/cm^3, default value recommended in EQM (1997).
6	Vadose zone soil total porosity	0.43, default value recommended in EQM (1997).
7	Vadose zone soil water-filled porosity	0.3 cm^3/cm^3, default value recommended in EQM (1997).
8	Vadose zone soil organic carbon fraction	0.002 (unitless), default value recommended in EQM (1997).
9	Averaging time for carcinogens	70 years, U.S. EPA (1997, 1989), OEHHA (1994), and DTSC (1999)
10	Averaging time for noncarcinogens	30 years (residents), U.S. EPA (1997, 1989), OEHHA (1994), and DTSC (1999)
11	Exposure duration	30 years (residential), U.S. EPA (1997), OEHHA (1994), and DTSC (1999)

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TABLE 2-1 (Continued)
SUMMARY OF JOHNSON AND ETTINGER MODEL ASSUMPTIONS - SOIL

Data Entry Number	Parameter	Comment
12	Exposure frequency	350 days per year (residential), U.S. EPA (1997)
13	Target risk for carcinogens	1×10^{-6}, considered as the *de minimis* standard by U.S. EPA.
14	Target hazard quotient for noncarcinogens	1.0, considered as the *de minimis* standard by U.S. EPA.

In all cases, the most health-protective model inputs were selected or, lacking site-specific information, the default model inputs recommended in EQM (1997) were selected. This approach represents a reasonable upper-bound on the range of values. Therefore, the risk assessment results are overly protective of human health.

2.1 SOIL GAS ANALYTICAL DATA

This risk assessment is based on soil gas data published in three reports of soil gas surveys conducted across the Playa Vista site in 1999 and 2000. The survey approach, areas of concern, and results are discussed below.

2.1.1 Exploration Technologies, Inc. (ETI), April 17, 2000.

ETI designed and supervised a shallow soil vapor survey in Tracts 01, 02, and 03 (First Phase) of the proposed Playa Vista development. The survey consisted of 812 sampling locations on a 100-foot staggered grid and soil vapor samples were collected from a depth of four-feet below ground surface (bgs). The vapor samples were analyzed for benzene, ethylbenzene, toluene, m/p-xylenes, and o-xylene (collectively known as the BTEX compounds), and hydrogen sulfide (H_2S). Generally, very low levels of BTEX and H_2S were observed in all samples collected: Benzene was detected in four of 721 samples (maximum = 3.85 ppmv). The next highest concentration of benzene was 1.05 ppmv. Toluene was detected in 199 of 721 samples (maximum = 5.09 ppmv), ethylbenzene in one of 721 samples (maximum = 1.5 ppmv), and total xylenes in 104 of 721 samples (maximum = 3.12 ppmv). H_2S was detected in 494 of 769 samples at a maximum concentration of 41 ppmv. ETI concluded that the source of BTEX and H_2S observed is near surface contamination and is not necessarily directed associated with methane observed at the site (ETI 2000).

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2.1.2 Camp Dresser & McKee, Inc. (CDM), November 2, 2000.

CDM (2000a) reported the results of a shallow soil gas survey conducted in Areas A, B, C, and D (Phase 2 Portion) of the Playa Vista Development. The vapor samples were analyzed for BTEX compounds and H_2S. The survey consisted of 215 sampling locations on a 300-foot grid in Areas A, B, and C, and a 500-foot grid in Area D. Samples were collected from a depth of 4.5 feet bgs. BTEX and H_2S were infrequently detected and when present were measured at relatively low concentrations: Benzene was detected in two of 215 samples (maximum = 1.05 ppmv), toluene was detected in 15 samples (maximum = 0.3 ppmv), ethylbenzene in five samples (maximum = 1.11 ppmv), and total xylenes in nine samples (maximum = 0.92 ppmv). H_2S was detected in 31 of 215 samples at a maximum concentration of 0.023 ppmv.

2.1.3 Camp Dresser & McKee, Inc. (CDM), November 9, 2000.

CDM (2000b) reported the results of a shallow soil gas survey conducted in Tracts 49104-01, -03, -05, and -06 of the Playa Vista Development. The samples were analyzed for BTEX compounds and H_2S. The survey consisted of 192 sampling locations and samples were collected from a depth of four feet bgs. BTEX and H_2S were infrequently detected and when present were measured a relatively low concentrations: Benzene was detected in 28 of 192 samples (maximum = 0.18 ppmv), and low concentrations (less than 1.08 ppmv) of toluene, ethylbenzene, and total xylenes were also measured. H_2S was detected in 49% of 215 samples. The maximum concentration of H_2S was 2.1 ppmv and the average concentration was 0.008 ppmv.

2.1.4 Preparation of Soil Gas Data for Risk Assessment

The volume of data and the thoroughness of the grid sampling yield a dataset that is more than adequate for the development of a human health risk assessment. The soil gas data generated in the three studies cited above were combined into a single dataset based on the similar methodologies for collection and analysis that were applied. From these data the average and maximum soil gas concentrations of each analyte were developed for use in this risk assessment and provide the basis for the calculation of cancer risk and noncancer hazard.

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Because the Johnson and Ettinger Model estimates cancer risk and noncancer hazard from a calculated source vapor concentration that is based on a soil or groundwater concentration entered by the model user, Kleinfelder estimated soil concentrations of the chemicals of concern that would yield a source vapor concentration equivalent to the average and maximum concentrations measured in the three soil gas surveys. The source vapor concentrations entered into the model are summarized in Table 2-2.

Table 2-2

Source Vapor Concentrations for the Chemicals of Concern

Chemical	Average Vapor Concentration (ug/m^3)	Maximum Vapor Concentration (ug/m^3)
Benzene	766	12,300
Ethylbenzene	1,261	6,530
Toluene	675	19,095
m/p-Xylenes	1,087	13,580
o-Xylenes	696	6,043
Hydrogen Sulfide (H_2S)	153	57,148

The source vapor concentrations summarized in Table 2-2 were calculated using the Johnson and Ettinger Model and can be found for each chemical in Appendix A as entry number 15 in the model spreadsheets. The data from which the source vapor concentrations were developed are summarized in Appendix B.

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3.0 RISK ASSESSMENT RESULTS AND CONCLUSIONS

The output of the Johnson and Ettinger Model Spreadsheet is an estimated cancer risk or noncancer hazard based on the soil or groundwater concentration entered for a given chemical of concern. For this risk assessment, the cancer risk and noncancer hazard estimates generated with the Johnson and Ettinger Model are summarized in Table 3-1. The Johnson and Ettinger Model spreadsheets, from which the information in Table 3-1 was generated, are presented in Appendix A.

TABLE 3-1
SUMMARY OF INHALATION CANCER RISK AND NONCANCER HAZARD FOR SOIL GAS CHEMICALS OF CONCERN, PLAYA VISTA DEVELOPMENT

Chemical	Estimated Cancer Risk		Estimated Noncancer Hazard	
	Average[a]	Maximum[b]	Average	Maximum
Benzene	7×10^{-9}	1×10^{-7}	9.7E-6	1.6E-4
Ethylbenzene	NA[c]	NA[c]	9.4E-7	4.8E-6
Toluene	NA[c]	NA[c]	1.3E-6	3.6E-5
m/p-Xylenes	NA[c]	NA[c]	1.2E-7	1.5E-6
o-Xylenes	NA[c]	NA[c]	7.5E-8	6.5E-7
Hydrogen Sulfide (H_2S)	NA[c]	NA[c]	1.4E-4	5.1E-2
TOTALS	**7×10^{-9}**	**1×10^{-7}**	**0.0001**	**0.051**

[a] Average indicates that the cancer risk or noncancer hazard presented is based on the average soil gas concentration measured on the subject site.

[b] Maximum indicates that the cancer risk or noncancer hazard presented is based on the maximum soil gas concentration measured on the subject site.

[c] Indicates that this chemical is not a known or suspected carcinogen, therefore, a cancer risk was not estimated.

Based on a comparison of the cancer risk estimates presented in Section 3.0 to the OEHHA and EPA acceptable cancer risk ranges (1×10^{-6} to 1×10^{-4}), the chemicals of concern present as soil gas (BTEX compounds and H_2S) do not pose an unacceptable cancer risk. Similarly, comparison of the noncancer hazard quotients for the chemicals of concern to the generally accepted noncancer hazard quotient standard of 1.0 indicates that the noncancer hazard that may

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be associated with the chemicals of concern is well below the acceptable level. It should be noted that these insignificant risks would be further reduced through potential soil and groundwater remediation activity at the site, use of vapor barriers, and other site mitigation measures required by the California Regional Water Quality Control Board, City of Los Angeles Fire Department, City of Los Angeles Department of Building and Safety, and other appropriate agencies. Furthermore, the HRA evaluated the effects of chemicals of concern found in fewer than 5% of the more than 1,000 samples analyzed. Chemicals detected in less than 5% of the samples analyzed do not necessarily warrant evaluation in a risk assessment and, with regulatory agency approval, can be omitted from a risk assessment (EPA 1989).

On the basis of these risk assessment results, Kleinfelder recommends that no further investigation or remediation are necessary to adequately protect commercial workers; adult and child residents; and school children from soil gas vapors that may migrate from the subsurface environment into the outdoor air or structures built on the subject property.

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APPENDIX A
JOHNSON AND ETTINGER MODEL SPREADSHEETS

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_A (µg/kg)	Chemical
71432	1,515	Benzene

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to top of contamination, L_I (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
1	2	3	4		
15	121.92	18	SIC		

ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Vadose zone soil organic carbon fraction, f_{oc}^V (unitless)
5	6	7	8
1.5	0.43	0.3	0.002

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
9	10	11	12	13	14
70	30	30	350	1.0E-06	1
				Used to calculate risk-based soil concentration.	

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RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	NA	NA	5.82E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
7.2E-09	9.7E-06
16	17

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VERSION 1.2
September, 1998

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES	

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES	X

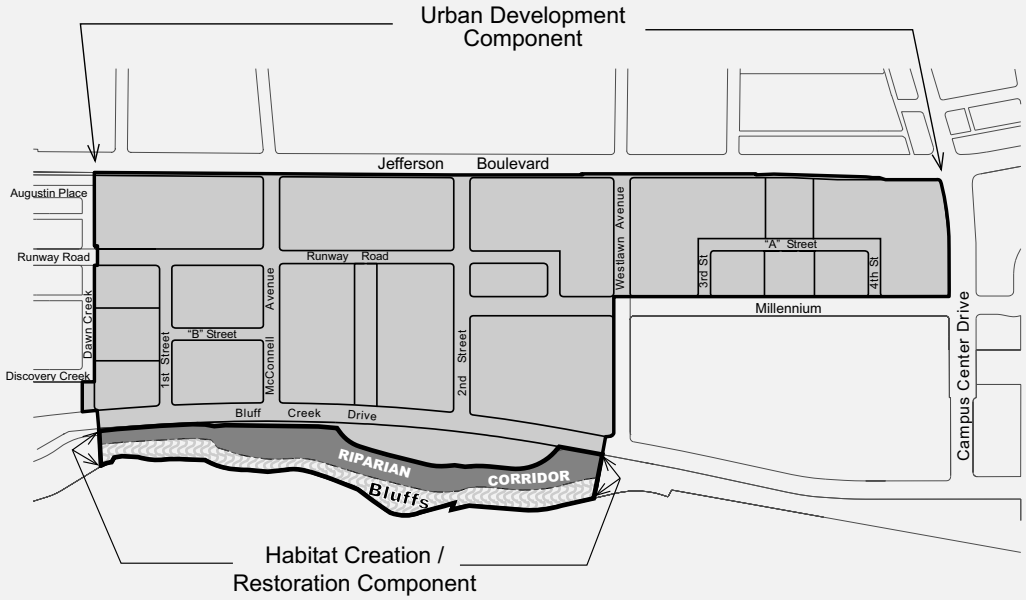
ENTER Chemical CAS No (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
71432	24.3	Benzene

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Average soil temperature, T_s (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	121.92	16	SIC		

ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^v (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^v (cm^3/cm^3)	ENTER Vadose zone soil organic carbon fraction, f_{oc}^v (unitless)
1.5	0.43	0.3	0.002

ENTER Averaging time for carcinogens, AT_c (yrs)	ENTER Averaging time for noncarcinogens, AT_{nc} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based soil concentration.	

Draft Environmental Impact Report (DEIR)
Village at Playa Vista



Volume XVII
Technical Appendix J

J. Safety/Risk of Upset (Cont.)

City of Los Angeles/EIR No. ENV-2002-6129-EIR

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TECHNICAL APPENDICES

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APPENDIX J:

SAFETY/RISK OF UPSET TECHNICAL APPENDIX

(CONTINUED)

City of Los Angeles
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J-10	Exploration Technologies Inc. (ETI), Subsurface Geochemical Assessment of Methane Gas Occurrences, Playa Vista Development, First Phase Project, Los Angeles, California. Prepared for the City of Los Angeles, Department of Building and Safety, Project No. 99-2219, April 17, 2000.

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J-6	*City of Los Angeles, Office of the Chief Legislative Analyst. "Final Report for City Investigation of Potential Issues of Concern for Community Facilities District No. 4, Playa Vista Development Project," May 2001.*
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INTEGRATED
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Health-Based Remediation Goals

Playa Vista

Los Angeles, California

February 2000

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PLAYA VISTA

SIGNATURES

HEALTH-BASED REMEDIATION GOALS

PLAYA VISTA

LOS ANGELES, CALIFORNIA

FEBRUARY 2000

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PROGRAM MANAGER

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Senior Program Manager

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NOTICE

This report was prepared for Playa Capital Company (PCC) by Integrated Environmental Services, Inc. (Integrated), an independent consultant, and is based in part on information not within the control of either PCC or Integrated. While it is believed that the information contained herein will be reliable under the conditions and subject to the limitations set forth herein, neither PCC nor Integrated guarantee the accuracy thereof. The use of this report or any information contained therein shall be at the user's sole risk. Such use shall constitute an agreement to release, defend and indemnify PCC and Integrated from and against any and all liability in connection therewith (including any liability for special, indirect, incidental or consequential damages) whether such arises in contract, negligence or otherwise.

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ACRONYMS

API	American Petroleum Institute
ARL	acceptable risk level
ATSDR	Agency for Toxic Substances and Disease Registry
BC	Brown & Caldwell
Cal/EPA	California Environmental Protection Agency
CAO	cleanup and abatement order
CDM	Camp Dresser & McKee, Inc.
CEM	conceptual exposure model
COC	constituent of concern
COPC	constituent of potential concern
CSF	cancer slope factor
CSV	chemical specific value
DTSC	Department of Toxic Substances Control
EMTD	Entertainment, Media and Technology District
EPA	Environmental Protection Agency (U.S.)
GI	gastrointestinal
GSC	General Sciences Corporation
HBRG	health based remediation goal
HDPE	high-density polyethylene
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HLA	Harding Lawson Associates
HQ	hazard quotient
HSDB	Hazardous Substance Data Base
IARC	International Agency for Research on Cancer
IESI	Integrated Environmental Services, Inc.
ILCR	incremental lifetime cancer risk
IRIS	Integrated Risk Information System
ISC2	Industrial Source Complex 2
LA	Los Angeles
LAX	Los Angeles International Airport
LCA	LeRoy Crandall and Associates
LOAEL	lowest-observable-adverse-effect level
MCLG	maximum contaminant level goal
MEE	McLaren Environmental Engineers
MF	modifying factor
M/H	McLaren/Hart, Inc.

1. INTRODUCTION

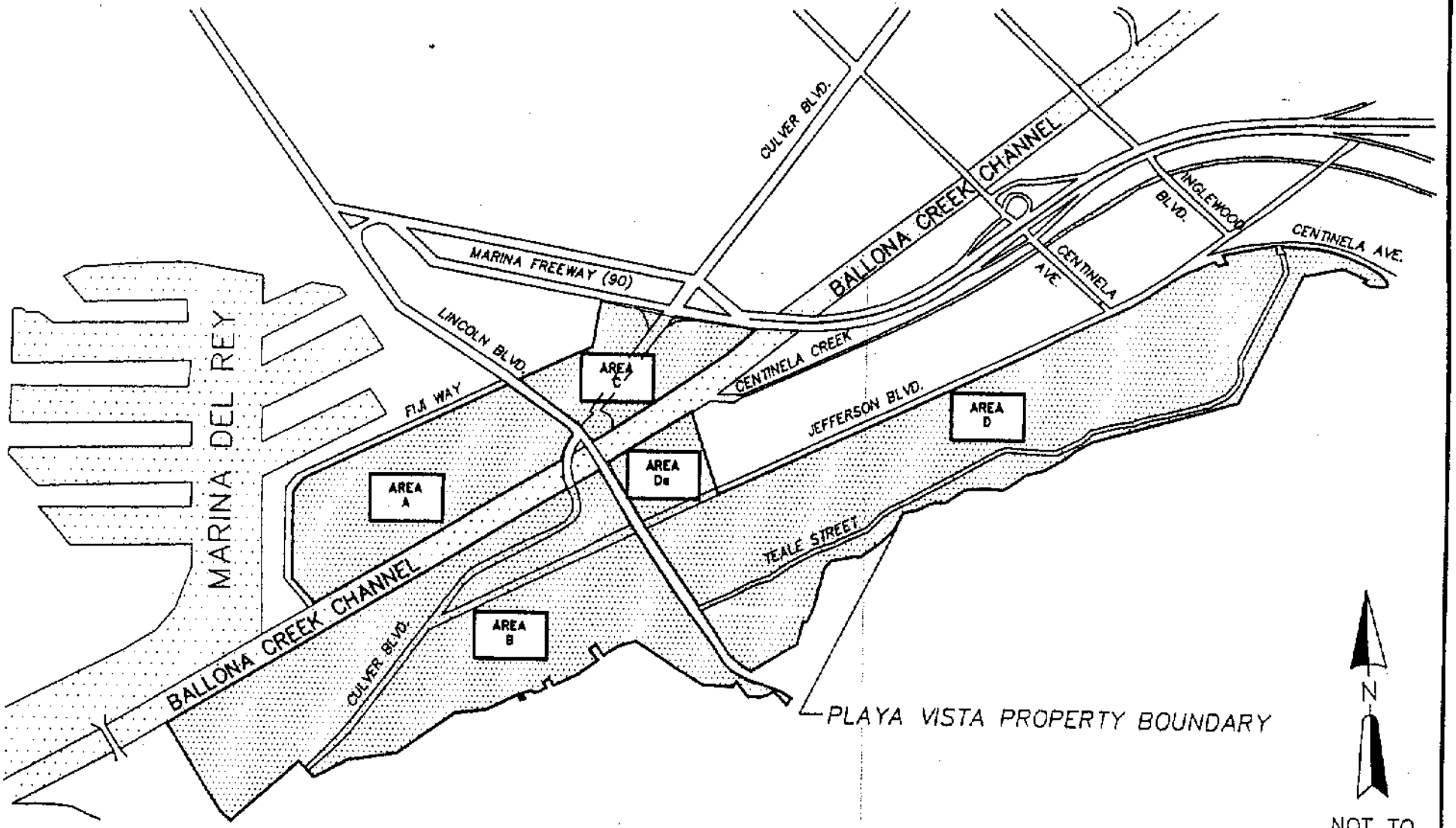
This document presents the health-based remediation goals (HBRGs) proposed for the Playa Vista site in Los Angeles, California. Conservative HBRGs have been calculated for each potentially hazardous constituent detected in the surface and subsurface soils and groundwater. The specific methodologies, assumptions, and equations used to develop these values are described here, as are the sources data used in the calculations. Approval of this document is being sought from the California Environmental Protection Agency (Cal/EPA) to expedite development. The lead agency for the site, the Los Angeles Regional Water Quality Control Board (RWQCB), and the designated agency for human health issues, the Office of Environmental Health Hazard Assessment (OEHHA), are the Cal/EPA entities responsible for review.

1.1 SITE LOCATION AND HISTORY

The Playa Vista site consists of approximately 1,087 acres of predominantly undeveloped land on the west side of Los Angeles, just north of the Los Angeles International Airport and south of the community of Marina del Rey (Figure 1-1). At its nearest point, the site is about 1,500 feet from the ocean (BC 1999a).

As shown in Figure 1-1, the site is comprised of four geographic areas—Areas A, B, C, and D. Lincoln Boulevard bisects the property from north to south and Jefferson Boulevard from east to west. Ballona Creek flows through the site to the ocean.

Prior to the 1920's the site was undeveloped upland (generally Areas C and D) and wetlands (generally Areas A and B). Portions of the property began to be used for agricultural purposes during the 1920's and 1930's; however, a majority of the property remained undeveloped. It is also believed that a portion of the northwestern portion of the property (north of Ballona Creek



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Area A, B, C, and D
6775 Centinela Avenue
Los Angeles, CA

DWN:	DES.:	PROJECT NO.:
JDL	JDL	012A/025PVV
CHK:	APPD:	
JFH	JSB	FIGURE NO.:
DATE:	REV.:	1-1
05/10/9	2	

and west of Lincoln Boulevard) was used as an automobile racetrack (CDM 1999a, ENSR 1997). In addition, Ballona Creek was channelized during the 1920's and 1930's. Material dredged during construction of the Ballona Channel were deposited in Areas A and C, raising those areas and filling the wetlands. Material dredged during the creation of Marina del Rey in the 1960's were also placed on Areas A and C, further elevating those areas (CDM 1999a).

Hughes Tools (later Hughes Aircraft Company) began industrial operations on the eastern portion of the site (now referred to as Area D) in the late 1930's. Hughes constructed numerous aircraft-related buildings and a runway on the site. The historic "Spruce Goose" flying boat was constructed at the site during the mid-1940's. Hughes Aircraft Company continued industrial development and expansion at the property after World War II and into the 1960's, manufacturing radar systems and helicopters (CDM 1999a, ENSR 1997).

The facility was operated by various divisions of Hughes until 1982 when McDonnell Douglas Helicopters (MDDH) began operations at the site. MDDH conducted operations at the site until 1994. Since that time, a majority of the site structures have been demolished. The site is currently being redeveloped for commercial and residential uses. In addition, the site is used by the film and television industry for set construction and filming activities (ENSR 1997).

1.2 REGULATORY INTERACTION

The following discussion is borrowed from the Fourth Quarter Groundwater Monitoring and Progress Report (CDM 2000a).

Since the 1980s, the site has undergone extensive environmental study (soil and groundwater) and remediation under the direction of the RWQCB. Several underground pits, sumps, and fuel tanks have been removed, and several potential contaminant source areas ("hot spots") have been excavated. The recovery of free-phase petroleum product has occurred since 1987, and a groundwater extraction and treatment system has been operating since 1994.

On December 22, 1998, the RWQCB issued Cleanup and Abatement Order (CAO) No. 98-125 (File No. 98-192) for the Playa Vista site. The CAO directs Playa Capital Company to remediate

impacts to soil and groundwater resulting from historical operations at the former Hughes facility (Cal/EPA 1998). The CAO requires a complete site-wide soil and groundwater assessment and remediation of impacted areas to support site closure. A phased approach to complete the assessment is stipulated in the CAO.

The first phase targeted the entertainment, media, and technology district (EMTD) and included the portion of Area D formerly designated as the "Dream Works Project" (CDM 1999d). The demolition and decontamination of buildings within the EMTD area occurred between June and December of 1998. A soil and groundwater investigation workplan (CDM 1999c) for investigating the EMTD was implemented in August 1999, and the investigation has since been completed. A report providing the results of the investigation is currently being prepared (CDM 1999d).

A second soil and groundwater investigation workplan (CDM 1999d) was prepared to address the remainder (non-Dream Works areas) of the Phase 1 project. These areas include:

- Western portion of Area D
- Eastern portion of Area D (excluding the EMTD)
- Area De
- Small portion of Area B located south of and generally parallel to Jefferson Boulevard

Investigation of these areas began in December 1999 and is currently ongoing. Results of the investigation are anticipated by the spring of 2000.

Other activities conducted to date to comply with the provisions of the CAO include:

- An evaluation of the groundwater treatment system (IESI 1999b)
- Groundwater sampling and reporting under the Interim Groundwater Sampling and Analysis Plan for the first and second quarters of 1999
- Groundwater sampling and reporting under the Final Groundwater Sampling and Analysis Plan for the third and fourth quarters of 1999

An investigation of the remainder of the site (portions of Area D scheduled for Phase 2 development, the remainder of Area B, and Areas A and C), which are planned for development during later phases of the project have not yet begun.

1.3 SUMMARY OF PREVIOUS INVESTIGATIONS AND REMEDIATIONS

As mentioned, the site has undergone extensive investigation since the 1980's, and remediation of many areas has already occurred. This section presents a brief summary of the investigations and remediation that has occurred at the site to date. For more detailed information, please consult the references cited.

1.3.1 Soil Investigation and Remediation

Areas A and C

A study to evaluate the potential for the presence of significant contamination in Areas A and C was conducted in 1997. The investigation revealed that the average thickness of dredge spoil deposited on Areas A and C is about 5 feet. Samples were collected at depths of 2 and 4 feet bgs and analyzed for total petroleum hydrocarbons (TPH), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, polychlorinated biphenyls (PCBs) and pesticides (ENSR 1997).

Analyses of the soil samples collected indicated that VOCs, SVOCs, PCBs, and pesticides were all non-detect. TPH was detected in two locations at 10 ppm and 22 ppm, which are both below action levels. With the exception of lead, all metals were detected at concentrations at or below naturally occurring background levels. Lead was detected at a 200 ppm at a depth of 2 feet bgs at the southern end of Area A (ENSR 1997). Elevated levels of metals were not detected in Area C.

To date, no remediation has occurred within Areas A or C.

Area B

Area B contains the Ballona wetlands, which have been degraded by urban runoff from the highly industrial areas of Los Angeles that are located upstream of the wetlands. Soil and sediment samples collected from within Area B during a 1998 investigation indicate that the area has been impacted by metals, particularly copper, lead, and zinc. These constituents are typically found in urban runoff, and indicate both past and continuing influence of urban runoff on the area (CDM 1999a).

To date, no remedial activities have occurred within Area B.

Area D

Area D housed the historic industrial operations associated with the site, and consequently has been the subject of a majority of the investigation and remediation that has occurred to date. Within the former plant site area, eight potential sources of constituents have been identified:

1. Former Drum Storage Area
2. Underground Tanks North of Building 12
3. Building 14 Clarifiers
4. Building 15 Utility Trenches and Clarifier
5. Building 12 Backfilled Clarifiers and Test Sump
6. Storm Drain Discharge Site
7. Underground Tanks West of Building 11
8. Underground Tanks South of Building 5

The types of chemicals historically used at the plant site include VOCs, SVOCs, TPH, metals, pesticides, and PCBs (CDM 1999b).

A very brief description of the removal actions that have occurred at each of these locations is provided below.

1. The former drum storage area was used to store kerosene, lubricating oils, cutting oils, hydraulic fluids, degreasers, solvents, and antifreeze. Soil samples collected during the 1986 investigation revealed the presence of high levels of VOCs and TPH in soil (MEE 1988). The impacted soil was excavated between 1988 and 1989. The RWQCB issued a No Further Action Letter in 1989 for the site, recognizing that approximately 35 cubic yards of marginally contaminated soil was left in an inaccessible area (CDM 1999b).

2. Underground tanks located north of Building 12 were used to store aviation fuel. Samples collected during the 1986 investigation of the site revealed the presence of low levels of TPH in groundwater in the vicinity of the tanks. No soil samples were collected at that time. The tanks were removed in 1996, and subsequent sampling revealed only the presence of low levels of TPH (CDM 1999b).

3. Building 14 clarifiers received cutting oils and solvents from machining operations. Soil samples collected in the vicinity of the clarifiers contained trace levels of VOCs, TPH, PCBs, and low concentrations of metals (BC 1999b). Although the clarifiers have been cleaned and inspected, they have not been excavated due to the destabilizing impact this activity would have upon Building 14, which remains at the site as a designated historic structure. Additional investigation of the area is planned (CDM 1999b).

4. Building 15 trenches contained underground piping associated with former manufacturing operations within the building (BC 1999b). Although the trenches have been cleaned and inspected, they have not been excavated due to destabilizing impact this activity would have on Building 15, which remains at the site as a designated historic structure. Additional investigation of the area is planned (CDM 1999b).

5. Building 12 clarifiers and sump were removed between 1988 and 1989, and the impacted soil excavated to remove soil impacted by solvents which had leaked from the sump (MEE 1988, CDM 1999b).

6. The storm drain discharge site received treated industrial wastewater from several industrial waste clarifiers and neutralization sumps prior to 1954. Soil samples collected from the area during the 1986 investigation of the site indicated that VOCs and TPH had impacted soil. Excavation of the impacted soil occurred between 1988 and 1989 (CDM 1999b).

7. Underground gasoline tanks were located west of Building 11. Petroleum hydrocarbons were detected in groundwater samples collected near the tanks in 1984. Subsequent investigation and tank integrity testing indicated a leak in one of the tanks or the associated piping. The tanks were taken out of service in 1986 and were removed 10 years later. Free-phase petroleum hydrocarbons were detected in this area in 1987. Free product recovery operations were initiated in 1987 after the discovery. Free product recovery efforts have continued since that time whenever free-phase constituents are detected (CDM 1999b).

8. Two underground storage tanks located south of Building 5 were used to store cutting oils. At least one of the tanks was found to have leaked and impacted soil in the area. During a 1986 investigation of the site, elevated levels of TPH, VOCs, and PCBs were found in soil in the vicinity of the tanks. Both tanks were taken out of service and abandoned in place in 1988 with the approval of the RWQCB. In 1998, the tanks were excavated and removed. Confirmation samples collected after the removal revealed the presence of residual constituents in soil (BC 1999b). Subsequent investigation and remediation of the site, if necessary, are planned (CDM 1999b).

In addition to these areas within the plant site, other potential sources within Area D have been identified:

1. Fire Training Burn Pit
2. Test Site 2
3. Test Site 3
4. Former clarifier and sump area adjacent to Building 35

Investigations and remedial activities associated with each of these sites are briefly discussed below.

1. The Fire Training Burn Pit was used several times per year from the early 1960's to the mid-1980's to train firefighters in the handling of chemical and fuel fires. An investigation of the area in 1986 indicated that soil had been impacted by TPH. The pit was excavated to a depth of 17 feet bgs and backfilled. Confirmation samples collected after the excavation indicated that residual concentrations were below the cleanup criteria approved by the RWQCB for the site in 1987 (CDM 1999d). A reinvestigation of the Fire Training Burn Pit was conducted in January 2000 to confirm the success of the earlier remediation. Results of that investigation are pending.

2. Former Test Site 2 was used for testing aircraft equipment. Materials used to test and clean the equipment were stored in drums on racks and on the asphalt pavement. Soil samples collected during the 1996 investigation revealed that soil had been impacted primarily by benzene and petroleum hydrocarbons. All facilities at the former test site (including pavement) were demolished in November 1986, and impacted soil was excavated and removed from the site (CDM 1999d). A reinvestigation of the former test site was conducted in January 2000 to confirm the success of the earlier remediation. Results of that investigation are pending.

3. Former Test Site 3 was used for helicopter testing and hazardous drum storage on asphalt pavement. In addition, agricultural chemicals were stored in a shed located west of Test Site 3. Soil samples collected during the 1986 investigation revealed that soil had been impacted primarily by benzene and petroleum hydrocarbons. All facilities at the former test site (including pavement) were demolished in November 1986, and impacted soil was excavated and removed from the site (CDM 1999d). A reinvestigation of the former test site was conducted in January 2000 to confirm the success of the earlier remediation. Results of that investigation are pending.

4. A concrete clarifier, a chromate waste sump, and an organic sump were located adjacent to Building 35. The organic sump received waste solvents and paint sludge from paint

booths located inside the building. Samples collected during the 1986 investigation indicate that low levels of VOCs, TPH, metals, and pesticides have impacted soils in the surrounding area. The clarifier and chromate waste sump were not considered significant sources of contaminant releases, and were relined and retrofitted in 1987. The organic sump was excavated, and impacted soils were excavated. Confirmation sampling confirmed that residual levels were below the 1987 cleanup levels established by the RWQCB (CDM 1999d).

1.3.2 Groundwater Investigation and Remediation

Areas A and C

In 1996, groundwater samples were collected in Areas A and C and analyzed for TPH, VOCs, metals, PCBs, and pesticides. The analytical results for all analytes except metals were non-detect. Of the metals detected in groundwater, only arsenic (140 ppb) at one location was detected above the maximum contaminant level (50 ppb). The elevated level of arsenic in groundwater is believed to have resulted from leaching of the metal from dredge spoils deposited on the site (CDM 1999b).

In addition, groundwater samples from Areas A and C were collected during the latest quarterly monitoring for which results are available, and analyzed for VOCs. Results for each well were non-detect (CDM 2000a).

Area B

Groundwater samples were also collected from Area B during the 1996 investigation and analyzed for metals, VOCs, pesticides, and PCBs. The results of the analyses were non-detect for VOCs, pesticides, and PCBs. Low levels of arsenic, cadmium, lead, and zinc were detected in samples at levels below MCLs (CDM 1999b).

In addition, groundwater samples from Area B were collected during the latest quarterly monitoring for which results are available, and analyzed for VOCs. Results for each well were non-detect (CDM 2000a).

Area D

Four separate plumes were identified in Area D during the site investigations conducted in the 1980's. These plums were believed to be associated with the:

1. Fire Training Burn Pit
2. Temporary Drum Storage Area
3. Salvage Yard
4. Plant Site

The first three plumes were small and localized. The largest identified plume was located in the eastern portion of Area D beneath the former manufacturing facility. This plume extends approximately 3,200 feet from west to east. Within the plume, localized hot spots associated with specific areas of the former facility were identified (CDM 1999b).

As mentioned, a treatment system was installed in 1994 to remove the VOCs (primarily chlorinated solvents) that have impacted groundwater beneath Area D. Quarterly groundwater monitoring and reporting of results occur in accordance with a final groundwater sampling and analysis plan (CDM 1999b).

1.4 SITE DEVELOPMENT PLAN

The current owner, Playa Capital Company LLC (PCC), began a phased redevelopment of the Playa Vista property in 1998, moving from the conceptual design and planning stages to construction of Phase One infrastructure (PV 1998a). As mentioned, the property has been divided into four geographical areas (Figure 1-1), each of which will undergo environmental assessment, investigation, and, as necessary, remediation prior to construction.

The full development program proposed for the site envisions an integrated, mixed-use community composed of residential and commercial uses. Plans for the entire property include residential units, new or replacement offices, light industrial or similar facilities, and retail space. In addition, the redevelopment includes the planned preservation and restoration of approximately 350 acres of natural habitat, which include a 190-acre saltwater wetlands, a freshwater wetlands system, a 25-acre riparian corridor area, and bordering native upland habitats (CDM 1999a). Phase One Construction is expected to begin by the spring of 2000 (PV 1998a).

1.5 USE OF HEALTH-BASED REMEDIATION GOALS IN SITE REMEDIATION

Soil and groundwater for the entire Playa Vista site will undergo separate, phased remediation programs. Surface soils are a concern due to their potential health impact to future site users, while groundwater is a concern because of its potential impact to the underlying aquifers. For this project, surface soils are defined as extending vertically to 2 feet above the water table (or to a maximum depth of 12 feet), while groundwater includes both the saturated zone and all potential subsurface soil sources less than 2 feet above the saturated zone.

The following programmatic approach is proposed for remediation of surface soils and groundwater throughout the site. The Playa Vista site has undergone extensive remediation in the past 11 years, most recently during demolition and decontamination (see Section 1.3.1). HBRGs will be used to identify additional areas that require remediation.

To expedite the cleanup and redevelopment of the Playa Vista site while ensuring protection of human health and the environment, PCC adopted a "90/10" health-based remediation strategy. Under this strategy, PCC developed a set of HBRGs following the methodologies adopted by the regulatory agencies. Those HBRGs are presented in this document.

The PCC HBRGs are based on lower risk thresholds and more conservative approaches, assumptions and parameters than those described in Cal/EPA protocols. Constituent-specific HBRGs are derived so that exposure to any single constituent will result in an incremental

lifetime cancer risk (ILCR) of 1.0×10^{-6} or less and a hazard index (HI) of 0.2 or less (ILCR and HI are described in Section 1.6, below).

The use of such HBRGs in the soil and groundwater cleanup (which are projected to be about 90 to 100 percent of the entire cleanup effort needed) should theoretically result in site conditions that pose no significant health risk to future land users from exposure to any one constituent. However, due to the complexity of exposure to multiple constituents, the cumulative health effects associated with post-remediation site conditions may not be fully characterized until cleanup is complete. For this reason, PCC is prepared to conduct additional site remediation, if warranted by exposures to multiple residual chemicals (this additional cleanup is projected to be no more than 10 percent of the currently planned remediation).

As mentioned, under this approach, the HBRGs are developed using more health-protective levels for ILCR and HI than those required by Cal/EPA, which is consistent with the conservative health-risk approach adopted by the project. The HBRGs are constituent specific, so that the risk to the target receptor does not exceed an ILCR of 1×10^{-6} and HI of 0.2 for any one constituent. This means the remediated site would safely accommodate exposure to multiple (perhaps 5 to 10) constituents while still ensuring the cumulative risk for each receptor would not exceed 1×10^{-5} for ILCR and 1 for HI.

As stated, the site has already undergone comprehensive environmental investigation and remediation. The existing soil constituent concentrations will be compared with the HBRGs to identify remaining potentially impacted soils. Areas of impacted soil with residual constituent concentrations exceeding the HBRG of any particular constituent (presented later in Tables 5-4 and 5-5) will be remediated to below the HBRG level. The final site conditions will be assessed with post-remediation confirmation sampling to verify that residual constituent levels are protective of human health and the environment.

1.6 OBJECTIVE

The objective of this HBRG process is to expedite agency approval of PCC's constituent-specific HBRGs for the completion of remediation throughout the site. In accordance with the National

Contingency Plan (EPA 1990b) and other guidelines published by the EPA, as well as guidelines from Cal/EPA, the remediation goals described in this document have been developed with the purpose of protecting human health and the environment.

Two types of health effects may potentially result from exposure to chemical contaminants: carcinogenic and noncarcinogenic effects. In the National Contingency Plan (EPA 1990b), EPA has identified a target range for acceptable cancer risk of 1 in 1,000,000 (10^{-6}) to 1 in 10,000 (10^{-4}) for National Priority List (NPL) sites. This target range is designed to limit the possibility that an individual would develop cancer from exposure to site-related residual contaminants (EPA 1989a, 1991). As part of the cleanup effort at NPL sites, EPA strives to manage possible ILCR within this target range.

For noncarcinogenic effects, the hazard index (HI) represents the sum of hazard quotients (HQs) for multiple chemicals and/or multiple exposure pathways. The HQ is the ratio of a single chemical exposure level developed over a specified time period to a reference dose (RfD) developed over a similar time period. Therefore, a HI of less than 1 means the exposure to the toxicant is less than the level at which a toxic health effect may occur.

1.7 METHODOLOGY

This section summarizes the methodology used to derive HBRGs appropriate for the future land use within the site, and ensures protection of human health and the environment. As shown in Figure 1-2, the methodology consists of five distinct steps, some of which may be performed concurrently.

As described in Section 2 of this report, a traditional risk assessment involves the screening of constituents detected at the site to determine "constituents of concern" (COCs). Detected constituents are screened based on prevalence, distribution, concentration, and relative toxicity. Since this HBRG document serves as a guide to cleanup, no such screening has been performed; in Step 1, all detected constituents have been retained as "constituents of potential concern" (COPCs) and are included in the remedial goal calculations. If, in the future, additional

constituents are detected on site, HBRGs will be developed for them as well. The final list of COPCs for the site will be developed during post-remediation confirmation sampling.

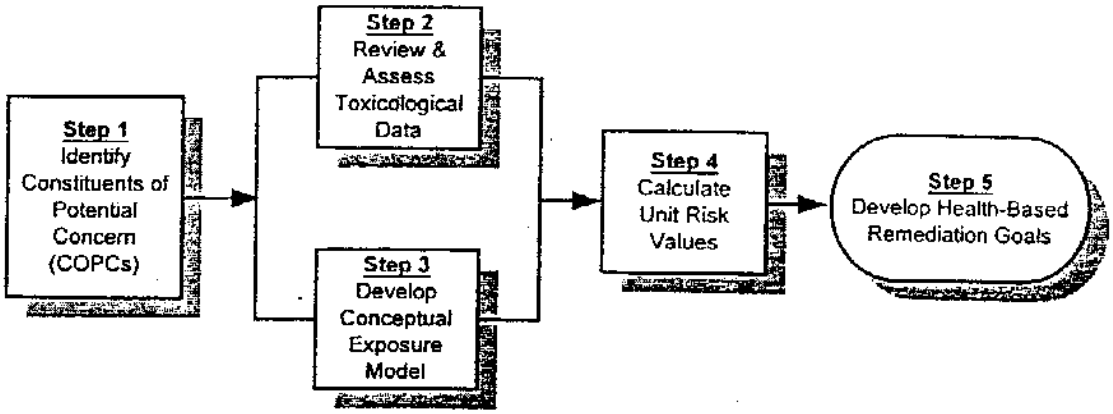


FIGURE 1-2
METHODOLOGY FOR CALCULATION OF HBRGs

In Step 2 (Section 2), those COPCs for which EPA toxicity data exist—as published in the California Cancer Potency Factors Update, the Integrated Risk Information System (IRIS) or Health Effects Assessment Summary Tables (HEAST)—were selected for risk analysis and evaluation. For those COPCs that have no available toxicity data, HBRGs cannot be established.

In Step 3 (Section 3), conceptual exposure scenarios were developed for the site to describe the potential soil and groundwater exposures and provide a basis for quantifying these exposures. Each exposure scenario addresses the source of chemicals, route or mechanism of exposure, and potentially exposed populations (known as "receptors"). When site-specific data for scenario development were unavailable, conservative values found in the literature were used.

In Step 4 (Section 4), receptor-specific unit risk factors were calculated to quantify the potential human health risks associated with exposure to unit concentrations of analytes in soil and groundwater. As a result of this effort, a linear relationship is established between the source term concentration (e.g., soil concentration) and receptor-specific risk. Specially designed databases were developed to calculate chemical-specific, multipathway unit risks for each of the hypothetical receptors.

In Step 5 (Section 5), the unit risk values were used to quantify source term concentrations equivalent to receptor-specific target risk levels. These new values represent the initial HBRGs for the identified receptor. The initial HBRGs undergo a final evaluation to ensure they are both effective and protective of human health and the environment; the resultant values are the final HBRGs. The initial HBRGs developed for organic constituents derive from all significant exposure scenarios and must be normalized to ensure health protectiveness prior to setting final HBRGs. Final HBRGs for inorganic compounds must account for the potential impact of naturally occurring background concentrations.

To reiterate, this five-step procedure was established specifically to ensure the final HBRGs are both effective (i.e., not below background levels, or greater than soil saturation limits) and protective of human health and the environment. The HBRGs were developed following standard guidance for development of risk-based remediation goals as promulgated by EPA and Cal/EPA. Following the completion of all surface soil remediation, a human health risk assessment will be conducted to confirm the health protectiveness of residual constituent concentrations within the site.

1.8 GUIDANCE AND AGREEMENTS

The following major guidance documents and/or information sources were consulted in the preparation of this document:

- Risk Assessment Guidance for Superfund (RAGS), Volume I - Human Health Evaluation Manual, Part A (EPA 1989a)
- Risk Assessment Guidance for Superfund (RAGS), Volume I - Human Health Evaluation Manual, Part B, Development of Risk-Based Preliminary Remediation Goals (EPA 1991)
- National Oil and Hazardous Substances Pollution Contingency Plan (EPA 1990b)
- Exposure Factors Handbook (EPA 1997)
- Dermal Exposure Assessment, Principals and Applications (EPA 1992a)
- California Cancer Potency Factors Update (Cal/EPA 1996a)

- Integrated Risk Information System (IRIS) database (EPA 1999)
- Health Effects Assessment Summary Tables (HEAST) FY-1998 (EPA 1998)
- Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities (Cal/EPA 1992)
- Preliminary Endangerment Assessment Guidance Manual (Cal/EPA 1994)

The HBRG development methodology is presented in the HBRG Protocol (IESI 1999), which was approved by Cal/EPA in May 1999.

1.9 REPORT ORGANIZATION

This report has seven sections:

- Section 1, *Introduction*, provides site history and an overview of the document.
- Section 2, *Toxicological Information*, briefly explains the methods and assumptions used by EPA and Cal/EPA to set toxicity criteria; explains how reference doses and cancer slope factors are established to assess, respectively, noncarcinogenic and carcinogenic risk; explains how these toxicity criteria are adjusted for dermal exposure assessments, and the approach to the toxicity equivalence factors method used to assess the cancer risk from mixtures of structurally related compounds such as PCBs, chlorinated dibenzodioxins/furans, and polycyclic aromatic hydrocarbons (PAHs).
- Section 3, *Exposure Assessment*, describes the conceptual exposure setting during and after construction of the facility and presents the rationale and development of the appropriate conceptual exposure model.
- Section 4, *Calculation of Unit Risk*, presents the calculation of unit risk and unit toxicity for the identified complete exposure pathways.
- Section 5, *Development of Health-Based Remediation Goals*, presents the quantitative methodologies used to develop the chemical-specific, receptor-specific HBRGs, and refers to the study conducted for the Playa Vista property to determine inorganic background concentrations. The HBRGs developed in this section will be used to evaluate the health protectiveness of residual surface soil and groundwater concentrations throughout the remedial operation of the site.
- Section 6, *Uncertainties*, discusses the uncertainties inherent in any risk-based calculations, and qualitatively discusses uncertainties associated with the parameters and assumptions used in this evaluation.

- Section 7. *References*, lists literature cited in this report.

2. TOXICITY ASSESSMENT

The objective of the toxicity assessment is to provide information on the toxic effects of exposure to chemical constituents. Specifically, the relationship between exposure and the severity or probability of human biological effects is estimated quantitatively for each chemical constituent. Section 2.1 describes how toxicity values are established and used for noncarcinogenic constituents, while Section 2.2 presents a similar discussion for carcinogenic constituents. Section 2.3 describes how dermal exposures are quantified. Section 2.4 discusses potency equivalence factors and their use in assessing mixtures of structurally related compounds such as polycyclic aromatic hydrocarbons.

Relevant carcinogenic and noncarcinogenic toxicity data were obtained from the following sources (in descending order of preference):

1. California Cancer Potency Factors Update (Cal/EPA 1996)
2. Integrated Risk Information System (IRIS) database (EPA 1999)
3. Health Effects Assessment Summary Tables (HEAST) (EPA 1998)
4. Cal/EPA Potency Equivalency Factors for Poly-Aromatic Hydrocarbons (Cal/EPA 1993)

Table 2-1 presents the comprehensive list of constituents of potential concern detected at the site. Each of these compounds was subjected to toxicological review. Constituents in the table marked with an asterisk (*) lack certain pathway-specific toxicological data (as of this printing). Consequently, HBRGs cannot be developed for these compounds in those pathways.

TABLE 2-1
CONSTITUENTS OF POTENTIAL CONCERN
PLAYA VISTA SITE

1,1-dichloroethane	benzo(k)fluoranthene*	iron*
1,1-dichloroethene	beryllium	lead*
1,1,1-trichloroethane*	beta-BHC*	manganese
1,1,2-trichloroethane	bis-(2ethylhexyl) phthalate	mercury
1,1,2,2-tetrachloroethane*	bromochloromethane*	methylene chloride
1,2-dichlorobenzene*	bromodichloromethane	molybdenum
1,2-dichloroethane	bromoform	n-propylbenzene*
1,2-dichloropropane	cadmium	naphthalene*
1,2,4-trimethylbenzene*	carbon disulfide	nickel
1,3-dichlorobenzene*	carbon tetrachloride	p-cymene*
1,3,5-trimethylbenzene*	chlorobenzene	phenol
1,4-dichlorobenzene	chloroform	pyrene
1,4-dioxane*	chromium III	selenium
2-butanone	chromium VI	silver
2-hexanone*	chrysene	strontium
2,4-dichlorophenol	cis-1,2-dichloroethene	tetrachloroethene
4-methyl-2-pentanone	cobalt*	thallium*
4,4'-DDD	copper	toluene
4,4'-DDE	cumene	trans-1,2-dichloroethene
4,4'-DDT	cyanide	trichloroethene
acetone	delta-BHC*	trichlorofluorethane*
alpha-BHC*	di-n-butyl phthalate	trichlorofluoromethane
antimony	di-n-octyl phthalate	trichlorotrifluoroethane (freon)
aroclor 1254**	dibromochloromethane	vanadium
arsenic	endosulfan sulfate	vinyl acetate
barium	endrin	vinyl chloride
benzene	ethyl chloride*	m-xylene
benzo(a)anthracene	ethylbenzene*	o-xylene*
benzo(a)pyrene	gamma-BHC	p-xylene*
benzo(b)fluoranthene	hydrogen sulfide	zinc
benzo(g,h,i)perylene*	indeno(1,2,3-cd)pyrene	

NOTE:

*Certain pathway-specific toxicity values unavailable; therefore, HBRGs cannot be calculated for these constituents in those pathways.

**Toxicity factors for Aroclor 1254 are similar if not identical to other PCBs.

SOURCES:

California Cancer Potency Factors Update (Cal/EPA 1996)
IRIS (EPA 1999)
HEAST (EPA 1998)

2.1 NONCARCINOGENIC CONSTITUENTS

When evaluating the noncarcinogenic effects of constituents, the EPA assumes that a dose exists below which no adverse health effects will be seen (EPA 1989a). Below this "threshold," it is believed that exposure to a constituent can be tolerated without adverse effects, and the body burden is not increased. Toxic effects occur only when physiologic protective mechanisms are overcome by exposure doses above the threshold.

The toxicity of noncarcinogenic compounds is expressed in terms of a reference dose (RfD). The RfD, measured in units of milligrams per kilogram per day (mg/kg-d), represents the daily intake of a constituent per kilogram of body weight (averaged over a year) that is below the effect threshold for that constituent. In essence, the RfD represents the receptor-specific threshold dose. In addition, EPA assumes noncarcinogenic exposure doses are not cumulative from age group to age group over a lifetime of exposure (EPA 1989a). An RfD is specific to the constituent, route of exposure, and duration of exposure.

The EPA reviews all relevant human and animal studies for each constituent and selects the studies pertinent to the derivation of specific RfDs. Each study is evaluated to determine the no-observable-adverse-effect level (NOAEL) or, if data are inadequate for such a determination, the lowest-observable-adverse-effect level (LOAEL). The NOAEL corresponds to the dose (mg/kg-d) that can be administered over a lifetime without inducing observable adverse effects. The LOAEL corresponds to the lowest daily dose (mg/kg-d) that can be administered over a lifetime that induces an observable adverse effect. The toxic effect characterized by the LOAEL is referred to as the "critical effect" (EPA 1998a).

To derive an RfD, the NOAEL (or LOAEL) is divided by uncertainty factors to ensure that the RfD will be protective of human health. Uncertainty factors are applied to account for:

1. Extrapolation of data from laboratory animals to humans (interspecies extrapolation)
2. Variation in human sensitivity to the toxic effects of a constituent (intraspecies differences)
3. Derivation of a chronic RfD based on a subchronic rather than a chronic study

4. Derivation of an RfD from the LOAEL rather than the NOAEL.

Each of these uncertainties usually represents a factor of 10. In addition to these uncertainty factors, modifying factors between 0 and 10 may be applied to reflect additional qualitative considerations in evaluating the data (EPA 1989a).

For example, to calculate an RfD, the appropriate NOAEL (or the LOAEL if a suitable NOAEL is not available) is divided by the product of all of the applicable uncertainty factors and the modifying factor:

$$RfD = \frac{NOAEL \text{ or } LOAEL}{UF_1 \times UF_2 \times \cdots \times MF} \qquad (2\text{-}1)$$

where UF represents applicable uncertainty factor and MF represents a modifying factor. Only those uncertainty factors applicable to a particular RfD calculation are used in the equation. The default value for MF is 1; however, alternate values may be used if the toxicologist's assessment of a particular calculation indicates the need for an MF greater than 1.

The RfDs for noncarcinogenic chemicals are presented in Table 2-2. The primary source for toxicological reference values is the IRIS on-line database (EPA 1999), which contains current health risk and regulatory information. Provisional RfDs are tabulated in HEAST (EPA 1998).

In keeping with EPA guidance (EPA 1989a), all noncarcinogenic risk was considered additive for individual receptors. Since the noncarcinogenic constituents under investigation at the site are associated with various adverse effects on distinct target organs and systems, the assumption of additivity of effects may overstate the potential for harmful effects. On the other hand, the potential synergistic effects of two or more constituents must also be recognized. That is, the combined effects of exposure to two constituents may be worse than exposure to either constituent alone because of chemical interactions between the two constituents.

The noncarcinogenic risk associated with a constituent exposure is expressed as the *hazard quotient* (HQ). The HQ is a ratio of the estimated constituent intake divided by the appropriate oral or inhalation RfD. Methods for calculating intake are presented in Section 3, and are based

TABLE 2-2
REFERENCE DOSES

Constituent	Chronic Exposures[1]		Subchronic Exposures[2]	
	Oral (mg/kg-d)	Inhalation (mg/kg-d)	Oral (mg/kg-d)	Inhalation (mg/kg-d)
1,1-dichloroethane	1.00E-01	1.43E-01	1.00E+00	1.43E+00
1,1-dichloroethene	9.00E-03	9.00E-03	9.00E-03	9.00E-03
1,1,1-trichloroethane	2.00E-01	1.80E-01	NA	NA
1,1,2-trichloroethane	4.00E-03	4.00E-03	4.00E-02	4.00E-02
1,2-dichlorobenzene	9.00E-02	5.71E-02	NA	NA
1,2-dichloroethane	NA	NA	NA	NA
1,2-dichloropropane	NA	1.14E-03	NA	3.71E-03
1,4-dichlorobenzene	NA	2.29E-01	NA	7.14E-01
2,4-dichlorophenol	3.00E-03	3.00E-03	3.00E-03	3.00E-03
2-butanone	6.00E-01	2.86E-01	2.00E+00	2.86E+00
4,4'-DDD	NA	NA	NA	NA
4,4'-DDE	NA	NA	NA	NA
4,4'-DDT	5.00E-04	5.00E-04	5.00E-04	5.00E-04
4-methyl-2-pentanone	8.00E-02	2.29E-02	8.00E-01	2.29E-01
acetone	1.00E-01	1.00E-01	1.00E+00	1.00E+00
antimony	4.00E-04	4.00E-04	4.00E-04	4.00E-04
aroclor-1254	2.00E-05	2.00E-05	5.00E-05	5.00E-05
arsenic	3.00E-04	3.00E-04	3.00E-04	3.00E-04
barium	7.00E-02	1.43E-04	7.00E-02	1.43E-03
benzene	NA	NA	NA	NA
benzo(a)anthracene	NA	NA	NA	NA
benzo(a)pyrene	NA	NA	NA	NA
benzo(b)fluoranthene	NA	NA	NA	NA
beryllium	5.00E-03	5.00E-03	5.00E-03	5.00E-03
bis-(2ethylhexyl) phthalate	2.00E-02	2.00E-02	NA	NA
bromodichloromethane	2.00E-02	2.00E-02	2.00E-02	2.00E-02
bromoform	2.00E-02	2.00E-02	2.00E-02	2.00E-02
cadmium	5.00E-04	5.00E-04	5.00E-04	5.00E-04
carbon disulfide	1.00E-01	2.00E-01	1.00E-01	2.00E-01
carbon terrachloride	7.00E-04	7.00E-04	NA	NA
chlorobenzene	2.00E-02	5.71E-03	NA	NA

TABLE 2-2 (CONT.)
REFERENCE DOSES

Constituent	Chronic Exposures[1]		Subchronic Exposures[2]	
	Oral (mg/kg-d)	Inhalation (mg/kg-d)	Oral (mg/kg-d)	Inhalation (mg/kg-d)
chloroform	1.00E-02	1.00E-02	1.00E-02	1.00E-02
chromium III	1.50E+00	1.50E+00	1.00E+00	1.00E+00
chromium VI	3.00E-03	3.00E-03	2.00E-02	2.00E-02
chrysene	NA	NA	NA	NA
cis-1,2-dichloroethene	1.00E-02	1.00E-02	1.00E-01	1.00E-01
copper	3.70E-02	3.70E-02	3.70E-02	3.70E-02
cumene	1.00E-01	1.14E-01	4.00E-01	2.57E-02
cyanide	2.00E-02	2.00E-02	2.00E-02	2.00E-02
dibromochloromethane	2.00E-02	2.00E-02	2.00E-01	2.00E-01
di-n-butyl phthalate	1.00E-01	1.00E-01	1.00E+00	1.00E+00
di-n-octyl phthalate	2.00E-02	2.00E-02	2.00E-02	2.00E-02
endosulfan	6.00E-03	6.00E-03	6.00E-03	6.00E-03
endrin	3.00E-04	3.00E-04	3.00E-04	3.00E-04
ethylbenzene	1.00E-01	2.86E-01	NA	NA
gamma-BHC	3.00E-04	3.00E-04	3.00E-03	3.00E-03
manganese	4.60E-02	4.60E-02	5.00E-03	5.00E-03
mercury	3.00E-04	8.57E-05	3.00E-04	8.57E-05
methylene chloride	6.00E-02	8.57E-01	6.00E-02	8.57E-01
molybdenum	5.00E-03	5.00E-03	4.00E-02	4.00E-02
nickel	2.00E-02	2.00E-02	2.00E-02	2.00E-02
phenol	6.00E-01	6.00E-01	6.00E-01	6.00E-01
pyrene	3.00E-02	3.00E-02	3.00E-01	3.00E-01
selenium	5.00E-03	5.00E-03	5.00E-03	5.00E-03
silver	5.00E-03	5.00E-03	5.00E-03	5.00E-03
strontium	6.00E-01	6.00E-01	6.00E-01	6.00E-01
tetrachloroethylene	1.00E-02	1.00E-02	1.00E-01	1.00E-01
toluene	2.00E-01	1.14E-01	2.00E+00	2.00E+00
trans-1,2-dichloroethene	2.00E-02	2.00E-02	2.00E-01	2.00E-01
trichloroethene	7.35E-03	7.35E-03	NA	NA

TABLE 2-2 (CONT.)
REFERENCE DOSES

Constituent	Chronic Exposures[1]		Subchronic Exposures[2]	
	Oral (mg/kg-d)	Inhalation[3] (mg/kg-d)	Oral (mg/kg-d)	Inhalation[3] (mg/kg-d)
trichlorofluoromethane	3.00E-01	2.00E-01	7.00E-01	2.00E+00
trichlorotrifluoroethane	3.00E+01	8.57E+00	3.00E+00	8.57E+00
vanadium	7.00E-03	7.00E-03	7.00E-03	7.00E-03
vinyl acetate	1.00E+00	5.71E-02	1.00E+00	5.71E-02
vinyl chloride	NA	NA	NA	NA
xylenes	2.00E+00	2.00E-01	2.00E+00	2.00E+00
zinc	3.00E-01	3.00E-01	3.00E-01	3.00E-01

Notes:
(1) Chronic exposure is 7 years to lifetime (EPA 1989a).
(2) Subchronic exposure is 2 weeks to 7 years (EPA 1989a).
NA = Not Available. No toxicity data exist for pathway.

Sources:
California Cancer Potency Factors Update (Cal/EPA 1996a)
IRIS (EPA 1999)
HEAST (EPA 1998)

on the measured or calculated exposure point concentration for a constituent. If the HQ exceeds 1, some harmful effect may occur or the threshold dose may be exceeded. If the HQ is equal to or less than 1, the exposure level is not likely to cause adverse effects. If exposure to multiple constituents occurs, the potential for harmful effects is assessed by summing the HQs and is designated the *hazard index* (HI).

2.2 CARCINOGENIC CONSTITUENTS

The incremental lifetime cancer risk (ILCR) from a carcinogen is calculated as a product of the reasonable maximum daily intake (in units of milligram per kilogram per day [mg/kg-d]) and the cancer slope factor (CSF). EPA's model of carcinogenesis assumes the relationship between exposure to a carcinogen and cancer risk is linear over the entire dose range, except at very high doses (EPA 1989a). This linearity assumes that there is no threshold dose below which harmful

effects will not occur. Because of this, carcinogenic effects are considered to be cumulative across age groups when considering lifetime exposures.

CSFs are upper-bound (95th percent upper confidence limit [UCL]) estimates of the increased cancer risk per unit dose, in which risk is expressed as the probability that an individual will develop cancer within his or her lifetime as the result of exposure to a given level of a carcinogen. This approach is inherently conservative because of the no-threshold assumption and the use of the 95 percent UCL of the estimated slope of dose versus cancer risk.

In addition to the CSF, the toxicity information considered in the assessment of potential carcinogenic risks includes a weight-of-evidence classification. EPA groups constituents into 5 categories according to their potential for carcinogenic effects based on clinical evidence (EPA 1989a):

- Group A Human carcinogen (sufficient evidence of carcinogenicity in humans)
- Group B Probable human carcinogen (B1 - limited evidence of carcinogenicity in humans; B2 - sufficient evidence in animals with inadequate or lack of evidence in humans)
- Group C Possible human carcinogen (limited evidence of carcinogenicity in animals and inadequate evidence in humans)
- Group D Not classifiable as to human carcinogenicity (inadequate or no evidence)
- Group E Evidence of noncarcinogenicity for humans (no evidence of carcinogenicity in adequate studies)

The CSFs for chemicals studied in this report are presented in Table 2-3. The primary source for toxicological reference values is the California Cancer Potency Factors Update (Cal/EPA 1996a), followed by IRIS (EPA 1999). Provisional CSFs are tabulated in HEAST (EPA 1998).

2.3 QUANTIFICATION OF DERMAL EXPOSURE RISKS

Dermal RfDs and CSFs are traditionally derived from the corresponding oral values (EPA 1989a). However, DTSC recommends that dermal RfDs and CSFs should not be derived; rather

TABLE 2-3
CANCER SLOPE FACTORS

Constituent	Chronic/Subchronic Exposures	
	Oral(mg/kg-d)$^{-1}$	Inhalation(mg/kg-d)$^{-1}$
1,1-dichloroethane	5.70E-03	5.70E-03
1,1-dichloroethene	6.00E-01	1.20E+00
1,1,1-trichloroethane	NA	NA
1,1,2-trichloroethane	7.20E-02	7.20E-02
1,2-dichlorobenzene	NA	NA
1,2-dichloroethane	7.00E-02	7.00E-02
1,2-dichloropropane	6.30E-02	6.30E-02
1,4-dichlorobenzene	4.00E-02	4.00E-02
2,4-dichlorophenol	NA	NA
2-butanone	NA	NA
4,4'-DDD	2.40E-01	2.40E-01
4,4'-DDE	2.40E-01	2.40E-01
4,4'-DDT	3.40E-01	3.40E-01
4-methyl-2-pentanone	NA	NA
acetone	NA	NA
antimony	NA	NA
arsenic	1.50E+00	1.20E+01
barium	NA	NA
benzene	1.00E-01	1.00E-01
benzo(a)anthracene	1.20E+00	4.00E-01
benzo(a)pyrene	1.20E+01	3.90E+00
benzo(b)fluoranthene	1.20E+00	4.00E+00
beryllium	NA	8.40E+00
bis-(2ethylhexyl)phthalate	8.40E-03	8.40E-03
bromodichloromethane	1.30E-01	1.30E-01
bromoform	7.93E-03	3.90E-03
cadmium	NA	1.50E+01
carbon disulfide	NA	NA
carbon tetrachloride	1.50E-01	1.50E-01

TABLE 2-3 (CONT.)
CANCER SLOPE FACTORS

Constituent	Chronic/Subchronic Exposures	
	Oral $(mg/kg\text{-}d)^{-1}$	Inhalation $(mg/kg\text{-}d)^{-1}$
chlorobenzene	NA	NA
chloroform	3.10E-02	1.90E-02
chromium III	NA	NA
chromium VI	4.20E-01	5.10E+02
chrysene	7.3E-03	NA
cis-1,2-dichloroethene	NA	NA
copper	NA	NA
cyanide	NA	NA
dibromochloromethane	9.40E-02	9.40E-02
dichloromethane	NA	NA
di-n-butyl phthalate	NA	NA
di-n-octyl phthalate	NA	NA
ethylbenzene	NA	NA
gamma-BHC	1.30+00	1.10E+00
hydrogen sulfide	NA	NA
indeno(1,2,3-cd)pyrene	7.30E-01	3.10E-01
manganese	NA	NA
mercury	NA	NA
methylene chloride	1.40E-02	3.50E-03
molybdenum	NA	NA
nickel	NA	9.10E-01
phenol	NA	NA
pyrene	NA	NA
selenium	NA	NA
silver	NA	NA
strontium	NA	NA
tetrachloroethylene	NA	NA
toluene	NA	NA
trans-1,2-dichloroethene	NA	NA
trichloroethene	1.50E-02	1.00E-02
trichlorofluoromethane	NA	NA
trichlorotrifluoroethane	NA	NA

TABLE 2-3 (CONT.)
CANCER SLOPE FACTORS

Constituent	Chronic/Subchronic Exposures	
	Oral $(mg/kg\text{-}d)^{-1}$	Inhalation $(mg/kg\text{-}d)^{-1}$
vanadium	NA	NA
vinyl acetate	NA	NA
vinyl chloride	2.70E-01	2.70E-01
xylenes	NA	NA
zinc	NA	NA

Notes: NA = Not Available. No toxicity data exists for pathway.
Sources: Cal/EPA CPF Update (Cal/EPA 1996), IRIS (EPA 1999), HEAST (EPA 1998)

oral RfDs and CSFs should be used in place of derived dermal toxicity values (Cal/EPA 1998a, 1998b).

2.4 POTENCY EQUIVALENCE FACTORS

One approach used to assess the cancer risk of mixtures of structurally related compounds such as polycyclic aromatic hydrocarbons (PAHs) is to characterize the toxicities of these compounds relative to the toxicity of a compound representative of the group. Known as the potency equivalence factors (PEFs) approach, this method takes into account the differing potencies of carcinogenic compounds from structurally related mixtures. This weighting scheme for PAHs was developed by the Air Toxicology and Epidemiology Section of the Office of Environmental Health Hazard Assessment in the document entitled *Health Effects of Benzo(a)pyrene* (Cal/EPA 1993).

The PEFs presented in Table 2-4 may be used for both inhalation and oral exposure pathways, although data used by Cal/EPA for their development were prioritized so inhalation exposure received higher priority than did other exposures. The benzo(a)pyrene CSF will be multiplied by the appropriate chemical-specific PEF value to derive oral and inhalation toxicity values.

TABLE 2-4
POTENCY EQUIVALENCE FACTORS (PEFs) FOR POLYAROMATIC HYDROCARBONS (PAHs)

PAH or Derivative	CAS No.	Suggested PEF
benzo(a)pyrene (index compound)	50-32-8	1.0
1,6-dinitropyrene	42397-64-8	10
1,8-dinitropyrene	42397-65-9	1.0
1-nitropyrene	5522-43-0	0.1
2-nitrofluorene	607-57-8	0.01
4-nitropyrene	57835-92-4	0.1
5-methylchrysene	3697-24-3	1.0
6-nitrocrysene	7496-02-8	10
7H-dibenzo(c,g)carbazole	194-59-2	1.0
benzo(a)anthracene	56-55-3	0.1
benzo(b)fluoranthene	205-99-2	0.1
benzo(j)fluoranthene	205-82-3	0.1
chrysene	218-01-9	0.01
dibenz(a,h)acridine	226-36-8	0.1
dibenz(a,j)acridine	224-42-0	0.1
dibenzo(a,e)pyrene	192-65-4	1.0
dibenzo(a,h)pyrene	189-64-0	10
dibenzo(a,i)pyrene	189-55-9	10
dibenzo(a,l)pyrene	191-30-0	10
indeno(1,2,3-c,d)pyrene	193-39-5	0.1

SOURCE:
Health Effects of Benzo(a)pyrene (Cal/EPA 1993)

3. CONCEPTUAL EXPOSURE MODEL

This section describes the projected exposures associated with the final site land use and with an interim scenario representing site construction. The general post-remediation setting for the two exposure scenarios is described first (Section 3.1), followed by a site-specific conceptual exposure model (CEM), which traces the pathways of exposure from constituent source to potentially exposed populations or "receptors" (Section 3.2).

Development of the post-remediation exposure setting and CEM for the site followed standard agency guidance, including:

- Supplemental Guidance for Human Health Risk Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities (Cal/EPA 1992).
- Risk Assessment Guidance for Superfund (RAGS) Human Health Evaluation Manual, Volume I (EPA 1989a).
- Data Quality Objectives Guidance for Superfund (EPA 1993).

When available, site-specific information was used when estimating HBRGs. When site-specific data were unavailable, conservative parameter values were obtained from the literature. The CEM for the site is based on conservative assumptions with the understanding that part of the property will undergo commercial redevelopment and part will undergo residential redevelopment. The exposure pathways, parameters, and receptors used in the development of the HBRGs provided in Section 5 are those presented in the approved HBRG Protocol (IESI 1999, Cal/EPA 1999).

3.1 EXPOSURE SETTING

The specific characteristics of the site exposure setting influence the availability of constituents to potential receptors, release mechanisms, exposure routes, and receptor activities. A receptor's actual exposure depends on the site's physical attributes and land use. While discussions of

future land use are necessarily speculative, health-protective remedial goals are based on assumptions that ensure a reasonable maximum exposure of receptors to constituents.

3.1.1 Future Land Use and Associated Exposure Scenarios

For the purpose of defining potential receptor exposures, this document assumes multiple land uses for the site (commercial and residential). Given these land uses, two exposure scenarios were examined; one associated with construction at the site (the *construction scenario*), the other with operation of the site (the *operational scenario*). Applicable receptors under the construction scenario include on-site construction workers and, for the operational scenario, on-site operations/office personnel, and children in a proposed on-site daycare center.

In addition, hypothetical off-site residents (adults and children) who use groundwater for domestic purposes are considered. The term "hypothetical" is used since groundwater in the vicinity of the site is not potable and therefore, the exposures considered are not probable. Hypothetical off-site receptors were considered to quantitatively demonstrate that HBRGs developed for the site are more than adequate to ensure the health protection of neighboring residents.

The land use assumed for HBRG calculations is consistent with the zoning and deed restrictions to be implemented at the site. While final decisions concerning the exact design of the site have not been made and approval of the site plan has not been issued by the city, reasonable and conservative assumptions concerning potential commercial uses and facility construction have been employed in the development of the exposure scenarios. In developing the exposure scenarios, it was assumed that:

- Access controls and security will minimize trespassing during construction.
- All surfaces will be capped with cement or asphalt (for building foundations, roadways, or parking areas) or covered with vegetation (landscaping) after development.
- Clean, imported soil will be placed over the ground surface at any daycare center.
- All buildings will have a high-density polyethylene vapor barrier beneath the foundation. Los Angeles City code requires comprehensive methane mitigation measures for the project.

These assumptions are consistent with the anticipated development.

3.1.2 Reasonable Maximum Exposure

Both EPA (1989a) and Cal/EPA (1992) recommend the use of reasonable maximum exposure (RME) to express the highest exposure that could reasonably occur at a site. As a conservative estimate, the RME is within the range of possible exposures but higher than the typical or average exposure. RMEs are estimated for individual pathways. If a population is exposed to more than one pathway, the sum of the exposures across pathways represents the RME (EPA 1989a).

In calculating exposure, EPA (1989a) suggests that specific values for each parameter in the exposure equation be combined to generate the RME. The parameters are presented in Table 3-1.

TABLE 3-1
RECOMMENDED RME PARAMETERS

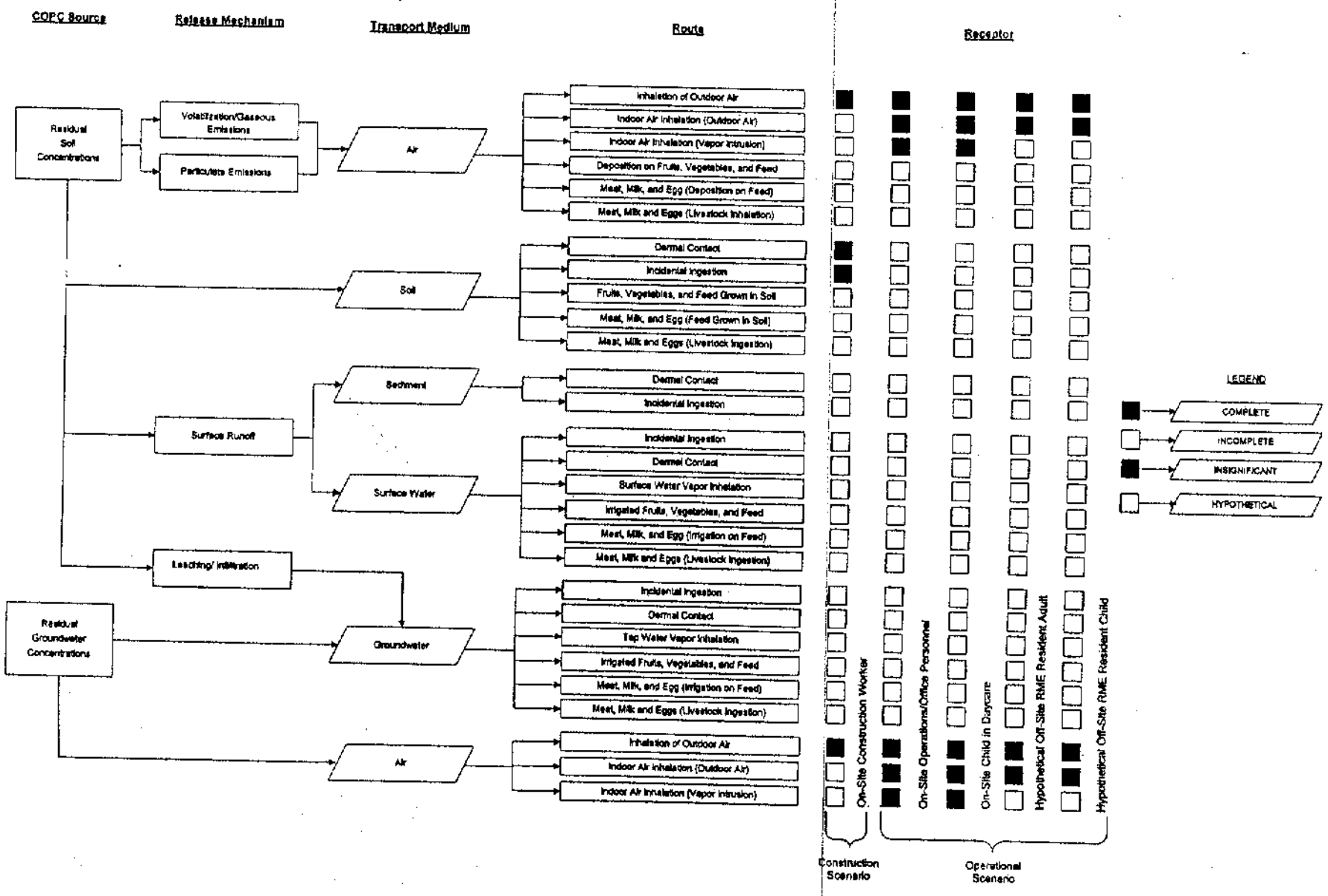
Parameter	Recommended RME Approach
Intake Rate	Upper 95th percentile
Exposure Frequency & Duration	Upper 95th percentile estimate or develop an alternate conservative value
Body Weight	Arithmetic average over exposure period

Populations potentially exposed to site constituents include individuals of various ages and lifestyles who live or conduct business at or near the site. These individuals are grouped into representative receptor categories based on their relationship to the site (e.g., on-site construction worker or hypothetical off-site resident). Each receptor evaluated in this process has been developed to conservatively represent the upper-bound exposures to a group of people that have similar lifestyles or perform similar daily activities.

3.2 CONCEPTUAL EXPOSURE MODEL

The CEM identifies which exposure routes are complete and significant under the given land use. Figure 3-1 presents the CEM developed to describe the site exposure setting under the

FIGURE 3-1
CONCEPTUAL EXPOSURE MODEL (CEM), PLAYA VISTA SITE



construction and operational exposure scenarios. Given these scenarios, there are several potential exposure pathways through which a receptor may come in contact with constituents at the site; however, four elements must be present for an exposure pathway to be deemed complete:

1. constituent source
2. release mechanism and transport medium
3. receptor
4. exposure route

The following sections provide details on each of these elements.

3.2.1 Constituent Sources

Discussion of constituent sources provides a starting point for the development of the exposure pathways. The following sources have been identified at the site:

- Constituents in the soil to a depth of 2 feet above the shallow water-bearing zone or a maximum depth of 12 feet
- Constituents in the soil below 12 feet or within 2 feet of the shallow water-bearing zone
- Constituents in the water-bearing zone

These sources and the resultant CEM (Figure 3-1) address all COPCs detected during previous site investigations. The division of soil sources is based on the potential for direct exposures, typically assumed to be within the top 12 feet of soil or to within 2 feet of the shallow water-bearing zone. In addition, impacted soil may act as reservoir for constituents that slowly migrate to other environmental compartments, such as groundwater, and serve as an indirect source of human exposure.

3.2.2 Release Mechanisms

The constituent sources discussed above can be divided conceptually into two categories:

1. Direct sources, such as surface soils, which are readily available for potential receptor exposures

2. Indirect sources, such as groundwater and subsurface soil, which are not readily available for receptor exposure and require an intermediate release and transport mechanism before receptors can be exposed

The mechanisms for constituent release and transport for indirect sources are:

- Groundwater flow
- Leaching
- Volatilization
- Dust and particulate emissions

Constituent migration by way of groundwater flow depends on the properties of the aquifer, constituent, and lithology. For example, the solubility and organic carbon partition coefficient (K_{oc}) affect the transport of organic constituents in the groundwater. Organic constituents tend to flow in the direction of the groundwater but at a slower rate. This is because organic constituents moving with groundwater tend to partition or divide themselves between the mobile water phase and the stationary soil particles that are in contact with groundwater (i.e., the process of adsorption). The overall effect of this sorption process is to retard the constituent's rate of transport. Retardation increases the travel time required for the bulk of the constituent plume to reach the receptor.

Constituents can also be released to groundwater from soil (surface and subsurface) as a result of leaching. Precipitation infiltrating the source media initiates the release of constituents from the soil into the downward migrating water. As the infiltrating water moves toward underlying groundwater, the constituents are subjected to many of the same mechanisms discussed above. Transport time from source to groundwater is highly dependent upon additional conditions, including infiltration volume, surface structures, frequency of precipitation, depth from source to groundwater, and soil properties.

Chemical composition, molecular weight, solubility, and viscosity also influence constituent migration. In general, constituents that are highly soluble in water are considered mobile in groundwater. Those with high water solubilities (greater than 1,000 mg/L) and low K_{oc} values (less than 150 cm^3/g) are considered very mobile in water (Howard 1989). Those constituents exhibiting low mobility, based on their solubility and K_{oc} values, would not be expected to move readily in groundwater or leach into groundwater.

Volatilization is the mass transfer of an organic constituent from a specific medium (e.g., soil or groundwater) to air. Vapor from volatile constituents moves in the subsurface soil away from the source toward the atmosphere. Environmental factors that affect volatilization include temperature, soil porosity, soil moisture content, soil organic carbon content, depth to contamination, and surface structures. The volatility of a constituent is a function of its vapor pressure, water solubility, and air diffusion coefficient. Among constituents with similar vapor pressures, those with high water solubilities are less likely to become volatile than those with lower solubilities. Generally, constituents with high vapor pressures (greater than 0.001 mm Hg) or high Henry's Law constants (greater than 10^{-5} atm-m^3/mol) can be expected to volatilize readily from water and soil (Cal/EPA 1994).

Dust and soil particulate emissions can result from wind and mechanical erosion (e.g., construction activities). Environmental factors that influence wind erosion are wind speed, moisture content, vegetative cover, soil composition, and surface structures. Chemical and physical properties can also be used to estimate the potential for a constituent to be emitted in dust. Constituents with relatively high organic carbon partition coefficients (K_{oc} greater than 2,000 cm^3/g) are more likely to be sorbed on dust or soil particulate and become airborne (EPA 1988c).

3.2.3 Potentially Exposed Populations

Persons on the site are the most likely to be exposed to site constituents. To develop conservative HBRGs, five potential receptors were considered: an on-site construction worker, on-site operations/office personnel, the on-site child in daycare, and two hypothetical off-site residents

(adult and child) who live at the site boundary downgradient of prevailing groundwater flow. The on-site construction worker is associated with the construction scenario, while the remaining receptors are associated with the operational scenario.

The development and selection of these receptors were based on the RME concept discussed in Section 3.1.2 and regulatory guidance (Cal/EPA 1992), and are consistent with those outlined in the risk assessment MOU (PV 1999). These receptors were chosen to ensure that constituent-specific HBRG values are protective of human health, and that receptor exposure to multiple constituents via multiple pathways will not result in risks that exceed acceptable risk levels.

Descriptions of the types, locations, and lifestyles of these populations are provided below.

3.2.3.1 On-Site Construction Worker

This potential receptor includes all workers engaged in construction, excavation, or other earth moving activities at the site during development. These workers are categorized separately because they are likely to have elevated inhalation and soil contact rates and are likely to spend the majority of their time outdoors. Exposure parameters for construction workers are presented in Section 4.

Three significant exposure pathways (Figure 3-1) are applicable to this receptor under the construction scenario:

- Inhalation of volatilized constituents and resuspended particulate (ambient/outdoor air)
- Incidental ingestion of soil
- Dermal contact with soil

Although volatile constituents are present in both soil and groundwater, the groundwater-to-air volatilization of constituents is believed to be insignificant when compared with soil-to-air volatilization. That is, HBRGs based on the soil-to-air pathway are more conservative than those based on the groundwater-to-air pathway.

This assertion can be qualitatively demonstrated by examining the transport mechanisms involved. When calculating a soil-based HBRG for the groundwater-to-air volatilization pathway, the following mechanisms must be considered:

1. Volatilization of the constituent from groundwater
2. Transport of the volatilized constituent back through the soil matrix to the atmosphere

The physical processes involved in each of these mechanisms generally tend to decrease the concentration of the constituent. Consequently, an HBRG that considers the transport of a constituent from groundwater-to-vapor-to-air is less conservative than an HBRG that considers the more direct transport of the constituent from soil-to-air. Therefore, for purposes of HBRG determination, HBRGs based on the soil-to-air pathway are more conservative than those based on the groundwater-to-air pathway.

Ingestion of groundwater drawn from the underlying aquifer is not applicable to this receptor since the local municipality will provide all on-site water.

3.2.3.2 On-Site Operations/Office Personnel

This potential receptor includes security personnel, maintenance workers, production support personnel, and office workers employed on site following construction of the commercial facilities. This receptor is likely to have the greatest potential for exposure to residual site constituents during operation of the facility. Exposure parameters for operations/office personnel are presented in Section 4.

The only significant exposure pathways applicable to this receptor under the operational scenario are inhalation of vapors and gases migrating into building structures (vapor intrusion) and inhalation of airborne constituents in outdoor air. Volatilization and particulate emission mechanisms may allow residual soil constituents to become airborne and taken into the body through inhalation. Although volatile constituents are also present in the groundwater, the groundwater-to-air volatilization of constituents is believed to be insignificant when compared with soil-to-air volatilization (Section 3.2.3.1).

Because of the proposed land use, deed restrictions, abovegrade landscaping and pavement, this receptor's direct exposure to soils would require intrusive activities. Such intrusive exposures are often associated with construction and are considered as part of the on-site construction worker. Therefore, this pathway of exposure is deemed incomplete for on-site operations/office personnel.

Ingestion of groundwater drawn from the underlying aquifer is not applicable to this receptor because the local municipality will provide all on-site water.

3.2.3.3 Children in the On-Site Daycare Center

This potential receptor includes children in the on-site daycare center proposed for the commercial parcels. Playa Vista has incorporated many safety measures to eliminate this receptor's potential for exposure. As previously mentioned, comprehensive methane mitigation measures will be implemented for the project, which will be in accordance with the Los Angeles City code requirement (Section 3.1.1). All building foundations will be lined with a high-density polyethylene (HDPE) liner, and an active vapor extraction system will be incorporated beneath the foundation. Exposure parameters for children in daycare are presented in Section 4.

Clean fill will be used to cover exposed soil and in landscaping the site, thereby reducing or eliminating the direct exposure to soil pathway. The only significant exposure pathways applicable to this receptor under the operational scenario are inhalation of vapors and gases migrating into building structures (vapor intrusion) and inhalation of airborne chemicals in outdoor air. Volatilization and particulate emission mechanisms may allow residual soil constituents to become airborne and taken into the body through inhalation. Although volatile constituents are also present in the groundwater, the groundwater-to-air volatilization of constituents is believed to be insignificant when compared with soil-to-air volatilization (Section 3.2.3.1).

Ingestion of groundwater drawn from the underlying aquifer is not applicable to this receptor since the local municipality will provide all on-site water.

3.2.3.4 Hypothetical Off-Site Resident Adult

This hypothetical receptor is conservatively assumed to reside off site at the property boundary (hydraulically downgradient) and to use groundwater from the shallow water-bearing zone for domestic purposes.

> **Note**: The groundwater beneath the site is not potable for domestic or agricultural use due to its poor quality and low yield. In addition, off-site receptors for whom groundwater exposures were modeled are actually located cross-gradient of groundwater flow. The nearest "true" downgradient residents are significantly farther from the site.

Exposure parameters for the hypothetical off-site resident adult are presented in Section 4.

The significant exposure pathways for this receptor are:

- Ingestion of groundwater
- Dermal contact with groundwater while bathing or showering
- Inhalation of volatile constituents released during domestic/tap water usage

Since the receptor does not access the site, there is no potential for direct exposure to residual constituents in site soils.

Although the potential exists for airborne transport constituents from the site to off-site receptors, due to tremendous dilution of the source term released from the site to off-site areas, the inhalation of constituents in outdoor air were deemed to be insignificant for off-site receptors.

3.2.3.5 Hypothetical Off-Site Resident Child

Young children (ages 1 through 6) living in the vicinity of the site are considered a special category of receptor because they may be more sensitive to a certain type of exposure than are adults (e.g., noncarcinogenic exposures). For the calculation of HBRGs, this potential receptor, like the adult receptor, is conservatively assumed to reside at the property boundary (hydraulically downgradient) and use groundwater for domestic purposes. Exposure pathways

are identical to those presented for the hypothetical off-site resident adult; however, the exposure parameters presented in Section 4 are different.

3.2.4 Significant Exposure Routes

Not all release mechanisms lead to significant exposure pathways under the scenarios examined. This section discusses the significance of each potential exposure pathway and gives the rationale for determining the viability of each pathway. Figure 3-1 summarizes the potential exposure pathways at the site and their relationships to the previously discussed constituent sources.

3.2.4.1 Inhalation Exposure Routes

Exposures via the inhalation pathways occur when constituents in airborne vapor, gases, and/or suspended particulate are inhaled by a receptor. The following inhalation pathways were reviewed for inclusion in this document (Cal/EPA 1992):

- Inhalation of gases and suspended particulate in outdoor air
- Inhalation of gases and particulate migrating from outdoor to indoor air
- Inhalation of constituents released during tap water usage
- Inhalation of gases and suspended particulate by livestock
- Deposition of airborne constituents on fruits, vegetables, and livestock feed

The emission of vapors and the suspension of particulate in outdoor air are likely to be more significant during the construction scenario. Due to the extensive use of asphalt paving, concrete slabs, and clean, imported soil within the area, emission of vapors and gases and suspension of particulate in outdoor air will be significantly reduced for operational and hypothetical off-site receptors. Inhalation of vapors, gases, and suspended particulate from outdoor air is deemed insignificant for the hypothetical off-site adult and child receptors due to the significant dispersion that occurs between the source and the property boundary. The inhalation pathway through vapor intrusion is deemed incomplete for the off-site receptors.

Due to the proposed redevelopment plans, agricultural use of the property is precluded. Therefore, air transport pathways associated with agricultural use are deemed incomplete.

In addition, a local municipality supplies all domestic water to the site; therefore, inhalation of constituents released during tap water usage for on-site construction and operational receptors is not a viable pathway. However, hypothetical exposure associated with groundwater usage at the nearest downgradient well is considered for off-site adult and child receptors.

Although volatile constituents are present in both soil and groundwater, the groundwater-to-air volatilization of constituents is believed to be insignificant when compared with soil-to-air volatilization (Section 3.2.3.1).

3.2.4.2 Dermal Contact Exposure Routes

This group of pathways encompasses all receptor activities that result in direct contact with constituents in soil or groundwater. The following dermal contact exposure pathways are considered potentially viable when evaluating dermal exposure:

- Dermal contact with surface soils and sediment
- Dermal contact with surface water during recreational use (i.e., swimming, wading, etc.)
- Dermal contact with groundwater in baths and showers

Dermal exposure to surface soils during construction are considered for the on-site receptor (i.e., construction worker). However, extensive use of asphalt paving, concrete slabs, and clean, imported soil within the site will eliminate direct soil contact by the on-site operations/office personnel and daycare children during the operational scenario. Also, it is highly unlikely that significant dermal contact with surface water or sediment will occur due to the nature of the proposed redevelopment. Since the off-site adult and child receptors do not access the site, there is no potential for exposure to residual constituents in site soils, sediment or surface water.

A local municipality will supply all domestic water; therefore, dermal exposure to on-site groundwater is not a reasonable possibility. However, hypothetical exposure associated with

groundwater usage at the nearest down-gradient well is considered for hypothetical off-site residential receptors.

3.2.4.3 Ingestion Exposure Routes

These exposure pathways include the most likely routes by which a receptor may incidentally ingest constituents originating from the site. The following ingestion exposure pathways are considered potentially viable when evaluating exposures resulting from constituent ingestion:

- Incidental ingestion of soil
- Incidental ingestion of sediment
- Ingestion of groundwater
- Ingestion of surface water during recreational use (i.e., swimming, wading, etc.)
- Ingestion of fruits, vegetables, and grains containing constituents due to transfer from the air to plant tissues
- Ingestion of meat, milk, and eggs containing constituents due to livestock consumption of constituents transferred from the air to the feed source
- Ingestion of meat, milk, and eggs containing constituents due to livestock inhalation of atmospheric constituents
- Ingestion of fruits, vegetables, and grains grown in soil containing constituents
- Ingestion of meat, milk, and eggs containing constituents due to livestock consumption of feed grown in soil containing constituents
- Ingestion of meat, milk, and eggs containing constituents due to incidental ingestion of soil by livestock
- Ingestion of fruits, vegetables, and grains irrigated with groundwater or surface water containing constituents
- Ingestion of meat, milk, and eggs containing constituents due to livestock consumption of feed irrigated with groundwater or surface water containing constituents
- Ingestion of meat, milk, and eggs containing constituents due to livestock consumption of groundwater or surface water containing constituents

The proposed redevelopment plans preclude agricultural use of the site. Thus, all agriculturally-based exposure pathways are not applicable. Since the potential exists for direct soil contact during the construction phase, incidental ingestion of soil for on-site receptors during the

construction scenario is a complete pathway. However, extensive use of asphalt paving, concrete slabs, and clean, imported soil within the site will eliminate direct soil contact by on-site and off-site receptors during the operational scenario. Also, it is highly unlikely that significant contact with surface water or sediment will occur due to the nature of the proposed redevelopment.

In addition, all domestic water needs will be supplied by the local municipality; therefore, groundwater ingestion for the on-site construction worker, operational/office personnel, and child in daycare is not a complete pathway. However, exposure associated with ingestion of water drawn from a hypothetical groundwater well located at the nearest down gradient residence is considered for hypothetical off-site residential receptors.

4. CALCULATION OF UNIT RISK

Section 4 presents the calculation of unit risk for constituents described in Section 2 and the significant exposure pathways presented in Section 3. Calculating unit risk is identical to calculating incremental lifetime cancer risk (ILCR) and/or a hazard index (HI), except a unit value of 1.0 replaces the source term exposure point concentration (1.0 mg/kg for direct exposures and modeled unit emissions for indirect exposures). Unit risks are used in Section 5 to determine HBRG values.

The unit risk calculations presented here quantify the magnitude, frequency, and duration of exposure for those populations and exposure pathways selected for quantitative evaluation in the conceptual exposure model (CEM) presented in Figure 3-1 (Section 3). The following sections give standard equations for estimating human intake and subsequent risk for the selected exposure pathways. Unless otherwise noted, the parameters and equations used in this section were drawn from the following guidance documents:

- Supplemental Guidance for Human Health Risk Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities (Cal/EPA 1992)
- Risk Assessment Guidance for Superfund (RAGS) Human Health Evaluation Manual, Volume I (EPA 1989a)
- Exposure Factors Handbook (EPA 1997)

When available, site-specific values were used, supplemented with values from the literature. Exposure parameters for each receptor under study are presented in Table 4-1, while constituent-specific dermal absorption values are presented in Table 4-2. These two tables are referenced extensively in the following sections.

Two types of exposures are identified in the CEM and quantified in this document, *direct* and *indirect*. Incidental soil ingestion, groundwater ingestion, and dermal contact with soil or groundwater are examples of direct exposure pathways, in which the receptor comes in direct

TABLE 4-1
RECEPTOR EXPOSURE PARAMETERS

		On-Site Receptors		
Pathway	Parameter	Construction Worker	Operations/ Office Personnel	Child in Daycare
Inhalation of Gases	IR - Inhalation Rate (m^3/h)	1.5	1.25	0.6
	EF - Exposure Frequency (d/y)	250	250	250
	ED - Exposure Duration (y)	1	25	5
	ET - Exposure Time (h/d)	12	8	8
	BW - Body Weight (kg)	70	70	15
	AT - Averaging Time -car. (d)	25,550	25,550	25,550
	AT - Averaging Time - noncar. (d)	365	9,125	1,825
Inhalation Of Particulate	IR - Inhalation Rate (m^3/h)	1.5	1.25	0.6
	RFP - Respirable Fraction	0.5	0.5	0.5
	EF - Exposure Frequency (d/y)	250	250	250
	ED - Exposure Duration (y)	1	25	5
	ET_o - Exposure Time, Outdoors (h/d)	12	1	1
	BW - Body Weight (kg)	70	70	15
	AT - Averaging Time -car. (d)	25,550	25,550	25,550
	AT - Averaging Time - noncar. (d)	365	9,125	1,825
Incidental Ingestion of Soil	IR - Ingestion Rate (mg/d)	480	NA	NA
	EF - Exposure Frequency (d/y)	250	▲	▲
	ED - Exposure Duration (y)	1	⋮	⋮
	BW - Body Weight (kg)	70	⋮	⋮
	AT - Averaging Time - car. (d)	25,550	⋮	⋮
	AT - Averaging Time - noncar. (d)	365	▼	▼
	CF - Conversion Factor (kg/mg)	1.00E-06	NA	NA
Dermal Contact With Soil	SA - Surface Area (cm^2/d)	3,760	NA	NA
	ABS - Absorption Coefficient	csv (Table 4-2)	▲	▲
	AF - Adherence Factor (mg/cm^2)	1	⋮	⋮
	ED - Exposure Duration (y)	1	⋮	⋮
	EF - Exposure Frequency (d/y)	250	⋮	⋮
	BW - Body Weight (kg)	70	⋮	⋮
	AT - Averaging Time - car. (d)	25,550	⋮	⋮
	AT - Averaging Time - noncar. (d)	365	⋮	⋮
	CF - Conversion Factor (kg/mg)	1.00E-06	▼ NA	▼ NA

TABLE 4-1 (CONT'D)
RECEPTOR EXPOSURE PARAMETERS

Pathway	Parameter	Off-Site Receptors: Resident Adult	Off-Site Receptors: Resident Child
Inhalation of Gases from Household Water Use	IR - Inhalation Rate (m^3/h)	0.83	0.6
	EF - Exposure Frequency (d/y)	350	350
	ED - Exposure Duration (y)	30	6
	ET - Exposure Duration (hr/event)	0.25	0.25
	BW - Body Weight (kg)	70	15
	AT - Averaging Time -car. (d)	25,550	25,550
	AT - Averaging Time - noncar. (d)	10,950	2,190
Ingestion of Groundwater	IR - Ingestion Rate (L/d)	2	1
	EF - Exposure Frequency (d/y)	350	350
	ED - Exposure Duration (y)	30	6
	BW - Body Weight (kg)	70	15
	AT - Averaging Time - car. (d)	25,550	25,550
	AT - Averaging Time - noncar. (d)	10,950	2,190
Dermal Contact While Bathing	SA - Surface Area (cm^2)	19400	9310
	EF - Exposure Frequency (event/y)	350	350
	ED - Exposure Duration (y)	30	6
	ET - Exposure Duration (hr/event)	0.25	0.17
	BW - Body Weight (kg)	70	15
	AT - Averaging Time - car. (d)	25,550	25,550
	AT - Averaging Time - noncar. (d)	10,950	2,190

Notes:

car. = carcinogenic
noncar. = noncarcinogenic
csv = constituent specific value
NA = Not Applicable

Sources:

Risk Assessment Memorandum of Understanding (BC 1999)
RAGS (EPA 1989a)
Exposure Factors Handbook (EPA 1997)

TABLE 4-2
PERMEABILITY CONSTANT (PC) AND DERMAL ABSORPTION (ABS) VALUES

Constituent	PC (cm/hr)	ABS (unitless)	Constituent	PC (cm/hr)	ABS (unitless)
1,1-dichloroethane	8.90E-03	1.00E-01	chloroform	8.90E-03	1.00E-01
1,1-dichloroethene	8.90E-03	1.00E-01	chromium (III)	1.00E-03	1.00E-02
1,1,1-trichloroethane	1.70E-02	1.00E-02	chromium (VI)	1.00E-03	1.00E-04
1,1,2-trichloroethane	8.40E-03	1.00E-01	chrysene	8.10E-01	1.50E-01
1,2-dichlorobenzene	6.10E-02	1.00E-01	cis-1,2-dichloroethene	1.00E-02	1.00E-01
1,2-dichloroethane	5.30E-03	1.00E-01	copper	1.00E-03	1.00E-02
1,2-dichloropropane	1.00E-02	1.00E-01	cumene	1.10E-01	1.00E-01
1,4-dichlorobenzene	6.20E-02	1.00E-01	cyanide	7.50E-03	1.00E-02
2-butanone	NA	1.00E-01	di-n-butyl phthalate	NA	1.00E-01
2,4-dichlorophenol	6.00E-02	1.00E-01	di-n-octyl phthalate	NA	1.00E-01
4,4'-DDD	2.80E-01	5.00E-02	dibromochloromethane	3.90E-03	1.00E-01
4,4'-DDE	2.40E-01	5.00E-02	endosulfan sulfate	2.10E-03	5.00E-02
4,4'-DDT	4.30E-01	5.00E-02	endrin	1.60E-02	5.00E-02
acenaphthene	2.50E-01	1.50E-01	ethylbenzene	7.40E-02	1.00E-01
acetone	5.70E-04	1.00E-01	gamma-BHC	NA	5.00E-02
antimony	1.00E-03	1.00E-02	hydrogen sulfide	5.60E-03	1.00E-03
aroclor-1254	3.50E-01	1.00E-01	indeno(1,2,3-cd)pyrene	1.90E+00	1.00E-02
arsenic	1.00E-03	3.00E-02	manganese	1.00E-03	1.00E-03
barium	1.00E-03	1.00E-02	mercury	1.00E-03	1.00E-02
benzene	2.10E-02	1.00E-01	methylene chloride	4.50E-03	1.00E-01
benzo(a)anthracene	NA	1.50E-01	molybdenum	1.00E-03	1.00E-02
benzo(a)pyrene	1.20E+00	1.50E-01	nickel	1.00E-03	1.00E-02
benzo(b)fluoranthene	1.20E+00	1.50E-01	phenol	5.50E-03	1.00E-01
beryllium	1.00E-03	1.00E-02	pyrene	3.20E-01	1.50E-01
bis(2-ethylhexyl)phthalate	2.30E-02	1.00E-01	selenium	1.00E-03	1.00E-02
bromodichloromethane	5.80E-03	1.00E-01	silver	1.00E-03	1.00E-02
bromoform	2.60E-03	1.00E-01	tetrachloroethene	3.70E-01	1.00E-01
cadmium	1.00E-03	1.00E-03	toluene	4.50E-02	1.00E-01
carbon disulfide	2.40E-02	1.00E-01	trans-1,2-dichloroethene	1.10E-03	1.00E-01
chlorobenzene	4.10E-02	1.00E-01	trichloroethene	1.60E-02	1.00E-01

TABLE 4-2 (CONT'D)
PERMEABILITY CONSTANT (PC) AND DERMAL ABSORPTION (ABS) VALUES

Constituent	PC (cm/hr)	ABS (unitless)	Constituent	PC (cm/hr)	ABS (unitless)
trichlorofluoromethane	1.70E-02	1.00E-02	vinyl chloride	7.30E-03	1.00E-01
trichlorotrifluoroethane (freon)	9.6E-03	1.00E-02	xylenes	8.00E-02	1.00E-01
vanadium	1.00E-03	1.00E-02	zinc	1.00E-03	1.00E-02
vinyl acetate	1.20E-02	1.00E-01			

Sources:
RAGS (EPA 1989a)
Exposure Factors Handbook (EPA 1997)

contact with the source medium. Section 4.1 presents the equations used for calculating unit intakes, risks, and hazards for all complete direct exposure pathways.

Indirect exposure pathways, such as soil-to-air volatilization, involve the transfer of constituents from the source medium to a secondary medium, with exposure occurring in the secondary medium. Section 4.2 presents the equations used for calculating unit intakes, risks, and hazards for all complete indirect exposure pathways.

The methodology used to quantify receptor-specific unit risk values must account for exposures via multiple direct and indirect exposure pathways. The aggregate risk for a receptor, or the sum of exposures from all applicable pathways, is presented in Section 4.3.

4.1 DIRECT EXPOSURE QUANTIFICATION

For direct exposure pathways, the point of exposure (POE) is located at the source zone; consequently, the constituent concentration at the POE is equal to the representative concentration determined for the source medium. For calculating unit intakes and unit risk, that concentration is 1 milligram per kilogram. Standard intake and risk quantification equations presented in the Supplemental Guidance (Cal/EPA 1992) and RAGS (EPA 1989a) can be used to evaluate these exposures.

Four direct exposure pathways are presented in this section:

1. Incidental ingestion of soil
2. Direct contact with soil
3. Ingestion of groundwater
4. Dermal contact with groundwater while showering

The direct exposure pathways for soil—incidental ingestion of soil and dermal contact with soil—are associated with the construction scenario. No direct soil exposure pathways are quantified under the operational scenario, since all direct exposures will be prevented through the construction of parking areas, buildings, and associated landscaping. The hypothetical direct exposure pathways for groundwater—ingestion of groundwater and dermal contact with groundwater—are associated with the off-site resident adult and child. No direct groundwater exposure pathways are quantified for on-site receptors, since water used on site is provided by the local municipality and is not impacted by on-site sources.

4.1.1 Incidental Ingestion of Soil

Equation 6-14 from RAGS (EPA 1989a) was used to quantify intake via ingestion of soil:

$$I_{si} = \frac{C_s \times IR \times CF \times FI \times EF \times ED}{BW \times AT} \qquad (4\text{-}1)$$

where

I_{si} = intake from incidental ingestion of a constituent in soil (mg/kg-d)
C_s = concentration of constituent in soil (mg/kg)
IR = ingestion rate (mg/d)
CF = conversion factor, 10^{-6} kg/mg
FI = fraction ingested from constituent source (unitless)
EF = exposure frequency (d/y)
ED = exposure duration (y)
BW = body weight (kg)
AT = averaging time (d); for noncarcinogens, ED times 365 d/y; for carcinogens, 70 y times 365 d/y

To illustrate the use of Equation 4-1, the construction worker and 1,1-dichloroethane have been selected for an example calculation. Specifically, unit intakes resulting from ingestion of soil containing a unit concentration of 1 mg/kg of 1,1-dichloroethane are calculated. This constituent was chosen because it potentially exhibits both carcinogenic and toxic effects. The reasonable maximum ingestion rate (IR) of soil during construction activities is 480 milligrams per day with a fractional intake (FI) of 1. The exposure frequency (EF) is 250 days per year, and the exposure duration (ED) is 1 year. The body weight (BW) for an adult is 70 kilograms.

Since 1,1-dichloroethane potentially exhibits both potential carcinogenic and toxic effects, receptor intakes must be evaluated for both effects. For potential carcinogenic effects, the intake is averaged over a 70-year lifetime (AT = 25,550 d). For potential toxic hazards, the intake is averaged over the actual duration of exposure (AT = ED x 365 d). For the construction worker, the exposure duration is 1 year; hence the exposure is averaged over 365 days. Table 4-1 presents the exposure parameters and sources used in this report. Substituting these values into Equation 4-1 yields:

Carcinogens

$$I_{si} = \frac{(1\,mg/kg)\times(480\,mg/d)\times(1x10^{-6}\,kg/mg)\times(1)\times(250\,d/yr)\times(1\,yr)}{(70\,kg)\times(25{,}550\,d)}$$

$$I_{si} = 6.71 \times 10^{-8}\ mg/kg\text{-}d$$

(4-2)

Noncarcinogens

$$I_{si} = \frac{(1\,mg/kg)\times(480\,mg/d)\times(1x10^{-6}\,kg/mg)\times(1)\times(250\,d/yr)\times(1\,yr)}{(70\,kg)\times(365\,d)}$$

$$I_{si} = 4.70 \times 10^{-6}\ mg/kg\text{-}d$$

The unit risk and unit hazard to this receptor through the incidental ingestion of soil pathway are calculated as follows:

$$UR_{si} = I_{si} \times SF_{ing}$$

(4-3)

$$UH_{si} = \frac{I_{si}}{RFD_{img}}$$

where

UR_{si}	=	unit risk to receptor from incidental ingestion of soil
UH_{si}	=	unit hazard to receptor from incidental ingestion of soil
I_{si}	=	intake from incidental ingestion of soil containing 1 mg/kg of a constituent (mg/kg-d)
SF_{ing}	=	slope factor for ingestion of a constituent [(mg/kg-d)$^{-1}$]
RfD_{ing}	=	reference dose for ingestion of a constituent (mg/kg-d)

Toxicity values used for these calculations are discussed in Section 2 of this report.

As equations 4-1 and 4-3 demonstrate, the relationship between concentration and intake is linear, and the relationship between intake and risk is linear. Therefore, the relationship between risk and concentration is linear. This fact makes the calculation of unit risk mathematically possible. The use of unit factors greatly facilitates the development of HBRGs.

As an example of this type of calculation, the unit factors for the construction worker exposed to 1,1-dichloroethane via the incidental ingestion of soil pathway, can be obtained by substituting the 1,1-dichloroethane unit intake (calculated in Equation 4-2), reference dose (from Table 2-2), and ingestion slope factor (from Table 2-3) into Equation 4-3. Substituting the appropriate values yields:

$$UR_{si} = (6.71 \times 10^{-8}\ mg/kg-d) \times (5.70 \times 10^{-3}\ kg-d/mg)$$

$$UR_{si} = 3.82 \times 10^{-10}$$

(4-4)

$$UH_{si} = \frac{4.70 \times 10^{-6}\ mg/kg-d}{1.00\ mg/kg-d}$$

$$UH_{si} = 4.70 \times 10^{-6}$$

Due to the linearity in the relationship between concentration and risk discussed previously, UR_{si} and UH_{si} represent unit risk and unit hazard factors, respectively. That is, each additional milligram per kilogram of the constituent in the soil increases carcinogenic risk by a factor of UR_{si} and toxic hazard by a factor of UH_{si}. Appendix B presents the complete calculation sheets for soil ingestion unit risk values.

4.1.2 Dermal Contact with Soil

Equation 6-15 from RAGS (EPA 1989a) was used to quantify intake from dermal contact with soil:

$$I_{sd} = \frac{C_s \times SA \times CF \times AF \times ABS \times EF \times ED}{BW \times AT} \qquad (4\text{-}5)$$

where

I_{sd}	=	intake resulting from dermal contact with a constituent in soil (mg/kg-d)
C_s	=	concentration of constituent in soil (mg/kg)
SA	=	skin surface area in contact with soils (cm^2/d)
CF	=	conversion factor, 10^{-6} kg/mg
AF	=	soil-to-skin adherence factor (mg/cm^2)
ABS	=	constituent-specific absorption factor (unitless), from Table 4-2
EF	=	exposure frequency (d/y)
ED	=	exposure duration (y)
BW	=	body weight (kg)
AT	=	averaging time (d); for noncarcinogens, ED times 365 d/y; for carcinogens, 70 y times 365 d/y

As before, the construction worker and 1,1-dichloroethane have been selected for an example calculation. Specifically, intakes resulting from dermal contact with soil containing a unit concentration of 1 mg/kg of 1,1-dichloroethane are calculated. The adult skin surface area (SA) assumed to be exposed during construction activities is 3,760 square centimeters per day with a soil-to-skin adherence factor (AF) of 1.0 and an absorption factor (ABS) of 1.0×10^{-1} (Table 4-2 presents the absorption factors for each constituent evaluated in this report). The exposure frequency (EF) is 250 days per year, and the exposure duration (ED) is 1 year. The body weight for an adult is 70 kilograms.

Since 1,1-dichloroethane potentially exhibits both carcinogenic and toxic effects, receptor intakes must be evaluated for both effects. For potential carcinogenic effects, the intake is averaged over a 70-year lifetime (AT = 25,550 d). For potential toxic effects, the intake is averaged over the actual duration of exposure (AT = ED x 365 d). For the construction worker, the exposure duration is 1 year; hence, the exposure is averaged over 365 days. Substituting these values into Equation 4-5 yields:

Carcinogens

$$I_{sd} = \frac{(1\,mg/kg)\times(3760\,cm^2/d)\times(1\,x\,10^{-6}\,kg/mg)\times(1\,mg/cm^2)\times(1\,x\,10^{-1})\times(250\,d/yr)\times(1\,yr)}{(70\,kg)\times(25{,}550\,d)}$$

$$I_{si} = 5.26\,x\,10^{-8}\ mg/kg\text{-}d$$

(4-6)

Noncarcinogens

$$I_{sd} = \frac{(1\,mg/kg)\times(3760\,cm^2/d)\times(1\,x\,10^{-6}\,kg/mg)\times(1\,mg/cm^2)\times(1\,x\,10^{-1})\times(250\,d/yr)\times(1\,yr)}{(70\,kg)\times(365\,d)}$$

$$I_{si} = 3.68\,x\,10^{-6}\ mg/kg\text{-}d$$

The unit risk and unit hazard to this receptor through the dermal contact with soil pathway are calculated as follows:

$$UR_{sd} = I_{sd} \times SF_{der}$$

(4-7)

$$UH_{sd} = \frac{I_{sd}}{RFD_{der}}$$

where

UR_{sd} = unit risk to the receptor resulting from dermal contact with soil
UH_{sd} = unit hazard to the receptor resulting from dermal contact with soil
I_{sd} = intake from dermal contact with soil containing 1 mg/kg of a constituent (mg/kg-d)

SF_{der} = slope factor for dermal contact with a constituent [(mg/kg-d)$^{-1}$]
RfD_{der_i} = reference dose for dermal contact with a constituent (mg/kg-d)

Toxicity values used for these calculations are discussed in Section 2 of this report.

As an example of this type of calculation, the unit factors for the construction worker exposed to 1,1 dichloroethane in soil via the dermal pathway, can be obtained by substituting the 1,1-dichloroethane unit intake (calculated in Equation 4-6), reference dose (from Table 2-2), and ingestion slope factor (from Table 2-3) into Equation 4-7. Substituting the appropriate values yields:

$$UR_{sd} = (5.26 \times 10^{-8}\ mg/kg-d) \times (5.73 \times 10^{-3}\ kg-d/mg)$$

$$UR_{sd} = 3.01 \times 10^{-10} \qquad (4\text{-}8)$$

$$UH_{sd} = \frac{3.68 \times 10^{-6}\ mg/kg-d}{9.00 \times 10^{-1}\ mg/kg-d}$$

$$UH_{sd} = 4.09 \times 10^{-6}$$

Due to the linearity in the relationship between concentration and risk discussed previously, UR_{sd} and UH_{sd} represent unit risk and unit hazard factors, respectively. That is, each additional milligram per kilogram of the constituent in the soil increases carcinogenic risk by a factor of UR_{si} and toxic hazard by a factor of UH_{si}. Appendix C presents the complete calculation sheets for dermal exposure to soil unit risk values.

4.1.3 Ingestion of Groundwater

As discussed in Section 3.2.3.3, the ingestion of groundwater pathway is complete only for the hypothetical off-site receptors who are assumed to use groundwater for domestic purposes. Consequently, fate and transport computer codes were used to model the migration of constituents in groundwater from the source to the exposure point. The models selected for this task are the Seasonal Soil Compartment Model (SESOIL; GSC 1998, Hetrick 1993, Bonazountas

and Wagner 1984) and the Analytical, Transient One-, Two-, and Three-Dimensional Simulator (AT123D; GSC 1998, Yeh 1981) saturated zone fate and transport model. Each of these models is described in detail in Section 4.2.1.3. A unit exposure point concentration was assumed to arrive at a corresponding health-protective groundwater concentration. This concentration was then used in the AT123D and SESOIL codes to back calculate a corresponding soil concentration.

Equation 6-11 from RAGS (EPA 1989a) was used to quantify intake via ingestion of groundwater:

$$I_{wi} = \frac{C_w \times IR \times EF \times ED}{BW \times AT} \qquad (4\text{-}9)$$

where

I_{wi} = intake from ingestion of a constituent in groundwater (mg/kg-d)
C_w = concentration of the constituent in water (mg/L)
IR = ingestion rate (L/d)
EF = exposure frequency (d/y)
ED = exposure duration (y)
BW = body weight (kg)
AT = averaging time (d); for noncarcinogens, ED times 365 d/y; for carcinogens, 70 y times 365 d/y

A unit constituent concentration in water (C_w = 1 mg/L) was assumed. Values for other parameters in Equation 4-9 are receptor specific and can be found in Table 4-1.

The only constituent-specific parameter in Equation 4-9 is the averaging time (AT). For potential carcinogenic effects, the intake is averaged over a 70-year lifetime (AT = 25,550 d). For potential toxic hazards, the intake is averaged over the actual exposure duration (AT = ED x 365 d). If a compound exhibits both carcinogenic and toxic effects, the intake must be evaluated for both adverse effects.

Since the relationship between constituent concentration, intake, and risk or hazard is linear, the calculation of unit risk or unit hazard is straightforward. The constituent-specific unit risk and unit hazard to a receptor through the ingestion of groundwater pathway are calculated as follows:

$$UR_{wi} = I_{wi} \times SF_{ing} \qquad (4\text{-}10)$$

$$UH_{wi} = \frac{I_{wi}}{RFD_{ing}}$$

where

UR_{wi} = unit risk to the receptor resulting from ingestion of groundwater
UH_{wi} = unit hazard to the receptor resulting from ingestion of groundwater
I_{wi} = intake from ingestion of groundwater (mg/kg-d)
SF_{ing} = slope factor for ingestion of a constituent [(mg/kg-d)$^{-1}$]
RfD_{ing} = reference dose for ingestion of a constituent (mg/kg-d)

The relationship between groundwater concentration and risk for a receptor, pathway, and constituent is determined by substituting the constituent-specific intake (calculated in Equation 4-9), ingestion slope factor, and reference dose into Equation 4-10. Toxicity values used for these calculations are discussed in Section 2 of this report.

Because the intake is based on a unit concentration of the constituent in the source medium, and because the intake responds linearly to changes in concentration, UR_{wi} and UH_{wi} represent unit risk and unit hazard factors, respectively. That is, each additional milligram per kilogram of the constituent in the source medium increases carcinogenic risk by a factor of UR_{wi} and toxic hazard by a factor of UH_{wi}.

4.1.4 Dermal Contact with Groundwater

As discussed in Section 3.2.3.2, the dermal contact with groundwater pathway while showering is complete only for off-site receptors. Unit exposure point concentrations were assumed, and the AT123D model described in Section 4.1.3 was used to back calculate corresponding soil concentrations.

Equation 6-13 from RAGS (EPA 1989a) was used to quantify intake via dermal contact with water:

$$I_{wd} = \frac{C_w \times SA \times CF \times PC \times ET \times EF \times ED}{BW \times AT} \qquad (4\text{-}11)$$

where

I_{wd}	=	intake from dermal contact with a constituent in water (mg/kg-d)
C_w	=	concentration of the constituent in water (mg/L)
SA	=	skin surface area in contact with the water (cm2)
CF	=	conversion factor, 1 L/1000 cm^3
PC	=	constituent-specific dermal permeability constant (cm/hr)
ET	=	exposure time, (h/d)
EF	=	exposure frequency (d/y)
ED	=	exposure duration (y)
BW	=	body weight (kg)
AT	=	averaging time (d); for noncarcinogens, ED times 365 d/y; for carcinogens, 70 y times 365 d/y

A unit constituent concentration in water (C_w = 1 mg/L) was assumed. Values for other parameters in Equation 4-11 are receptor specific and can be found in Table 4-1.

Two parameters in Equation 4-11 are dependent upon the constituent: the dermal permeability constant (PC) and the averaging time (AT). Dermal permeability constants were obtained from the appropriate EPA guidance documents for each constituent and are presented in Table 4-2. For those constituents exhibiting potential carcinogenic effects, the intake is averaged over a 70-year lifetime (AT = 25,550 d). For constituents exhibiting potential toxic hazards, the intake is averaged over the actual duration of exposure (AT = ED x 365 d). If a compound exhibits both carcinogenic and toxic effects, the intake must be evaluated for both effects.

Since the relationship between constituent concentration, intake, and risk or hazard is linear, the calculation of unit risk or unit hazard is straightforward. The constituent-specific unit risk and unit hazard to a receptor through dermal contact with groundwater are calculated as follows:

$$UR_{wd} = I_{wd} \times SF_{der} \qquad (4\text{-}12)$$

$$UH_{wd} = \frac{I_{wd}}{RFD_{der}}$$

where

UR_{wd} = unit risk to the receptor resulting from dermal contact with groundwater
UH_{wd} = unit hazard to the receptor resulting from dermal contact with groundwater
I_{wd} = intake from dermal contact with groundwater (mg/kg-d)
SF_{der} = slope factor for dermal contact with a constituent [(mg/kg-d)$^{-1}$]
RfD_{der} = reference dose for dermal contact with a constituent (mg/kg-d)

The relationship between groundwater concentration and risk for a receptor, pathway, and constituent is determined by substituting the constituent-specific intake (calculated in Equation 4-11), dermal slope factor, and reference dose into Equation 4-12. Toxicity values used for these calculations are discussed in Section 2 of this report.

Because the intake is based on a unit concentration of the constituent in the source medium, and because the intake responds linearly to changes in concentration, UR_{wd} and UH_{wd} represent unit risk and unit hazard factors, respectively. That is, each additional milligram per kilogram of the constituent in the source medium increases carcinogenic risk by a factor of UR_{wd} and toxic hazard by a factor of UH_{wd}.

4.2 INDIRECT EXPOSURE QUANTIFICATION

For indirect exposure pathways, the POE is located in a medium other than the source. Therefore, a transport computer code must be used to model the migration of constituents from the source to the POE and estimate an exposure point concentration. In these cases, the constituent concentrations at the exposure point are typically lower than the representative value determined for the source medium.

To quantify exposure through indirect pathways, the reduction in constituent concentrations associated with each transport mechanism from the source to the exposure point is characterized by an attenuation factor. The standard intake and risk quantification equations presented in the Supplemental Guidance (Cal/EPA 1992) and RAGS (EPA 1989a) can be used to evaluate these exposures based on either the exposure point concentration or the attenuation factor determined by the transport model. Many constituent-specific parameters are needed in the quantification of

TABLE 4-3
CONSTITUENT-SPECIFIC CONSTANTS

Constituent	CAS No.	Organic Carbon Partition Coefficient, K_{oc} (L/kg)	Diffusivity in Air, D_a (cm^2/s)	Diffusivity in Water, D_w (cm^2/s)	Water Solubility, S (mg/l)	Henry's Law Constant at Reference Temperature, H (atm-m^3/mol)	Henry's Law Constant, H' (unitless)	Normal Boiling Point, T_b (K)	Critical Temperature, T_c (K)	Enthalpy of Vaporization at Normal Boiling Point, $H_{v,b}$ (cal/mol)	Volatile Screening
1,1,1-trichloroethane	71556	1.10E+02	7.80E-02	8.80E-06	1.33E+03	1.72E-02	7.05E-01	347.24	545.00	7,136	V
1,1,2-trichloroethane	79005	5.01E+01	7.80E-02	8.80E-06	4.50E+03	9.12E-04	4.92E-02	386.15	602.00	8,322	V
1,1-dichloroethane	75343	3.16E+01	7.42E-02	1.05E-05	5.50E+03	5.61E-03	2.34E-01	330.55	523.00	6,895	V
1,1,-dichloroethene	75354	5.89E+01	9.00E-02	1.04E-05	2.25E+03	2.61E-02	1.07E+00	304.75	576.05	6,247	V
1,2-dichlorobenzene	95501	1.70E+03	6.90E-02	7.90E-06	1.18E+02	1.90E-03	7.79E-02	453.57	705.00	9,700	V
1,2-dichloroethane	107062	1.74E+01	1.04E-01	9.90E-06	8.52E+03	9.78E-04	4.10E-02	356.65	561.00	7,645	V
1,2-dichloropropane	78875	4.37E+01	7.82E-02	8.73E-06	2.70E+03	2.80E-03	6.31E+00	369.52	572.00	7,590	V
1,4-dichlorobenzene	106467	1.70E+03	7.13E-02	7.90E-06	7.38E+01	1.60E-03	6.56E-02	447.21	684.75	9,271	V
2,4 dichlorophenol	120832	1.47E+02	3.46E-02	8.77E-06	4.6E+03	3.17E-06	1.30E-04	482.15	708.17	11,000	NV
2 butanone	78933	NA	8.94E-02	NA	NA	NA	NA	NA	NA	NA	NA
4,4 DDD	72548	1.00E+06	1.69E-02	4.76E-06	1.00E-01	4.00E-06	3.26E-04	639.90	863.77	14,000	NV
4,4 DDE	72559	4.47E+06	1.44E-02	5.87E-06	4.00E-02	2.10E-05	2.79E-03	636.44	860.38	13,000	NV
4,4-DDT	50293	2.63E+06	1.37E-02	4.95E-06	5.00E-03	8.10E-06	3.40E-04	535.15	720.75	11,000	NV
4-methyl-2-pentanone	108101	NA	7.87E-02	NA	1.90E+04	6.77E-05	NA	NA	NA	NA	NV
acetone	67641	5.75E-01	1.24E-01	1.14E-05	1.00E+06	3.88E-05	1.59E-03	329.20	508.10	6,955	NV
antimony	7440360	NA	NA	NA	NA	NA	NA	1913.15	NA	NA	I
aroclor-1254	11091691	2.00E+05	1.56E-02	5.00E-06	4.10E-02	2.00E-04	8.20E-02	377.50	512.27	19,000	NA
arsenic	7440382	NA	NA	NA	NA	NA	NA	888.15	1673	NA	I
barium	7440393	NA	NA	NA	NA	NA	NA	1913.15	NA	NA	I
benzene	71432	5.89E+01	9.32E-02	9.80E-06	1.75E-03	5.56E-03	2.24E-01	353.24	562.16	7,342	V
benzo(a)anthacene	56553	3.98E+05	5.10E-02	0.00E-06	9.40E-03	1.37E-04	5.34E-06	708.15	1004.79	15,000	V
benzo(a)pyrene	50328	1.02E+06	4.30E-02	9.00E-06	1.62E-03	4.63E-05	1.13E-06	715.90	969.27	15,000	NV
benzo(b)fluoranthene	205992	1.23E+06	2.26E-02	5.56E-06	1.50E-03	4.55E-03	1.11E-04	715.90	969.27	15,000	V
beryllium	7440417	NA	NA	NA	NA	NA	NA	3243.15	NA	NA	I
bis-(2ethylhexyl)phthalate	117817	1.51E+07	3.51E-02	3.66E-06	4.00E-01	1.02E-07	4.18E-06	657.15	806.00	15,999	NV
bromodichloromethane	75274	5.50E+01	2.98E-02	1.06E-05	5.00E+01	1.60E-03	1.05E+01	363.15	585.85	7,000	V
bromoform	75252	8.71E+01	1.49E-02	1.03E-05	3.01E+03	5.34E-04	2.18E-02	422.35	696.00	9,479	V
cadmium	7440439	NA	NA	NA	NA	NA	NA	1038.15	NA	NA	I
carbon disulfide	75150	4.57E+01	1.04E-01	1.00E-05	2.94E+03	3.02E-02	1.24E+00	319.00	552.00	6,391	V
carbon tetrachloride	56235	1.74E+02	7.80E-02	8.80E-06	7.58E+02	3.05E-02	9.43E-01	349.90	556.60	7,127	V
chlorobenzene	108907	2.19E+02	7.30-02	8.70E-06	4.91E+02	3.71E-03	1.39E-01	404.87	632.40	8,410	V
chloroethane	75003	NA	1.15E-01	NA	5.74E+03	2.00E-03	NA	NA	NA	NA	V
chloroform	67663	3.98E+01	1.04E-02	1.00E-05	7.22E+03	3.66E-03	1.56E-01	334.32	536.40	6,988	V
chromium iii	16065831	NA	NA	NA	NA	NA	NA	NA	NA	NA	I
chromium vi	18540299	NA	NA	NA	NA	NA	NA	NA	NA	NA	I
chrysene	281019	3.98E+05	2.48E-02	6.21E-06	1.60E-03	3.88E-03	9.46E-05	714.15	979.00	16,455	V

TABLE 4-3 (CONT'D)

CONSTITUENT-SPECIFIC CONSTANTS

Constituent	CAS No.	Organic Carbon Partition Coefficient, K_{oc} (l/kg)	Diffusivity in Air, D_a (cm^2/s)	Diffusivity in Water, D_w (cm^2/s)	Water Solubility, S (mg/l)	Henry's Law Constant at Reference Temperature, H (atm-m^3/mol)	Henry's Law Constant, H' (unitless)	Normal Boiling Point, T_b (K)	Critical Temperature, T_c (K)	Enthalpy of Vaporization at Normal Boiling Point, $H_{v,b}$ (cal/mol)	Volatile Screening
cis-1,2-dichloroethene	156592	3.55E+01	7.36E-02	1.13E-05	5.00E+03	4.07E-03	1.38E-01	333.65	544.00	7,192	V
cobalt	7440484	NA	NA	NA	NA	NA	NA	NA	NA	NA	I
copper	7440508	NA	NA	NA	NA	NA	NA	2840.15	NA	NA	I
cumene	98828	2.29E+03	6.50E-02	NA	NA	1.74E-02	NA	NA	NA	NA	V
cyanide	57125	5.75E-01	1.85E-01	NA	NA	NA	NA	NA	NA	NA	NA
dibromochloromethane	124481	6.31E+01	1.96E-02	1.05E-05	4.54E+03	1.61E+00	1.88E-01	416.14	678.20	8,000	V
dichloromethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
di-n-butyl phthalate	84742	3.39E+04	4.38E-02	7.86E-06	1.12E+01	9.39E-10	3.85E-08	613.15	798.67	14,751	NV
di-n-octyl phthalate	117840	8.32E+07	1.51E-02	3.58E-06	3.40E-01	6.68E-05	2.74E-03	704.09	862.22	15,000	NV
endosulfan sulfate	1031078	2.14E+03	1.15E-02	4.55E-06	1.17E-01	1.12E-05	4.59E-04	674.43	942.94	14,000	NV
endrin	72208	1.23E+04	1.25E-02	4.74E-06	2.00E-01	7.51E-06	3.08E-04	718.15	986.20	12,000	NV
ethylbenzene	100414	3.63E+02	7.50E-02	7.80E-06	1.53E+02	7.88E-03	3.46E-01	409.34	617.20	8,501	V
gamma bhc	58899	1.07E+03	1.42E-02	7.34E-06	7.80E+00	7.85E-06	5.74E-04	596.55	839.36	13,000	NV
hydrogen sulfide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
manganese	7439965	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
mercury	7439976	5.20E+01	3.07E-02	6.30E-06	3.00E-02	1.14E-02	4.51E-01	629.88	1750.00	14,127	I
methylene chloride	75092	1.17E+01	1.01E-01	1.17E-05	1.80E+04	2.19E-03	1.07E-01	313.00	510.00	6,706	V
molybdenum	7439987	NA	NA	NA	NA	NA	NA	4885.15	NA	NA	I
nickel	7440020	NA	NA	NA	NA	NA	NA	3003.15	NA	NA	I
phenol	108952	2.88E+01	8.20-02	9.10E-06	9.30E+04	3.98E-07	1.62E-05	455.02	694.20	10,920	NV
pyrene	129000	1.05E+05	2.72E-02	7.24E-06	1.35E-01	1.10E-05	3.63E-04	667.95	936.00	14,370	NV
selenium	7782492	NA	NA	NA	NA	NA	NA	958.15	NA	NA	I
silver	7440224	NA	NA	NA	NA	NA	NA	2333.15	NA	NA	I
strontium	7440246	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
tetrachloroethene	127184	1.55E+02	7.20E-02	8.20E-06	4.84E+02	1.84E-02	9.43E-01	394.40	620.20	8,288	V
toluene	108883	1.82E+02	8.70E-02	8.60E-06	1.55E+03	6.63E-03	2.71E-01	383.78	591.79	7,930	V
trans-1,2-dichloroethene	156605	5.25E+01	7.07E-02	1.19E-05	6.30E+03	9.39E-03	2.71E-01	320.85	516.50	6,717	V
trichloroethene	79016	1.66E+02	7.90E-02	9.10E-06	1.47E+03	1.03E-02	5.65E-01	360.36	544.20	7,505	V
trichlorofluoromethane	75694	1.59E+02	9.34-02	9.70E-06	1.10E+03	1.19E+02	2.39E+00	296.85	471.15	6021	V
trichlorotrifluoroethane (freon)	76131	3.89E+02	2.88E-02	8.07E-06	1.7E+02	3.91E-01	NA	NA	NA	NA	NA
vanadium	7440622	NA	NA	NA	NA	NA	NA	3653.15	NA	NA	I
vinyl acetate	108054	5.25E+00	8.50E-02	9.20E-06	2.00E+04	5.12E-04	2.10E-02	345.65	519.13	7,000	V
vinyl chloride	75014	1.86E+01	1.06E-01	1.23E-06	2.67E+03	2.71E-02	2.83E+01	259.35	432.00	5,250	V
xylenes	1330207-	2.40E+02	3.74E+02	9.34E-06	1.98E+02	5.25E-03	2.15E-01	413.15	623	8525	V
zinc	7440666	NA	NA	NA	NA	NA	NA	1180.15	NA	NA	I

NOTES: I =Inorganic; NA =Not Available; NV= Not Volatile (according to Henry's Law screening, PEA Cal/EPA 1994); V= Volatile

SOURCES: ERAV (1999); CRC Handbook of Chemistry and Physics (1994), User's Guide for the Johnson and Ettinger Model for Subsurface Vapor into Buildings (EPA 1997); Soil Screening Level (SSL) G
Documents (EPA 1996), MICROMEDICS Environmental Health and Safety Series Database (1996); ORNL Risk Tools Online Database (1999)

The AREA-ST dispersion model is based on the Gaussian dispersion principle. Gaussian models assume material that is continually released will be transported against the wind direction, and time-averaged spreading of the pollutants will result in normal distribution if sampled in cross-sections of the plume. AREA-ST is extremely useful as a practical modeling tool, but it relies on several fundamental assumptions that must be noted. Emission rates are assumed to be constant and continuous. No variations occur in wind speed, wind direction, or Pasquill stability class during transport from source to receptor.

The volatilization attenuation factor for on-site receptors is calculated as follows:

$$VF = \frac{Q}{C} \times \frac{\sqrt{3.1416ZT}}{2D_{ei}P_aK_{as}} \times UC \qquad (4\text{-}13)$$

where

VF	=	volatilization attenuation factor (m^3/kg)
Q/C	=	dispersion component, emission flux per unit concentration [(g/m^2/sec)/(kg/m^3)], from Equation 4-14
Z	=	intermediate conversion factor (cm^2/sec), from Equation 4-18
T	=	exposure interval (s)
D_{ei}	=	effective diffusivity of a constituent through a soil matrix (cm^2/sec), from Equation 4-15
P_a	=	air filled porosity of the soil matrix (unitless), 0.07 (M/H 1990)
K_{as}	=	soil-to-air partition coefficient (g/cm^3), from Equation 4-17
UC	=	unit conversion factor (0.0001 m^2/cm^2)

The dispersion coefficient, Q/C, is calculated using the following equation:

$$\frac{Q}{C} = \frac{1}{e^{[(0.1004\ln(A)-5.3466)+2.92sY]}} \qquad (4\text{-}14)$$

where

A	=	assumed area of contiguous contamination (m^2), 484 m^2 (CalEPA 1994)
sY	=	intermediate value for calculating Q/C, derived as follows:

$$sY = 0.02685 \times \left[0.25 + \frac{(\ln(A) - 11.0509)^2}{26.3608} \right] \qquad (4\text{-}15)$$

The effective diffusivity of the constituent through the soil matrix, D_{ei}, is estimated by:

$$D_{ei} = D_i \times \frac{P_a^{3.33}}{P_t^2} \qquad (4\text{-}16)$$

where

D_i = constituent-specific diffusivity of constituent in air (cm^2/sec), Table 4-3
P_a = air filled porosity of soil matrix (unitless), 0.07 (M/H 1990)
P_t = total porosity of soil matrix (unitless), 0.25

The soil-to-air partition coefficient, K_{as}, is derived from the constituent-specific soil-to-water partition coefficient and Henry's Law constant:

$$K_{as} = \frac{H}{R \times T \times K_d} \qquad (4\text{-}17)$$

where

K_{as} = soil-to-air partition coefficient (g/cm^3)
H = constituent-specific Henry's Law Constant (atm-m^3/mol), Table 4-3
R = ideal gas constant (atm-m^3/mol-K), 8.20562E-5 atm-m^3/mol-K, (CRC Press 1980)
T = temperature in Kelvin, 298 K (LAX Weather Station)
K_d = soil-to-water partition coefficient (cm^3/g), Table 4-3

The intermediate conversion factor, Z, in the volatilization attenuation factor can be calculated using Equation 4-18:

$$Z = \frac{D_{ei} P_a}{P_a + \left[\rho_s \times \frac{1 - P_a}{K_{as}} \right]} \qquad (4\text{-}18)$$

where

D_{ei} = effective diffusivity of the constituent through a soil matrix (cm^2/sec), Equation 4-16
P_a = air filled porosity of the soil matrix (unitless), 0.07 (M/H 1990)
ρ_s = true soil or particle density (g/cm^3), 1.65
K_{as} = soil-to-air partition coefficient (g soil/cm^3 air), from Equation 4-17

Constituent-specific soil-to-air volatilization factors for the on-site receptors were calculated using Equation 4-13 and the supporting Equations 4-14 through 4-18. Values for the parameters required for these calculations were obtained from site-specific data or, when unavailable, appropriate guidance or reference documents. The constituent-specific volatilization attenuation factors are presented in Appendix D.

4.2.1.2 Particulate Resuspension Attenuation Factors

As mentioned, estimating airborne concentrations of constituents in the particulate phase involves modeling both resuspension and dispersion. The selected resuspension component was designed by Cowherd (1985) as a rapid assessment procedure applicable to a typical hazardous waste site where the surface contamination provides relatively continuous and constant potential for emission over an extended period of time. This component considers wind-borne emissions but not dust emissions from traffic or other forms of mechanical disturbances. However, the degree of accuracy attainable using this model is thought to be consistent with that generally expected to result from simplified quantitative estimation procedures (EPA 1986).

The Gaussian dispersion component applied to volatile emissions (Section 4.2.1.1) is also applied to particulate dispersion.

The particulate resuspension attenuation factor is calculated as follows:

$$PEF = \frac{Q}{C} \times \left[\frac{3600}{RPF \times (1-G) \times \left(\frac{U_m}{U_t} \right)^3 \times F_x} \right] \qquad (4\text{-}19)$$

where

PEF = particulate attenuation factor (m^3/kg)
Q/C = dispersion component, emission flux per unit concentration [$(g/m^2/sec)/(kg/m^3)$], from Equation 4-14
RPF = respirable fraction of particulate ($g/m^2/h$), 0.036 $g/m^2/h$, (CalEPA 1994)
U_m = wind speed (m/sec), 4.5 m/sec (LAX Weather Station)
U_t = equivalent threshold value of wind speed at 10 meters (m/sec), 12.8 m/sec (Los Angeles International Airport Weather Station)
F_x = Function describing U_t/U_m (unitless), from Equation 4-20

The function F_x is calculated as follows:

$$Fx = 0.18 \times \left(8X^3 + 12X\right) \times e^{-X^2} \qquad (4\text{-}20)$$

where

$$X = 0.866 \times \frac{U_t}{U_m}$$

Since there are no constituent-dependent variables in the equations for determining PEF, the calculated particulate attenuation factor is independent of the constituent and represents a constant rate of resuspension of soil.

4.2.1.3 Soil-to-Groundwater Attenuation Factors

Soil-to-groundwater attenuation factors are based on the following fate and transport pathway:

- Impacted soil (source) → Groundwater at the nearest residence

Thus, some analytes in unsaturated soils are presumed to leach vertically downward into groundwater and be laterally transported to a point within the saturated zone beneath the nearest residence. The soil-to-groundwater attenuation factor (AF_{s-gw}) is defined as the ratio of concentration in the impacted unsaturated soil (source) to the predicted concentration in groundwater at the property line of the nearest residence:

$$AF_{s-gw} = \frac{C_{s(source)}}{C_{gw(property)}} \qquad (4\text{-}21)$$

where

AF_{s-gw} = soil-to-groundwater attenuation factor ([mg/kg]/[mg/L])

$C_{s(source)}$ = soil concentration in unsaturated soil source, assumed to be a unit soil concentration, 1 mg/kg

$C_{gw(property)}$ = predicted concentration in groundwater at the nearest residence (mg/L)

Analyte-specific values of AF_{s-gw} were calculated based on site-specific data (M/H 1990, LCA 1986 and 1990), literature data, the results of simulations performed using a proprietary version of the EPA-sponsored unsaturated zone fate and transport computer code SESOIL (GSC 1998, Hetrick 1993, Bonazountas and Wagner 1984), and the results of simulations performed using a proprietary version of the DOE-sponsored saturated zone fate and transport computer code AT123D (GSC 1998, Yeh 1981).

SESOIL simulates one-dimensional fate and transport in the unsaturated zone using two "cycles":

1. the hydrologic cycle and
2. the pollutant fate cycle.

To maximize the simulated potential impact to groundwater from impacted unsaturated zone soils and thus provide a conservative analysis, a third, "washload" cycle, which simulates erosion and transport of surface soils and any adsorbed constituents, was not used. The one-dimensional nature of SESOIL further ensures a conservative analysis. For this analysis, the primary function of SESOIL was to calculate analyte-specific, time-variant mass loading via aqueous-phase transport to the saturated zone. The SESOIL-predicted mass loadings were subsequently used as input to AT123D.

SESOIL simulates the hydrologic and pollutant fate cycles through the use of four input files:

1. Application file

2. Soil file
3. Climate file
4. Chemical file.

The application file for this analysis consists of several input parameters related to the physical and chemical properties of the soil layers and the nature and lateral and vertical extent of the simulated source. Parameters related to the physical and chemical properties of the soil layers include area, thickness, intrinsic permeability, organic carbon content, and analyte concentrations in the soil.

The source is assumed to be square-shaped in plan-view with a total area of 900 square feet. Using site-specific groundwater and surface elevations, the thickness of the unsaturated zone is estimated to be 15 feet. The unsaturated zone was divided into three 5-foot layers, which were each divided into ten 0.5-foot sublayers to refine the analysis. Thus, the model was divided into thirty discrete 0.5-foot sublayers. Given the fact that sources have been or are being removed, it was assumed that the hypothetical source of analytes is no longer being replenished. Given our understanding of the source removal activities, it is conservatively assumed that all analytes are uniformly distributed throughout the upper 5 feet of the unsaturated zone at a concentration of 1 mg/kg.

The soil file for this evaluation consists of five input parameters:

1. intrinsic permeability
2. porosity
3. dry bulk density
4. soil disconnectedness index
5. organic carbon content.

These parameters are applied by SESOIL to all layers and sublayers.

The value of the intrinsic permeability (8.5×10^{-11} square centimeters) was based on site-specific and literature data, which indicate that the unsaturated zone soils may be classified as a silty clay loam. The porosity value (40 percent) and bulk density value (1.59 g/cm^3) were also based on the site-specific and literature data associated with this textural classification. The value of the disconnectedness index (9.33) was based on literature values (Table 4.4 from Hetrick 1993) and was calibrated to provide a reasonable groundwater recharge rate given that development plans call for ninety percent of the site to be paved or covered with buildings. The SESOIL-calculated groundwater recharge rate was approximately 0.056 cm/yr. This value corresponds to approximately 0.2 percent of the total annual rainfall (approximately 33 cm/yr) and is conservative, given the low permeability soils, yet reasonable, considering the findings of Wood (1999).[1] The organic carbon content was assigned a value of 0.3 percent, based on professional judgment given the fine-grained nature of the unsaturated zone soils and experience at nearby facilities.

The climate file was based on data collected from the Los Angeles International Airport (LAX) weather station as provided in the SESOIL climate database. The input parameters are specified on a monthly basis and include values for average temperature, cloud cover fraction, relative humidity, short wave albedo fraction, rainfall, storm duration, and storm frequency. The input parameters for the climate file are shown in Figures 4-1 and 4-2.

The chemical file includes analyte-specific values for the organic carbon-water partition coefficient (K_{oc}, for organic analytes), soil-water partition coefficient (K_d, for inorganic analytes), Henry's Law constant (K_H), vapor-phase diffusion coefficient (D_{air}), and degradation rate constant (k_{deg}). Values for these parameters were obtained from various governmental and literature sources. To eliminate any losses due to volatilization or degradation, thus providing a conservative analysis, values of K_H, D_{air}, and k_{deg} were set to zero. This approach ensures that the only simulated movement of analytes is vertically downward toward the saturated zone. Values

[1] Recharge flux in arid and semiarid environments typically ranges from 2 to 4% of average precipitation and is generally focused in playas, arroyos and other topographic depressions.... Paraphrased from Wood 1999.

FIGURE 4-1.
INPUT PARAMETERS FOR SESOIL CLIMATE FILE
(TEMPERATURE, PRECIPITATION, STORM FREQUENCY)

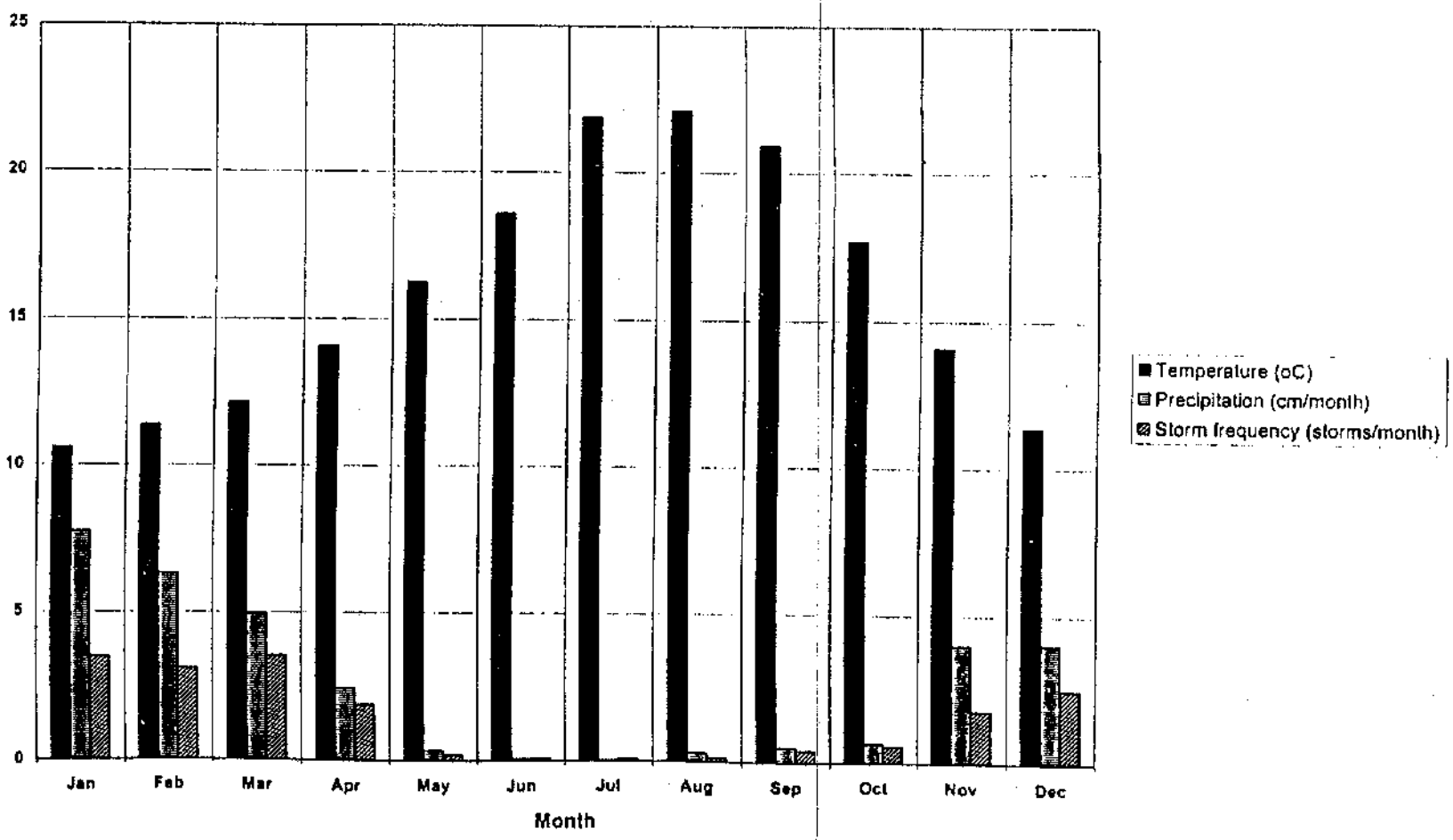
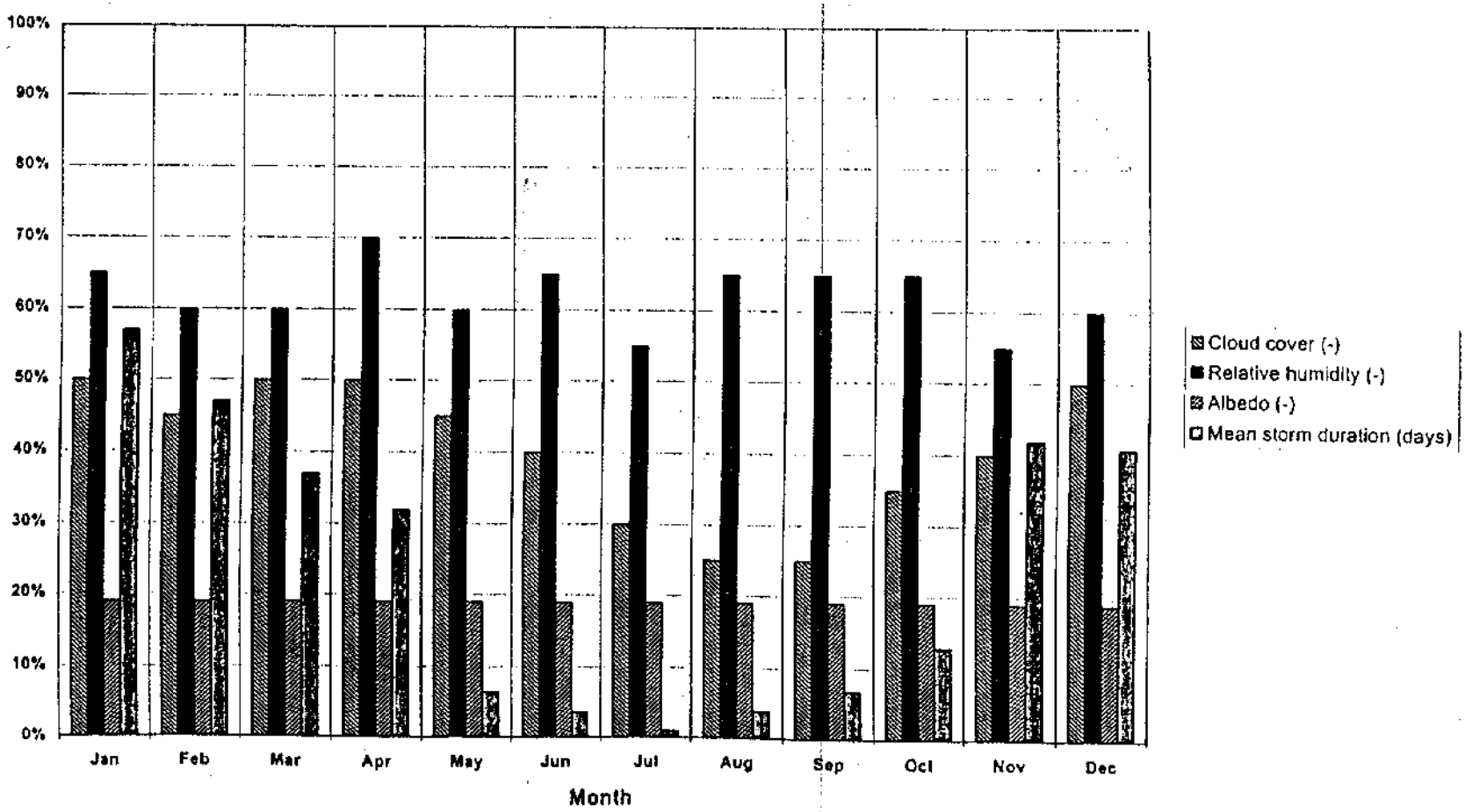


FIGURE 4-2.
INPUT PARAMETERS FOR SESOIL CLIMATE FILE
(CLOUD COVER, RELATIVE HUMIDITY, ALBEDO, STORM DURATION)



for K_{oc} (for organic analytes) and K_d (for inorganic analytes) are given in Tables 4-4 and 4-5, respectively.

AT123D simulates the transient, three-dimensional migration of analytes in the saturated zone. For this analysis, the fate and transport processes simulated included advection (due to the bulk movement of groundwater within the saturated zone), dispersion, sorption, and degradation. Using the SESOIL-predicted mass loading as input, the primary function of AT123D was to estimate analyte-specific concentrations in groundwater at the nearest residence (approximately 545 feet). Only those analytes that were predicted (using SESOIL) to enter the saturated zone ("leachable" analytes such as those having K_{oc} values less than approximately 200 cm^3/g) were assessed using AT123D. The AT123D input parameters, values, and justification for the values used are summarized in Table 4-6.

Values of AF_{s-gw}, calculated using Equation 4-21 for all leachable analytes, are listed in Table 4-7. The values are conservative in that they are based on the maximum, 6-year-average model-predicted $C_{gw(property)}$ for each analyte.

The value of AF_{s-gw} is infinite for non-leachable analytes. Non-leachable analytes include all of the inorganic analytes and organic analytes with K_{oc} values greater than approximately 200 cm^3/g.

4.2.1.4 Groundwater-to-Air Attenuation Factors

Groundwater-to-air attenuation factors are based on the following hypothetical fate and transport scenarios:

- Impacted soil (source) → Groundwater at the nearest residence → Bathtub Water → Bathtub Air
- Impacted soil (source) → Groundwater at the nearest residence → Shower Water → Shower Air

Groundwater-to-air attenuation factors are calculated only for the leachable analytes since an analyte must be leachable for it to be transported in groundwater to either a residential bathtub or shower. As has been discussed, the groundwater-to-air pathway evaluated for hypothetical off-site receptors is not realistic due to the poor quality and yield of the shallow groundwater in the general area of the Playa Vista site. Calculations for hypothetical off-site residents have been performed to quantitatively demonstrate that HBRGs developed for the Playa Vista site are more than adequate to ensure the health protection of neighboring residents.

Bathtub Air Pathway

The attenuation factor for this pathway is conservatively based on the assumption that groundwater at the nearest residence is placed directly in a residential bathtub. Thus, it is conservatively assumed that there is no loss of analytes during transfer of groundwater (1) through residential plumbing to the bathtub tap or (2) from the bathtub tap to the bathtub. Analytes within the bathtub water subsequently volatilize from the bathtub water into a "bathtub air breathing zone," where they may be inhaled.

The groundwater-to-bathtub air attenuation factor is defined as the ratio of the groundwater concentration beneath the nearest residence—conservatively assumed to be equal to that at the bathtub tap and in the bathtub water and the concentration in the bathtub air-breathing zone:

$$AF_{gw-bathtub} = \frac{C_{gw(property)}}{C_{air-bathtub}} \qquad (4\text{-}22)$$

where

$AF_{gw-bathtub}$ = groundwater-to-bathtub air attenuation factor ([mg/L]/[mg/m^3])

$C_{gw(property)}$ = initial concentration in bathtub water prior to volatilization from bathtub water into bathtub air breathing zone (mg/L); it is based on a unit concentration, 1 mg/L, and for calculation of HBRGs, is conservatively assumed to be equal to the concentration in groundwater beneath the residence

$C_{air-bathtub}$ = concentration in bathtub air as the result of volatilization from bathtub water into the bathtub air breathing zone (mg/m^3)

Values of $AF_{gw-bathtub}$, calculated using Equation 4-22 for all leachable analytes, are listed in Table 4-8.

Concentrations in the bathtub air are estimated based on a modification of the shower air inhalation model contained in American Petroleum Institute (API 1994). The text that follows is paraphrased from this reference.

Analyte-specific values of $C_{air-bathtub}$ are conservatively estimated assuming that the air in the bathtub area is instantaneously and fully mixed. Thus, the $C_{air-bathtub}$ can be expressed as:

$$C_{air-bathtub} = \frac{M_{a-bathtub}}{V_{a-bathtub} \times E_{a-bathtub} \times t_{bath}} \qquad (4\text{-}23)$$

where:

$M_{a-bathtub}$ = mass of analytes that volatilize into bathtub air (mg/m^3)

$V_{a-bathtub}$ = volume of air in the bathtub air breathing zone (10 m^3/exchange; based on McKone 1987)

$E_{a-bathtub}$ = bathtub air exchange rate (1 exchange per hour; conservative value based on range given in McKone 1987)

$t_{bathtub}$ = bathtub bathing duration (0.17 hour; exposure duration for residential child bathing dose equation)

The release of analyte mass from the water used for bathing depends on a number of factors that include, but are not limited to, the amount of water in the bathtub, analyte concentration in the water at the bathtub nozzle, the volatility of the analyte, and the size of the bathtub. The overall effect of these factors can be lumped together and expressed as the efficiency of volatilization that represents the fraction of the total analyte mass in the bathtub water that is released to the air. Thus, the mass of analyte released into the bathtub air-breathing zone can be expressed as:

$$M_{a-bathtub} = f_v \times V_{w-bathtub} \times C_{w-bathtub} \qquad (4\text{-}24)$$

where:

f_v = fraction of analyte volatilized into bathtub air breathing zone

$V_{w-bathtub}$ = volume of water in the bathtub (assumed to be a constant value of 0.255 m^3; based on a depth of 1 foot, a width of 2 feet, and a length of 4.5 feet [professional judgment])

Other parameters are as defined in Equations 4-22 and 4-23.

The Foster and Chrostowski model (1986) treats volatilization as a first order process and estimates f_v as:

$$f_v = 1 - \exp\left(\frac{-K_L' t_{bath}}{(D_{w-bathtub}) \times 3600}\right) \qquad (4\text{-}25)$$

where:

K_L' = analyte-specific overall mass transfer coefficient at the temperature of the bathtub water (cm/hr)

$D_{w-bathtub}$ = depth of water in the bathtub (1 foot = 30.48 cm; professional judgment); this term is the inverse of the specific surface through which volatilization occurs

3600 = conversion factor (sec/hr)

The value of K_L' is estimated as:

$$K_L' = K_L \sqrt{\left(\frac{T_{w-bathtub} \times \mu_{calib}}{T_{calib} \times \mu_{w-bathtub}}\right)} \qquad (4\text{-}26)$$

where:

K_L = analyte-specific overall mass transfer coefficient at known calibration water temperature (cm/hr)

$T_{w-bathtub}$ = temperature of bathtub water (303 K, based on page I-5 of AMI 1994)

T_{calib} = calibration temperature for which mass transfer coefficients have been estimated (293 K, based on page I-5 of AMI 1994)

μ_{calib} = viscosity of water at T_{calib} (g/m-sec)

$\mu_{w-bathtub}$ = viscosity of water at $T_{w-bathtub}$ (g/m-sec)

K_L is estimated as:

$$K_L = \left(\frac{1}{k_l} + \frac{1}{K_H \times k_g} \right)^{-1} \qquad (4\text{-}27)$$

where:

k_l = liquid-phase mass transfer coefficient (cm/hr)

k_g = gas-phase mass transfer coefficient (cm/hr)

K_H = Henry's Law constant (dimensionless); values are listed in Table 4-3

where:

$$k_g = k_{g(H_2O)} \sqrt{\left(\frac{18}{MW_{VOC}} \right)} \qquad (4\text{-}28)$$

and:

$$k_l = k_{l(CO_2)} \sqrt{\left(\frac{44}{MW_{VOC}} \right)} \qquad (4\text{-}29)$$

Typical values of $k_{g(H_2O)}$ (gas-phase mass transfer coefficient for water) and $k_{g(CO_2)}$ (liquid-phase mass transfer coefficient for carbon dioxide) are 3,000 cm/hr and 20 cm/hr, respectively. The values 18 and 44 are the molecular weights (g/mol) of water and carbon dioxide, respectively. The parameter MW_{VOC} is the molecular weight (also in g/mol) of the analyte of interest.

The following relationship was used to estimate the viscosity of water as a function of temperature (for temperatures greater than or equal to 20°C [293 K]):

$$\mu_w = 1.002 \times 10^{y} \qquad (4\text{-}30)$$

where:

$$y = \frac{(-1.3272 \times [T_{w-bathtub} - 20] - 0.001053 \times [T_{w-bathtub} - 20]^2)}{(T_{w-bathtub} + 105)} \qquad (4\text{-}31)$$

Analyte-specific values of $AF_{gw-bathtub}$, based on Equation 4-22 and Equations 4-23 throu 4-31 for the calculation of $C_{air-bathtub}$ are presented in Table 4-10.

Shower Air Pathway

The attenuation factor for this pathway is conservatively based on the assumption tl groundwater beneath the nearest residence is emitted directly from the shower nozzle. Thus, it conservatively assumed that there is no loss of analytes during transfer of groundwater throu residential plumbing to the shower nozzle. Analytes within the shower water subsequen volatilize from the shower water into a 'shower air breathing zone', where they may be inhaled

The groundwater-to-shower air attenuation factor is defined as the ratio of the concentration groundwater to the calculated concentration in shower air.

$$AF_{gw-shower} = \frac{C_{w-shower}}{C_{air-shower}} \qquad (4-$$

where:

$AF_{gw-shower}$	=	groundwater-to-bathtub air attenuation factor ([mg/L]/[mg/m^3])
$C_{w-shower}$	=	concentration in shower water (mg/L); it is based on a u concentration (i.e., 1 mg/L) and, for calculation of HBRGs, conservatively assumed to be equal to the concentration groundwater beneath the nearest residence
$C_{air-shower}$	=	concentration in shower air as the result of volatilization from shov water into the shower air breathing zone (mg/m^3)

Concentrations in the shower air are estimated based on a modified version of the shower inhalation model contained in American Petroleum Institute (API 1994). As such, the equatic used to calculate shower air concentrations are similar to those used to calculate bathtub concentrations and are repeated for the sake of completeness. The text that follows paraphrased from API 1994.

Analyte-specific values of $C_{air-shower}$ are conservatively estimated assuming that the air in shower stall is instantaneously and fully mixed. Thus, the $C_{air-shower}$ can be expressed as:

$$C_{air-shower} = \frac{M_{a-shower}}{V_{a-shower} \times E_{a-shower} \times t_{shower}} \qquad (4\text{-}33)$$

where:

$M_{a-shower}$	=	mass of analytes that volatilize into shower air (mg/m^3)
$V_{a-shower}$	=	volume of air in the shower air breathing zone (2 m^3/exchange; based on McKone 1987)
$E_{a-shower}$	=	shower air exchange rate (2 exchanges per hour; conservative value based on range given in McKone 1987)
t_{shower}	=	shower bathing duration (0.25 hour; exposure duration for residential adult bathing dose equation)

The release of analyte mass from the water used for showering depends on a number of factors that include, but are not limited to, the amount of water consumed, analyte concentration in the water at the shower nozzle, the volatility of the analyte, and the size of the droplets. The overall effect of these factors can be lumped together and expressed as the efficiency of volatilization that represents the fraction of the total analyte mass in the shower water that is released to the air. Thus, the mass of analyte released into the shower air-breathing zone can be expressed as:

$$M_{a-shower} = f_v \times Q \times t_{shower} \times C_{w-shower} \qquad (4\text{-}34)$$

where:

f_v	=	fraction of analyte volatilized into shower air breathing zone
Q	=	the volumetric flow rate of shower water (10 L/min, based on page I-5 of API 1994)

The value of t_{shower} assumes that the exposure time is equal to the duration for which water flows from the shower nozzle.

Other parameters are as defined in Equations 4-32 and 4-33.

The Foster and Chrowstowski model (1986) treats volatilization as a first order process and estimates f_v as:

$$f_v = 1 - \exp\left(\frac{-K_L' t}{(d/6)\times 3600}\right) \qquad (4\text{-}35)$$

where:

K_L'	=	analyte-specific overall mass transfer coefficient at the temperature of the shower water (cm/hr)
t	=	shower droplet drop time (2 sec, based on page I-5 of API 1994)
d	=	representative diameter of shower droplet (0.1 cm, based on page I-5 of API 1994); this term is the inverse of the specific surface through which volatilization occurs.
3600	=	conversion factor (sec/hr)

The value of K_L' is estimated as:

$$-K_L' = K_L \sqrt{\left(\frac{T_{w-shower} \times \mu_{calib}}{T_{calib} \times \mu_{w-shower}}\right)} \qquad (4\text{-}36)$$

where:

K_L	=	analyte-specific overall mass transfer coefficient at known calibration water temperature (cm/hr)
$T_{w-shower}$	=	temperature of shower water (303 K, based on page I-5 of AMI 1994)
T_{calib}	=	calibration temperature for which mass transfer coefficients have been estimated (293 K, based on page I-5 of AMI 1994)
μ_{calib}	=	viscosity of water at T_{calib} (g/m-sec)
$\mu_{w-shower}$	=	viscosity of water at $T_{w-shower}$ (g/m-sec)

K_L is estimated as:

$$K_L = \left(\frac{1}{k_l} + \frac{1}{K_H \times k_g}\right)^{-1} \qquad (4\text{-}37)$$

where:

k_l	=	liquid-phase mass transfer coefficient (cm/hr)
k_g	=	gas-phase mass transfer coefficient (cm/hr)

K_H = Henry's Law constant (dimensionless); values are listed in Table 4-3

where:

$$k_g = k_{g(H_2O)}\sqrt{\left(\frac{18}{MW_{VOC}}\right)} \qquad (4\text{-}38)$$

and:

$$k_g = k_{g(CO_2)}\sqrt{\left(\frac{44}{MW_{VOC}}\right)} \qquad (4\text{-}39)$$

Typical values of $k_{g(H_2O)}$ (gas-phase mass transfer coefficient for water) and $k_{g(CO_2)}$ (liquid-phase mass transfer coefficient for carbon dioxide) are 3000 cm/hr and 20 cm/hr, respectively. The values 18 and 44 are the molecular weights (g/mol) of water and carbon dioxide, respectively. The parameter MW_{VOC} is the molecular weight (also in g/mol) of the analyte of interest.

The following relationship was used to estimate the viscosity of water as a function of temperature (for temperatures greater than or equal to 20°C [293 K]):

$$\mu_w = 1.002 \times 10^{y} \qquad (4\text{-}40)$$

where:

$$y = \frac{(-1.3272 \times [T_{w-shower} - 20] - 0.001053 \times [T_{w-shower} - 20]^2)}{(T_{w-shower} + 105)} \qquad (4\text{-}41)$$

Analyte-specific values of $AF_{gw-shower}$, based on Equation 4-32 and Equations 4-33 through 4-39 for the calculation of $C_{air-shower}$ are presented in Table 4-10.

4.2.1.5 Indoor Air Attenuation Factors

The Johnson and Ettinger model for subsurface vapor intrusion into buildings (Johnson and Ettinger 1991) was used to estimate potential indoor air concentrations resulting from

constituents that may volatilize from soil and enter future buildings constructed on the property. The model is provided and maintained by EPA on its Superfund Risk Assessment Tools worldwide web site (epa.gov/superfund/programs/risk/calctool.htm). The user's guide has been included in Appendix A.

This screening-level model simulates the transport of vapor into indoor spaces and provides an estimated indoor air attenuation coefficient that relates the vapor concentration in the indoor space to the vapor concentration at the source of contamination. The model is constructed as both a steady-state solution to vapor transport (infinite or nondiminishing source) and as a quasi-steady-state solution (finite or diminishing source) (EPA 1997).

The Johnson and Ettinger model incorporates several fundamental assumptions. The constituent is assumed to be present as a non-degrading source even though, for most constituents, biodegradation and other transformation mechanisms are expected to occur in the subsurface over time. This is therefore a conservative assumption. The system is assumed to be at equilibrium, and exposure to constituents at levels above equilibrium (e.g., due to shutdown of the building ventilation system) is assumed to be trivial in terms of exposure duration. It is assumed that flux occurs only through infiltration areas such as cracks in the building slab and that flux through the building slab itself is insignificant. Finally, all vapors originating directly below the foundation are assumed to enter the building. This is a highly conservative assumption that leads to overstated risk estimates (Johnson and Ettinger 1991, EPA 1997).

Model inputs include parameters such as chemical properties of the constituents, soil properties of saturated and unsaturated zone, and the structural properties of the building. Thus, site-specific data are fundamental to the proper application of this model and were used when available. Conservative default values were identified based on known site characteristics for parameters that were not directly measured.

The City of Los Angeles has required that development of the Playa Vista site comply with the methane zone requirements of the City of Los Angeles (LA 1999). These requirements include vent piping and a liner beneath all on grade slabs and around basements; and ventilation or

electronic gas detection inside the lowest levels on grade. Consequently, a high-density polyethylene (HDPE) liner will be placed beneath the foundation slabs of all buildings constructed on the Playa Vista site and a methane collection system will be installed. The presence of the liner and collection system will reduce the intrusion of soil vapors into building structures by 99.9 percent.

Indoor air concentrations calculated using the Johnson and Ettinger model are presented in Tables D-3 and D-5 located in Appendix D. These concentrations are predicted values based on site-specific and COPC-specific factors. All calculations are based on a unit concentration of the constituent in the source. Two types of indoor air concentrations are provided. The first, No Liner A, is the predicted indoor air concentration assuming that the HDPE liner and vapor collection system is not present, while the second, Liner A, assumes that the liner and collection system are present. Since the City of Los Angeles requires the installation of a liner and vapor collection system, initial HBRG values for the indoor air pathway will assume the presence of these controls.

4.2.2 Determination of Soil Saturation Limit

The soil saturation limit (C_{sat}) is the contaminant concentration at which soil pore air and pore water are saturated with the chemical. The adsorptive limits of the soil particles have been reached when a chemical is present at its saturation concentration (EPA 1996). At concentrations above C_{sat}, the constituent may be in a free-phase state.

C_{sat} concentrations represent the upper limit to the applicability of the vapor transport models discussed in the proceeding sections, since a basic principal of the models (Henry's Law) does not apply when constituents are present in free phase. The estimation of volatilized constituents is reliable only if soil concentrations are below the saturation limit. It is therefore necessary that the source term and C_{sat} be compared during the screening of HBRG values. This is discussed in Section 5.

The soil saturation limit for organic constituents in soil can be calculated using Equation 4-42:

$$C_{sat} = \left[\frac{S}{P_b}\right]\left(K_d P_b + \theta_w + H'\theta_a\right) \qquad (4\text{-}42)$$

where:

C_{sat} = soil saturation limit (mg/kg)
S = constituent solubility in water (mg/L)
P_b = dry soil bulk density (kg/L)
K_d = soil-water partition coefficient (L/kg)
θ_w = water-filled soil porosity (unitless)
H' = constituent-specific Henry's law constant (unitless)
θ_a = air-filled soil porosity (unitless)

Values for the parameters required for soil saturation limit calculation were obtained from site-specific data or, when unavailable, appropriate guidance or reference documents.

4.2.3 Quantification of Soil-to-Air Inhalation Pathways

Equation 6-16 from RAGS (EPA 1989a) was used to quantify intake from the soil-to-air inhalation pathway:

$$I_{sinh} = \frac{C_a \times IH \times ET \times EF \times ED}{BW \times AT} \qquad (4\text{-}43)$$

where

I_{sinh} = intake through inhalation of airborne constituents (mg/kg-d)
C_a = receptor-specific concentration of a constituent in air (mg/kg), from Equations 4-44 and 4-45
IH = inhalation rate (m^3/h)
ET = exposure time (hr/d)
EF = exposure frequency (d/y)
ED = exposure duration (y)
BW = body weight (kg)
AT = averaging time (d); for noncarcinogens, ED times 365 d/y;

for carcinogens, 70 y times 365 d/y

Intakes resulting from inhalation of airborne constituents originating from soil containing a unit concentration of 1 mg/kg were calculated. Values for other parameters in Equation 4-43 are receptor specific and can be found in Table 4-1.

Equation 4-27 contains two constituent-dependent parameters: the averaging time (AT) and the air concentration (C_a). For potential carcinogenic effects, the intake is averaged over a 70-year lifetime (AT = 25,550 d). For potential toxic hazards, the intake is averaged over the actual duration of exposure (AT = ED x 365 d). If a compound exhibits both carcinogenic and toxic effects, the intake must be evaluated for both effects.

Air concentrations are both constituent- and receptor-dependent. For the on-site construction worker, operations/office personnel, and child in the on-site daycare, exposure to volatilized and resuspended particulate constituents may occur when these receptors are outdoors. The equation for determining C_a is therefore dependent upon the unit concentration of the constituent in soil (C_s) and the volatile and particulate attenuation factors calculated in Equations 4-13 and 4-19:

$$C_a = C_s\left(\frac{1}{VF} + \frac{1}{PEF}\right) \qquad (4\text{-}44)$$

For operations/office personnel and children in the on-site daycare, who are exposed to volatilized constituents migrating into buildings from the underlying soil, C_a is dependent upon the unit concentration of the constituent in soil (C_s) and the attenuation coefficient (α), as determined by the Johnson and Ettinger model in Appendix A:

$$C_a = C_s\alpha_s \qquad (4\text{-}45)$$

Since the relationship between constituent concentration in soil, intake, and risk or hazard is linear, the calculation of unit risk or unit hazard is straightforward. The constituent-specific unit risk and unit hazard to a receptor through the soil-to-air inhalation pathway are calculated as follows:

$$UR_{sinh} = I_{sinh} \times SF_{inh} \qquad (4\text{-}46)$$

$$UH_{sinh} = \frac{I_{sinh}}{RFD_{inh}}$$

where

UR_{sinh} = unit risk to a receptor resulting from inhalation of airborne constituents
UH_{sinh} = unit hazard to a receptor resulting from inhalation of airborne constituents
I_{sinh} = intake of airborne constituents originating from soil containing 1 mg/kg of constituent (mg/kg-d)
SF_{inh} = slope factor for inhalation of a constituent [$(mg/kg\text{-}d)^{-1}$]
RfD_{inh} = reference dose for inhalation of a constituent (mg/kg-d)

Because a unit concentration of 1.0 mg/kg is used in the soil intake equation, and because the intake responds linearly to changes in concentration, UR_{sinh} and UH_{sinh} represent unit risk and unit hazard factors, respectively. That is, each additional milligram per kilogram of the constituent in the soil increases carcinogenic risk by a factor of UR_{sinh} and toxic hazard by a factor of UH_{sinh}.

4.2.5 Quantification of Groundwater-to-Air Inhalation Pathways

As discussed in Section 3.2.3.1, the groundwater pathways are complete only for hypothetical off-site receptors. Consequently, fate and transport computer codes were used to model the migration of constituents in groundwater from the source to the exposure point (a hypothetical well located at the nearest, downgradient residence). Unit concentrations of constituents in the source media were used to estimate exposure point concentrations for the off-site receptors. Constituent degradation was not considered to provide conservative HBRGs.

Equation 6-16 from RAGS (EPA 1989a) was used to quantify intake from the groundwater-to-air inhalation pathway:

$$I_{winh} = \frac{C_a \times IH \times ET \times EF \times ED}{BW \times AT} \quad (4\text{-}47)$$

where:

I_{winh}	=	intake through inhalation of airborne constituents (mg/kg-d)
C_a	=	receptor-specific concentration of a constituent in air (mg/kg), discussed in Section 4.2.1.4
IH	=	inhalation rate (m^3/h)
ET	=	exposure time (hr/d)
EF	=	exposure frequency (d/y)
ED	=	exposure duration (y)
BW	=	body weight (kg)
AT	=	averaging time (d); for noncarcinogens, ED times 365 d/y; for carcinogens, 70 y times 365 d/y

Intakes resulting from inhalation of airborne constituents originating from groundwater containing a unit concentration of 1 mg/L were calculated. Values for other parameters in Equation 4-47 are receptor specific and can be found in Table 4-1.

Equation 4-47 contains two constituent-dependent parameters: the averaging time (AT) and the air concentration (C_a). For potential carcinogenic effects, the intake is averaged over a 70-year lifetime (AT = 25,550 d). For potential toxic hazards, the intake is averaged over the actual duration of exposure (AT = ED x 365 d). If a compound exhibits both carcinogenic and toxic effects, the intake must be evaluated for both effects.

Air concentrations are both constituent- and receptor-dependent. The calculation of air concentrations for inhalation of shower and bathtub air was discussed previously in Section 4.2.1.4.

Since the relationship between constituent concentration in groundwater, intake, and risk or hazard is linear, the calculation of unit risk or unit hazard is straightforward. The constituent-

specific unit risk and unit hazard to a receptor through the groundwater-to-air inhalation pathway are calculated as follows:

$$UR_{winh} = I_{winh} \times SF_{inh} \qquad (4\text{-}48)$$

$$UH_{winh} = \frac{I_{winh}}{RFD_{winh}}$$

where

UR_{winh} = unit risk to a receptor resulting from inhalation of airborne constituents
UH_{winh} = unit hazard to a receptor resulting from inhalation of airborne constituents
I_{winh} = intake of airborne constituents originating from groundwater containing a unit concentration of constituent (mg/kg-d)
SF_{inh} = slope factor for inhalation of a constituent [$(mg/kg\text{-}d)^{-1}$]
RfD_{inh} = reference dose for inhalation of a constituent (mg/kg-d)

Because a unit concentration of 1.0 mg/L was used in the groundwater intake equation, and because the intake responds linearly to changes in concentration, UR_{winh} and UH_{winh} represent unit risk and unit hazard factors, respectively. That is, each additional milligram per liter of the constituent in groundwater increases carcinogenic risk by a factor of UR_{winh} and toxic hazard by a factor of UH_{winh}.

4.3 AGGREGATE RISK FOR ALL PATHWAYS

The aggregate risk from all exposure pathways must be calculated for each receptor identified in the CEM as having multiple complete exposure pathways. For example, the CEM (Section 3) indicates that the construction worker can be exposed to contaminated soil through incidental ingestion, dermal contact, and inhalation of constituents. The aggregate risk to the receptor as a result of soil exposure is calculated by summing the pathway-specific unit risk and unit hazard, as follows:

$$UR_s = UR_{si} + UR_{sd} + UR_{sinh}$$

$$UH_s = UH_{si} + UH_{sd} + UH_{sinh} \quad (4\text{–}49)$$

where

UR_s	=	total unit risk from exposure to constituents in soil
UR_{si}	=	unit risk from incidental soil ingestion
UR_{sd}	=	unit risk from dermal contact
Ur_{sinh}	=	unit risk from inhalation
UH_s	=	total unit hazard from exposure to soil
UH_{si}	=	unit hazard from incidental soil ingestion
UH_{sd}	=	unit hazard from dermal contact
UH_{sinh}	=	unit hazard from inhalation

Because a unit concentration of 1.0 mg/kg was used in the inhalation, dermal, and incidental ingestion intake equations, and because the intakes respond linearly to changes in concentration, UR_s and UH_s represent unit risk and unit hazard factors, respectively. That is, each additional milligram per kilogram of constituent in soil increases carcinogenic risk by a factor of UR_s and toxic hazard by a factor of UH_s.

The procedure used above to calculate total unit risk and total unit hazard for the construction worker due to exposure to constituents in soil can be used to calculate total unit risk and total unit hazard for the other receptors by summing the unit risks or unit hazards, respectively, for each applicable pathway. Table 4-11 presents the on-site receptors via the soil exposure pathway.

Total unit risk and total unit hazards for receptors exposed to constituents in groundwater can be calculated using the same procedure by replacing the soil-based unit risks with the applicable groundwater-based unit risks.

TABLE 4-4
ORGANIC CARBON-WATER PARTITION COEFFICIENTS FOR ORGANIC ANALYTES

Constituent	Koc (cm^3/g)
1,1,2-trichloroethane	5.01E+01
1,1-dichloroethane	3.16E+01
1,1-dichloroethene	6.50E+01
1,2-dichlorobenzene	6.17E+02
1,2-dichloropropane	4.37E+01
1,4-dichlorobenzene	6.17E+02
2-butanone	4.51E+00
2,4-dichlorophenol	1.47E+02
4,4'-DDD	1.00E+06
4,4'-DDE	4.47E+06
4,4'-DDT	2.63E+06
4-methyl-2-pentanone	1.90E+01
acetone	5.75E-01
aroclor-1254	2.00E+05
benzene	5.89E+01
benzo(a)anthracene	3.98E+05
benzo(a)pyrene	1.02E+06
benzo(b)fluoranthene	1.23E+06
bis(2-ethylhexyl)pthalate	1.51E+07
bromodichloromethane	5.50E+01
bromoform	8.71E+01
carbon disulfide	4.57E+01
carbon tetrachloride	1.74E+02
chlorobenzene	2.19E+02
chloroform	3.98E+01
chrysene	3.98E+05
cis-1,2-dichloroethene	3.55E+01
cumene	2.29E+03
dibromochloromethane	6.31E+01
di-n-butyl phthalate	3.39E+04
di-n-octyl phthalate	8.32E+07
endosulfan sulfate	2.14E+03
endrin	1.23E+04
ethylbenzene	3.63E+02
gamma-BHC	1.07E+03
indeno(1,2,3-cd)pyrene	3.47E+06
methylene chloride	1.17E+01
phenol	2.88E+01
pyrene	1.05E+05

TABLE 4-4 (CONT'D)
ORGANIC CARBON-WATER PARTITION COEFFICIENTS FOR ORGANIC ANALYTES

Constituent	Koc (cm^3/g)
tetrachloroethene	1.55E+02
toluene	1.82E+02
trans-1,2-dichloroethene	5.25E+01
trichloroethene	1.66E+02
trichlorofluoromethane	1.59E+02
vinyl acetate	5.25E+00
vinyl chloride	1.86E+01
xylene,m-	4.07E+02
xylene, o-	3.63E+02
xylene, p-	3.89E+02

Source: EPA 1996c, Attachment C

TABLE 4-5
SOIL-WATER PARTITION COEFFICIENTS FOR INORGANIC ANALYTES

Metal	Soil-water partition coefficient (cm^3/g)	Notes
antimony	4.5E+01	1
arsenic	3.0E+01	2
barium	4.5E+01	2
beryllium	8.6E+03	2
cadmium	4.0E+02	2
chromium (III)	3.7E+06	2
chromium (VI)	1.6E+01	2
copper	2.5E+01	3
mercury	1.5E+02	2
molybdenum	1.5E+05	4
nickel	2.5E+02	2
selenium	3.3E-00	2
silver	3.1E+01	2
vanadium	1.0E+03	1
zinc	1.3E+02	2

Source: EPA. 1996c (unless otherwise noted)

Notes:

1. Kd not pH-dependent.
2. Kd is pH-dependent. Value shown is based on site-specific groundwater data, which shows the pH of groundwater to be approximately 7.4.
3. Mean Kd value reported in Looney et al 1987.
4. Logarithmic mean Kd value calculated using Langmuir isotherm parameters estimated through twelve studies of molybdenum sorption as reported in Batelle, Pacific Northwest Laboratories. 1984.

TABLE 4-6
AT123D INPUT PARAMETER VALUES

Input Parameter	Value	Justification
Plan-view source area	484 meter^2	Based on unsaturated zone source area modeled using SESOIL
Mass loading from unsaturated zone into saturated zone	Variable	Predicted using SESOIL
Distance from center of source area to point of compliance	545 feet	Nearest residence to center of hypothetical source area (provided by IESI). Residence is conservatively assumed to be located directly downgradient of source area, despite site-specific data indicating that it is actually located cross-gradient of any reasonably expected hypothetical source area.
Thickness of saturated zone	10 feet	Conservatively taken to be the length of the screened interval of a ground-water monitoring well
Width of saturated zone	Infinitely wide	Professional judgment given the distance to the point of compliance and the dimensions of the site
Simulation time (coincident with 100-year SESOIL simulation)	100 years	Deemed sufficient to assess risk to human health
First-order biodegradation rate constant	Variable	Conservative, analyte-specific values reported in Howard et al. 1991 or Wiedemeier et al. 1999 Values are provided in Table 4-6a.
Organic carbon-water or soil-water partition coefficient	Variable	Various literature sources (see Table 4-4).
Organic carbon content	0.3 percent	Conservative value for silty sand based on professional judgment
Porosity	40 percent	Value for silty sand based on professional judgment for silty sand
Hydraulic conductivity	0.18 meter per hour (5×10^{-3} centimeter per second)	Conservative value for silty sand based on professional judgment
Bulk density	1.59 gram per centimeter^3	Value for silty sand based on professional judgment

TABLE 4-6 (CONT'D)
AT123D INPUT PARAMETER VALUES

Input Parameter	Value	Justification
Hydraulic gradient	3.5×10^{-3} feet per foot	Based on site-specific groundwater elevation contour map
Longitudinal dispersivity	16.6 meters (54.5 feet)	Calculated as one-tenth of the distance to the point of compliance (based on literature)
Transverse dispersivity	1.66 meters (5.45 feet)	Calculated as one-tenth of the longitudinal dispersivity (based on literature)
Vertical dispersivity	0.166 meters (0.545 feet)	Calculated as one-hundredth of the longitudinal dispersivity (based on literature)

TABLE 4-6A
HALF-LIVES OF LEACHABLE ANALYTES*

Constituent	Howard et al. (Note 1)	Wiedemeier et al. (Note 2) Note 3	Note 4	Note 5	Most conservative rate constant (1/hr) (Note 6)
1,1,2-trichloroethane	17520 hours	No Value Given	No Value Given	No Value Given	3.96E-05
1,1-dichloroethane	8640 hours	No Value Given	No Value Given	3792 hours	8.02E-05
1,2-dichloropropane	61872 hours	No Value Given	No Value Given	No Value Given	1.12E-05
bromodichloromethane	No Value Given	No Value Given	No Value Given	No Value Given	—
bromoform	8640 hours	No Value Given	No Value Given	No Value Given	8.02E-05
chlorobenzene	7200 hours	No Value Given	No Value Given	2808 hours	9.63E-05
chloroform	43200 hours	No Value Given	No Value Given	No Value Given	1.60E-05
cis-1,2-dichloroethene	4320 hours	No Value Given	No Value Given	33264 hours	2.08E-05
dibromochloromethane	4320 hours	No Value Given	No Value Given	No Value Given	1.60E-04
diethyl phthalate	2688 hours	No Value Given	No Value Given	No Value Given	2.58E-04
ethylbenzene	5472 hours	27720 hours	5040 hours	No Value Given	2.50E-05
methylene chloride	1344 hours	No Value Given	No Value Given	No Value Given	5.16E-04
phenol	168 hours	No Value Given	No Value Given	No Value Given	4.13E-03
toluene	672 hours	16800 hours	7560 hours	No Value Given	4.13E-05
trans-1,2-dichloroethene	4320 hours	No Value Given	No Value Given	3336 hours	1.60E-04
trichloroethene	8640 hours	No Value Given	No Value Given	36960 hours	1.88E-05
trichlorofluoromethane	17280 hours	No Value Given	No Value Given	No Value Given	4.01E-05
vinyl chloride	4320 hours	No Value Given	No Value Given	1392 hours	1.60E-04

* Reported in the Literature and Minimum (Conservative) First-Order Rate Constants Used to Calculate Soil-to-Groundwater Attenuation Factors

Note 1: Howard, P.H., Boethling, R.S., Jarvis, W.F., Meylan, W.M., and E.M. Michalenko. 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Values shown are the most conservative (largest) value of aqueous or 'ground-water' aerobic half-lives reported. To be conservative, values based on studies using unacclimated populations were used where provided.

Note 2: Wiedemeier, T.H., Rifai, H.S., Newell, C.J., and J.T. Wilson. 1999. Natural Attenuation of Fuels and Chlorinated Solvents in *the Subsurface. John Wiley & Sons, Inc.*

Note 3: From Table 5.4, p. 217 - Most conservative ('low end') half lives reported.

Note 4: From Table 5.5, p. 218 - Based on most conservative (smallest) first-order rates constants reported for California sites.

Note 5: From Table 6.6, pp. 278-279 - Based on most conservative (largest) half-lives reported. Precedence given to those values obtained under aerobic, field scale studies.

Note 6: Rate constant was conservatively assumed to be 0.0 for those analytes for which no half-lives were provided.

Note 7: Rate constant based on half-life of 5940 hours based on professional judgment.

TABLE 4-7
SOIL-TO-GROUNDWATER ATTENUATION FACTORS

Constituent	AFs-gw ([mg/kg]/[mg/l])
1,1,2-trichloroethane	1.11E+04
1,1-dichloroethane	8.70E+04
1,2-dichloroethane	5.49E+04
1,2-dichloropropane	7.94E+02
benzene	2.06E+06
bromodichloromethane	2.33E+02
bromoform	1.81E+07
chlorobenzene	2.41E+07
chloroform	1.18E+03
cis-1,2-dichloroethene	2.34E+03
dibromochloromethane	2.11E+07
ethylbenzene	5.48E+04
methylene chloride	5.90E+10
phenol	6.49E+35
toluene	4.89E+04
trans-1,2-dichloroethene	1.02E+07
trichloroethene	3.10E+03
trichlorofluoromethane	9.59E+04
vinyl chloride	1.37E+06

TABLE 4-8
GROUNDWATER-TO-AIR ATTENUATION FACTORS
(INHALATION OF BATHTUB AIR)

Constituent	AFgw-bathtub ([mg/l]/[mg/m^3])
1,1,2-trichloroethane	1.21E+02
1,1-dichloroethane	8.56E+01
1,2-dichloroethane	1.00E+02
1,2-dichloropropane	8.77E+01
benzene	7.66E+01
bromodichloromethane	2.27E+02
bromoform	1.87E+02
chlorobenzene	9.23E+01
chloroform	9.68E+01
cis-1,2-dichloroethene	8.44E+01
dibromochloromethane	1.21E+02
diethyl phthalate	2.02E+04
ethylbenzene	8.74E+01
methylene chloride	8.33E+01
phenol	4.95E+04
toluene	8.23E+01
trans-1,2-dichloroethene	8.43E+01
trichloroethene	9.65E+01
trichlorofluoromethane	9.67E+01

TABLE 4-9
UNITLESS HENRY'S LAW CONSTANTS FOR LEACHABLE ORGANIC ANALYTES

Constituent	KH (unitless)
1,1,2-trichloroethane	3.74E-02
1,1-dichloroethane	2.30E-01
1,2-dichloropropane	6.30E-00
bromodichloromethane	6.56E-02
bromoform	2.19E-02
chlorobenzene	1.52E-01
chloroform	1.50E-01
cis-1,2-dichloroethene	1.67E-01
dibromochloromethane	3.20E-01
diethyl phthalate	1.85E-05
ethylbenzene	3.23E-01
methylene chloride	8.98E-02
phenol	1.63E-05
toluene	2.72E-01
trans-1,2-dichloroethene	3.85E-01
trichloroethene	4.22E-01
trichlorofluoromethane	2.38E-00
vinyl chloride	1.11E+00

TABLE 4-10
GROUNDWATER-TO-AIR ATTENUATION FACTORS
(INHALATION OF SHOWER AIR)

Constituent	Afgw-shower ([mg/l]/[mg/m3])
1,1,2-trichloroethane	2.31E-02
1,1-dichloroethane	1.74E-02
1,2-dichloroethane	1.98E-02
1,2-dichloropropane	1.77E-02
benzene	1.59E-02
bromodichloromethane	4.08E-02
bromoform	3.41E-02
chlorobenzene	1.84E-02
chloroform	1.92E-02
cis-1,2-dichloroethene	1.72E-02
dibromochloromethane	2.33E-02
diethyl phthalate	3.38E-00
ethylbenzene	1.76E-02
methylene chloride	1.70E-02
phenol	8.29E-00
toluene	1.68E-02
trans-1,2-dichloroethene	1.71E-02
trichloroethene	1.91E-02
trichlorofluoromethane	1.92E-02
vinyl chloride	1.42E-02

TABLE 4-11
AGGREGATE UNIT RISK VALUES FOR ON-SITE RECEPTORS

	Construction Worker		Operations/Office Personnel		Child in Daycare	
Chemicals of Concern	Unit HQ	Unit ILCR	Unit HQ	Unit ILCR	Unit HQ	Unit ILCR
1,1-dichloroethane	1.14E-005	9.82E-010	1.44E-004	4.18E-008	3.22E-004	1.87E-008
1,1-dichloroethene	1.69E-003	1.82E-007	6.93E-003	NA	1.55E-002	NA
1,1,1-trichloroethane	NA	NA	1.44E-004	NA	6.41E-005	NA
1,1,2-trichloroethane	2.50E-004	9.86E-009	6.89E-004	7.08E-008	1.54E-003	3.17E-008
1,2-dichlorobenzene	NA	NA	6.17E-006	NA	1.38E-005	NA
1,2-dichloroethane	NA	1.08E-008	NA	1.09E-007	NA	2.44E-007
1,2-dichloropropane	6.11E-004	9.58E-009	6.90E-003	1.77E-007	1.55E-002	7.95E-008
1,4-dichlorobenzene	7.40E-007	5.09E-009	1.91E-006	6.24E-009	4.28E-006	2.79E-009
2-butanone	4.39E-006	NA	7.98E-012	NA	1.79E-011	NA
2,4-dichlorophenol	2.93E-003	NA	8.11E-006	NA	1.82E-005	NA
4-methyl-2-pentanone	1.10E-005	NA	9.97E-011	NA	2.23E-010	NA
4,4'-DDD	NA	2.24E-008	NA	4.52E-013	NA	2.03E-013
4,4'-DDE	NA	3.17E-008	NA	2.84E-012	NA	1.27E-012
4,4'-DDT	1.35E-002	3.17E-008	9.88E-009	6.00E-013	2.21E-008	2.69E-013
acetone	1.17E-005	NA	1.24E-004	NA	2.77E-004	NA
antimony	1.79E-002	NA	5.70E-009	NA	1.28E-008	NA
aroclor 1254	1.76E-001	NA	5.61E-005	3.09E-009	1.26E-004	1.38E-009
arsenic	1.95E-002	1.24E-007	7.60E-009	9.77E-012	1.70E-008	4.38E-012
barium	7.29E-005	NA	1.60E-008	NA	3.57E-008	NA
benzene	NA	1.61E-008	NA	4.51E-007	NA	2.02E-007
benzo(a)anthracene	NA	1.86E-007	NA	3.17E-013	NA	1.42E-013
benzo(a)pyrene	NA	1.86E-006	NA	3.17E-012	NA	1.42E-012
benzo(b)fluoranthene	NA	1.86E-007	NA	1.43E-011	NA	6.41E-012
beryllium	8.30E-003	3.94E-012	4.56E-010	6.84E-012	1.02E-009	3.06E-012

TABLE 4-11 (CONT'D)
AGGREGATE UNIT RISK VALUES FOR ON-SITE RECEPTORS

	Construction Worker		Operations/Office Personnel		Child in Daycare	
Chemicals of Concern	Unit HQ	Unit ILCR	Unit HQ	Unit ILCR	Unit HQ	Unit ILCR
bis(2-ethylhexyl)phthalate	NA	1.01E-009	1.15E-010	6.89E-015	2.57E-010	3.08E-015
bromodichloromethane	4.86E-004	1.73E-008	1.19E-004	1.11E-007	2.67E-004	4.96E-008
bromoform	4.55E-004	9.66E-010	3.82E-005	1.06E-009	8.56E-005	4.77E-010
cadmium	1.09E-002	7.03E-012	4.56E-009	1.22E-011	1.02E-008	5.47E-012
carbon disulfide	1.30E-004	NA	5.12E-004	NA	1.15E-003	NA
carbon tetrachloride	NA	2.60E-008	2.94E-002	3.89E-007	6.58E-002	1.74E-007
chlorobenzene	NA	NA	3.36E-004	NA	7.52E-004	NA
chloroform	1.15E-003	4.56E-009	1.48E-003	1.00E-007	3.31E-003	4.49E-008
chromium iii	5.51E-006	NA	1.52E-012	NA	3.40E-012	NA
chromium vi	2.35E-004	2.84E-008	7.60E-010	4.15E-010	1.70E-009	1.86E-010
chrysene	NA	8.68E-009	NA	2.52E-015	NA	1.13E-015
cis-1,2-dichloroethene	1.17E-004	NA	1.36E-003	NA	3.06E-003	NA
copper	1.44E-004	NA	6.16E-011	NA	1.38E-010	NA
cumene	4.06E-005	NA	4.33E-007	NA	9.69E-007	NA
cyanide	2.60E-004	NA	1.14E-010	NA	2.55E-010	NA
di-n-butylphthalate	8.78E-006	NA	1.54E-010	NA	3.44E-010	NA
di-n-octylphthalate	4.39E-004	NA	5.10E-010	NA	1.14E-009	NA
dibromochloromethane	4.62E-005	1.19E-008	6.28E-005	4.22E-008	1.41E-004	4.72E-010
endosulfan sulfate	1.12E-003	NA	6.45E-007	NA	1.44E-006	NA
endrin	2.25E-002	NA	1.60E-006	NA	3.59E-006	NA
ethylbenzene	NA	NA	8.11E-006	NA	1.82E-005	NA
gamma-bhc	2.20E-003	1.21E-007	3.23E-005	3.80E-009	7.23E-005	1.70E-009
hydrogen sulfide	1.63E-004	NA	7.98E-009	NA	1.79E-008	NA
indeno(1,2,3-cd)pyrene	NA	1.44E-007	5.70E-011	3.17E-013	1.28E-010	1.42E-013
manganese	1.12E-003	NA	4.95E-011	NA	1.11E-010	NA

TABLE 4-11 (CONT'D)
AGGREGATE UNIT RISK VALUES FOR ON-SITE RECEPTORS

	Construction Worker		Operations/Office Personnel		Child in Daycare	
Chemicals of Concern	Unit HQ	Unit ILCR	Unit HQ	Unit ILCR	Unit HQ	Unit ILCR
mercury	5.46E-002	NA	2.14E-003	NA	4.78E-003	NA
methylene chloride	1.45E-004	1.90E-009	3.31E-005	3.55E-008	7.42E-005	1.72E-010
molybdenum	1.42E-004	NA	4.56E-010	NA	1.02E-009	NA
nickel	6.03E-004	4.27E-013	1.14E-010	7.41E-013	2.55E-010	3.32E-013
phenol	1.46E-005	NA	4.37E-008	NA	9.78E-008	NA
pyrene	5.84E-005	NA	6.44E-009	NA	1.44E-008	NA
selenium	1.02E-003	NA	4.56E-010	NA	1.02E-009	NA
silver	1.29E-003	NA	4.56E-010	NA	1.02E-009	NA
strontium	8.13E-006	NA	3.80E-012	NA	8.51E-012	NA
tetrachloroethene	1.18E-004	6.99E-009	1.18E-003	8.89E-008	2.65E-003	6.92E-010
toluene	5.09E-006	NA	4.07E-005	NA	9.11E-005	NA
trans-1,2-dichloroethene	6.20E-005	NA	1.01E-003	NA	2.26E-003	NA
trichloroethene	NA	2.12E-009	9.97E-004	2.62E-008	2.23E-003	1.17E-008
trichlorofluoromethane	2.00E-005	NA	1.81E-006	NA	4.05E-006	NA
trichlorotrifluoromethane	2.36E-006	NA	1.00E-007	NA	4.47E-008	NA
vanadium	1.72E-003	NA	3.26E-010	NA	7.29E-010	NA
vinyl acetate	5.99E-005	NA	3.55E-006	NA	5.52E-004	NA
vinyl chloride	NA	8.17E-008	NA	8.57E-008	NA	1.45E-006
xylene, m-	9.28E-005	NA	3.58E-008	NA	3.58E-007	NA
xylene, o-	NA	NA	3.56E-008	NA	3.55E-007	NA
xylene, p-	2.35E-005	NA	NA	NA	NA	NA
zinc	1.97E-005	NA	7.60E-012	NA	1.70E-011	NA

Notes:
NA = Not Available. No toxicity data exist for pathways.

5. DEVELOPMENT OF HEALTH-BASED REMEDIATION GOALS

Section 5 describes how the unit risk values calculated in Section 4 are used to quantify constituent-specific HBRGs for the receptors discussed in Section 3. Section 5 also describes how these *initial* receptor- and pathway-specific HBRGs undergo a final evaluation to determine resultant, *final* HBRGs that are both health protective and reasonable for all receptors.

Section 5.1 discusses the health protection levels used in the development of the initial HBRGs. Section 5.2 describes the methodology used to calculate the initial HBRGs and summarizes the goals developed for the on-site construction worker, operations/office personnel, and the on-site child in daycare. The approach used to finalize the remediation goals for both organic and inorganic constituents is presented Section 5.3, as are the final HBRGs for the remediation of the site.

5.1 HEALTH PROTECTION LEVELS

As previously mentioned, one goal of the National Contingency Plan is to manage total site-wide cancer risk such that the sum of all exposures does not exceed 10^{-4} (EPA 1990a). Although this upper limit of the target range for incremental lifetime cancer risk (ILCR) is generally used to make risk management decisions—particularly in determining whether remedial actions are necessary or warranted—EPA does not consider 10^{-4} an absolute limit. Risks below that level may be considered generally acceptable based on site-specific conditions and land use (EPA 1991). For the purpose of developing conservative HBRGs for the site, the value of 10^{-6} was used for initial, constituent-specific HBRG calculations in this report. This is a very conservative value, 100 times more conservative than EPA's target and 10 times more conservative than the "no significant risk" level presented in California Proposition 65.

For noncarcinogenic compounds, EPA indicates that the cumulative site hazard index (HI) should be less than 1 (EPA 1989a). However, no EPA guidance is available on apportioning the

allowable level among the range of constituents in various environmental media. The most relevant guidance is provided by the Office of Drinking Water which, in calculating maximum contaminant level goals (MCLGs), uses a relative source contribution (RSC) factor to account for other sources of exposure (EPA 1989a). The RSC value assumed in this report is 0.2, five times more conservative than the standard EPA value of 1.

5.2 CALCULATION OF INITIAL HEALTH-BASED REMEDIATION GOALS

Relevant methodologies for calculating potential human health effects are set forth in recent EPA guidance such as the Risk Assessment Guidance for Superfund (RAGS) Human Health Evaluation Manual (EPA 1989a) and its supporting documents. The general procedures for rearranging these standard risk equations for HBRG calculation are provided by EPA (1991). Exposures are first quantified using a set of equations and parameters unique to each exposure pathway as presented in Section 4 of this report.

The exposure assessment process estimates daily intake, expressed in milligrams per kilogram per day (mg/kg-d), of a hazardous chemical. Since a unit concentration (1 mg/kg) was assumed in the intake calculations, unit intakes (intake per unit concentration) were actually calculated. The calculated unit intakes are then multiplied by an appropriate cancer slope factor (CSF) to calculate a unit ILCR, or divided by a chemical's reference dose (RfD) to yield the unit hazard quotient (HQ). In this manner, unit risk values (risk per unit concentration) are determined.

HBRGs were established for the site by considering potential future land uses, receptors, exposure parameters, and analytes applicable for site characterization. Generally, risk-based values are derived independent of site concentrations (the unit risk approach) and consider only the receptor's potential exposure (or contact rate) to a particular medium.

For this report, a compound-specific HBRG in a distinct environmental medium is evaluated after considering all exposure pathways applicable to the receptor within that medium. As a result, a single equation to calculate these values would be too unwieldy to present here. To

simplify the presentation, this section incorporates the cumulative, receptor-specific unit risk values derived in Section 4. Thus, the relationship between unit risk or unit hazard and a medium-specific HBRG can be described with a simplified standard equation, as follows:

$$HBRG = \frac{ARL}{UF} \qquad (5\text{-}1)$$

where:

HBRG = medium-specific health-based remediation goal (mg/kg chemical in soil)
ARL = an acceptable risk level (target risk) or an acceptable hazard value (10^{-6} ILCR, 0.2 HI)
UF = unit factor (unit risk for carcinogenic effects, unit hazard for toxic effects)

Using the construction scenario as an example and inserting the construction worker unit risk and unit hazard for 1,1-dichloroethane soil exposures into the equation, HBRGs for 1,1-dichloroethane in soil are calculated as follows:

Carcinogens	*Toxicants*	(5-2)
$HBRG = 1 \times 10^{-6} / 9.82 \times 10^{-10}$	$HBRG = 0.2 / 1.14 \times 10^{-5}$	
or	*or*	
$HBRG = 1.02 \times 10^{3}$ mg/kg	$HBRG = 1.76 \times 10^{4}$ mg/kg	

For chemicals similar to 1,1-dichloroethane in which both carcinogenic and toxic effects are documented, the lowest value (either that based on an ILCR of 10^{-6} or that based on an HQ of 0.2) was selected.

Tables 5-1 through 5-3 present the initial HBRGs for soil exposures as calculated for the construction and operational scenarios. Appendix D presents the complete calculation sheets for the HBRGs under each scenario.

In some instances, the HBRGs presented in Appendix D represent concentrations that are physically unrealistic. For inorganic compounds, the highest concentration of a constituent in soil that is physically possible is 1×10^{6} milligrams per kilogram. A concentration greater than

1×10^6 milligrams per kilogram suggests that, for a given volume of soil, the mass of constituent within the volume is greater than or equal to the soil mass, which is physically impossible. For organic compounds the soil saturation limit represents the highest possible concentration of a constituent in a soil matrix. The soil saturation limit was discussed in Section 4.2.2. For HBRGs that are greater than or equal to the maximum possible soil concentration, the HBRG values presented in Tables 5-1 through 5-3 are reported as either C_{sat} (the saturation concentration) for organic compound or C_{pure} (pure product) for inorganic compounds.

5.3 Final Health-Based Remediation Goals for Surface Soils

Final soil-based HBRGs represent concentrations of constituents in soil that are protective both of human health and groundwater. Consequently, two types of soil-based HBRGs were determined. The first type, discussed in this section, ensures that receptors exposed to constituents in soil will not be exposed at levels exceeding the allowable level of risk (an ILCR of 10^{-5} or an HI of 1.0). The second type, discussed in Section 5.4, ensures that concentrations of constituents migrating from soil are low enough to prevent the resulting groundwater concentrations from exceeding health and groundwater protective levels.

The initial HBRGs developed for organic and inorganic constituents in soil are based on two distinct exposure scenarios (construction and operational scenarios) and must be normalized to ensure health protectiveness prior to setting final HBRGs. However, the finalization of remediation goals is different for organic and inorganic compounds. Final HBRGs for organic compounds must consider site-specific soil saturation concentrations while final HBRGs for inorganic compounds must account for the potential impact of naturally occurring background concentrations. The following presents the methodology used for both organic and inorganic compounds in the derivation of final HBRGs.

5.3.1 Final Health-Based Remediation Goals for Organic Compounds

To ensure health protectiveness under both the construction and operational scenarios, and to ensure physically realistic remediation goals, the final HBRG for organic compounds must

TABLE 5-1
INITIAL SOIL HBRGS FOR THE ON-SITE CONSTRUCTION WORKER

Chemicals of Concern	Scaled Soil Conc. (mg/kg) HQ=0.2	Scaled Soil Conc. (mg/kg) ILCR=1E-06	Initial HBRG (mg/kg)
1,1-dichloroethane	1.76E+004	1.02E+003	1.02E+003
1,1-dichloroethene	1.18E+002	5.49E+000	5.49E+000
1,1,2-trichloroethane	8.01E+002	1.01E+002	1.01E+002
1,2-dichloroethane	NA	9.24E+001	9.24E+001
1,2-dichloropropane	3.27E+002	1.04E+002	1.04E+002
1,4-dichlorobenzene	2.70E+005	1.97E+002	1.97E+002
2-butanone	4.55E+004	NA	4.55E+004
2,4-dichlorophenol	6.83E+001	NA	6.83E+001
4-methyl-2-pentanone	1.82E+004	NA	1.82E+004
4,4'-DDD	NA	4.46E+001	4.46E+001
4,4'-DDE	NA	3.15E+001	3.15E+001
4,4'-DDT	1.48E+001	3.15E+001	1.48E+001
acetone	1.71E+004	NA	1.71E+004
antimony	1.12E+001	NA	1.12E+001
aroclor 1254	1.14E+000	NA	1.14E+000
arsenic	1.02E+001	8.05E+000	8.05E+000
barium	2.74E+003	NA	2.74E+003
benzene	NA	6.19E+001	6.19E+001
benzo(a)anthracene	NA	5.39E+000	5.39E+000
benzo(a)pyrene	NA	5.39E-001	5.39E-001
benzo(b)fluoranthene	NA	5.39E+000	5.39E+000
beryllium	2.41E+001	2.54E+005	2.41E+001
bis(2-ethylhexyl)phthalate	NA	9.95E+002	9.95E+002
bromodichloromethane	4.11E+002	5.78E+001	5.78E+001
bromoform	4.40E+002	1.04E+003	4.40E+002
cadmium	1.84E+001	1.42E+005	1.84E+001
carbon disulfide	1.54E+003	NA	1.54E+003
carbon tetrachloride	NA	3.85E+001	3.85E+001
chloroform	1.74E+002	2.19E+002	1.74E+002
chromium iii	3.63E+004	NA	3.63E+004
chromium vi	8.50E+002	3.52E+001	3.52E+001
chrysene	NA	1.15E+002	1.15E+002
cis-1,2-dichloroethene	1.70E+003	NA	1.70E+003
copper	1.39E+003	NA	1.39E+003
cumene	4.93E+003	NA	4.93E+003
cyanide	7.68E+002	NA	7.68E+002
di-n-butylphthalate	2.28E+004	NA	2.28E+004
di-n-octylphthalate	4.55E+002	NA	4.55E+002
dibromochloromethane	4.33E+003	8.44E+001	8.44E+001
endosulfan sulfate	1.78E+002	NA	1.78E+002
endrin	8.90E+000	NA	8.90E+000
gamma-BHC	9.10E+001	8.24E+000	8.24E+000
hydrogen sulfide	1.23E+003	NA	1.23E+003
indeno(1,2,3-cd)pyrene	NA	6.96E+000	6.96E+000
manganese	1.78E+002	NA	1.78E+002
mercury	3.66E+000	NA	3.66E+000
methylene chloride	1.38E+003	5.27E+002	5.27E+002
molybdenum	1.41E+003	NA	1.41E+003

TABLE 5-1 (CONT'D)
INITIAL SOIL HBRGS FOR THE ON-SITE CONSTRUCTION WORKER

Chemicals of Concern	Scaled Soil Conc. (mg/kg) HQ=0.2	Scaled Soil Conc. (mg/kg) ILCR=1E-06	Initial HBRG (mg/kg)
nickel	3.32E+002	2.34E+006	3.32E+002
phenol	1.37E+004	NA	1.37E+004
pyrene	3.42E+003	NA	3.42E+003
selenium	1.97E+002	NA	1.97E+002
silver	1.55E+002	NA	1.55E+002
strontium	2.46E+004	NA	2.46E+004
tetrachloroethene	1.70E+003	1.43E+002	1.43E+002
toluene	3.93E+004	NA	3.93E+004
trans-1,2-dichloroethene	3.23E+003	NA	3.23E+003
trichloroethene	NA	4.73E+002	4.73E+002
trichlorofluoromethane	1.00E+004	NA	1.00E+004
trichlorotrifluoroethane (freon)	8.47E+004	NA	8.47E+004
vanadium	1.16E+002	NA	1.16E+002
vinyl acetate	3.34E+003	NA	3.34E+003
vinyl chloride	NA	1.22E+001	1.22E+001
xylene, m-	2.16E+003	NA	2.16E+003
xylene, p-	8.50E+003	NA	8.50E+003
zinc	1.01E+004	NA	1.01E+004

Notes:

NA = no data available

C_{pure} = the constituent concentration is greater than or equal to $1x10^6$ mg/kg; i.e., the mass of constituent exceeds the mass of soil for a given volume

C_{sat} = soil saturation limit, i.e., the mass of constituent exceeds the soil saturation concentration

TABLE 5-2
INITIAL SOIL HBRGS FOR ON-SITE OPERATIONS/OFFICE PERSONNEL

Chemicals of Concern	Scaled Soil Conc. (mg/kg) HQ=0.2	Scaled Soil Conc. (mg/kg) ILCR=1E-06	Initial HBRG (mg/kg)
1,1-dichloroethane	1.39E+003	2.39E+001	2.39E+001
1,1-dichloroethene	2.89E+001	NA	2.89E+001
1,1,1-trichloroethane	3.12E+003	NA	3.12E+003
1,1,2-trichloroethane	2.90E+002	1.41E+001	1.41E+001
1,2-dichlorobenzene	3.24E+004	NA	3.24E+004
1,2-dichloroethane	NA	4.10E+000	4.10E+000
1,2-dichloropropane	2.90E+001	5.63E+000	5.63E+000
1,4-dichlorobenzene	1.05E+005	1.60E+002	1.60E+002
2-butanone	2.51E+010	NA	C_{sat}
2,4-dichlorophenol	2.47E+004	NA	2.47E+004
4-methyl-2-pentanone	2.01E+009	NA	C_{sat}
4,4'-DDD	NA	2.21E+006	C_{sat}
4,4'-DDE	NA	3.52E+005	3.52E+005
4,4'-DDT	2.02E+007	1.67E+006	C_{sat}
acetone	1.62E+003	NA	1.62E+003
antimony	3.51E+007	NA	C_{pure}
aroclor 1254	3.56E+003	3.24E+002	3.24E+002
arsenic	2.63E+007	1.02E+005	1.02E+005
barium	1.25E+007	NA	C_{pure}
benzene	NA	2.22E+000	2.22E+000
benzo(a)anthracene	NA	3.15E+006	3.15E+006
benzo(a)pyrene	NA	3.15E+005	3.15E+005
benzo(b)fluoranthene	NA	6.99E+004	6.99E+004
beryllium	4.39E+008	1.46E+005	1.46E+005
bis(2-ethylhexyl)phthalate	1.74E+009	1.45E+008	C_{sat}
bromodichloromethane	1.68E+003	9.03E+000	9.03E+000
bromoform	5.23E+003	9.39E+002	9.39E+002
cadmium	4.39E+007	8.19E+004	8.19E+004
carbon disulfide	3.90E+002	NA	3.90E+002
carbon tetrachloride	6.81E+000	2.57E+000	2.57E+000
chlorobenzene	5.96E+002	NA	5.96E+002
chloroform	1.35E+002	9.98E+000	9.98E+000
chromium iii	1.32E+011	NA	C_{pure}
chromium vi	2.63E+008	2.41E+003	2.41E+003
chrysene	NA	3.96E+008	C_{sat}
cis-1,2-dichloroethene	1.47E+002	NA	1.47E+002
copper	3.25E+009	NA	C_{pure}
cumene	4.62E+005	NA	4.62E+005
cyanide	1.76E+009	NA	C_{pure}
di-n-butylphthalate	1.30E+009	NA	C_{sat}
di-n-octylphthalate	3.92E+008	NA	C_{sat}
dibromochloromethane	3.19E+003	2.37E+001	2.37E+001
endrin	1.25E+005	NA	1.25E+005
endosulfan sulfate	3.10E+005	NA	3.10E+005
ethylbenzene	2.47E+004	NA	2.47E+004
gamma-BHC	6.20E+003	2.63E+002	2.63E+002
hydrogen sulfide	2.51E+007	NA	C_{pure}
indeno(1,2,3-cd)pyrene	3.51E+009	3.15E+006	3.15E+006

TABLE 5-2 (CONT'D)
INITIAL SOIL HBRGS FOR ON-SITE OPERATIONS/OFFICE PERSONNEL

Chemicals of Concern	Scaled Soil Conc. (mg/kg) HQ=0.2	Scaled Soil Conc. (mg/kg) ILCR=1E-06	Initial HBRG (mg/kg)
manganese	4.04E+009	NA	C_{pure}
mercury	9.37E+001	NA	9.37E+001
methylene chloride	6.04E+003	2.82E+001	2.82E+001
molybdenum	4.39E+008	NA	C_{pure}
nickel	1.76E+009	1.35E+006	C_{pure}
phenol	4.58E+006	NA	C_{sat}
pyrene	3.10E+007	NA	C_{sat}
selenium	4.39E+008	NA	C_{pure}
silver	4.39E+008	NA	C_{pure}
strontium	5.27E+010	NA	C_{pure}
tetrachloroethene	1.69E+002	1.13E+001	1.13E+001
toluene	4.92E+003	NA	4.92E+003
trans-1,2-dichloroethene	1.98E+002	NA	1.98E+002
trichloroethene	2.01E+002	3.82E+001	3.82E+001
trichlorofluoromethane	1.11E+005	NA	1.11E+005
trichlorotrifluoroethane (freon)	4.48E+006	NA	C_{sat}
vanadium	6.14E+008	NA	C_{pure}
vinyl acetate	5.63E+004	NA	8.12E+002
vinyl chloride	NA	1.17E+001	1.17E+001
xylene, m-	5.58E+006	NA	C_{sat}
xylene, o-	5.62E+006	NA	C_{sat}
zinc	2.63E+010	NA	C_{pure}

Notes:

NA = no data available

C_{pure} = the constituent concentration is greater than or equal to $1x10^6$ mg/kg; i.e., the mass of constituent exceeds the mass of soil for a given volume

C_{sat} = soil saturation limit, i.e., the mass of constituent exceeds the soil saturation concentration

TABLE 5-3
INITIAL SOIL HBRGS FOR THE ON-SITE CHILD IN DAYCARE

Chemicals of Concern	Scaled Soil Conc. (mg/kg) HQ=0.2	Scaled Soil Conc. (mg/kg) ILCR=1E-06	Initial HBRG (mg/kg)
1,1-dichloroethane	6.21E+002	5.34E+001	5.34E+001
1,1-dichloroethene	1.29E+001	NA	1.29E+001
1,1,1-trichloroethane	1.39E+003	NA	1.39E+003
1,1,2-trichloroethane	1.30E+002	3.15E+001	3.15E+001
1,2-dichlorobenzene	1.45E+004	NA	1.45E+004
1,2-dichloroethane	NA	9.15E+000	9.15E+000
1,2-dichloropropane	1.29E+001	1.26E+001	1.26E+001
1,4-dichlorobenzene	4.68E+004	3.58E+002	3.58E+002
2-butanone	1.12E+010	NA	C_{sat}
2,4-dichlorophenol	1.10E+004	NA	1.10E+004
4-methyl-2-pentanone	8.95E+008	NA	C_{sat}
4,4'-DDD	NA	4.94E+006	C_{sat}
4,4'-DDE	NA	7.86E+005	7.86E+005
4,4'-DDT	9.03E+006	3.72E+006	C_{sat}
acetone	7.22E+002	NA	7.22E+002
antimony	1.57E+007	NA	C_{pure}
aroclor 1254	1.59E+003	7.23E+002	7.23E+002
arsenic	1.18E+007	2.29E+005	2.29E+005
barium	5.60E+006	NA	C_{pure}
benzene	NA	4.95E+000	4.95E+000
benzo(a)anthracene	NA	7.03E+006	C_{sat}
benzo(a)pyrene	NA	7.03E+005	7.03E+005
benzo(b)fluoranthene	NA	1.56E+005	1.56E+005
beryllium	1.96E+008	3.26E+005	3.26E+005
bis(2-ethylhexyl)phthalate	7.78E+008	3.24E+008	C_{sat}
bromodichloromethane	7.48E+002	2.02E+001	2.02E+001
bromoform	2.34E+003	2.10E+003	2.10E+003
cadmium	1.96E+007	1.83E+005	1.83E+005
carbon disulfide	1.74E+002	NA	1.74E+002
carbon tetrachloride	3.04E+000	5.74E+000	3.04E+000
chlorobenzene	2.66E+002	NA	2.66E+002
chloroform	6.04E+001	2.23E+001	2.23E+001
chromium iii	5.88E+010	NA	C_{pure}
chromium vi	1.18E+008	5.38E+003	5.38E+003
chrysene	NA	8.85E+008	C_{sat}
cis-1,2-dichloroethene	6.54E+001	NA	6.54E+001
copper	1.45E+009	NA	C_{pure}
cumene	2.06E+005	NA	2.06E+005
cyanide	7.84E+008	NA	C_{pure}
di-n-butylphthalate	5.81E+008	NA	C_{sat}
di-n-octylphthalate	1.75E+008	NA	C_{sat}
dibromochloromethane	1.42E+003	2.12E+003	1.42E+003
endosulfan sulfate	1.38E+005	NA	1.38E+005
endrin	5.57E+004	NA	5.57E+004
ethylbenzene	1.10E+004	NA	1.10E+004
gamma-BHC	2.77E+003	3.04E+004	2.77E+003
hydrogen sulfide	1.12E+007	NA	C_{pure}
indeno(1,2,3-cd)pyrene	1.57E+009	7.03E+006	C_{sat}

TABLE 5-3 (CONT'D)
INITIAL SOIL HBRGS FOR THE ON-SITE CHILD IN DAYCARE

Chemicals of Concern	Scaled Soil Conc. (mg/kg) HQ=0.2	Scaled Soil Conc. (mg/kg) ILCR=1E-06	Initial HBRG (mg/kg)
manganese	1.80E+009	NA	C_{pure}
mercury	4.18E+001	NA	4.18E+001
methylene chloride	2.70E+003	5.82E+003	2.70E+003
molybdenum	1.96E+008	NA	C_{pure}
nickel	7.84E+008	3.01E+006	C_{pure}
phenol	2.04E+006	NA	C_{sat}
pyrene	1.39E+007	NA	C_{sat}
selenium	1.96E+008	NA	C_{pure}
silver	1.96E+008	NA	C_{pure}
strontium	2.35E+010	NA	C_{pure}
tetrachloroethene	7.53E+001	1.44E+003	7.53E+001
toluene	2.20E+003	NA	2.20E+003
trans-1,2-dichloroethene	8.84E+001	NA	8.84E+001
trichloroethene	8.95E+001	8.53E+001	8.53E+001
trichlorofluoromethane	4.94E+004	NA	4.94E+004
trichlorotrifluoroethane (freon)	2.00E+006	NA	C_{sat}
vanadium	2.74E+008	NA	C_{pure}
vinyl acetate	2.34E+003	NA	2.34E+003
vinyl chloride	NA	6.88E-001	6.88E-001
xylene, m-	5.58E+005	NA	5.58E+005
xylene, o-	5.63E+005	NA	5.63E+005
zinc	1.18E+010	NA	C_{pure}

Notes:

NA = no data available

C_{pure} = the constituent concentration is greater than or equal to $1x10^6$ mg/kg; i.e., the mass of constituent exceeds the mass of soil for a given volume

C_{sat} = soil saturation limit, i.e., the mass of constituent exceeds the soil saturation concentration

represent the lowest of the following three values: construction scenario HBRG, operational scenario HBRG, and soil saturation limit. A comparison of these three values for all organic compounds was performed to determine which is the lowest. The lowest value was then selected as the final HBRG for that compound in surface soils. This procedure ensures that the final HBRG is health protective and does not present a potential nonaqueous phase liquid (NAPL) condition. Thus, the final cleanup level for organic compounds cannot exceed the soil saturation limit regardless of risk. If the HBRG for an organic compound exceeds the soil saturation limit, the value is listed as C_{sat}, the soil saturation limit for that compound. Table 5-4 presents the final HBRGs for organic compounds. .

5.3.2 Final Health-Based Remediation Goals for Inorganic Compounds

Numerous inorganic compounds evaluated at the site occur in native, uncontaminated soils. In addition, the environmental concentrations of some inorganic compounds may have been increased by general human activity. Inorganic constituents that have been added to the environment as a result of regional human activity, such as automobile emissions, are referred to as anthropogenic (or man-made) background constituents. Anthropogenic background levels must be accounted for in the finalization of remediation goals, to ensure that existing inorganic background concentrations do not bias the remedial effort.

Final HBRGs for inorganic compounds were determined by comparing the initial HBRGs for both the construction and operational scenarios to site-specific background concentrations determined in a site-specific background metals and pesticide assessment (HLA 1999). To accomplish this, an interim HBRG was determined first by comparing the initial HBRGs for the construction and operational scenarios to determine the lowest (most conservative) value. This ensures that the interim HBRG used in the comparison process is health protective, regardless of the receptor-exposure assumed.

Then, the interim HBRG was compared to site-specific soil background concentrations (HLA 1999). The higher of the two values in this comparison was adopted as the final HBRG for the site. Since it would be unreasonable to have a remediation goal less than the existing background

TABLE 5-4
FINAL HBRGS FOR ORGANIC COMPOUNDS IN SOIL

Constituent	Construction Worker Initial HBRG (mg/kg)	Operations/ Office Personnel Initial HBRG (mg/kg)	Daycare Child Initial HBRG (mg/kg)	Soil Saturation Limit (mg/kg)	Final HBRG (mg/kg)
1,1-dichloroethane	1.02E+003	2.39E+001	5.34E+001	8.66E+003	2.39E+001
1,1-dichloroethene	5.49E+000	2.89E+001	1.29E+001	7.00E+003	5.49E+000
1,1,1-trichloroethane	NA	3.12E+003	1.39E+003	7.52E+003	1.39E+003
1,1,2-trichloroethane	1.01E+002	1.41E+001	3.15E+001	1.16E+004	1.41E+001
1,2-dichlorobenzene	NA	3.24E+004	1.45E+004	2.29E+003	C_{sat}
1,2-dichloroethane	9.24E+001	4.10E+000	9.15E+000	8.46E+003	4.10E+000
1,2-dichloropropane	1.04E+002	5.63E+000	1.26E+001	6.47E+003	5.63E+000
1,4-dichlorobenzene	1.97E+002	1.60E+002	3.58E+002	2.29E+003	1.60E+002
2-butanone	4.55E+004	C_{sat}	C_{sat}	8.29E+004	4.55E+004
2,4-dichlorophenol	6.83E+001	2.47E+004	1.10E+004	3.36E+004	6.83E+001
4-methyl-2-pentanone	1.82E+004	C_{sat}	C_{sat}	2.04E+004	1.82E+004
4,4'-DDD	4.46E+001	C_{sat}	C_{sat}	5.00E+003	4.46E+001
4,4'-DDE	3.15E+001	3.52E+005	7.86E+005	8.94E+003	3.15E+001
4,4'-DDT	1.48E+001	C_{sat}	C_{sat}	3.29E+003	1.48E+001
acetone	1.12E+001	1.62E+003	7.22E+002	1.50E+005	1.12E+001
aroclor 1254	1.14E+000	3.24E+002	7.23E+002	5.70E+006	1.14E+000
benzene	6.19E+001	2.22E+000	4.95E+000	5.51E+003	2.22E+000
benzo(a)anthracene	5.39E+000	3.15E+006	C_{sat}	2.79E+002	5.39E+000
benzo(a)pyrene	5.39E-001	3.15E+005	7.03E+005	2.55E+000	5.39E-001
benzo(b)fluoranthene	5.39E+000	6.99E+004	1.56E+005	8.61E+002	5.39E+000
bis(2-ethylhexyl)phthalate	9.95E+002	C_{sat}	C_{sat}	2.57E+005	9.95E+002
bromodichloromethane	5.78E+001	9.03E+000	2.02E+001	1.94E+004	9.03E+000
bromoform	4.40E+002	9.39E+002	2.10E+003	1.39E+004	4.40E+002
carbon disulfide	1.54E+003	3.90E+002	1.74E+002	2.93E+003	1.74E+002
carbon tetrachloride	3.85E+001	2.57E+000	3.04E+000	7.04E+003	2.57E+000
chlorobenzene	NA	5.96E+002	2.66E+002	5.23E+003	2.66E+002
chloroform	1.74E+002	9.98E+000	2.23E+001	1.69E+004	9.98E+000
chrysene	1.15E+002	C_{sat}	C_{sat}	3.98E+001	C_{sat}
cis-1,2-dichloroethene	1.70E+003	1.47E+002	6.54E+001	6.66E+003	6.54E+001
cumene	4.93E+003	4.62E+005	2.06E+05	5.73E+003	4.93E+003
di-n-butylphthalate	2.28E+004	C_{sat}	C_{sat}	1.90E+004	C_{sat}
di-n-octylphthalate	4.55E+002	C_{sat}	C_{sat}	8.32E+004	4.55E+002
dibromochloromethane	8.44E+001	2.37E+001	1.42E+003	1.49E+004	2.37E+001
endosulfan sulfate	1.78E+002	3.10E+005	1.38E+005	5.46E+001	C_{sat}
endrin	8.90E+000	1.25E+005	5.57E+004	1.54E+002	8.90E+000
ethylbenzene	NA	2.47E+004	1.34E+002	3.09E+003	1.34E+002
gamma-BHC	8.24E+000	2.63E+002	2.77E+003	4.18E+002	8.24E+000
hydrogen sulfide	1.23E+003	C_{sat}	C_{sat}	5.01E+002	C_{sat}
indeno(1,2,3-cd)pyrene	6.96E+000	C_{sat}	C_{sat}	9.20E+001	6.96E+000

TABLE 5-4 (CONT'D)
FINAL HBRGS FOR ORGANIC COMPOUNDS IN SOIL

Constituent	Construction Worker Initial HBRG (mg/kg)	Operations/ Office Personnel Initial HBRG (mg/kg)	Daycare Child Initial HBRG (mg/kg)	Soil Saturation Limit (mg/kg)	Final HBRG (mg/kg)
methylene chloride	5.27E+002	2.82E+001	2.70E+003	9.23E+003	2.82E+001
phenol	1.37E+004	C_{sat}	C_{sat}	1.29E+005	1.37E+004
pyrene	3.42E+003	C_{sat}	C_{sat}	7.09E+002	C_{sat}
tetrachloroethene	1.43E+002	1.13E+001	7.53E+001	1.58E+003	1.13E+001
toluene	3.93E+004	4.92E+003	2.20E+003	4.86E+003	2.20E+003
trans-1,2-dichloroethene	3.23E+003	1.98E+002	8.84E+001	1.74E+004	8.84E+001
trichloroethene	4.73E+002	3.82E+001	8.53E+001	9.28E+003	3.82E+001
trichlorofluoromethane	1.00E+004	1.11E+005	4.94E+004	8.94E+003	C_{sat}
trichlorotrifluoroethane (freon)	8.47E+004	C_{sat}	C_{sat}	3.44E+003	C_{sat}
vinyl acetate	3.34E+003	5.63E+004	2.34E+003	7.69E+003	3.63E+002
vinyl chloride	1.22E+001	1.17E+001	6.88E-001	3.03E+003	6.88E-001
xylene, m-	2.16E+003	C_{sat}	5.58E+005	4.06E+003	2.16E+003
xylene, o-	NA	C_{sat}	5.63E+005	3.69E+003	C_{sat}
xylene, p-	8.50E+003	NA	NA	3.88E+003	C_{sat}

Notes:
NA = no data available
C_{sat} = soil saturation limit.

TABLE 5-5
FINAL HBRGS FOR INORGANIC COMPOUNDS IN SOIL

Constituent	Construction Worker Initial HBRG (mg/kg)	Operations/ Office Personnel Initial HBRG (mg/kg)	Daycare Child Initial HBRG (mg/kg)	Background Soil Concentration (mg/kg)	Final HBRG (mg/kg)
antimony	1.12E+001	C_{pure}	C_{pure}	5.00E-000	1.12E+001
arsenic	8.05E+000	1.02E+005	2.29E+005	5.20E-000	8.05E+000
barium	2.74E+003	C_{pure}	C_{pure}	1.47E+002	2.74E+003
beryllium	2.41E+001	1.46E+005	3.26E+005	7.00E-001	2.41E+001
cadmium	1.84E+001	8.19E+004	1.83E+005	6.60E-001	1.84E+001
chromium iii	3.63E+004	C_{pure}	C_{pure}	NA	3.63E+004
chromium vi	8.50E+002	2.41E+003	5.38E+003	5.00E-001	8.50E+002
copper	1.39E+003	C_{pure}	C_{pure}	2.90E+001	1.39E+003
cyanide	7.68E+002	C_{pure}	C_{pure}	NA	7.68E+002
manganese	1.78E+002	C_{pure}	C_{pure}	NA	1.78E+002
mercury	3.66E+000	9.37E+001	4.18E+001	1.00E-001	3.66E+000
molybdenum	1.41E+003	C_{pure}	C_{pure}	1.80E-000	1.41E+003
nickel	3.32E+002	1.69E+005	C_{pure}	1.80E+001	3.32E+002
selenium	1.97E+002	C_{pure}	C_{pure}	5.00E-001	1.97E+002
silver	1.55E+002	C_{pure}	C_{pure}	5.00E-001	1.55E+002
strontium	2.46E+004	C_{pure}	C_{pure}	NA	2.46E+004
vanadium	1.16E+002	C_{pure}	C_{pure}	4.50E+001	1.16E+002
zinc	1.01E+004	C_{pure}	C_{pure}	5.60E+001	1.01E+004

Notes:
NA = no data available
C_{pure} = pure product concentration in soil

concentration, this comparison allows realistic remediation goals to be established for inorganic compounds. The final HBRGs for inorganic compounds are presented in Table 5-5.

5.4 FINAL HEALTH-BASED REMEDIATION GOALS FOR GROUNDWATER PROTECTION

Final HBRGs for groundwater represent constituent concentrations in soil that are protective of groundwater and, therefore, of human health. While the HBRGs for surface soil ensure the protection of on-site receptors, the groundwater HBRGs developed for the site ensure the protection of off-site receptors. In reality, there are no complete groundwater exposure pathways

for on- or off-site receptors. However, hypothetical groundwater exposure pathways have been conservatively assumed for off-site receptors. The development of HBRGs for groundwater is presented below and follows an approach similar to that described above for surface soils.

HBRGs for groundwater are based on attenuation factors described in Section 4 for the following fate and transport scenarios:

- Impacted soil (source) → Groundwater at property line of the nearest residence (*Soil-to-groundwater attenuation factor*: Groundwater ingestion and dermal contact with groundwater)
- Impacted soil (source) → Groundwater at property line of nearest residence → Bathtub Water → Bathtub Air (*Soil-to-groundwater attenuation factor and Groundwater-to-bathtub air attenuation factor*: Inhalation of bathtub air)
- Impacted soil (source) → Groundwater at property line of nearest residence → Shower Water → Shower Air (*Soil-to-groundwater attenuation factor and Groundwater-to-shower air attenuation factor*: Inhalation of shower air)

The initial groundwater HBRGs developed for organic constituents are based on two distinct hypothetical receptors (off-site resident adult and off-site resident child) and must be normalized to ensure health protectiveness prior to setting final HBRGs. As was the case for surface soils, the finalization of remediation goals based on groundwater exposure pathways must consider site-specific soil saturation concentrations when determining final HBRGs for organic compounds. No HBRGs for inorganic constituents via the groundwater pathway were developed. Fate and transport modeling of inorganic compounds indicated that inorganics would not leach from soil and be transported to an off-site receptor where exposure could occur via the pathways considered. Fate and transport models predicted that organic constituents could potentially be transported to the off-site exposure points considered. Namely:

- in the aqueous phase in groundwater at the property line of the nearest residence
- in the vapor phase in bathtub air at the nearest residence
- in the vapor phase in shower air at the nearest residence

The initial HBRGs for ingestion of, and dermal contact with, groundwater were calculated as follows:

$$HBRG_{gw-ingest/dermal} = AF_{s-gw} \times C_{w(risk-based)} \quad (5\text{-}3)$$

where:

$HBRG_{gw-ingest/dermal}$ = health-based remediation goal for soil, based on ingestion of, and dermal contact with, groundwater (mg/kg)

AF_{s-gw} = soil-to-groundwater attenuation factor at residential property boundary ([mg/kg]/[mg/L]), as described in Section 4.2.1.3

$C_{w(risk-based)}$ = minimum (most conservative) risk-based water concentration for ingestion of, and dermal contact with, aqueous-phase analytes (mg/L).

Values of $HBRG_{gw-ingest/dermal}$ are listed in Table 5-6.

The initial HBRGs for inhalation of bathtub vapors were calculated as follows:

$$HBRG_{bathtub} = AF_{s-gw} \times AF_{gw-bathtub} \times C_{a(risk-based)} \quad (5\text{-}4)$$

where:

$HBRG_{bathtub}$ = health-based remediation goal for soil, based on inhalation of bathtub vapors (mg/kg)

AF_{s-gw} = soil-to-groundwater attenuation factor at residential property boundary ([mg/kg]/[mg/L]), as described in Section 4.2.1.3

$AF_{gw-bathtub}$ = groundwater-to-bathtub air attenuation factor in residential bathtub air breathing zone ([mg/L]/[mg/m^3]), as described in Section 4.2.1.4

$C_{a(risk-based)}$ = minimum (most conservative) risk-based air concentration for inhalation of vapor-phase analytes (mg/m^3).

Values of $HBRG_{bathtub}$ are listed in Table 5-7.

The initial HBRGs for inhalation of shower vapors were calculated as follows:

$$HBRG_{shower} = AF_{s-gw} \times AF_{gw-shower} \times C_{a(risk-based)} \quad (5\text{-}5)$$

where:

TABLE 5-6
GROUNDWATER INGESTION/DERMAL CONTACT HBRGS

Chemical of Concern	AFs-gw ([mg/kg]/[mg/l])	Risk-based Cgw (mg/l)	HBRGs (mg/kg)
1,1,2-trichloroethane	1.11E+004	1.16E-003	1.29E+001
1,1-dichloroethene	1.23E+007	2.75E-002	3.39E+005
1,2-dichloropropane	7.94E+002	1.32E-003	1.05E-000
benzene	2.06E+006	6.85E-004	1.41E+003
bromodichloromethane	2.33E+002	6.46E-004	1.50E-001
bromoform	1.81E+007	1.07E-002	1.94E+005
chlorobenzene	2.41E+007	5.88E-002	C_{sat}
chloroform	1.18E+003	2.21E-003	2.60E-000
cis-1,2-dichloroethene	2.34E+003	3.08E-002	7.21E+001
dibromochloromethane	2.11E+007	8.98E-004	1.90E+004
ethylbenzene	5.48E+004	1.23E-001	6.72E+003
methylene chloride	5.90E+010	6.02E-003	C_{sat}
phenol	6.49E+035	1.85E-000	C_{sat}
toluene	4.89E+004	2.45E-001	1.20E+004
trans-1,2-dichloroethene	1.02E+007	6.25E-002	6.37E+005
trichloroethene	3.10E+003	3.82E-003	1.19E+001
trichlorofluoromethane	9.59E+004	9.14E-001	8.77E+004
vinyl chloride	1.37E+006	3.10E-004	4.26E+002

Notes:
C_{sat} = soil saturation limit

TABLE 5-7
BATHTUB AIR INHALATION HBRGS

Chemical of Concern	Groundwater-to-Air Attenuation Factor ([mg/l]/[mg/m^3])	Soil-to-Groundwater Attenuation Factor ([mg/kg]/[mg/l])	Risk-Based Target C (mg/m^3)	HBRGs (mg/kg)
1,1,2-trichloroethane	1.21E+002	1.11E+004	1.14E-002	1.52E+004
1,1-dichloroethane	8.56E+001	8.70E+004	1.44E-001	C_{sat}
1,2-dichloropropane	8.77E+001	7.94E+002	1.49E-002	1.04E+003
benzene	7.66E+001	2.06E+006	1.64E-006	2.59E+002
bromodichloromethane	2.27E+002	2.33E+002	2.10E-001	1.11E+004
bromoform	1.87E+002	1.81E+007	4.38E-002	C_{sat}
chlorobenzene	9.23E+001	2.41E+007	4.32E-002	C_{sat}
chloroform	9.68E+001	1.18E+003	1.30E-001	1.49E+004
cis-1,2-dichloroethene	8.44E+001	2.34E+003	8.73E-003	1.73E+003
dibromochloromethane	1.21E+002	2.11E+007	1.75E-000	C_{sat}
ethylbenzene	8.74E+001	5.48E+004	9.20E-000	C_{sat}
methylene chloride	8.33E+001	5.90E+010	2.63E+001	C_{sat}
phenol	4.95E+004	6.49E+035	6.13E-001	C_{sat}
toluene	8.23E+001	4.89E+004	8.21E-002	3.30E+005
trans-1,2-dichloroethene	8.43E+001	1.02E+007	6.13E-000	C_{sat}
trichloroethene	9.65E+001	3.10E+003	1.75E-000	5.24E+005
trichlorofluoromethane	9.67E+001	9.59E+004	3.04E-003	2.82E+004
vinyl chloride	6.63E+001	1.37E+006	1.75E-000	C_{sat}

Notes:
C_{sat} = soil saturation limit

$HBRG_{shower}$	=	health-based remediation goal for soil, based on inhalation of shower vapors (mg/kg)
AF_{s-gw}	=	soil-to-groundwater attenuation factor at residential property boundary ([mg/kg]/[mg/L]), as described in Section 4.2.1.3
$AF_{gw-shower}$	=	groundwater-to-shower air attenuation factor in residential shower air breathing zone ([mg/L]/[mg/m^3]), as described in Section 4.2.1.4
$C_{a(risk-based)}$	=	minimum (most conservative) risk-based air concentration for inhalation of vapor-phase analytes (mg/m^3).

Values of $HBRG_{shower}$ are listed in Table 5-8.

The initial HBRGs presented in Tables 5-6 through 5-8 represent concentrations of constituents in soil. Constituents present in soil at these levels, when migrating from soil to groundwater to offsite receptor, will not result exposures that exceed the acceptable risk levels discussed earlier in Section 5.1.

A comparison of the three sets of initial HBRGs for the groundwater pathways was performed to determine the lowest value. The lowest value was selected as the final HBRG for that compound based on exposure via the groundwater pathways. If the final HBRG exceeds the soil saturation limit, the value is listed as C_{sat}, the soil saturation limit for that compound. This procedure ensures that the final HBRG is health protective and does not present a potential nonaqueous phase liquid (NAPL) condition. Thus, the final cleanup level for organic compounds cannot exceed the soil saturation limit regardless of risk. Table 5-9 presents the final HBRGs for exposure to organic compounds via groundwater exposure pathways.

TABLE 5-8
SHOWER AIR INHALATION HBRGS

Chemical of Concern	AFgw-shower ([mg/l]/[mg/m3])	AFs-gw ([mg/kg]/[mg/l])	Risk-based Target Ca (mg/m^3)	HBRGs (mg/kg)
1,1,2-trichloroethane	2.31E-002	1.11E+004	1.14E-002	2.92E-000
1,1-dichloroethane	1.74E-002	8.70E+004	1.44E-001	2.17E+002
1,2-dichloropropane	1.77E-002	7.94E+002	1.30E-002	1.83E-001
benzene	1.59E-002	2.06E+006	8.21E-003	2.68E+002
bromodichloromethane	4.08E-002	2.33E+002	6.31E-003	5.99E-002
bromoform	3.41E-002	1.81E+007	2.10E-001	1.30E+005
chlorobenzene	1.84E-002	2.41E+007	1.75E-001	7.79E+004
chloroform	1.92E-002	1.18E+003	4.32E-002	9.76E-001
cis-1,2-dichloroethene	1.72E-002	2.34E+003	3.07E-001	1.23E+001
dibromochloromethane	2.33E-002	2.11E+007	8.73E-003	4.30E+003
ethylbenzene	1.76E-002	5.48E+004	8.76E-000	8.48E+003
methylene chloride	1.70E-002	5.90E+010	2.35E-001	C_{sat}
phenol	8.29E-000	6.49E+035	1.84E+001	C_{sat}
toluene	1.68E-002	4.89E+004	3.51E-000	2.88E+003
trans-1,2-dichloroethene	1.71E-002	1.02E+007	6.13E-001	1.07E+005
trichloroethene	1.91E-002	3.10E+003	8.21E-002	4.87E-000
trichlorofluoromethane	1.92E-002	9.59E+004	6.13E-000	1.13E+004
vinyl chloride	1.42E-002	1.37E+006	3.04E-003	5.94E+001

Notes:
C_{sat} = soil saturation limit

TABLE 5-9
FINAL HBRGS FOR GROUNDWATER EXPOSURE PATHWAYS

Chemical of Concern	GW Ingestion / Dermal Contact HBRGs (mg/kg)	Bathtub Air Inhalation HBRGs (mg/kg)	Shower Air Inhalation HBRGs (mg/kg)	Final HBRGs (mg/kg)
1,1,2-trichloroethane	1.29E+001	1.52E+004	2.92E-000	2.92E-000
1,1-dichloroethane	3.39E+005	C_{sat}	2.17E+002	2.17E+002
1,2-dichloropropane	1.05E-000	1.04E+003	1.83E-001	1.83E-001
benzene	1.41E+003	2.59E+002	2.68E+002	2.59E+002
bromodichloromethane	1.50E-001	1.11E+004	5.99E-002	5.99E-002
bromoform	1.94E+005	C_{sat}	1.30E+005	1.30E+005
chlorobenzene	C_{sat}	C_{sat}	7.79E+004	7.79E+004
chloroform	2.60E-000	1.49E+004	9.76E-001	9.76E-001
cis-1,2-dichloroethene	7.21E+001	1.73E+003	1.23E+001	1.23E+001
dibromochloromethane	1.90E+004	C_{sat}	4.30E+003	4.30E+003
ethylbenzene	6.72E+003	C_{sat}	8.48E+003	6.72E+003
methylene chloride	C_{sat}	C_{sat}	C_{sat}	C_{sat}
phenol	C_{sat}	C_{sat}	C_{sat}	C_{sat}
toluene	1.20E+004	3.30E+005	2.88E+003	2.88E+003
trans-1,2-dichloroethene	6.37E+005	C_{sat}	1.07E+005	1.07E+005
trichloroethene	1.19E+001	5.24E+005	4.87E-000	4.87E-000
trichlorofluoromethane	8.77E+004	2.82E+004	1.13E+004	1.13E+004
vinyl chloride	4.26E+002	C_{sat}	5.94E+001	5.94E+001

Notes:
C_{sat} = soil saturation limit

6. UNCERTAINTIES

Site-specific HBRGs were developed for the Playa Vista site to ensure that target cleanup levels are protective of human health and the environment. The development of HBRGs presented in Section 5 followed standard guidance for development of risk-based remediation goals as promulgated by EPA and Cal/EPA.

When using HBRGs for remedial decision making, one should consider the processes employed in deriving the predicted values. The selection of the appropriate models and assumptions used to develop HBRGs is crucial to the calculation of realistic values. Decision-makers, as well as the general public, can be misled if they rely only on a simplified numerical presentation without considering uncertainties, limitations, and assumptions inherent in the HBRG calculation process. In this section, as recommended in EPA and Cal/EPA guidance, the calculated HBRG values are evaluated to identify the type and degree of uncertainty introduced in any risk-based calculation process.

6.1 SOURCES OF UNCERTAINTY

Risk-based calculations generally carry two types of uncertainty: measurement and informational. Measurement uncertainty refers to the usual variance that accompanies scientific measurements (such as soil porosity or bulk density) and reflects the accumulated variances of the individually measured values. Examples of this type of uncertainty include the use of discrete samples to define overall site conditions.

Informational uncertainty arises if information needed to complete the HBRG calculations is unavailable. In some instances the impact is significant, such as the absence of toxicity data for a compound. The overall impact can be minimized by using the most reliable information available, coupled with reasonable assumptions to place an upper limit on the uncertainty. This approach can be applied to such uncertainties as the use of default computer model values to

represent site conditions, the accuracy with which the model represents actual environmental or biological processes, the manner in which the exposure scenario is developed, and the high-to-low dose and inter-species extrapolations for dose-response relationships.

The estimation of HBRG values is an iterative process involving sequential evaluation of site data. Any uncertainty introduced into the early stages of the process will propagate as calculations proceed. In addition, conservatism exercised in making assumptions and defining parameter values propagates through the calculations, thereby producing highly conservative HBRG estimates. In its guidance for human health risk assessments, the EPA states that "it is more important to identify the key site-related variables and assumptions that contribute most to the uncertainty than to precisely quantify the degree of uncertainty in the health risk assessment" (EPA 1989a). The following sections discuss the site-related variables and assumptions used to develop HBRGs and present a qualitative evaluation of the associated uncertainties.

6.2 Uncertainties in Selection of Constituents of Potential Concern

HBRGs were developed for a comprehensive list of constituents. This list includes *all* compounds detected in soil and groundwater at the site (Section 2). Due to the comprehensive nature of the constituents for which HBRG values have been calculated, it is unlikely that any constituents of potential concern (COPCs) present at the site have been omitted. There is little or no uncertainty in the selection of constituents, since all detected compounds are considered COPCs for the purposes of calculating HBRGs.

6.3 Uncertainties in Toxicity Assessment

Considerable uncertainty is associated with the qualitative (hazard assessment) and quantitative (dose-response) evaluations of constituent toxicity. Hazard assessment deals with characterizing the nature and strength of the evidence of causation, or the likelihood that a constituent that induces adverse effects in animals will induce adverse effects in humans. As an example, TCE is considered a probable carcinogen; however, epidemiological evidence of TCE-induced excess

cancer risk in humans is very difficult to obtain. This is largely because currently available human studies lack quantitative information concerning TCE exposure, previous TCE exposures, and profiles of receptors' lifestyles (such as smoking). These facts weaken the potential to discern the degree of carcinogenicity of TCE in humans.

Dose-response assessment is the process of characterizing the relationship between the administered dose of an agent and the incidence and severity of adverse health effects in an exposed population. Examples of uncertainties inherent in the modeling of dose-response relationships, upon which RfD values and/or cancer slope factors were based, include:

- Extrapolation of findings at high exposure levels to low exposure levels
- Extrapolation of findings from acute exposures to chronic exposures and/or occupational conditions to nonoccupational or environmental conditions
- Extrapolation of findings for oral toxicity values to dermal toxicity values

The level of uncertainty for different constituents varies because information concerning some constituents and their associated health effects is comparatively scarce, while for others more information is available from health effects studies.

Regulatory agencies consistently use significant safety factors in determining the toxicity of a constituent to a human receptor, to ensure that potential health impacts to the exposed receptors will not be underestimated. Consequently, the built-in conservatism in determining the toxicity of a constituent is carried through to the predicted risk values. In this report, the toxicological constants of target compounds were obtained from data published by Cal/EPA or EPA (Cal/EPA 1996a, EPA 1998 & 1999) or by the application of guidelines recommended by the agencies involved and are not self-generated.

When determining the appropriate values for toxicity factors, it is usually necessary to extrapolate experimental toxicity data to humans under specified conditions. These extrapolations involve many assumptions and have a certain amount of inherent uncertainty. In the absence of (or in addition to) reliable epidemiological data, experimental toxicity data are used for dose-response assessments. The inference that adverse effects found in animal bioassays

are indicative of likely human toxicity is fundamental to toxicological research and risk assessment. This premise has been extended from experimental biology and medicine into the experimental observation of carcinogenic effects.

6.4 UNCERTAINTIES IN EXPOSURE ASSESSMENT

As mentioned, the uncertainty associated with HBRG values depends on the quality of the selected input parameters used to estimate intake. This section addresses the uncertainty related to the quantification of exposure and target compound intakes.

6.4.1 Site Setting

As presented in Section 3, many attributes of the site setting influence the outcome of exposure predictions. One of the key sources of uncertainty associated with predicting exposures at a site is the disposition of the property itself. However, the site setting at Playa Vista has been solidified through specific development plans and proposed deed restrictions, which significantly minimize the uncertainty associated with projecting potential future exposures.

6.4.2 Receptor Selection

The property land use and exposure scenarios (Section 3), including the associated receptor-specific exposure parameters (Section 4, Table 4-1), each represent RME conditions. Although the on-site receptors (construction worker, office/operations personnel, and child in daycare) have the potential for real exposures to residual site constituents, the off-site receptors presented in this analysis are *hypothetical, not probable.* Although residential areas border the site, it is unlikely that residents will tap into groundwater to meet domestic water needs as was assumed in the HBRG calculations. The low yield and poor water quality of the aquifer render it nonpotable. Therefore, the off-site resident adult and child represent hypothetical receptors.

As shown in Section 5, the HBRGs developed for on-site receptors are orders of magnitude lower than those developed for the hypothetical off-site residents. Consequently, the HBRGs

developed for on-site receptors will also protect the health of off-site receptors. Hypothetical off-site receptors were considered to quantitatively demonstrate that the HBRGs developed for the site are more than adequate to protect the health and environment of neighboring residents.

6.4.3 Pathway Selection

Although the exposure pathways presented in Section 3 are complete, the groundwater exposure pathways for the hypothetical off-site receptors are not. As was mentioned, it was conservatively assumed that hypothetical off-site receptors use groundwater for domestic purposes. This is highly unlikely, however, since the poor quality and low yield of the water in the shallow zone would require that a deeper aquifer be tapped. The concentration of compounds (if any) present in the deeper aquifer would be significantly less than those modeled in Section 4, and consequently the resulting HBRG values would be significantly higher. Consequently, the HBRG values derived for hypothetical off-site receptors exposed to groundwater are highly conservative and unrealistic.

6.4.4 Exposure Parameters

Each exposure parameter value selected for use in the calculation of HBRGs (Section 4, Table 4-1) has an associated uncertainty. Many exposure parameters published in EPA guidance documents are based on surveys of physiological and lifestyle profiles across the United States. The attributes and activities studied in these surveys generally have a broad distribution.

To account for this distribution, the exposure parameters used in risk-based calculations generally represent the habits defined by the 90-to-95-percent upper confidence limits (UCLs) for the entire population. Statistically, this means that 90-to-95 percent of the time, the actual value for the parameter is less than the value used in the exposure assessment. Conversely, 5 percent of the time the actual parameter value is greater than the value used in the exposure assessment. The use of the 90-to-95 percent UCL for exposure parameters has resulted in upper-bound estimates of exposure and, therefore, conservative HBRG values.

Many, conservative exposure parameters were assumed when modeling each receptor's exposure:

- The on-site child in daycare is present at the site 8 hours per day, 5 days per week for a period of 5 years
- Office/operations personnel are assumed to be present on-site 8 hours per day, 5 days per week for a period of 25 years, and breathe air at the conservative rate of 1.25 cubic meters per hour
- Construction workers are assumed to be present at the site 12 hours per day, 5 days per week, for period of 1 year, and ingest soil at a rate of 480 mg/day
- Hypothetical off-site resident adults and children are assumed to drink, shower, and bathe in water that is nonpotable.

In reality, it is unlikely that the child in daycare will be present at the site for the entire duration assumed, that office/operations personnel will work at the site for 25 years, and that construction worker would be present at the site 12 hours each day. It is also highly unlikely that the off-site receptors would use poor-quality, low-yield groundwater for domestic purposes since they receive their water from the non-impacted municipal supply.

Although the combination of these conservative exposure assumptions guarantees the health and safety of those who will inhabit adjacent properties or work at the property, they most likely produce overly conservative HBRG estimates. To put the values into perspective, consider arsenic. Arsenic exhibits both carcinogenic and toxic effects, with toxic effects contributing significantly to the initial HBRG value calculated for the construction worker (8.05 mg/kg). This concentration lies within the range of regional background concentrations (1 mg/kg to 97 mg/kg) determined for arsenic in the vicinity of the site (Shacklette & Boerngen, 1984). The initial HBRG for arsenic is less than the EPA Region 9 preliminary remediation goal (PRG) for arsenic in a residential setting (22 mg/kg).

The reason for the order-of-magnitude-difference between the calculated arsenic HBRG and the Region 9 PRG is due to assumptions used in selecting exposure parameters. As an example, construction workers are assumed to work at a physically demanding activity level for 12 hours continuously every day with an inhalation rate of 1.5 cubic meters per hour. In reality, it is more

likely that construction workers will work at this level of activity for more than 4 or 5 hours per 12-hour day. By comparison, the inhalation rate used in the Region 9 PRG calculations is 0.8 cubic meters per hour, the default commercial/industrial inhalation rate presented in Cal/EPA guidance (DTSC 1992).

Another conservative assumption is the 480-milligram per day ingestion rate assumed for construction workers. This ingestion rate is consistent with gardening and is assumed to occur only 8 hours per day, 2 days per week (EPA 1997). In the HBRG calculations it is assumed that construction workers ingest soil at this rate 12 hours per day, 5 days per week for 1 year. Conversely, the ingestion rate used in the Region 9 PRG calculations is 100 mg/day, the default agricultural soil ingestion rate presented in Cal/EPA guidance (DTSC 1992).

Together, the cumulative effects of overly conservative exposure assumptions cause an order-of-magnitude difference between the HBRG values calculated here and the Region 9 PRGs. It is important, therefore, to consider the assumptions used in calculating risk-based values when making comparisons.

6.4.5 Input Parameters

In computer modeling, if site-specific data are unavailable, necessary conservative assumptions are made either using regulatory default values or conservative professional judgment based upon the literature. All of these efforts are designed to overestimate exposure to ensure that some extreme and highly unlikely exposure conditions are covered by the predicted HBRG values. For instance, it is conservatively assumed that hypothetical off-site residents use the low-quality, low-yield local aquifer for domestic purposes even though the groundwater is nonpotable.

6.5 Algorithms for Computer Codes

There is additional built-in conservatism in the computer models used to predict the transport of constituents from the source to the receptor. Due to the complexity of the natural environment, programmers have used simplifying but conservative assumptions in developing the computer

codes. Each assumption carries with it a level of uncertainty. In addition, most model parameter values use maximized estimates of transport. For example, it is assumed that degradation of constituents in soil does not occur. This provides conservative modeled constituent concentrations. Consequently, the modeled concentrations are generally higher than actual concentration.

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APPENDIX A

USER'S GUIDE FOR THE JOHNSON AND ETTINGER (1991) MODEL FOR SUBSURFACE VAPOR INTRUSION INTO BUILDINGS

USER'S GUIDE FOR THE JOHNSON AND ETTINGER (1991) MODEL FOR SUBSURFACE VAPOR INTRUSION INTO BUILDINGS

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SECTION 1

INTRODUCTION

Volatilization of contaminants located in subsurface soils or in groundwater, and the subsequent mass transport of these vapors into indoor spaces constitutes a potential inhalation exposure pathway which may need to be evaluated when preparing risk assessments. Likewise, this potential indoor inhalation exposure pathway may need evaluation when estimating a risk-based soil or groundwater concentration below which associated adverse health effects are unlikely.

Johnson and Ettinger (1991) introduced a screening-level model which incorporates both convective and diffusive mechanisms for estimating the transport of contaminant vapors emanating from either subsurface soils or groundwater into indoor spaces located directly above or in close proximity to the source of contamination. In their article, Johnson and Ettinger reported that the results of the model were in qualitative agreement with published experimental case histories and in good qualitative and quantitative agreement with detailed three-dimensional numerical modeling of radon transport into houses (Loureiro, et al., 1990).

The Johnson and Ettinger model is a one-dimensional analytical solution to convective and diffusive vapor transport into indoor spaces and provides an estimated attenuation coefficient that relates the vapor concentration in the indoor space to the vapor concentration at the source of contamination. The model is constructed as both a steady-state solution to vapor transport (infinite or nondiminishing source) and as a quasi-steady-state solution (finite or diminishing source). Inputs to the model include chemical properties of the contaminant, saturated and unsaturated zone soil properties, and structural properties of the building.

This manual provides documentation and instructions for using the Johnson and Ettinger model as provided in the accompanying spreadsheets. The infinite source model and the finite source model are provided in both MICROSOFT EXCEL and LOTUS 1-2-3 formats for soil contamination and the infinite source model for contamination occurring below the water table. Model results (both screening and tier-2) are provided as either a risk-based soil or groundwater concentration, or as an estimate of the actual incremental risks associated with a user-defined initial concentration. That is to say that the model will reverse-calculate an "acceptable" soil or groundwater concentration given a user-defined risk level (i.e., target risk level or target hazard quotient), or the model may be used to forward-calculate an incremental cancer risk or hazard quotient based on an initial soil or groundwater concentration.

The infinite source models for soil contamination and groundwater contamination should be used as first-tier screening tools. In these models, all but the most sensitive model parameters have been set equal to central tendency or upper bound values. Values for the most sensitive parameters may be user-defined.

Second-tier estimates may be obtained using site-specific data and the finite source model for soil contamination. Because the source of groundwater contamination may be located upgradient of the enclosed structure for which the indoor inhalation pathway is to be assessed, the second-tier model for contaminated groundwater is based on an infinite source of contamination, however, site-specific values for all other model parameters may be user-defined.

Because of the paucity of empirical data available for either bench-scale or field-scale verification of the accuracy of these models, as well as for other vapor intrusion models, the user is advised to consider the variation of input parameters and to explore and quantity the impacts of assumptions on the uncertainty of model results. At a minimum, a range of results should be generated based on variation of the most sensitive model parameters (Section 6).

SECTION 2

MODEL THEORY

Chemical fate and transport within soils and between the soil column and enclosed spaces is determined by a number of physical and chemical processes. This section presents the theoretical framework on which the Johnson and Ettinger model is based, taking into account the most significant of these processes. In addition, this section also presents the theoretical basis for estimating values for some of the most sensitive model parameters when empirical field data are lacking. The fundamental theoretical development of this model was performed by Johnson and Ettinger (1991).

2.1 MODEL SETTING

Consider a contaminant vapor source (C_{source}) located some distance (L_T) below the floor of an enclosed building constructed with a basement or constructed slab-on-grade. The source of contamination is either a soil-incorporated volatile contaminant or a volatile contaminant in solution with groundwater below the water table.

Figure 1 is a simplified conceptual diagram of the scenario where the source of contamination is incorporated in soil and buried some distance below the enclosed space floor. At the top boundary of contamination, molecular diffusion moves the volatilized contaminant towards the soil surface until it reaches the zone of influence of the building. Here convective air movement within the soil column transports the vapors through cracks between the foundation and the basement slab floor. This convective sweep effect is induced by a negative pressure within the structure caused by a combination of wind effects and stack effects due to building heating and mechanical ventilation.

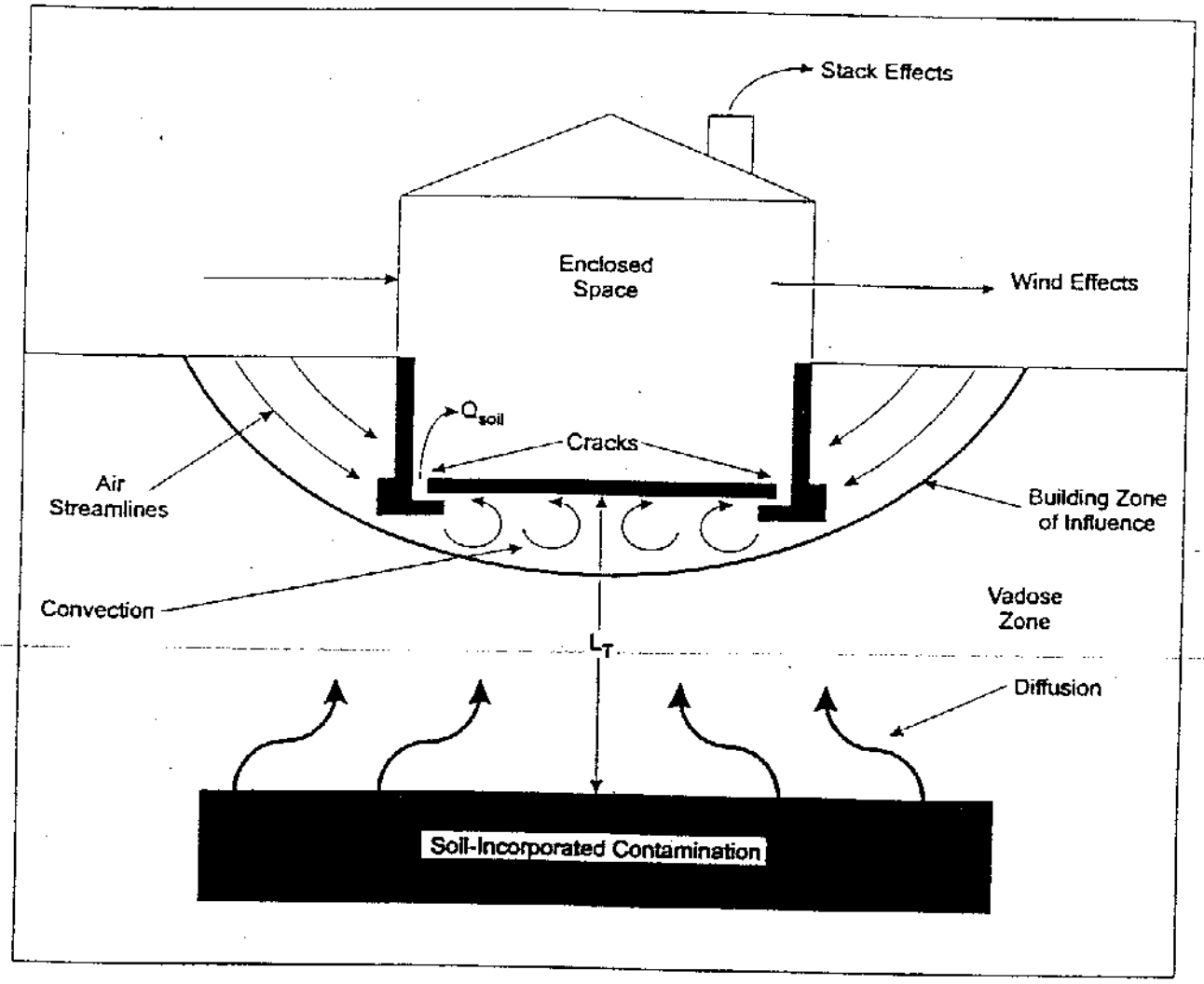


Figure 1. Conceptual Diagram of Soil Contamination

Figure 2 illustrates the scenario where the source of contamination is below the top of the water table. Here the contaminant must diffuse through a capillary zone immediately above the water table and through the subsequent unsaturated or vadose zone before convection transports the vapors into the structure.

The rate of soil gas entry (Q_{soil}) is a function solely of convection, however, the vapor concentration entering the structure may be limited by either convection or diffusion depending upon the magnitude of the source-building separation (L_T).

2.2 VAPOR CONCENTRATION AT THE SOURCE OF CONTAMINATION

With a general concept of the problem under consideration, the solution begins with an estimate of the vapor concentration at the source of contamination.

In the case of soil contamination, the initial concentration (C_R) does not contain a residual-phase (e.g., nonaqueous-phase liquid or solid); and in the case of contaminated groundwater, the initial contaminant concentration (C_w) is less than the aqueous solubility limit (i.e., in solution with water).

Given these initial conditions, C_{source} for soil contamination may be estimated from Johnson et al. (1990) as:

$$C_{source} = \frac{H'_{TS} C_R \rho_b}{\theta_w + K_d \rho_b + H'_{TS} \theta_a} \quad (1)$$

where C_{source} = Vapor concentration at the source of contamination, g/cm^3-v

H'_{TS} = Henry's law constant at the system (soil) temperature, dimensionless

C_R = Initial soil concentration, g/g

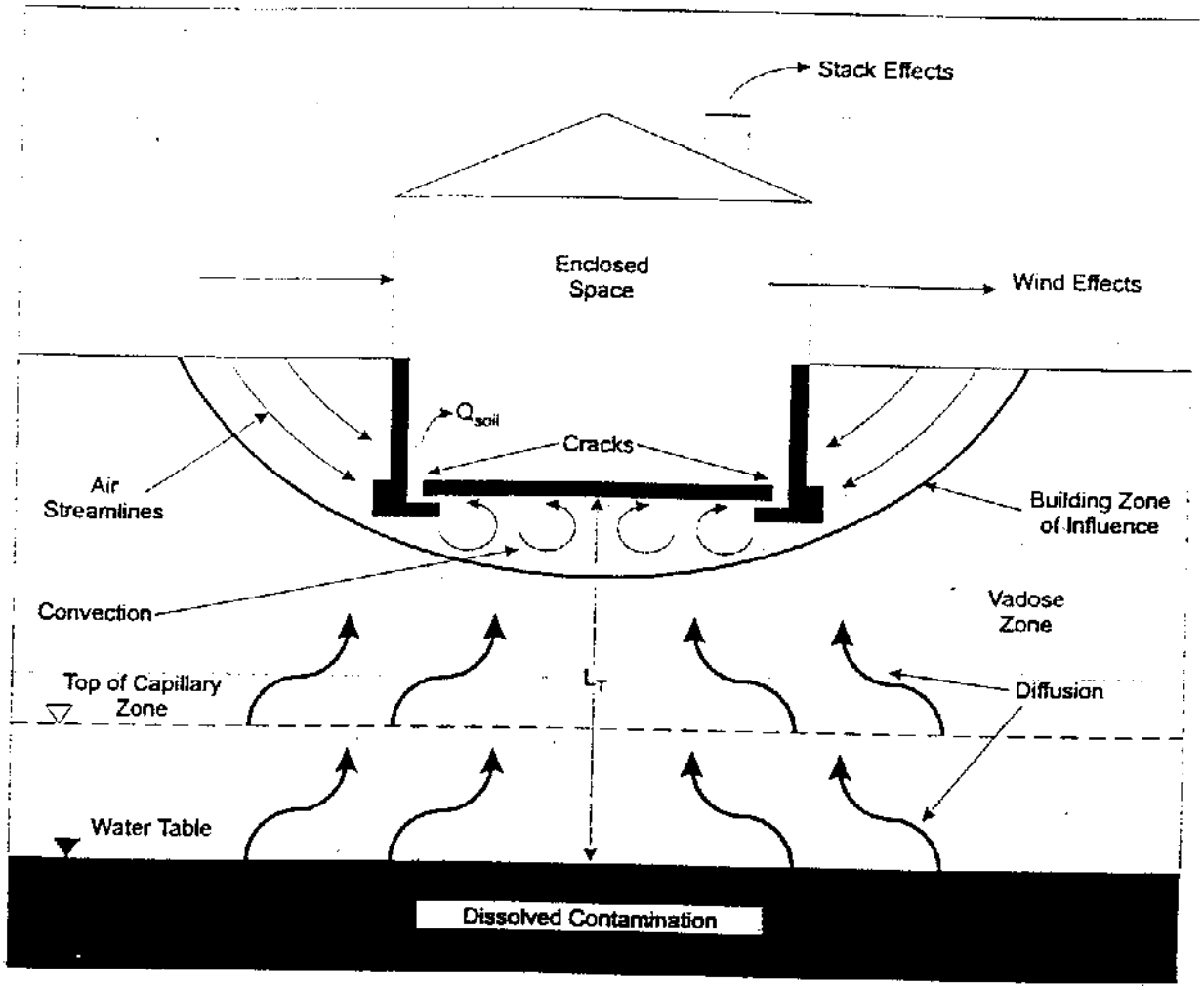


Figure 2. Conceptual Diagram of Groundwater Contamination

ρ_b = Soil dry bulk density, g/cm^3

θ_w = Soil water-filled porosity, cm^3/cm^3

K_d = Soil-water partition coefficient, cm^3/g (= K_{oc} x f_{oc})

θ_a = Soil air-filled porosity, cm^3/cm^3

K_{oc} = Soil organic carbon partition coefficient, cm^3/g

f_{oc} = Soil organic carbon weight fraction.

C_{source} for groundwater contamination is estimated assuming that the vapor and aqueous-phases are in local equilibrium according to Henry's law such that:

$$C_{source} = H'_{TS} C_w \qquad (2)$$

where C_{source} = Vapor concentration at the source of contamination, g/cm^3-v

H'_{TS} = Henry's law constant at the system (groundwater) temperature, dimensionless

C_w = Groundwater concentration, g/cm^3-w.

The dimensionless form of the Henry's law constant at the system temperature (i.e., at the average soil/groundwater temperature) may be estimated using the Clapeyron equation by:

$$H'_{TS} = \frac{\exp\left[-\frac{\Delta H_{v,TS}}{R_c}\left(\frac{1}{T_S} - \frac{1}{T_R}\right)\right] H_R}{RT_S} \qquad (3)$$

where H'_{TS} = Henry's law constant at the system temperature, dimensionless

$\Delta H_{v,TS}$ = Enthalpy of vaporization at the system temperature, cal/mol

T_S = System temperature, °K

T_R = Henry's law constant reference temperature, °K

H_R = Henry's law constant at the reference temperature, atm-m³/mol

R_C = Gas constant (= 1.9872 cal/mol - °K)

R = Gas constant (=·8.206 E-05 atm-m³/mol-°K).

The enthalpy of vaporization at the system temperature can be calculated from Lyman et al. (1990) as:

$$\Delta H_{v,TS} = \Delta H_{v,b}\left[\frac{(1-T_S/T_C)}{(1-T_B/T_C)}\right]^n \qquad (4)$$

where $\Delta H_{v,TS}$ = Enthalpy of vaporization at the system temperature, cal/mol

$\Delta H_{v,b}$ = Enthalpy of vaporization at the normal boiling point, cal/mol

T_S = System temperature, °K

T_C = Critical temperature, °K

T_B = Normal boiling point, °K

n = Constant, unitless.

Table 1 gives the value of n as a function of the ratio T_B/T_C.

TABLE 1. VALUES OF EXPONENT n AS A FUNCTION OF T_B/T_c

T_B/T_c	n
< 0.57	0.30
0.57 - 0.71	0.74 (T_B/T_c) - 0.116
> 0.71	0.41

Chemical properties are included in the accompanying spreadsheets for the 93 volatile chemicals listed in the U.S. Environmental Protection Agency (EPA) Soil Screening Guidance (EPA 1996a and b) and for four PCB aroclors. See Appendix C for the complete list of references by chemical.

2.3 DIFFUSION THROUGH THE CAPILLARY ZONE

Directly above the water table, a saturated capillary zone exists whereby groundwater is held within the soil pores at less than atmospheric pressure (Freeze and Cherry, 1979). Between drainage and wetting conditions, the saturated water content varies but is always less than the fully saturated water content which is equal to the soil total porosity. This is the result of air entrapment in the pores during the wetting process (Gillham, 1984). Upon rewetting, the air content of the capillary zone will be higher than after main drainage. Therefore, the air content will vary as a function of groundwater recharge and discharge. At the saturated water content, Freijer (1994) found that the relative vapor-phase diffusion coefficient was almost zero implying that all remaining air-filled soil pores are disconnected and thus blocked for gas diffusion. As the air-filled porosity increased, however, the relative diffusion coefficient indicated the presence of connected air-filled pores which corresponded to the air-entry pressure head. The air-entry pressure head corresponds with the top of the saturated capillary zone. Therefore, to account for the variation in the air content of the capillary zone, and to allow for the calculation of the effective diffusion coefficient by lumping the gas-phase and aqueous-phase together, the water-filled soil porosity in the capillary zone ($\theta_{w,cz}$) is calculated at the

air-entry pressure head (h) according to the procedures of Waitz et al. (1996) and the van Genuchten equation (van Genuchten, 1980) for the water retention curve:

$$\theta_{w,cz} = \theta_r + \frac{\theta_s - \theta_r}{\left[1 + (\alpha h)^N\right]^M} \quad (5)$$

where $\theta_{w,cz}$ = Water-filled porosity in the capillary zone, cm^3/cm^3

θ_r = Residual soil water content, cm^3/cm^3

θ_s = Saturated soil water content, cm^3/cm^3

α = Point of inflection in the water retention curve where $d\theta_w/dh$ is maximal, cm^{-1}

h = Air-entry pressure head, cm ($\approx 1/\alpha$ and assumed to be positive)

N = van Genuchten curve shape parameter, dimensionless

M = 1 - (1/N).

With a calculated value of $\theta_{w,cz}$ within the capillary zone at the air-entry pressure head, the air-filled porosity within the capillary zone ($\theta_{a,cz}$) corresponding to the minimum value at which gas diffusion is relevant is calculated as the total porosity (n) minus $\theta_{w,cz}$.

Carsel and Parrish (1988) computed mean values of the van Genuchten soil water retention curve parameters for the 12 Soil Conservation Service (SCS) soil textural classifications. The data base used to develop the mean values presented in Table 2 was developed from sampling data representing 42 States and ranged from sample population sizes of 46 to 1,183. With these data, a general estimate can be made of the values of $\theta_{w,cz}$ and $\theta_{a,cz}$ for each soil classification.

The total concentration effective diffusion coefficient across the capillary zone (D_{cz}^{eff}) may then be calculated using the Millington and Quirk (1961) model as:

TABLE 2. MEAN VALUES OF THE VAN GENUCHTEN SOIL WATER RETENTION PARAMETERS FOR THE 12 SCS SOIL TYPES

Soil texture (USDA)	Saturated water content, θ_s	Residual water Content, θ_r	Van Genuchten parameters			Number of samples[a]
			α (1/cm)	N	M	
Clayey soil[b]	0.38	0.068	0.008	1.09	0.083	400
Clay loam	0.41	0.095	0.019	1.31	0.237	364
Loam	0.43	0.078	0.036	1.56	0.359	735
Loamy sand	0.41	0.057	0.124	2.28	0.561	315
Silt	0.46	0.034	0.016	1.37	0.270	82
Silt loam	0.45	0.067	0.020	1.41	0.291	1093
Silty clay	0.26	0.070	0.005	1.09	0.083	374
Silty clay loam	0.43	0.089	0.010	1.23	0.187	641
Sand	0.43	0.045	0.145	2.68	0.627	246
Sandy clay	0.38	0.100	0.027	1.23	0.187	46
Sandy clay loam	0.39	0.100	0.059	1.48	0.324	214
Sandy loam	0.41	0.065	0.075	1.89	0.471	1183

[a]Number of samples as indicated with minor exceptions; see Carsel and Parrish (1988).
[b]Clay soil refers to agricultural soil with < 60 percent clay.

$$D_{cz}^{eff} = D_a\left(\theta_{a,cz}^{3.33}/n_{cz}^2\right) + \left(D_w/H'_{TS}\right)\left(\theta_{w,cz}^{3.33}/n_{cz}^2\right) \qquad (6)$$

where D_{cz}^{eff} = Effective diffusion coefficient across the capillary zone, cm^2/s

D_a = Diffusivity in air, cm^2/s

$\theta_{a,cz}$ = Soil air-filled porosity in the capillary zone, cm^3/cm^3

n_{cz} = Soil total porosity in the capillary zone, cm^3/cm^3

D_w = Diffusivity in water, cm^2/s

H'_{TS} = Henry's law constant at the system temperature, dimensionless

$\theta_{w,cz}$ = Soil water-filled porosity in the capillary zone, cm^3/cm^3.

According to Fick's law of diffusion, the rate of mass transfer across the capillary zone can be approximated by the expression:

$$E = A\left(C_{source} - C_{g0}\right)D_{cz}^{eff} / L_{cz} \qquad (7)$$

where

E = Rate of mass transfer, g/s

A = Cross-sectional area through which vapors pass, cm^2

C_{source} = Vapor concentration within the capillary zone, g/cm^3-v

C_{g0} = A known vapor concentration at the top of the capillary zone, g/cm^3-v (C_{g0} is assumed to be zero as diffusion proceeds upward)

D_{cz}^{eff} = Effective diffusion coefficient across the capillary zone, cm^2/s

L_{cz} = Thickness of capillary zone, cm.

The value of C_{source} is calculated using Equation 2; the value of A is assumed to be one cm^2; and the value of D_{cz}^{eff} is calculated by Equation 6. What remains is a way to estimate a value for L_{cz}.

Lohman (1972) and Fetter (1994) estimated the rise of the capillary zone above the water table using the phenomenon of capillarity such that water molecules are subject to an upward attractive force due to surface tension at the air-water interface and the molecular attraction of the liquid and solid phases. The rise of the capillary zone can thus be estimated using the equation for the height of capillary rise in a bundle of tubes of various diameters equivalent to the diameters between varying soil grain sizes. Fetter (1994) estimated the mean rise of the capillary zone as:

$$L_{\alpha} = \frac{2\ \alpha\ COS\ \lambda}{\rho_w\ g\ R} \qquad (8)$$

where L_{α} = Mean rise of the capillary zone, cm

σ = Surface tension of water, g/s (= 73)

λ = Angle of the water meniscus with the capillary tube, degrees (assumed to be zero)

ρ_w = Density of water, g/cm^3 (= 0.999)

g = Acceleration due to gravity, cm/s^2 (= 980)

R = Mean interparticle pore radius, cm

and,

$$R = 0.2D \qquad (9)$$

where R = Mean interparticle pore radius, cm

D = Mean particle diameter, cm.

Assuming that the default values of the parameters given in Equation 8 are for groundwater between 10° and 20°C, Equation 8 reduces to:

$$L_{\alpha} = \frac{0.15}{R} \qquad (10)$$

Nielson and Rogers (1990) estimated the arithmetic mean particle diameter for each of the 12 SCS soil textural classifications at the mathematical centroid calculated from its classification area (Figure 3). Table 3 shows the centroid compositions and mean particle sizes of the 12 SCS soil textural classes.

Given the mean particle diameter data in Table 3, the mean thickness of the capillary zone may then be estimated using Equations 9 and 10.

2.4 DIFFUSION THROUGH THE UNSATURATED ZONE

The effective diffusion coefficient within the unsaturated zone may also be estimated using the same form as Equation 6:

$$D_i^{eff} = D_a\left(\theta_{a,i}^{3.33} / n_i^2\right) + \left(D_w / H'_{TS}\right)\left(\theta_{w,i}^{3.33} / n_i^2\right) \qquad (11)$$

where D_i^{eff} = Effective diffusion coefficient across soil layer i, cm^2/s

D_a = Diffusivity in air, cm^2/s

$\theta_{a,i}$ = Soil air-filled porosity of layer i, cm^3/cm^3

n_i = Soil total porosity of layer i, cm^3/cm^3

D_w = Diffusivity in water, cm^2/s

$\theta_{w,i}$ = Soil water-filled porosity of layer i, cm^3/cm^3

H'_{TS} = Henry's law constant at the system temperature, dimensionless.

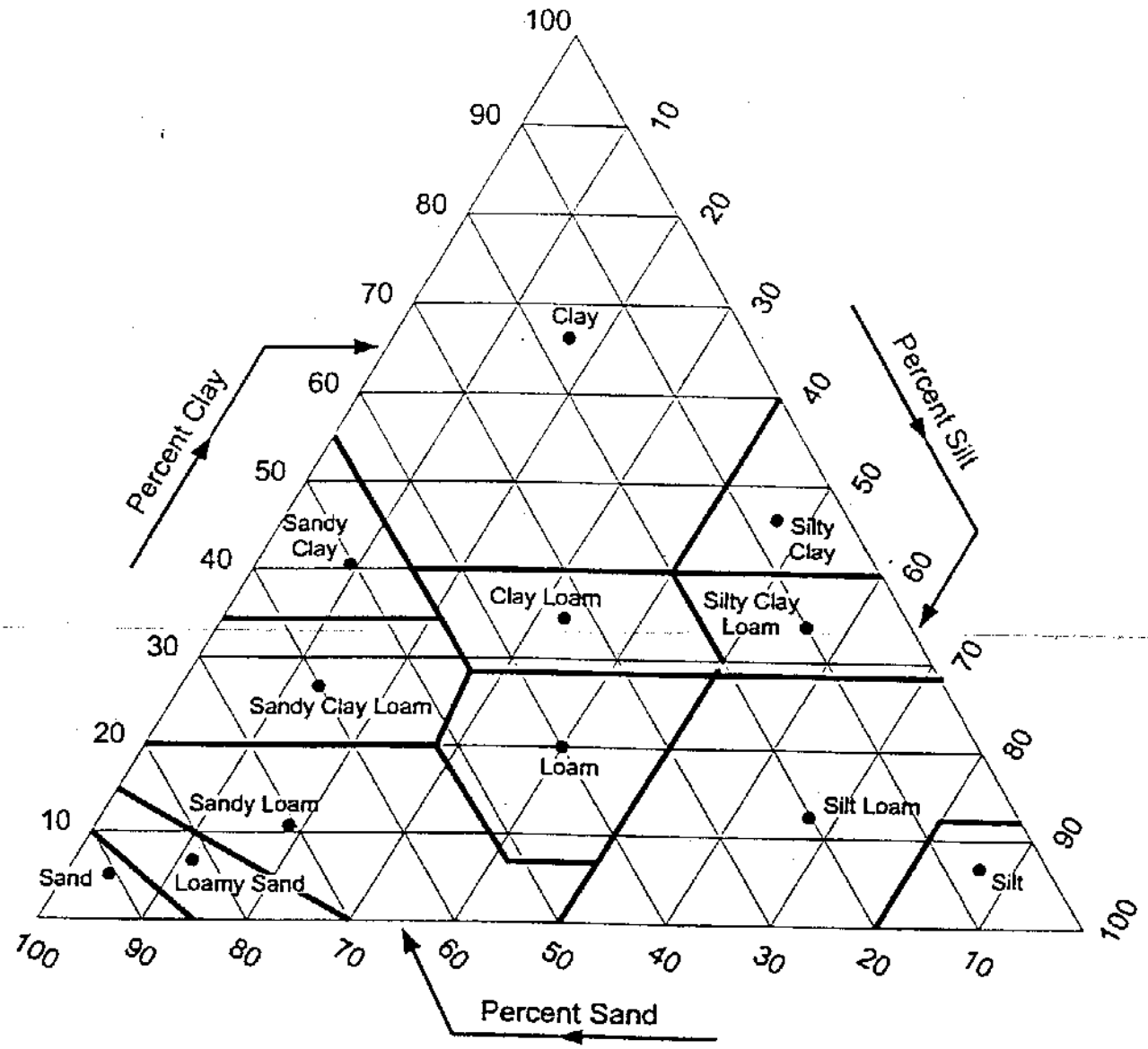


Figure 3. U.S. Soil Conservation Service Classification Chart Showing Centroid Compostions (Solid Circles)

TABLE 3. CENTROID COMPOSITIONS AND MEAN PARTICLE DIAMETERS OF THE 12 SCS SOIL CLASSIFICATIONS

Textural class	% clay	% silt	% sand	Arithmetic mean particle diameter, cm
Sand	3.33	5.00	91.67	0.044
Loamy sand	6.25	11.25	82.50	0.040
Sandy loam	10.81	27.22	61.97	0.030
Sandy clay loam	26.73	12.56	60.71	0.029
Sandy clay	41.67	6.67	51.66	0.025
Loam	18.83	41.01	40.16	0.020
Clay loam	33.50	34.00	32.50	0.016
Silt loam	12.57	65.69	21.74	0.011
Clay	64.83	16.55	18.62	0.0092
Silty clay loam	33.50	56.50	10.00	0.0056
Silt	6.00	87.00	7.00	0.0046
Silty clay	46.67	46.67	6.66	0.0039

The overall effective diffusion coefficient for systems composed of n distinct soil layers between the source of contamination and the enclosed space floor is:

$$D_T^{eff} = \frac{L_T}{\sum_{i=0}^{n} L_i / D_i^{eff}} \qquad (12)$$

where D_T^{eff} = Total overall effective diffusion coefficient, cm^2/s

L_i = Thickness of soil layer i, cm

D_i^{eff} = Effective diffusion coefficient across soil layer i, cm^2/s

L_T = Distance between the source of contamination and the bottom of the enclosed space floor, cm.

Note that in the case of cracks in the floor of the enclosed space, the value of L_T does not include the thickness of the floor, nor does the denominator of Equation 12 include the thickness of the floor and the associated effective diffusion coefficient across the crack(s). An unlimited number of soil layers, including the capillary zone, may be included in Equation 12, but all layers must be located between the source of contamination and the enclosed space floor.

2.5 THE INFINITE SOURCE SOLUTION TO CONVECTIVE AND DIFFUSIVE TRANSPORT

Under the assumption that mass transfer is steady-state (infinite source), Johnson and Ettinger (1991) give the solution for the attenuation coefficient (α) as:

$$\alpha = \frac{\left[\left(\frac{D_T^{eff} A_B}{Q_{building} L_T}\right) x \exp\left(\frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}}\right)\right]}{\left[\exp\left(\frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}}\right) + \left(\frac{D_T^{eff} A_B}{Q_{building} L_T}\right) + \left(\frac{D_T^{eff} A_B}{Q_{soil} L_T}\right)\left[\exp\left(\frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}}\right) - 1\right]\right]} \quad (13)$$

where

α = Infinite source attenuation coefficient, unitless

D_T^{eff} = Total overall effective diffusion coefficient, cm^2/s

A_B = Area of the enclosed space below grade, cm^2

$Q_{building}$ = Building ventilation rate, cm^3/s

L_T = Source-building separation, cm

Q_{soil} = Volumetric flow rate of soil gas into the enclosed space, cm^3/s

L_{crack} = Enclosed space foundation or slab thickness, cm

A_{crack} = Area of total cracks, cm^2

D^{crack} = Effective diffusion coefficient through the cracks, cm^2/s (assumed equivalent to D_i^{eff} of soil layer i in contact with the floor).

The total overall effective diffusion coefficient is calculated by Equation 12. The value of A_B includes the area of the floor in contact with the underlying soil and the total wall area below grade. The building ventilation rate ($Q_{building}$) may be calculated as:

$$Q_{building} = (L_B \; W_B \; H_B \; ER) / 3{,}600 \; s/h \qquad (14)$$

where $Q_{building}$ = Building ventilation rate, cm^3/s

L_B = Length of building, cm

W_B = Width of building, cm

H_B = Height of building, cm

ER = Air exchange rate, (1/h).

The building dimensions in Equation 14 are those dimensions representing the total "living" space of the building; this assumes that the total air volume within the structure is well mixed and that any vapor contaminant entering the structure is instantaneously and homogeneously distributed.

The volumetric flow rate of soil gas entering the building (Q_{soil}) is calculated by the analytical solution of Nazaroff (1988) such that:

$$Q_{soil} = \frac{2 \pi \Delta P \; k_v \; X_{crack}}{\mu \ln(2 \; Z_{crack} / r_{crack})} \qquad (15)$$

where Q_{soil} = Volumetric flow rate of soil gas entering the building, cm^3/s

π = 3.14159

ΔP = Pressure differential between the soil surface and the enclosed space, g/cm-s^2

k_v = Soil vapor permeability, cm^2

X_{crack} = Floor-wall seam perimeter, cm

μ = Viscosity of air, g/cm-s

Z_{crack} = Crack depth below grade, cm

r_{crack} = Equivalent crack radius, cm.

Equation 15 is an analytical solution to vapor transport solely by pressure-driven air flow to an idealized cylinder buried some distance (Z_{crack}) below grade; the length of the cylinder is taken to be equal to the building floor-wall seam perimeter (X_{crack}). The cylinder, therefore, represents that portion of the building below grade through which vapors pass. The equivalent radius of the floor-wall seam crack (r_{crack}) is given in Johnson and Ettinger (1991) as:

$$r_{crack} = \eta \left(A_B / X_{crack} \right) \tag{16}$$

where r_{crack} = Equivalent crack radius, cm

η = A_{crack}/A_B, $(0 \leq \eta \leq 1)$

A_B = Area of the enclosed space below grade, cm^2

X_{crack} = Floor-wall seam perimeter, cm.

The variable r_{crack} is actually the product of the fixed crack-to-total area ratio (η) and the hydraulic radius of the idealized cylinder, which is equal to the total area (A_B) divided by that portion of the cylinder perimeter in contact with the soil gas (X_{crack}). Therefore, if the dimensions of the enclosed space below grade (A_B) and/or the floor-wall seam perimeter

(X_{crack}) vary, and the crack-to-total area ratio (η) remains constant, the value of r_{crack} must also vary. The total area of cracks (A_{crack}) is the product of η and A_B.

Equation 15 requires that the soil column properties within the zone of influence of the building (e.g., porosities, bulk density, etc.) be homogeneous, that the soil be isotropic with respect to vapor permeability, and that the pressure within the building be less than atmospheric.

Equation 13 contains the exponent of following dimensionless group:

$$\left(\frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}} \right) \quad (17)$$

This dimensionless group represents the equivalent Peclet number for transport through the building foundation. As the value of this group approaches infinity, the value of α approaches:

$$\frac{\left(\frac{D_T^{eff} A_B}{Q_{building} L_T} \right)}{\left(\frac{D_T^{eff} A_B}{Q_{soil} L_T} \right) + 1} \quad (18)$$

In the accompanying spreadsheets, if the exponent of Equation 17 is too great to be calculated, the value of α is set equal to Equation 18.

With a calculated value of α, the steady-state vapor-phase concentration of the contaminant in the building ($C_{building}$) is calculated as:

$$C_{building} = \alpha C_{source} \quad (19)$$

2.6 THE FINITE SOURCE SOLUTION TO CONVECTIVE AND DIFFUSIVE TRANSPORT

If the thickness of soil contamination is known, the finite source solution of Johnson and Ettinger (1991) can be employed such that the time-averaged attenuation coefficient (<α>) may be calculated as:

$$\langle \alpha \rangle = \frac{\rho_b C_R \Delta H_c A_B}{Q_{building} C_{source} \tau} \left(\frac{L_T^0}{\Delta H_c} \right) \left[\left(\beta^2 + 2 \Psi \tau \right)^{1/2} - \beta \right] \qquad (20)$$

where <α> = Time-averaged finite source attenuation coefficient, unitless

ρ_b = Soil dry bulk density at the source of contamination, g/cm^3

C_R = Initial soil concentration, g/g

ΔH_c = Initial thickness of contamination, cm

A_B = Area of enclosed space below grade, cm^2

$Q_{building}$ = Building ventilation rate, cm^3/s

C_{source} = Vapor concentration at the source of contamination, g/cm^3-v

τ = Exposure interval, s

L_T^0 = Source-building separation at time = 0, cm

and,

$$\beta = \left(\frac{D_T^{eff} A_B}{L_T^0 Q_{soil}} \right) \left[1 - \exp\left(- \frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}} \right) \right] + 1 \qquad (21)$$

and,

$$\Psi = \frac{D_T^{eff}\, C_{source}}{\left(L_T^o\right)^2\, \rho_b\, C_R} \quad . \tag{22}$$

Implicit in Equation 20 is the assumption that source depletion occurs from the top boundary of the contaminated zone as contaminant volatilizes and moves upward toward the soil surface. This creates a hypothetical "dry zone" (δ) which grows with time; conversely, the "wet zone" of contamination retreats proportionally. When the thickness of the depletion zone (δ) is equal to the initial thickness of contamination (ΔH_c), the source is totally depleted. The unitless expression $(L_T^o/\Delta H_c)[(\beta^2 + 2\,\Psi\tau)^{1/2} - \beta]$ in Equation 20 represents the cumulative fraction of the depletion zone at the end of the exposure interval τ. Multiplying this expression by the remainder of Equation 20 results in the time-averaged finite source attenuation coefficient ($\langle\alpha\rangle$).

With a calculated value for $\langle\alpha\rangle$, the time-averaged vapor concentration in the building ($C_{building}$) is:

$$C_{building} = \langle\alpha\rangle\, C_{source} \quad . \tag{23}$$

For extended exposure intervals (e.g., 30 years), the time for source depletion may be less than the exposure interval. The time for source depletion (τ_D) may be calculated by:

$$\tau_D = \frac{\left[\Delta H_c / L_T^o + \beta\right]^2 - \beta^2}{2\,\Psi} \quad . \tag{24}$$

If the exposure interval (τ) is greater than the time for source depletion (τ_D), the time-averaged building vapor concentration may be calculated by a mass balance such that:

$$C_{building} = \frac{\rho_b C_R \Delta H_c A_B}{Q_{building} \tau} \quad (25)$$

where $C_{building}$ = Time-averaged vapor concentration in the building, g/cm^3-v

ρ_b = Soil dry bulk density at the source of contamination, g/cm^3

C_R = Initial soil concentration, g/g

ΔH_c = Initial thickness of contamination, cm

A_B = Area of enclosed space below grade, cm^2

$Q_{building}$ = Building ventilation rate, cm^3/s

τ = Exposure interval, s.

2.7 SOIL VAPOR PERMEABILITY

Soil vapor permeability (k_v) is one of the most sensitive model parameters associated with convective transport of vapors within the zone of influence of the building. Soil vapor permeability is typically measured from field pneumatic tests. If field data are lacking, however, an estimate of the value of k_v can be made with limited data.

Soil intrinsic permeability is a property of the medium alone that varies with the size and shape of connected soil pore openings. Intrinsic permeability (k_i) can be estimated from the soil hydraulic conductivity:

$$k_i = \frac{K_s \mu_w}{\rho_w g} \quad (26)$$

where k_i = Soil intrinsic permeability, cm^2

K_s = Soil saturated hydraulic conductivity, cm/s

μ_w = Dynamic viscosity of water, g/cm-s (= 0.01307 at 10°C)

ρ_w = Density of water, g/cm^3 (= 0.999)

g = Acceleration due to gravity, cm/s^2 (= 980.665).

Carsel and Parrish (1988) estimated the mean saturated hydraulic conductivity (K_s) of the 12 SCS soil textural classifications (Table 4). With these values, a general estimate of the value of k_i can be made by soil type.

Effective permeability is the permeability of the porous medium to a fluid when more than one fluid is present; it is a function of the degree of saturation. The relative air permeability of soil (k_{rg}) is the effective air permeability divided by the intrinsic permeability and therefore takes into account the effects of the degree of water saturation on air permeability.

Parker et al. (1987) extended the relative air permeability model of van Genuchten (1980) to allow estimation of the relative permeabilities of air and water in a two- or three-phase system:

$$k_{rg} = (1 - S_e)^{1/2} \left(1 - S_e^{1/M}\right)^{2M} \tag{27}$$

where k_{rg} = Relative air permeability, unitless ($0 \le k_{rg} \le 1$)

S_e = Effective total fluid saturation, unitless

M = van Genuchten shape parameter, unitless.

TABLE 4. MEAN VALUES OF SATURATED HYDRAULIC CONDUCTIVITY FOR THE 12 SCS SOIL TEXTURAL CLASSIFICATIONS

Soil texture , USDA	Saturated hydraulic conductivity, cm/h
Sand	29.70
Loamy sand	14.59
Sandy loam	4.42
Sandy clay loam	1.31
Sandy clay	0.12
Loam	1.04
Clay loam	0.26
Silt loam	0.45
Clay	0.20
Silty clay loam	0.07
Silt	0.25
Silty clay	0.02

Given a two-phase system (i.e., air and water), the effective total fluid saturation (S_{te}) is calculated as:

$$S_{te} = \frac{(\theta_w - \theta_r)}{(n - \theta_r)} \qquad (28)$$

where S_{te} = Effective total fluid saturation, unitless

θ_w = Soil water-filled porosity, cm^3/cm^3

θ_r = Residual soil water content, cm^3/cm^3

n = Soil total porosity, cm^3/cm^3.

Mean values for the parameters θ_i and M by SCS soil type may be obtained from Table 2.

The effective air permeability (k_v) is then the product of the intrinsic permeability (k_i) and the relative air permeability (k_{rg}) at the fixed soil water-filled porosity θ_w.

2.8 CALCULATION OF A RISK-BASED SOIL OR GROUNDWATER CONCENTRATION

Both the infinite source model estimate of the steady-state building concentration and the finite source model estimate of the time-averaged building concentration represent the exposure point concentration used to assess potential risks.

Calculation of a risk-based media concentration for a carcinogenic contaminant takes the form:

$$C_c = \frac{TR \, x \, AT_c \, x 365 \, days/yr}{URF \, x \, EF \, x \, ED \, x \, C_{building}} \qquad (29)$$

where C_c = Risk-based media concentration for carcinogens, µg/kg-soil, or µg/L-water

TR = Target risk level, unitless

AT_c = Averaging time for carcinogens, yr

URF = Unit risk factor, $(\mu g/m^3)^{-1}$

EF = Exposure frequency, days/yr

ED = Exposure duration, yr

$C_{building}$ = Vapor concentration in the building, $\mu g/m^3$ per µg/kg-soil, or $\mu g/m^3$ per µg/L-water.

In the case of a noncarcinogenic contaminant, the risk-based media concentration is calculated by:

$$C_{NC} = \frac{THQ \, x \, AT_{NC} \, x 365 \, days / yr}{EF \, x \, ED \, x \, \frac{1}{RfC} \, x \, C_{building}}$$

where C_{NC} = Risk-based media concentration for noncarcinogens, µg/kg-soil, or µg/L-water

THQ = Target hazard quotient, unitless

AT_{NC} = Averaging time for noncarcinogens, yr

EF = Exposure frequency, days/yr

ED = Exposure duration, yr

RfC = Reference concentration, mg/m^3

$C_{building}$ = Vapor concentration in the building, mg/m^3 per µg/kg-soil, or mg/m^3 per µg/L-water.

The accompanying spreadsheets calculate risk-based media concentrations based on a unity initial concentration. That is, soil risk-based concentrations are calculated with an initial hypothetical soil concentration of 1 µg/kg-soil, while for groundwater the initial hypothetical concentration is 1 µg/L-water.

2.9 CALCULATION OF INCREMENTAL RISKS

Forward-calculation of incremental risks begins with an actual initial media concentration (i.e., µg/kg-soil or µg/L-water). For carcinogenic contaminants, the risk level is calculated as:

$$Risk = \frac{URF \, x \, EF \, x \, ED \, x \, C_{building}}{AT_C \, x 365 \, days / yr}$$

For noncarcinogenic contaminants, the hazard quotient (HQ) is calculated as:

$$HQ = \frac{EF \; x \; ED \; x \frac{1}{RfC} \; x \; C_{building}}{AT_{NC} \; x \; 365 \; days / yr} \quad . \qquad (32)$$

2.10 MAJOR MODEL ASSUMPTIONS/LIMITATIONS

The following represent the major assumptions/limitations of the Johnson and Ettinger model. Additional assumptions specific to the application of the model as applied in the accompanying spreadsheets are contained in Section 5.

1. Contaminant vapors enter the structure primarily through cracks and openings in the walls and foundation.

2. Convective transport occurs primarily within the building zone of influence and vapor velocities decrease rapidly with increasing distance from the structure.

3. Diffusion dominates vapor transport between the source of contamination and the building zone of influence.

4. All vapors originating from below the building will enter the building unless the floors and walls are perfect vapor barriers.

5. All soil properties in any horizontal plane are homogeneous.

6. The contaminant is homogeneously distributed within the zone of contamination.

7. The areal extent of contamination is greater than that of the building floor in contact with the soil.

8. Vapor transport occurs in the absence of convective water movement within the soil column (i.e., evaporation or infiltration), and in the absence of mechanical dispersion.

9. The model does not account for transformation processes (e.g., biodegradation, hydrolysis, etc.).

10. The soil layer in contact with the structure floor and walls is isotropic with respect to permeability.

11. Both the building ventilation rate and the difference in dynamic pressure between the interior of the structure and the soil surface are constant values.

SECTION 3

MODEL APPLICATION

This section provides step-by-step instructions on how to implement the Johnson and Ettinger model using the accompanying spreadsheets. The user provides data and selects certain input options, and views model results via a series of worksheets. Error messages are provided within both the data entry worksheet and the results worksheet to warn the user that entered data are missing, out of range, or outside of permitted limits.

3.1 RUNNING THE MODELS

Four different models are provided as both MICROSOFT EXCEL and LOTUS 1-2-3 spreadsheets.

1. Screening-Level Models for Soil Contamination:

   - SLSCREEN.XLS (EXCEL)
   - SLSCREEN.WK4 (1-2-3)

2. Screening-Level Models for Groundwater Contamination:

   - GWSCREEN.XLS (EXCEL)
   - GWSCREEN.WK4 (1-2-3)

3. Tier-2 Models for Soil Contamination:

   - SLTIER2.XLS (EXCEL)
   - SLTIER2.WK4 (1-2-3)

4. Tier-2 Models for Groundwater Contamination:

   - GWTIER2.XLS (EXCEL)
   - GWTIER2.WK4 (1-2-3).

Both the screening-level models and the tier-2 models allow the user to calculate a risk-based media concentration or incremental risks from an actual starting concentration in soil or in groundwater. Data entry within the screening-level models is limited to the most sensitive model parameters and incorporates only one soil stratum above the contamination. The tier-2 models provide the user with the ability to enter data for all of the model parameters and also incorporates up to three individual soil strata above the contamination for which soil properties may be varied.

To run any of the models, simply open the appropriate model file within either MICROSOFT EXCEL or LOTUS 1-2-3. Each model is constructed of the following worksheets:

1. DATENTER (Data Entry Sheet)
2. CHEMPROPS (Chemical Properties Sheet)
3. INTERCALCS (Intermediate Calculations Sheet)
4. RESULTS (Results Sheet)
5. VLOOKUP (Lookup Tables)

The following is an explanation of what is contained in each worksheet, how to enter data, data entry conventions, how to interpret model results, and how to add/revise the chemical properties data found in the VLOOKUP Tables. As an example, Appendix A contains all the worksheets for the tier-2 soil contamination model SLTIER2.

Note: Because of the limitations of LOTUS 1-2-3, variable names (e.g., ΔH_c) appear in alphanumeric characters. Subscripts are preceded by the symbol "_" and superscripts are preceded by the symbol "^." Upper case greek characters are spelled with an initial capital letter and lower case greek characters are spelled in lower case. For example, the variable ΔH_c would appear as "Delta H_c" while the variable D_T^{eff} would appear as "D_T^eff."

3.2 THE DATA ENTRY SHEET (DATENTER)

Figure 4 is an example of a data entry sheet. In this case, it shows the data entry sheet for the screening-level model for contaminated groundwater (GWSCREEN). Figure 5 is an example of a tier-2 model data entry sheet (GWTIER2). Note that the screening-level model sheet requires entry of considerably less data than does the tier-2 sheet. To enter data, simply position the cursor within the appropriate box and type the value; all other cells are protected.

3.2.1 Error Messages

In the case of the screening-level models, all error messages will appear in red type below the applicable row of data entry boxes. For tier-2 models, error messages may appear on the data entry sheet or in the lower portion of the results sheet. Error messages will occur if required entry data are missing or if data are out of range or do not conform to model conventions. The error message will tell the user what kind of error has occurred.

Figure 6 is an example of an error message appearing on the data entry sheet. Figure 7 illustrates error messages appearing within the error summary section on the results sheet (tier-2 models only).

3.2.2 Entering Data

Each data entry sheet requires the user to input values for model variables. Data required for the soil contamination scenario will differ from that required for the groundwater contamination scenario. In addition, data required for the screening-level models will differ from that required for the tier-2 models.

Model Variables--

The following is a list of all data entry variables required for evaluating either a risk-based media concentration or the incremental risks due to actual contamination. A description for which model(s) the variable is appropriate is given in parenthesis after

CALCULATE RISK-BASED GRO UNDWATER CONCENTRATION (enter "X" in " YES" box)

YES	X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GRO UNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES	

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_w (µg/L)	Chemical
56235		Carbon tetrachloride

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)
200	400	SC	10

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone soil dry bulk density, ρ_b^v (g/cm^3)	ENTER Vadose zone soil total porosity, n^v (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^v (cm^3/cm^3)
SC			1.5	0.43	0.3

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_c (yrs)	ENTER Averaging time for noncarcinogens, AT_{nc} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	30	30	350

Used to calculate risk-based groundwater concentration.

Figure 4. GWSCREEN Data Entry Sheet

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES	X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES	

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_w (µg/L)	Chemical
56235		Carbon tetrachloride

ENTER Average soil/ groundwater temperature, T_s (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell D26)							
10	200	400	300	50	50	C	SC	C		

ENTER Stratum A soil dry bulk density, ρ_A^a (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B soil dry bulk density, ρ_B^a (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C soil dry bulk density, ρ_C^a (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
1.5	0.43	0.2	1.7	0.42	0.27	1.7	0.43	0.3

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm-s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space floor area, A_B (cm^2)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	981	981	962	0.1	0.45

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based groundwater concentration	

Figure 5. GWTIER2 Data Entry Sheet

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES	X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES	X

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER initial groundwater conc., C_w (µg/L)	Cannot calculate risk-based concentration and incremental risk simultaneously. Chemical

Figure 6. Example Error Message on Data Entry Sheet

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	NA	NA	4.81E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
2.9E-05	NA

ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

Combined thickness of strata A + B + C must be = depth below grade to top of contamination.

Figure 7. Example Error Message on Results Sheet

the name of the variable. In addition, notes on how the variable is used in the calculations, and how to determine appropriate values of the variable are given below the variable name. A quick determination of which variables are required for a specific model can be made by reviewing the data entry sheet for the model chosen. Example data entry sheets for each model can be found in Appendix B.

1. *Calculate Risk-Based Concentration* OR *Calculate Incremental Risks from Actual Concentration* (All Models)

   The model will calculate either a risk-based soil or groundwater concentration or incremental risks but cannot calculate both simultaneously. Enter an "X" in only one box.

2. *Chemical CAS No.* (All Models)

   Enter the appropriate CAS number for the chemical you wish to evaluate; do not enter dashes. The CAS number entered must exactly match that of the chemical or the error message "CAS No. not found" will appear in the "Chemical" box. Once the correct CAS number is entered, the name of the chemical will automatically appear in the "Chemical" box. A total of 97 chemicals and their associated properties are included with each model; see Section 4.4 for instructions on adding/revising chemicals.

3. *Initial Soil or Groundwater Concentration* (All Models)

   Enter a value only if incremental risks are to be calculated. Be sure to enter the concentration in units of µg/kg (soil) or µg/L (groundwater). Typically, this value represents the average concentration within the zone of contamination. If descriptive statistics are not available to quantify the uncertainty in the average value, the maximum value may be used as an upper bound estimate.

4. *Average Soil/Groundwater Temperature* (All Models)

   The soil/groundwater temperature is used to correct the Henry's law constant to the specified temperature. Figure 8 from U.S. EPA (1995) shows the average temperature of shallow groundwater in the continental United States. Another source of information may be your State groundwater protection regulatory agency.

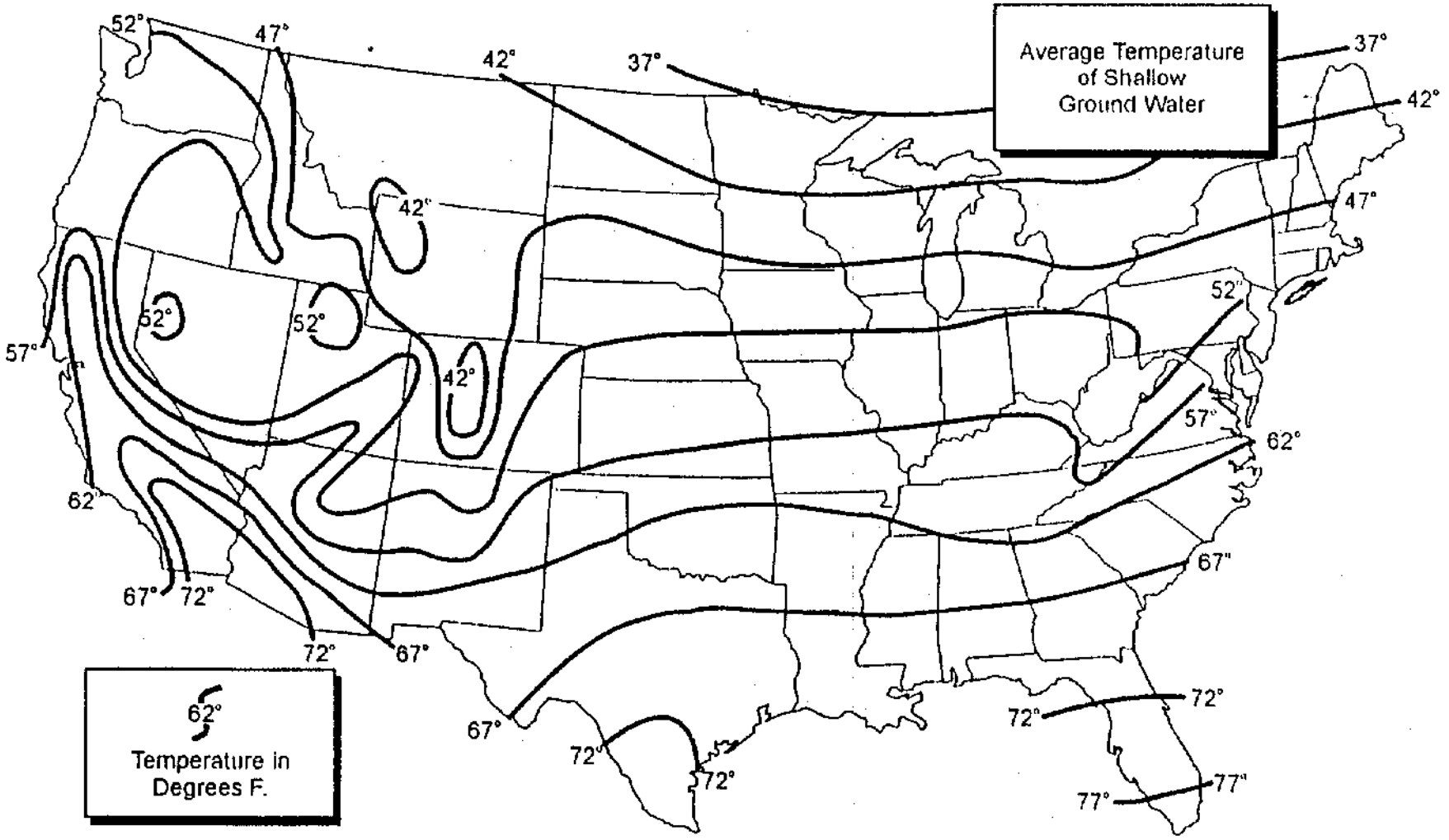


Figure 8. Average Shallow Groundwater Temperature in the United States

5. *Depth Below Grade to Bottom of Enclosed Space Floor* (All Models)

Enter the depth to the bottom of the floor in contact with the soil. The default value for slab-on-grade and basement construction is 15 cm and 200 cm, respectively.

6. *Depth Below Grade to Top of Contamination* (Soil Models Only)

Enter the depth to the top of soil contamination. If the contamination begins at the soil surface, enter the depth below grade to the bottom of the enclosed space floor. The depth to the top of contamination must be greater than or equal to the depth to the bottom of the floor.

7. *Depth Below Grade to Water Table* (Groundwater Models Only)

Enter the depth to the top of the water table (i.e., where the pressure head is equal to zero and the pressure is atmospheric).

Note: The thickness of the capillary zone is calculated based on the SCS soil type above the top of the water table. The depth below grade to the top of the water table minus the thickness of the capillary zone must be greater than the depth below grade to the bottom of the enclosed space floor. This means that the top of the capillary zone is always below the floor.

8. *Depth Below Grade to Bottom of Contamination* (Soil Tier-2 Model Only)

This value is used to calculate the thickness of soil contamination. A value greater than zero and greater than the depth to the top of contamination will automatically invoke the finite source model. If the thickness of contamination is unknown, two options are available:

1. Entering a value of zero will automatically invoke the infinite source model.

2. Enter the depth to the top of the water table. This will invoke the finite source model under the assumption that contamination extends from the top of contamination previously entered down to the top of the water table.

9. *Thickness of Soil Stratum "X"* (Tier-2 Models Only)

In the tier-2 models, the user can define up to three soil strata between the soil surface and the top of contamination. These strata are listed as A, B, and C. Stratum A extends down from the soil surface, Stratum B is below Stratum A, and Stratum C is the deepest stratum. The thickness of Stratum A must be at least as thick as the depth below grade to the bottom of the enclosed space floor. The combined thickness of all strata must be equal to the depth to the top of contamination or to the top of the water table, as appropriate. If soil strata B and/or C are not to be considered, a value of zero must be entered for each stratum not included in the analysis.

10. *Soil Stratum A SCS Soil Type* (Tier-2 Models Only)

Enter one of the following SCS soil type abbreviations:

Abbreviation	SCS Soil Type
C	Clay
CL	Clay loam
L	Loam
LS	Loamy sand
S	Sand
SC	Sandy clay
SCL	Sandy clay loam
SI	Silt
SIC	Silty clay
SICL	Silty clay loam
SIL	Silt loam
SL	Sandy loam

To determine the correct soil type, see the SCS soil textural classification triangle in Figure 3.

The SCS soil type along with the Stratum A soil water-filled porosity is used to estimate the soil vapor permeability of Stratum A which is in contact with the floor and walls of the enclosed space below grade. Alternatively, the user may define a soil vapor permeability (see Variable No. 11).

11. *User-Defined Stratum A Soil Vapor Permeability* (Tier-2 Models Only)

As an alternative to estimating the soil vapor permeability of soil Stratum A, the user may define the soil vapor permeability. As a general guide, the following represent the practical range of vapor permeabilities:

Soil type	Soil vapor permeability, cm^2
Medium sand	1.0×10^{-7} to 1.0×10^{-6}
Fine sand	1.0×10^{-8} to 1.0×10^{-7}
Silty sand	1.0×10^{-9} to 1.0×10^{-8}
Clayey silts	1.0×10^{-10} to 1.0×10^{-9}

12. *Vadose Zone SCS Soil Type* (Screening Models Only)

Because the screening-level models accommodate only one soil stratum above the top of contamination, enter the SCS soil type from the list given in Variable No. 10.

13. *User-Defined Vadose Zone Soil Vapor Permeability* (Screening Models Only)

For the same reason cited in No. 12 above, the user may alternatively define a soil vapor permeability. Use the list of values given in Variable No. 11 as a general guide.

14. *Soil Stratum Directly Above the Water Table* (Groundwater Tier-2 Models Only)

Enter either A, B, or C as the soil stratum directly above the water table. This value must be the letter of the deepest stratum for which a thickness value has been specified under Variable No. 9.

15. *SCS Soil Type Directly Above Water Table* (Groundwater Models Only)

Enter the correct SCS soil type from the list given in Variable No. 10 for the soil type directly above the water table. The soil type entered is used to estimate the rise (thickness) of the capillary zone.

16. *Stratum "X" Soil Dry Bulk Density* (Tier-2 Models Only)

Enter the average soil dry bulk density for the appropriate soil stratum. Dry bulk density is used in a number of intermediate calculations and is normally determined by field measurements (ASTM D 2937 Method).

17. *Stratum "X" Soil Total Porosity* (Tier-2 Models Only)

Total soil porosity (n) is determined as:

$$n = 1 - \rho_b/\rho_s$$

where ρ_b is the soil dry bulk density (g/cm^3) and ρ_s is the soil particle density (usually 2.65 g/cm^3).

18. *Stratum "X" Soil Water-Filled Porosity* (Tier-2 Models Only)

Enter the average long-term volumetric soil moisture content; this is typically a depth-averaged value for the appropriate soil stratum. A long-term average value is typically not readily available. Do not use values based on episodic measurements as they may not be representative of long-term conditions.

One option is to use a model to estimate the long-term average soil water-filled porosities of each soil stratum between the enclosed space floor and the top of contamination. The HYDRUS model version 5.0 (Vogel et al., 1996) is a public domain code for simulating one-dimensional water flow, solute transport, and heat movement in variably-saturated soils. The water flow simulation module of HYDRUS will generate soil water content as a function of depth and time given actual daily rainfall data. Model input requirements include either the soil hydraulic properties of van Genuchten (1980) or those of Brooks and Corey (1966). The van Genuchten soil hydraulic properties required are the same as those given in Tables 2 and 4 (i.e., θ_s, θ_r, N, α, and K_s). The HYDRUS model is available from the U.S. Department of Agriculture - Agricultural Research Service in Riverside, California via their internet website at http://www.ussl.ars.usda.gov/MODELS/HYDRUS.HTM.
Schapp et al. (1997) recently developed a hierarchical neural network approach to predict van Genuchten (1980) soil hydraulic properties from

basic soil properties. They concluded that of all the published models with which they compared their results, only the models of Vereecken et al. (1989) compared favorably. Vereecken et al. (1989) and Vereecken et al. (1990) developed a series of nonlinear regression equations to predict the soil hydraulic parameters of van Genuchten (1980) using simple soil properties such as particle size distribution, dry bulk density, and carbon content. With estimates of these values, the HYDRUS model may be employed to calculate long-term average soil moisture contents by soil stratum.

19. *Stratum "X" Soil Organic Carbon Fraction* (Soil Tier-2 Models Only)

Enter the depth-averaged soil organic carbon fraction for the stratum specified. Soil organic carbon is measured by burning-off soil carbon in a controlled-temperature oven (Nelson and Sommers, 1982). This parameter, along with the chemical's organic carbon partition coefficient (K_{oc}), is used to determine the soil-water partition coefficient (K_d).

20. *Vadose Zone Soil Dry Bulk Density* (Screening Models Only)

Because the screening-level models accommodate only one soil stratum above the top of contamination, enter the depth-averaged soil dry bulk density. The default value is 1.5 g/cm^3 which is consistent with U.S. EPA (1996a and b) for subsurface soils.

21. *Vadose Zone Soil Total Porosity* (Screening Models Only)

Because the screening-level models accommodate only one soil stratum above the top of contamination, enter the depth-averaged soil total porosity. The default value is 0.43 which is consistent with U.S. EPA (1996a and b) for subsurface soils.

22. *Vadose Zone Soil Water-Filled Porosity* (Screening Models Only)

Because the screening-level models accommodate only one soil stratum above the top of contamination, enter the depth-averaged soil water-filled porosity. The default value is 0.30 which is consistent with U.S. EPA (1996a and b) for subsurface soils.

23. *Vadose Zone Soil Organic Carbon Fraction* (Soil Screening Model Only)

Because the screening-level models accommodate only one soil stratum above the top of contamination, enter the depth-averaged soil organic carbon fraction. The default value is 0.002 which is consistent with U.S. EPA (1996a and b) for subsurface soils.

24. *Enclosed Space Floor Thickness* (Tier-2 Models Only)

Enter the thickness of the floor slab. All models operate under the assumption that the floor in contact with the underlying soil is composed of impermeable concrete whether constructed as a basement floor or slab-on-grade. The default value is 15 cm which is consistent with Johnson and Ettinger (1991).

25. *Soil-Building Pressure Differential* (Tier-2 Models Only)

Because of wind effects on the structure, stack effects due to heating of the interior air, and unbalanced mechanical ventilation, a negative pressure with respect to the soil surface is generated within the structure. This pressure differential (ΔP) induces a flow of soil gas through the soil matrix and into the structure through cracks, gaps, and openings in the foundation. The effective range of values of ΔP is 0-20 Pascals (Loureiro et al., 1990; Eaton and Scott, 1984). Individual average values for wind effects and stack effects are approximately 2 Pa (Nazaroff et al., 1985; Put and Meijer, 1989). Typical values for the combined effects of wind pressures and heating are 4 to 5 Pa (Loureiro et al., 1990; Grimsrud et al., 1983). A conservative default value of ΔP was therefore chosen to be 4 Pa (40 g/cm-s^2).

For more information on estimating site-specific values of ΔP, the user is referred to Nazaroff et al. (1987) and Grimsrud et al. (1983).

26. *Enclosed Space Floor Length* (Tier-2 Models Only)

The default value is 961 cm (see Variable No. 28).

27. *Enclosed Space Floor Width* (Tier-2 Models Only)

The default value is 961 cm (see Variable No. 28).

28. *Enclosed Space Height* (Tier-2 Models Only)

The default values of the enclosed space length, width, and height derived from the average estimated volume of both owner-occupied rental single-family detached residences in the U.S. (U.S. DOE, 19 These dimensions assume a living space volume of 451 m^3 divided into stories of equal volume with ceiling heights of 8 ft (2.44 m). Each flo assumed to be a square with a total floor area of 92.42 m^2 and equal len and widths of 9.61 m. The total height of the living space is 2 x 2.44 4.88 m.

29. *Floor-Wall Seam Crack Width* (Tier-2 Models Only)

The conceptual model used in the spreadsheets follows that of Loureii al. (1990) and Nazaroff (1988) and is illustrated in Figure 9. The moc based on a single-family house with a poured concrete basement floor wall foundations, or constructed slab-on-grade in similar fashion. A ga assumed to exist at the junction between the floor and the foundation a the perimeter of the floor. The gap exists as a result of building desig concrete shrinkage. This gap is assumed to be the only opening in understructure of the house and therefore the only route for soil gas e

Eaton and Scott (1984) reported typical open areas of joints between and floor slabs of residential structures in Canada of approximately 300 Therefore, given the default floor length and width of 961 cm, a gap w (w) of 0.1 cm equates to a total gap area of 384 cm^2, which is reason given the findings of Eaton and Scott. This value of the gap width is consistent with the typical value reported in Loureiro et al. (1990). default value of the floor-wall seam crack width was therefore set equ 0.1 cm.

30. *Indoor Air Exchange Rate* (Tier-2 Models Only)

The indoor air exchange rate is used, along with the building dimension calculate the building ventilation rate. The default value of the indoo exchange rate is 0.45/h. This value is consistent with both the geom mean and the 50th percentile of houses in all regions of the U.S. as repo in Koontz and Rector (1995). This value is also consistent with the ave of the control group of 331 houses in a study conducted by Parker e (1990) to compare data with that of 292 houses with energy-efficient feat in the Pacific Northwest.

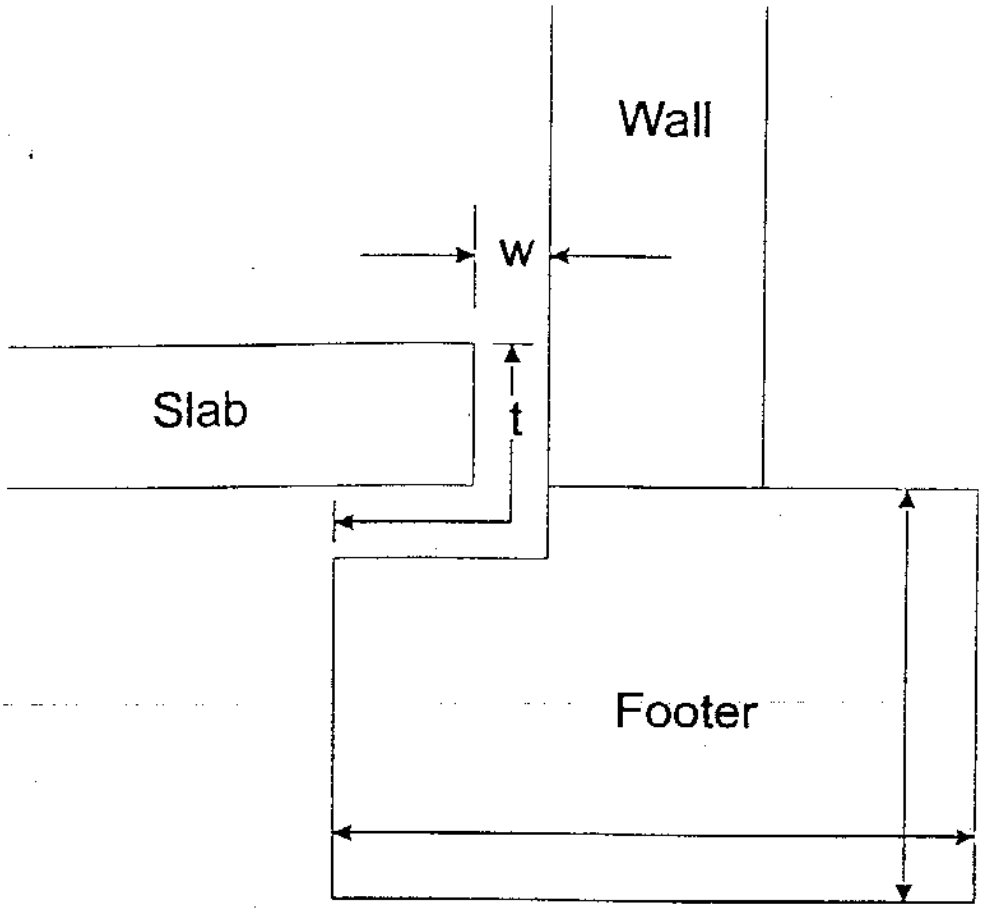


Figure 9. Floor Slab and Foundation

31. *Averaging Time for Carcinogens* (All Models)

Enter the averaging time in units of years. The default value is 70 years.

32. *Averaging Time for Noncarcinogens* (All Models)

Enter the averaging time in units of years. The averaging time for noncarcinogens is set equal to the exposure duration. The default value for residential exposure from U.S. EPA (1996a and b) is 30 years.

33. *Exposure Duration* (All Models)

Enter the exposure duration in units of years. The default value for residential exposure from U.S. EPA (1996a and b) is 30 years.

34. *Exposure Frequency* (All Models)

Enter the exposure frequency in units of days/yr. The default value for residential exposure from U.S. EPA (1996a and b) is 350 days/yr.

35. *Target Risk for Carcinogens* (All Models)

If a risk-based media concentration is to be calculated, enter the target risk-level. The default value is 1×10^{-6}.

36. *Target Hazard quotient for Noncarcinogens* (All Models)

If a risk-based media concentration is to be calculated, enter the target hazard quotient. The default value is 1.

SECTION 4

THE RESULTS SHEET AND ANCILLARY SHEETS

The remaining four worksheets include the results sheet (RESULTS) and three ancillary sheets. The ancillary sheets include the chemical properties sheet (CHEMPROPS), the intermediate calculations sheet (INTERCALCS), and the lookup tables (VLOOKUP).

4.1 THE RESULTS SHEET (RESULTS)

Once all data are entered in the data entry sheet, the model results may be viewed on the RESULTS sheet. Model calculations are presented as either a risk-based soil or groundwater concentration, or the incremental risks associated with an initial soil or groundwater concentration. In the case of the tier-2 models, the user should check the error summary below the results section to ensure that no error messages appear. If one or more error messages appear, re-enter the appropriate data. All data in the results sheet are protected.

4.2 THE CHEMICAL PROPERTIES SHEET (CHEMPROPS)

The chemical properties sheet provides a summary of the chemical and toxicological properties of the chemical selected for analysis. These data are retrieved from the VLOOKUP sheet by CAS number. All data in the chemical properties sheet are protected.

4.3 THE INTERMEDIATE CALCULATIONS SHEET (INTERCALCS)

The intermediate calculations sheet provides solutions to intermediate variables. Review of the values of the intermediate variables may be helpful in an analysis of the cause-and-effect relationships between input values and model results. All data in the intermediate calculations sheet are protected.

4.4 THE LOOKUP TABLES (VLOOKUP)

The VLOOKUP sheet contains two lookup tables from which individual data are retrieved for a number of model calculations. The first table is the Soil Properties Lookup Table. This table contains the average soil water retention curve data of Carsel and Parrish (1988) (see Tables 2 and 4) and the mean grain diameter data of Nielson and Rogers (1990) (see Table 3) by SCS soil type. The second table contains all of the chemical and toxicological data for all of the chemicals included with each model.

Data for any chemical may be edited, new chemicals added, or existing chemicals deleted from the Chemical Properties Lookup Table. To begin an editing session, the user must unprotect (unseal) the worksheet (the password is "ABC" in capital letters); editing of individual elements or deletion of chemicals may then proceed. Space has been allocated for up to 150 chemicals in the lookup table. Row number 171 is the last row that may be used to add new chemicals. After the editing session is complete, the user must sort all the data in the lookup table (except the column headers) in ascending order by CAS number. After sorting is complete, the worksheet should again be protected (sealed).

SECTION 5

MODEL ASSUMPTIONS AND LIMITATIONS

The following is a discussion of the major assumptions and limitations of the Johnson and Ettinger vapor intrusion model as well as the ancillary models for estimating the vapor concentration at the source of contamination, soil vapor permeability, the rise of the capillary zone, and the effective diffusion coefficient across the capillary zone.

5.1 SOURCE VAPOR CONCENTRATION

As applied in the accompanying spreadsheets, the vapor equilibrium model employed to estimate the vapor concentration at the source of soil contamination is applicable in the limit of "low" concentrations where compounds are sorbed to organic carbon in the soil, dissolved is soil moisture, and present as vapor within the air-filled soil pores (i.e., a three-phase system). The model does not account for a residual phase (e.g., NAPL) and will overpredict vapor concentrations in such cases. In the case of contaminated groundwater, the vapor equilibrium model operates under the assumption that the contaminant is present at levels below the water solubility limit. Therefore, use of these models to calculate incremental risks under inappropriate conditions will cause erroneous results.

The user is also reminded that when estimating a risk-based soil concentration, the model will compare the calculated soil concentration with the soil saturation concentration above which a residual phase is likely to occur. The soil saturation concentration (C_{sat}) is calculated as in U.S. EPA (1996a and b). If the risk-based concentration is greater than the saturation concentration, the final soil concentration will be set equal to the soil saturation concentration. This tends to eliminate the possibility of allowing a residual phase to exist within the soil column.

Likewise, the groundwater models will compare the calculated risk-based groundwater concentration to the aqueous solubility limit of the compound and will limit the allowed concentration to a value less than or equal to the solubility limit.

Finally, it should be recognized that the procedures used to estimate both the soil saturation concentration and the aqueous solubility limit do not consider the effects of multiple contaminants. The estimated values, therefore, may be artificially high such that a residual phase may actually exist at somewhat lower concentrations.

5.2 SOIL VAPOR PERMEABILITY

The procedures used to estimate the soil vapor permeability of the soil stratum in contact with the building floor and walls assumes isotropic soils and steady-state soil moisture content. In addition, the calculations do not account for preferential vapor pathways due to soil fractures, vegetation root pathways, or the effects of a gravel layer below the floor slab or backfill which may act to increase the vapor permeability with respect to in situ soils.

If in situ pump tests are used to measure site vapor permeability, care must be taken to ensure adequate sampling to reduce the possibility of missing important soil structure effects due to anisotropy.

5.3 RISE OF AND DIFFUSION ACROSS THE CAPILLARY ZONE

Estimation of the rise of the capillary zone is based on the equation for the rise of a liquid in a capillary tube. The procedure assumes that the interstitial space between the soil particles is equivalent to the capillary tube diameter and that the resulting rise of water occurs under steady-state soil column drainage conditions. In actuality, the height of the capillary zone is uneven or fingered due to the variation in the actual in situ particle size distribution. In addition, the groundwater models do not account for the episodic rise and fall of the water table or the capillary zone due to aquifer recharge and discharge. As constructed, the groundwater models do not allow the top of the capillary zone to be above the bottom of the building floor in contact with the soil. The user should be aware,

however, that in reality the top of the capillary zone may rise to levels above the floor in some cases.

Diffusion across the capillary zone is estimated based on lumping vapor and aqueous-phase diffusion together within the calculation of the effective diffusion coefficient. To allow for vapor-phase diffusion within the capillary zone, the air-filled soil pores must be connected. In reality, the capillary zone is comprised of a tension-saturated zone immediately above the water table and the deep portion of the vadose zone within which the soil water content is a strongly dependent on the pressure head. Diffusion across the tension-saturated zone is dominated by liquid-phase diffusion which is typically four orders of magnitude less than vapor-phase diffusion. Therefore, a large concentration gradient may exist between the top of the water table and the top of the tension-saturated zone (McCarthy and Johnson, 1993).

Lumping vapor and aqueous-phase diffusion together is a less intensive, although less rigorous, method for estimating the effective diffusion coefficient. The result is typically a higher effective diffusion coefficient relative to separate solutions for aqueous diffusion across the tension-saturated zone and both vapor and aqueous diffusion across the unsaturated portion of the vadose zone.

To minimize the over estimation of the effective diffusion coefficient, the soil air-filled porosity within the capillary zone is estimated based on the air-entry pressure head, which corresponds with the water-filled porosity at which the interstitial air-filled pores first become connected. The user should be aware that this procedure is inherently conservative if a significant concentration gradient exists across the tension-saturated zone. This conservatism may be somewhat offset in that the model does not consider episodic rises in the level of the water table. During such events, water which had previously been part of the saturated zone (and hence contain higher contaminant concentrations) is redistributed in the vadose zone resulting in temporary elevations in soil gas concentrations.

5.4 DIFFUSIVE AND CONVECTIVE TRANSPORT INTO THE STRUCTURE

The following is a discussion of the major assumptions and limitations of the Johnson and Ettinger model for diffusive and convective vapor transport into buildings.

The model assumes that all vapors from underlying soils will enter the building through gaps and openings in the walls, floor and foundation. This implies that a constant pressure field is generated between the interior spaces and the soil surface and that the vapors are intercepted within the pressure field and transported into the building. This assumption is inherently conservative in that it neglects periods of near zero pressure differential (e.g., during mild weather when windows are left open).

As with the estimation procedure for soil vapor permeability, the model assumes isotropic soils in the horizontal direction; vertical anisotropy is accounted for by a series of isotropic soil strata above the top of contamination. Soil properties within the zone of soil contamination are assumed to be identical to those of the soil stratum directly above the contamination and extend downward to an infinite depth. Solute transport by convection (e.g., water infiltration) and by mechanical dispersion are neglected. Transformation processes (e.g., biodegradation, hydrolysis, etc.) are also neglected.

A recent empirical field study (Fitzpatrick and Fitzgerald, 1997) indicates that the model may be overly conservative for nonchlorinated species (e.g., benzene, toluene, ethybenzene and xylene) but in some cases, may underpredict indoor concentrations for chlorinated species. The authors contribute the likely cause for this discrepancy to the significant biodegradation of the nonchlorinated compounds.

The Johnson and Ettinger model treats the entire building as a single chamber with instantaneous and homogeneous vapor dispersion. It therefore neglects contaminant sinks and the room-to-room variation in vapor concentration due to unbalanced mechanical and/or natural ventilation.

Finally, convective vapor flow from the soil matrix into the building is represented as an idealized cylinder buried below grade. This cylinder represents the total area of the structure below the soil surface (walls and floor). The total crack or gap area is assumed to be a fixed fraction of this area. Because of the presence of basement walls, the actual

vapor entry rate is expected to be 50 to 100 percent of that provided by the idealized geometry (Johnson and Ettinger, 1991).

SECTION 6

VALUES FOR INPUT VARIABLES

The Johnson and Ettinger model as constructed within the accompanying spreadsheets requires a range of input variables depending on whether a screening-level or tier-2 model is chosen.

Table 5 provides a list of all major input variables, the range of practical values for each variable, the default value for each variable, and the relative model sensitivity and uncertainty of each variable. Table 5 also includes references for each value or range of values.

Table 6 indicates the results of an increase in the value of each input parameter. The results are shown as either an increase or a decrease in the building concentration ($C_{building}$) of the pollutant. An increase in the building concentration will result in an increase in the risk when forward-calculating from an initial soil or groundwater concentration. When reverse-calculating to a risk-based "acceptable" soil or groundwater concentration, an increase in the hypothetical unit building concentration will result in a lower "acceptable" soil or groundwater concentration.

TABLE 5.. RANGE OF VALUES, SENSITIVITY, AND UNCERTAINTY OF MODEL INPUT PARAMETERS

Input parameter	Practical range of values	Default value	Relative model sensitivity	Relative uncertainty
Soil water-filled porosity (θ_w)	0.02 -0.43 cm^3/cm^3[a]	0.30 cm^3/cm^3[a]	High	High
Soil vapor permeability (k_v)	10^{-6} - 10^{-12} cm^2[b,c]	10^{-8} cm^2[d]	High	High
Soil-building pressure differential (ΔP)	0 - 20 Pa[e]	4 Pa[f]	High	High
Media initial concentration (C_R, C_w)	User-defined	NA	High	Moderate
Depth to bottom of soil contamination (L_b)	User-defined	NA	High	Moderate
Depth to top of contamination (L_t)	User-defined	NA	High	Low
Floor-wall seam gap (w)	0.05 - 1.0 cm[e]	0.1 cm[e]	Moderate	High
Soil organic carbon fraction (f_{oc})	0.001 - 0.006[e]	0.002[e]	Moderate	Moderate
Building air exchange rate (ER)	0.18 - 1.26 (h^{-1})[g]	0.45 (h^{-1})[g,h]	Moderate	Moderate
Building volume	147 - 672 m^3	451 m^3[i]	Moderate	Low
Soil total porosity (n)	0.34 - 0.53 cm^3/cm^3[a]	0.43 cm^3/cm^3[a]	Moderate	Low
Soil dry bulk density (ρ_b)	1.25 - 1.75 g/cm^3[a]	1.5 g/cm^3[a]	Low	Low

[a]U.S. EPA (1996a and b).
[b]Johnson and Ettinger (1991).
[c]Nazaroff (1988).
[d]Based on transition point between diffusion and convection dominated transport from Johnson and Ettinger (1991).
[e]Eaton and Scott (1984); Loureiro et al. (1990).
[f]Loureiro et al. (1990); Grimsrud et al. (1983).
[g]Koontz and Rector (1995).
[h]Parker et al. (1990).
[i]U.S. DOE (1995).

TABLE 6. EFFECT ON BUILDING CONCENTRATION FROM AN INCREASE IN INPUT PARAMETER VALUES

Input parameter	Change in parameter value	Effect on building concentration
Soil water-filled porosity (θ_w)	Increase	Decrease
Soil vapor permeability (k_v)	Increase	Increase
Soil-building pressure differential (ΔP)	Increase	Increase
Media initial concentration (C_n, C_w)[a]	Increase	Increase
Depth to bottom of soil contamination (L_b)[b]	Increase	Increase
Depth to top of contamination (L_t)	Increase	Decrease
Floor-wall seam gap (w)	Increase	Increase
Soil organic carbon fraction (f_{oc})	Increase	Decrease
Building air exchange rate (ER)	Increase	Decrease
Building volume[c]	Increase	Decrease
Soil total porosity (n)	Increase	Increase
Soil dry bulk density (ρ_b)	Increase	Decrease

[a]This parameter is applicable only when forward-calculating risk.
[b]Applicable only to tier-2 model for soil contamination.
[c]Used with building air exchange rate to calculate building ventilation rate.

SECTION 7

INTERPRETATION OF RESULTS

The models described herein are theoretical approximations of complex physical and chemical processes and as such should not be used in a deterministic fashion (i.e., to generate a single outcome). At the least, a range of outcomes should be explored focusing on the most sensitive model input variables. In general, using the default values for input variables will result in higher indoor air concentrations and thus higher incremental risks or lower risk-based media concentrations. With a realistic range of outcomes, the risk manager may assess the uncertainty in the model predictions.

From a conceptual point of view, the Johnson and Ettinger model provides a theoretical description of the processes involved in vapor intrusion from subsurface soils or groundwater into indoor structures. A combination of modeling and monitoring methods is also possible to reduce the uncertainty of the calculated indoor air concentrations. Typically this involves field methods for measuring soil gas very near an actual or hypothetical structure. Once a representative average concentration is determined, all vapor directly below the areal extent of the building is presumed to enter the structure. This concentration, along with the building ventilation rate, will determine the indoor concentration. When using soil gas measurements, it must be remembered that no analysis has been made concerning the source of contamination. Therefore, the calculated indoor concentration must be assumed to be steady-state. Soil gas monitoring may also be used to help calibrate the theoretical equilibrium partitioning and diffusion transport considerations of the model. The reader is referred to U.S. EPA (1992) for a more detailed discussion of applying soil gas measurements to indoor vapor intrusion.

Finally, calibration and verification of the model has been limited to radon studies due to the paucity of suitable data. Research is needed to provide spatially and temporally

correlated measurements during different seasons, at different locations, with different buildings, and over a range of different contaminants such that the accuracy of the model may be determined.

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APPENDIX A

EXAMPLE WORKSHEETS FOR THE TIER-2 SOIL CONTAMINATION MODEL

DATA ENTRY SHEET

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES	X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES	

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_{is} (µg/kg)	Chemical
71432		Benzene

ENTER Average soil temperature, T_s (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_{esp} (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell D28)			ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
				Thickness of soil stratum A, h_A (cm)	Thickness of soil stratum B, (Enter value or 0) h_B (cm)	Thickness of soil stratum C, (Enter value or 0) h_C (cm)			
10	200	400	600	200	100	100	SCL		

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.15	0.008	1.5	0.43	0.25	0.003	1.7	0.34	0.26	0.002

ENTER Enclosed space floor thickness, L_{slab} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	981	981	488	0.1	0.45

ENTER Averaging time for carcinogens, AT_c (yrs)	ENTER Averaging time for noncarcinogens, AT_{nc} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based soil concentration.

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w * (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_r (°C)	Enthalpy of vaporization at the normal boiling point, ΔH_v (cal/mol)	Normal boiling point, T_b (°K)	Critical temperature, T_c (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
8.80E-02	9.80E-06	5.56E-03	25	7,342	353.24	562.16	5.89E+01	1.75E+03	8.3E-06	0.0E+00

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, t (sec)	Source-building separation, L_s (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k (cm^2)	Stratum A soil relative air permeability, k_{ra} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg ventilation rate, $Q_{building}$ (cm^3/s)
9.46E+08	300	0.280	0.180	0.080	0.152	4.85E-09	0.819	4.46E-09	3,844	1	5.63E+04

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,ave}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
1.69E+06	2.22E-04	200	8,122	2.89E-03	1.18E-01	1.75E-04	6.86E-03	2.58E-03	1.78E-04	3.19E-04	200	300

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_0 (sec)	Exposure duration > time for source depletion (YES/NO)
1.18E-01	4.19E+02	0.10	2.96E+00	6.86E-03	3.84E+03	2.07E+07	NA	NA	1.91E+00	1.97E-09	1.23E+09	NO

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m^3)	Finite source bldg. conc., $C_{building}$ (µg/m^3)	Final finite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF $(µg/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
2.07E-05	NA	8.69E-03	8.69E-03	8.3E-06	NA

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
3.37E+01	NA	3.37E+01	4.83E+05	3.37E+01

ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

VLOOKUP TABLES

Soil Properties Lookup Table

SCS Soil Type	K_s (cm/h)	α (1/cm)	N (unitless)	M (unitless)	θ_r (cm^3/cm^3)	θ_s (cm^3/cm^3)	Mean Grain Diameter (cm)
C	0.20	0.008	1.09	0.083	0.38	0.068	0.0092
CL	0.26	0.019	1.31	0.237	0.41	0.095	0.018
L	1.04	0.036	1.56	0.359	0.43	0.078	0.020
LS	14.59	0.124	2.28	0.561	0.41	0.057	0.040
S	29.70	0.145	2.68	0.627	0.43	0.045	0.044
SC	0.12	0.027	1.23	0.187	0.38	0.100	0.025
SCL	1.31	0.059	1.48	0.324	0.39	0.100	0.029
SI	0.25	0.016	1.37	0.270	0.45	0.034	0.0046
SIC	0.02	0.005	1.09	0.083	0.26	0.070	0.0039
SICL	0.07	0.010	1.23	0.187	0.43	0.089	0.0056
SIL	0.45	0.020	1.41	0.291	0.45	0.087	0.011
SL	4.42	0.075	1.89	0.471	0.41	0.065	0.030

Chemical Properties Lookup Table

CAS No.	Chemical	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Pure component water solubility, S (mg/L)	Henry's law constant H' (unitless)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
50293	DDT	2.63E+06	1.37E-02	4.95E-06	2.50E-02	3.32E-04	8.10E-06	25	533.15	720.75	11,000	9.7E-05	0.0E+00
50328	Benzo(a)pyrene	1.02E+06	4.30E-02	8.90E-06	1.62E-03	4.63E-05	1.13E-06	25	715.90	969.27	15,000	2.1E-03	0.0E+00
51285	2,4-Dinitrophenol	1.00E-02	2.73E-02	9.06E-06	2.79E+03	1.82E-05	4.44E-07	25	605.28	827.85	15,000	0.0E+00	7.0E-03
53703	Dibenz(a,h)anthracene	3.80E+06	2.02E-02	5.18E-06	2.49E-03	8.03E-07	1.47E-08	25	743.24	990.41	16,000	2.1E-03	0.0E+00
56235	Carbon tetrachloride	1.74E+02	7.80E-02	8.80E-06	7.93E+02	1.25E+00	3.03E-02	25	349.90	556.60	7,127	1.5E-05	0.0E+00
56553	Benz(a)anthracene	3.98E+05	5.10E-02	9.00E-06	9.40E-03	1.37E-04	3.34E-06	25	708.15	1004.79	15,000	2.1E-04	0.0E+00
57749	Chlordane	8.20E+05	1.18E-02	4.37E-06	5.60E-02	1.99E-03	4.85E-05	25	624.24	885.73	13,000	3.7E-04	0.0E+00
58899	gamma-HCH (Lindane)	1.07E+03	1.42E-02	7.34E-06	6.80E+00	5.74E-04	1.40E-05	25	596.55	839.36	13,000	1.7E-04	0.0E+00
60571	Dieldrin	2.14E+04	1.25E-02	4.74E-06	1.95E-01	6.19E-04	1.51E-05	25	613.32	842.25	13,000	4.6E-03	0.0E+00
65850	Benzoic Acid	6.00E-01	5.36E-02	7.97E-06	3.50E+03	6.31E-05	1.54E-06	25	720.00	751.00	10,000	0.0E+00	1.4E+01
67641	Acetone	5.75E-01	1.24E-01	1.14E-05	1.00E+06	1.59E-03	3.88E-05	25	329.20	508.10	6,955	0.0E+00	3.5E-01
67663	Chloroform	3.98E+01	1.04E-01	1.00E-05	7.92E+03	1.50E-01	3.66E-03	25	334.32	536.40	6,988	2.3E-05	0.0E+00
67721	Hexachloroethane	1.78E+03	2.50E-03	6.80E-06	5.00E+01	1.59E-01	3.88E-03	25	458.00	695.00	9,510	4.0E-06	0.0E+00
71363	Butanol	8.92E+00	8.00E-02	9.30E-06	7.40E+04	3.61E-04	8.80E-06	25	390.88	563.05	10,346	0.0E+00	3.5E-01
71432	Benzene	5.89E+01	8.80E-02	9.80E-06	1.75E+03	2.28E-01	5.56E-03	25	353.24	562.16	7,342	8.3E-06	0.0E+00
71556	1,1,1-Trichloroethane	1.10E+02	7.80E-02	8.80E-06	1.33E+03	7.05E-01	1.72E-02	25	347.24	545.00	7,135	0.0E+00	1.0E+00
72208	Endrin	1.23E+04	1.25E-02	4.74E-06	2.50E-01	3.08E-04	7.51E-06	25	718.15	986.20	12,000	0.0E+00	1.1E-03
72435	Methoxychlor	9.77E+04	1.56E-02	4.48E-06	4.50E-02	8.48E-04	2.06E-05	25	651.02	848.49	14,000	0.0E+00	1.8E-02
72548	DDD	1.00E+06	1.69E-02	4.78E-06	9.00E-02	1.84E-04	4.00E-06	25	639.90	863.77	14,000	6.9E-05	0.0E+00
72559	DDE	4.47E+06	1.44E-02	5.87E-06	1.20E-01	8.61E-04	2.10E-05	25	636.44	860.38	13,000	9.7E-05	0.0E+00
74839	Methyl bromide	1.05E+01	7.28E-02	1.21E-05	1.52E+04	2.56E-01	6.24E-03	25	276.71	467.00	5,714	0.0E+00	5.0E-03
75014	Vinyl chloride (chloroethene)	1.86E+01	1.06E-01	1.23E-05	2.76E+03	1.11E+00	2.71E-02	25	259.25	432.00	5,250	8.4E-05	0.0E+00
75092	Methylene chloride	1.17E+01	1.01E-01	1.17E-05	1.30E+04	8.94E-02	2.19E-03	25	313.00	510.00	6,706	4.7E-07	3.0E+00
75150	Carbon disulfide	4.57E+01	1.04E-01	1.00E-05	1.19E+03	1.21E+00	3.02E-02	25	319.00	552.00	6,391	0.0E+00	7.0E-01
75252	Bromoform	8.71E+01	1.49E-02	1.03E-05	3.10E+03	2.19E-02	5.34E-04	25	422.35	696.00	9,479	1.1E-06	0.0E+00
75274	Bromodichloromethane	5.50E+01	2.98E-02	1.06E-05	6.74E+03	6.56E-02	1.60E-03	25	363.15	585.85	7,000	1.8E-05	0.0E+00
75343	1,1-Dichloroethane	3.16E+01	2.42E-02	1.03E-05	5.06E+03	2.30E-01	5.61E-03	25	330.55	523.00	6,895	0.0E+00	5.0E-01
75354	1,1-Dichloroethylene	5.89E+01	9.00E-02	1.04E-05	2.25E+03	1.07E+00	2.61E-02	25	304.75	576.05	6,247	5.0E-05	0.0E+00
76448	Heptachlor	1.41E+06	1.12E-02	5.69E-06	1.80E-01	4.47E-02	1.09E-03	25	603.69	846.31	13,000	1.3E-03	0.0E+00
77474	Hexachlorocyclopentadiene	2.00E+05	1.61E-02	7.21E-06	1.80E+00	1.11E+00	2.71E-02	25	512.15	746.00	10,931	0.0E+00	7.0E-05
78591	Isophorone	4.68E+01	8.23E-02	8.76E-06	1.20E+04	2.72E-04	6.63E-06	25	488.35	715.00	10,271	2.7E-07	0.0E+00
78875	1,2-Dichloropropane	4.37E+01	7.82E-02	8.73E-06	2.80E+03	1.15E-01	2.80E-03	25	369.52	572.00	7,590	0.0E+00	4.0E-03
79005	1,1,2-Trichloroethane	5.01E+01	7.80E-02	8.80E-06	4.42E+03	3.74E-02	9.12E-04	25	386.15	602.00	8,322	1.6E-05	0.0E+00
79016	Trichloroethylene	1.66E+02	7.90E-02	9.10E-06	1.10E+03	4.22E-01	1.03E-02	25	360.36	544.20	7,505	1.7E-06	0.0E+00
79345	1,1,2,2-Tetrachloroethane	9.33E+01	7.40E-02	7.90E-06	2.97E+03	1.41E-02	3.44E-04	25	419.60	661.15	8,996	5.8E-05	0.0E+00
83329	Acenaphthene	7.08E+03	4.21E-02	7.69E-06	4.24E+00	6.36E-03	1.55E-04	25	550.54	803.15	12,155	0.0E+00	2.1E-01
84662	Diethylphthalate	2.88E+02	2.56E-02	8.35E-06	1.08E+03	1.65E-05	4.51E-07	25	567.15	757.00	13,733	0.0E+00	2.8E+00
84742	Din-butyl phthalate	3.39E+04	4.36E-02	7.86E-06	1.12E+01	3.85E-04	9.39E-10	25	613.15	798.67	14,751	0.0E+00	3.5E-01
85687	Butyl benzyl phthalate	5.75E+04	1.74E-02	4.83E-06	2.69E+00	5.17E-05	1.26E-06	25	660.60	839.68	13,000	0.0E+00	7.0E-01
86306	N-Nitrosodiphenylamine	1.29E+03	3.12E-02	8.35E-06	3.51E+01	2.05E-04	5.00E-06	25	632.26	890.45	13,000	1.4E-06	0.0E+00
86737	Fluorene	1.38E+04	3.63E-02	7.86E-06	1.98E+00	2.61E-03	6.37E-05	25	570.44	870.00	12,666	0.0E+00	1.4E-01
86748	Carbazole	3.39E+03	3.90E-02	7.03E-06	7.48E+00	6.28E-07	1.53E-08	25	627.87	899.00	13,977	5.7E-06	0.0E+00

87683	Hexachloro-1,3-butadiene	5.37E+04	5.61E-02	6.16E-06	3.23E+00	3.34E-01	6.15E-03	25	486.15	738.00	10,206	2.2E-05	0.0E+00
87865	Pentachlorophenol	5.93E+02	5.60E-02	6.10E-06	1.95E+03	1.00E-06	3.44E-06	25	582.15	813.20	14,000	3.4E-05	0.0E+00
88062	2,4,6-Trichlorophenol	3.81E+02	3.18E-02	6.25E-06	6.00E+02	3.19E-04	1.78E-06	25	519.15	749.03	12,000	3.1E-05	0.0E+00
91203	Naphthalene	2.00E+03	5.90E-02	7.50E-06	3.10E+01	1.98E-02	4.83E-04	25	491.14	748.40	10,373	0.0E+00	1.4E-01
91941	3,3-Dichlorobenzidine	7.24E+01	1.94E-02	6.74E-06	3.11E+00	1.64E-07	4.00E-09	25	560.26	754.03	13,000	1.3E-04	0.0E+00
95476	o-Xylene	3.93E+02	8.70E-02	1.00E-05	1.78E+02	2.13E-01	5.20E-03	25	417.60	630.30	8,661	0.0E+00	7.0E+00
95487	2-Methylphenol (o-cresol)	9.12E+01	7.40E-02	8.30E-06	2.80E+04	4.92E-05	1.20E-06	25	464.19	697.60	10,800	0.0E+00	1.8E-01
95501	1,2-Dichlorobenzene	8.17E+02	6.90E-02	7.90E-06	1.56E+02	7.79E-02	1.90E-03	25	453.57	705.00	9,700	2.0E-01	0.0E+00
95578	2-Chlorophenol	3.89E+02	5.61E-02	6.46E-06	2.20E+04	1.60E-02	3.90E-04	25	447.53	675.00	9,572	0.0E+00	1.8E-02
95954	2,4,5-Trichlorophenol	1.60E+03	2.91E-02	7.03E-06	1.20E+03	1.78E-04	4.34E-06	25	526.15	759.13	13,000	0.0E+00	3.5E-01
96953	Nitrobenzene	6.48E+01	7.60E-02	8.80E-06	2.09E+03	9.84E-04	2.40E-05	25	483.95	719.00	10,566	0.0E+00	2.0E-03
100414	Ethylbenzene	3.63E+02	7.50E-02	7.80E-06	1.69E+02	3.23E-01	7.88E-03	25	409.34	617.20	8,501	0.0E+00	1.0E+00
100425	Styrene	7.78E+02	7.10E-02	8.00E-06	3.10E+02	1.13E-01	2.76E-03	25	416.31	636.00	8,737	0.0E+00	1.0E+00
105679	2,4-Dimethylphenol	2.58E+02	5.84E-02	6.89E-06	7.87E+03	6.20E-05	2.00E-06	25	484.13	707.60	11,329	0.0E+00	7.0E-02
106423	p-Xylene	3.89E+02	7.69E-02	8.44E-06	1.85E+02	3.14E-01	7.66E-03	25	411.52	616.20	8,525	0.0E+00	7.0E+00
106467	1,4-Dichlorobenzene	8.17E+02	6.80E-02	7.90E-06	7.34E+01	9.96E-02	2.43E-03	25	447.21	684.75	9,271	8.0E-01	0.0E+00
106478	p-Chloroaniline	6.61E+01	4.83E-02	1.01E-05	6.30E+03	1.35E-05	3.32E-07	25	503.65	754.00	11,689	0.0E+00	1.4E-02
107062	1,2-Dichloroethane	1.74E+01	1.04E-01	9.90E-06	9.52E+03	4.01E-02	9.78E-04	25	356.85	561.00	7,643	2.6E-05	0.0E+00
108054	Vinyl acetate	5.25E+00	9.50E-02	9.20E-06	2.00E+04	2.10E-02	5.12E-04	25	345.65	519.13	7,800	0.0E+00	2.0E-01
108383	m-Xylene	4.07E+02	7.00E-02	7.80E-06	1.61E+02	3.01E-01	7.34E-03	25	412.27	617.05	8,523	0.0E+00	7.0E+00
108883	Toluene	1.82E+02	8.70E-02	8.60E-06	5.26E+02	2.72E-01	6.63E-03	25	383.78	591.79	7,930	0.0E+00	4.0E-01
108907	Chlorobenzene	2.19E+02	7.30E-02	8.70E-06	4.72E+02	1.52E-01	3.71E-03	25	404.87	632.40	8,410	0.0E+00	2.0E-02
108952	Phenol	2.86E+01	8.20E-02	9.10E-06	8.26E+04	1.63E-03	3.98E-05	25	455.02	694.20	10,920	0.0E+00	2.1E+00
111444	Bis(2-chloroethyl)ether	1.55E+01	8.92E-02	7.53E-06	1.72E+04	7.38E-04	1.80E-05	25	451.15	659.79	9,000	3.3E-04	0.0E+00
115297	Endosulfan	2.14E+03	1.15E-02	4.85E-06	5.10E-01	4.59E-04	1.12E-05	25	674.43	942.94	14,000	0.0E+00	2.1E-02
117817	Bis(2-ethylhexyl)phthalate	1.51E+07	3.51E-02	3.66E-06	3.40E-01	4.18E-06	1.02E-07	25	657.15	806.00	15,999	4.0E-06	0.0E+00
117840	Di-n-octyl phthalate	8.32E+07	1.51E-02	3.56E-06	2.60E-02	2.74E-03	6.68E-05	25	704.09	862.22	15,000	0.0E+00	7.0E-02
118741	Hexachlorobenzene	5.50E+04	5.42E-02	5.91E-06	6.20E+00	5.41E-02	1.32E-03	25	582.55	825.00	14,447	4.6E-04	0.0E+00
120127	Anthracene	2.65E+04	3.24E-02	7.74E-06	4.34E-02	2.67E-03	6.51E-05	25	615.18	873.00	13,121	0.0E+00	1.1E+00
120821	1,2,4-Trichlorobenzene	9.78E+02	3.00E-02	8.23E-06	3.00E+02	5.62E-02	1.42E-03	25	486.15	725.00	10,471	0.0E+00	2.0E-01
120832	2,4-Dichlorophenol	1.47E+02	3.48E-02	8.77E-06	4.50E+03	1.30E-04	3.17E-06	25	482.15	706.17	11,000	0.0E+00	1.1E-02
121142	2,4-Dinitrotoluene	8.55E+01	2.03E-01	7.06E-06	2.70E+02	3.80E-06	9.27E-08	25	590.00	814.00	13,467	1.9E-04	0.0E+00
124481	Chlorodibromomethane	6.31E+01	1.96E-02	1.05E-05	2.60E+03	3.21E-02	7.83E-04	25	416.14	678.20	8,000	2.4E-05	0.0E+00
127184	Tetrachloroethylene	1.55E+02	7.20E-02	8.20E-06	2.00E+02	7.54E-01	1.84E-02	25	394.40	620.20	8,288	5.8E-07	0.0E+00
129000	Pyrene	1.05E+05	2.72E-02	7.24E-06	1.35E-01	4.51E-04	1.10E-05	25	667.95	936.00	14,370	0.0E+00	1.1E-01
156592	cis-1,2-Dichloroethylene	3.65E+01	7.36E-02	1.13E-05	3.50E+03	1.67E-01	4.07E-03	25	333.65	544.00	7,192	0.0E+00	3.5E-02
156605	trans-1,2-Dichloroethylene	5.25E+01	7.07E-02	1.19E-05	6.30E+03	3.85E-01	9.39E-03	25	320.85	516.50	6,717	0.0E+00	7.0E-02
193395	Indeno(1,2,3-cd)pyrene	3.47E+06	1.90E-02	9.66E-06	2.20E-05	6.56E-05	1.60E-06	25	809.15	1076.24	17,000	2.1E-04	0.0E+00
205992	Benzo(b)fluoranthene	1.23E+06	2.26E-02	5.56E-06	1.50E-03	4.55E-03	1.11E-04	25	715.90	969.27	15,000	2.1E-04	0.0E+00
206440	Fluoranthene	1.07E+05	3.02E-02	6.35E-06	2.06E-01	6.60E-04	1.61E-05	25	655.95	905.00	13,615	0.0E+00	1.4E-01
207089	Benzo(k)fluoranthene	1.23E+06	2.26E-02	5.56E-06	8.00E-04	3.40E-05	8.29E-07	25	753.15	1019.70	16,000	2.1E-05	0.0E+00
218019	Chrysene	3.98E+05	2.48E-02	6.21E-06	1.60E-03	3.88E-03	9.46E-05	25	714.15	979.00	16,455	2.1E-06	0.0E+00
309002	Aldrin	2.45E+06	1.32E-02	4.86E-06	1.80E-01	6.97E-03	1.70E-04	25	603.01	839.37	13,000	4.9E-03	0.0E+00
319846	alpha-HCH (alpha-BHC)	1.23E+03	1.42E-02	7.34E-06	2.00E+00	4.35E-04	1.06E-05	25	596.55	839.35	13,000	1.8E-03	0.0E+00
319857	beta-HCH (beta-BHC)	1.26E+03	1.42E-02	7.34E-06	2.40E-01	3.05E-05	7.44E-07	25	596.55	839.38	13,000	5.3E-04	0.0E+00
542756	1,3-Dichloropropene	4.57E+01	6.26E-02	1.00E-05	2.80E+03	7.26E-01	1.77E-02	25	381.15	587.38	7,000	3.7E-05	2.0E-02
606202	2,6-Dinitrotoluene	8.92E+01	3.27E-02	7.26E-06	1.82E+02	3.08E-05	7.46E-07	25	558.00	770.00	12,938	1.9E-04	0.0E+00
621647	N-Nitrosodi-n-propylamine	2.40E+01	5.45E-02	8.17E-06	9.89E+03	9.23E-05	2.25E-06	25	509.60	746.87	11,000	2.0E-03	0.0E+00
1024573	Heptachlor epoxide	8.32E+04	1.52E-02	4.23E-06	2.00E-01	3.90E-04	9.51E-06	25	613.96	848.76	13,000	2.6E-03	0.0E+00
7439976	Mercury (elemental)	5.20E+01	3.07E-02	6.30E-06	5.62E-02	4.67E-01	1.14E-02	25	629.88	1750.00	14,127	0.0E+00	3.0E-04
8001352	Toxaphene	2.57E+05	1.18E-02	4.34E-06	7.40E-01	2.48E-04	6.00E-06	25	657.15	873.31	14,000	3.2E-04	0.0E+00
11096825	Aroclor 1260 (PCB-1260)	2.90E+05	1.38E-02	4.32E-06	4.00E-02	1.89E-01	4.60E-03	25	402.50	539.37	19,000	1.0E-04	0.0E+00
11097691	Aroclor 1254 (PCB-1254)	2.00E+05	1.56E-02	5.00E-06	5.70E-02	8.20E-03	2.00E-03	25	377.50	512.27	19,000	1.0E-04	0.0E+00
12674112	Aroclor 1016 (PCB-1016)	3.30E+04	2.22E-02	5.42E-06	4.20E-01	1.19E-03	2.90E-04	25	340.50	475.22	18,000	1.0E-04	0.0E+00
53469219	Aroclor 1242 (PCB-1242)	3.30E+04	2.14E-02	5.31E-06	3.40E-01	2.13E-02	5.20E-04	25	345.50	482.20	18,000	1.0E-04	0.0E+00

APPENDIX B

SAMPLE DATA ENTRY SHEETS FOR EACH MODEL

DATA ENTRY SHEET (SLSCREEN)

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES	X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES	

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER (initial soil conc., C_s (µg/kg)	Chemical
71432		Benzene

ENTER Depth below grade to bottom of enclosed space floor, L_B (15 or 200 cm)	ENTER Depth below grade to top of contamination, L_s (cm)	ENTER Average soil temperature, T_s (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
200	400	10	SCL		

ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^A (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Vadose zone soil organic carbon fraction, f_{oc}^A (unitless)
1.5	0.43	0.3	0.002

ENTER Averaging time for carcinogens, AT_c (yrs)	ENTER Averaging time for noncarcinogens, AT_{nc} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based soil concentration.	

DATA ENTRY SHEET (GWSCREEN)

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES	X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES	

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_w (µg/L)	Chemical
71432		Benzene

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to water table, L_{wt} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_s (°C)
200	400	SC	10

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone soil dry bulk density, ρ_b* (g/cm^3)	ENTER Vadose zone soil total porosity, n* (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w* (cm^3/cm^3)
SCL			1.5	0.43	0.3

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_c (yrs)	ENTER Averaging time for noncarcinogens, AT_{nc} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	30	30	350

Used to calculate risk-based groundwater concentration.

DATA ENTRY SHEET (SLTIER2)

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES	X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES	

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_s (µg/kg)	Chemical
71432		Benzene

ENTER Average soil temperature, T_s (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_B (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell D38)			ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
				Thickness of soil stratum A, h_A (cm)	Thickness of soil stratum B, (Enter value or 0) h_B (cm)	Thickness of soil stratum C, (Enter value or 0) h_C (cm)			
10	200	400	600	200	100	100	SCL		

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.15	0.008	1.5	0.43	0.25	0.003	1.7	0.34	0.28	0.002

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	981	981	488	0.1	0.45

ENTER Averaging time for carcinogens, AT_c (yrs)	ENTER Averaging time for noncarcinogens, AT_{nc} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based soil concentration.	

DATA ENTRY SHEET (GWTIER2)

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES	X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES	

ENTER Chemical CAS No (numbers only, no dashes)	ENTER Initial groundwater conc., C_w (µg/L)	Chemical
71432		Benzene

ENTER Average soil/ groundwater temperature, T_s (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_f (cm)	ENTER Depth below grade to water table, L_{wt} (cm)	ENTER Totals must add up to value of L_{wt} (cell D28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
10	200	400	300	50	50	C	SC	L		

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
1.5	0.43	0.2	1.7	0.42	0.27	1.7	0.43	0.3

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg pressure differential, ΔP ($g/cm\cdot s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	961	961	488	0.1	0.45

ENTER Averaging time for carcinogens, AT_c (yrs)	ENTER Averaging time for noncarcinogens, AT_{nc} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

APPENDIX C

CHEMICAL PROPERTIES LOOKUP TABLE AND REFERENCES

CAS No.	Chemical	Organic carbon partition coefficient, K_{oc} (cm^3/g)		Diffusivity in air, D_a * (cm^2/s)		Diffusivity in water, D_w (cm^2/s)		Pure component water solubility, S (mg/L)		Henry's law constant H' (unitless)		Henry's law constant at reference temperature, H (atm-m^3/mol)		Henry's law constant reference temperature, T_R (°C)		Normal boiling point, T_b (°K)		Critical temperature, T_c (°K)		Enthalpy of vaporization at the normal boiling point, ΔH_v (cal/mol)		Unit risk factor, URF ($\mu g/m^3)^{-1}$		Reference conc., RfC (mg/m^3)	
50293	DDT	2.63E+06	I	1.37E-02	I	4.95E-06	I	2.50E-02	I	3.32E-04	I	8.10E-06	S	25	I	533.15	7	720.75	11	11,000	12	9.7E-05	I		
50328	Benzo(a)pyrene	1.02E+06	I	4.30E-02	I	9.00E-06	I	1.62E-03	I	4.63E-05	I	1.13E-06	S	25	I	716.90	8	969.27	11	15,000	12	2.1E-03	13		
51285	2,4-Dinitrophenol	1.00E-02	I	2.73E-02	I	9.06E-06	I	2.79E+03	I	1.82E-09	I	4.44E-07	S	25	I	605.28	8	827.85	11	15,000	12			7.0E-03	13
53703	Dibenz(a,h)anthracene	3.80E+06	I	2.02E-02	I	5.18E-06	I	2.49E-03	I	5.03E-07	I	1.47E-08	S	25	I	743.24	6	990.41	11	16,000	12	2.1E-03	13		
56235	Carbon tetrachloride	1.74E+02	I	7.80E-02	I	8.80E-06	I	2.93E+02	I	1.25E+00	I	3.05E-02	S	25	I	349.90	9	556.60	9	7,127	9	1.5E-05	I		
56553	Benz(a)anthracene	3.98E+05	I	6.10E-02	I	9.00E-06	I	9.40E-03	I	1.37E-04	I	3.34E-06	S	25	I	708.15	6	1004.79	11	15,000	12	2.1E-04	13		
57749	Chlordane	1.20E+05	I	1.18E-02	I	4.37E-06	I	5.60E-02	I	1.99E-03	I	4.85E-05	S	25	I	624.24	8	885.73	11	13,000	12	3.7E-04	I		
58899	gamma-HCH (Lindane)	1.07E+03	I	1.42E-02	I	7.34E-06	I	6.80E+00	I	5.74E-04	I	1.40E-05	S	25	I	596.55	7	839.36	11	13,000	12	3.7E-04	13		
60571	Dieldrin	2.14E+04	I	1.25E-02	I	4.74E-06	I	1.95E-01	I	8.19E-04	I	1.51E-05	S	25	I	613.32	6	842.25	11	13,000	12	4.6E-03	I		
65850	Benzoic Acid	6.00E-01	I	5.36E-02	I	7.97E-06	I	3.50E+03	I	8.31E-09	I	1.54E-06	S	25	I	720.00	10	751.00	10	10,000	12			1.4E+01	13
67641	Acetone	5.75E-01	I	1.24E-01	I	1.14E-05	I	1.00E+06	I	1.56E-03	I	3.88E-05	S	25	I	329.20	9	508.10	9	6,955	9			3.5E-01	13
67663	Chloroform	3.98E+01	I	1.04E-01	I	1.00E-05	I	7.92E+03	I	1.50E-01	I	3.66E-03	S	25	I	334.32	9	536.40	9	6,988	9	2.3E-05	I		
67721	Hexachloroethane	1.78E+03	I	2.50E-03	I	8.80E-06	I	5.00E+01	I	1.59E-01	I	3.88E-03	S	25	I	456.00	10	695.00	10	9,510	10	4.0E-06	I		
71363	Butanol	8.92E+00	I	9.00E-02	I	9.30E-06	I	7.40E+04	I	8.81E-06	I	1.80E-06	S	25	I	390.88	9	563.05	9	10,346	9			3.5E-01	13
71432	Benzene	6.89E+01	I	8.80E-02	I	9.80E-06	I	1.75E+03	I	2.28E-01	I	5.56E-03	S	25	I	353.24	9	562.16	9	7,342	9	8.3E-06	I		
71556	1,1,1-Trichloroethane	1.10E+02	I	7.80E-02	I	8.80E-06	I	1.33E+03	I	1.05E-01	I	1.72E-02	S	25	I	347.24	9	545.00	9	7,136	9			5.0E+00	1
72208	Endrin	1.23E+04	I	1.25E-02	I	4.74E-06	I	2.50E-01	I	3.08E-04	I	7.51E-06	S	25	I	718.15	9	986.20	11	12,000	12			6.3E-03	13
72435	Methoxychlor	9.27E+04	I	1.56E-02	I	4.46E-06	I	4.50E-02	I	8.48E-04	I	1.56E-05	S	25	I	651.02	8	848.49	11	14,000	12			1.8E-02	13
72548	DDD	1.00E+06	I	1.88E-02	I	4.70E-06	I	9.00E-02	I	1.64E-04	I	4.00E-06	S	25	I	639.90	8	863.77	11	14,000	12	6.9E-05	13		
72559	DDE	4.47E+06	I	1.44E-02	I	5.87E-06	I	1.20E-01	I	8.61E-04	I	2.10E-05	S	25	I	636.44	8	860.36	11	13,000	12	9.7E-05	13		
74839	Methyl bromide	1.05E+01	I	7.28E-02	I	1.21E-05	I	1.52E+04	I	2.56E-01	I	6.24E-03	S	25	I	276.71	9	467.00	10	5,714	9			5.0E-03	1
75014	Vinyl chloride (chloroethene)	1.86E+01	I	1.06E-01	I	1.23E-05	I	2.76E+03	I	1.11E+00	I	2.71E-02	S	25	I	259.25	10	432.00	10	5,250	10	8.4E-05	I		
75092	Methylene chloride	1.17E+01	I	1.01E-01	I	1.17E-05	I	1.30E+04	I	8.98E-02	I	2.19E-03	S	25	I	313.00	9	510.00	9	6,706	9	4.7E-07	I	3.0E+00	1
75150	Carbon disulfide	4.57E+01	I	1.04E-01	I	1.00E-05	I	1.19E+03	I	1.24E+00	I	3.02E-02	S	25	I	319.00	9	552.00	9	6,391	9			7.0E-01	1
75252	Bromoform	8.71E+01	I	1.49E-02	I	1.03E-05	I	3.10E+03	I	2.19E-02	I	5.34E-04	S	25	I	422.35	10	696.00	10	9,479	9	1.1E-06	I		
75274	Bromodichloromethane	5.50E+01	I	2.88E-02	I	1.06E-05	I	6.74E+03	I	6.56E-02	I	1.60E-03	S	25	I	363.15	7	585.85	11	7,000	12	1.8E-05	13		
75343	1,1-Dichloroethane	3.16E+01	I	7.42E-02	I	1.05E-05	I	5.06E+03	I	2.30E-01	I	5.61E-03	S	25	I	330.55	9	523.00	9	6,895	9			5.0E-01	1
75354	1,1-Dichloroethylene	5.89E+01	I	9.00E-02	I	1.04E-05	I	2.25E+03	I	1.07E+00	I	2.61E-02	S	25	I	304.75	9	576.05	9	6,247	9	5.0E-05	I		
76448	Heptachlor	1.41E+06	I	1.12E-02	I	5.69E-06	I	1.80E-01	I	4.47E-02	I	1.09E-03	S	25	I	603.69	8	846.31	11	13,000	12	1.3E-03	I		
77474	Hexachlorocyclopentadiene	2.00E+05	I	1.61E-02	I	7.21E-06	I	1.80E+00	I	1.11E+00	I	2.71E-02	S	25	I	512.15	10	746.00	10	10,931	10			7.0E-05	1
78591	Isophorone	4.68E+01	I	8.23E-02	I	8.76E-06	I	1.20E+04	I	2.72E-04	I	6.63E-06	S	25	I	488.35	10	715.00	10	10,271	10	2.7E-07	13		
78875	1,2-Dichloropropane	4.37E+01	I	7.83E-02	I	8.73E-06	I	2.80E+03	I	1.15E-01	I	2.80E-03	S	25	I	369.52	10	572.00	10	7,590	10			4.0E-03	I
79005	1,1,2-Trichloroethane	5.01E+01	I	7.80E-02	I	8.80E-06	I	4.42E+03	I	3.74E-02	I	9.12E-04	S	25	I	386.15	9	602.00	10	8,322	9	1.6E-05	I		
79016	Trichloroethylene	1.66E+02	I	7.90E-02	I	9.10E-06	I	1.10E+03	I	4.22E-01	I	1.03E-02	S	25	I	360.36	9	544.20	9	7,505	9	1.7E-06	I		
79345	1,1,2,2-Tetrachloroethane	9.33E+01	I	7.10E-02	I	7.90E-06	I	2.97E+03	I	1.41E-02	I	3.44E-04	S	25	I	419.60	9	661.16	9	8,996	9	5.8E-05	I		
83329	Acenaphthene	7.08E+03	I	4.21E-02	I	7.89E-06	I	4.24E+00	I	6.36E-03	I	1.55E-04	S	25	I	550.54	10	803.15	10	12,156	10			2.1E-01	13
84662	Diethylphthalate	2.88E+02	I	2.56E-02	I	8.35E-06	I	1.08E+03	I	1.85E-05	I	4.51E-07	S	25	I	567.15	10	757.00	10	13,733	10			2.6E+00	13
84742	Di-n-butyl phthalate	3.39E+04	I	4.38E-02	I	7.86E-06	I	1.12E+01	I	3.85E-08	I	9.39E-10	S	25	I	613.15	9	796.67	11	14,751	9			3.5E-01	13
85687	Butyl benzyl phthalate	9.75E+04	I	1.74E-02	I	4.83E-06	I	2.69E+00	I	5.17E-05	I	1.26E-06	S	25	I	660.80	8	839.68	11	13,000	12			7.0E-01	13
86306	N-Nitrosodiphenylamine	1.29E+03	I	3.12E-02	I	8.35E-06	I	3.51E+01	I	2.05E-04	I	5.00E-06	S	25	I	632.28	8	890.45	11	13,000	12	1.4E-06	13		
86737	Fluorene	1.38E+04	I	3.63E-02	I	7.89E-06	I	1.98E+00	I	2.61E-03	I	6.37E-05	S	25	I	570.44	10	870.00	10	12,666	10			1.4E-01	13
86748	Carbazole	3.39E+03	I	3.90E-02	I	7.03E-06	I	7.48E+00	I	6.26E-07	I	1.53E-08	S	25	I	627.87	10	899.00	10	13,977	10	5.7E-06	13		
87683	Hexachloro-1,3-butadiene	5.37E+04	I	5.61E-02	I	8.16E-06	I	3.23E+00	I	3.34E-01	I	8.15E-03	S	25	I	486.15	10	738.00	10	10,206	10	2.2E-05	I		
87865	Pentachlorophenol	5.92E+03	I	5.60E-02	I	8.10E-06	I	1.95E+03	I	1.00E-06	I	2.44E-08	S	25	I	582.15	9	813.20	11	14,000	12	3.4E-05	13		
88062	2,4,6-Trichlorophenol	3.81E+02	I	3.18E-02	I	8.25E-06	I	8.00E+02	I	3.18E-04	I	7.76E-06	S	25	I	519.15	9	749.03	11	12,000	12	3.1E-06	I		
91203	Naphthalene	2.00E+03	I	5.90E-02	I	7.50E-06	I	3.10E+01	I	1.98E-02	I	4.83E-04	S	25	I	491.14	10	748.40	10	10,373	10			8.4E-01	13
91941	3,3-Dichlorobenzidine	7.24E+02	I	1.94E-02	I	6.74E-06	I	3.11E+00	I	1.64E-07	I	4.00E-09	S	25	I	560.26	8	754.03	11	13,000	12	1.3E-04	13		
95476	o-Xylene	3.63E+02	I	8.70E-02	I	1.00E-05	I	1.78E+02	I	2.13E-01	I	5.20E-03	S	25	I	417.60	9	630.30	9	8,661	9			7.0E+00	13
95487	2-Methylphenol (o-cresol)	9.12E+01	I	7.40E-02	I	8.30E-06	I	2.60E+04	I	4.92E-05	I	1.20E-06	S	25	I	464.19	9	697.60	9	10,800	9			1.4E-01	13
95501	1,2-Dichlorobenzene	6.17E+02	I	8.90E-02	I	7.90E-06	I	1.56E+02	I	7.79E-02	I	1.90E-03	S	25	I	453.57	10	705.00	10	9,700	10	2.0E-01	I		
95578	2-Chlorophenol	3.88E+02	I	5.01E-02	I	9.46E-06	I	2.20E+04	I	1.60E-02	I	3.90E-04	S	25	I	447.53	10	675.00	10	9,572	10			1.8E-02	13
95954	2,4,5-Trichlorophenol	1.60E+03	I	2.91E-02	I	7.03E-06	I	1.20E+03	I	1.78E-04	I	4.34E-06	S	25	I	526.15	9	759.13	11	13,000	12			3.5E-01	13
98953	Nitrobenzene	8.46E+01	I	7.80E-02	I	8.80E-06	I	2.09E+03	I	9.84E-04	I	2.40E-05	S	25	I	483.98	10	719.00	10	10,566	10			2.0E-03	1
100414	Ethylbenzene	3.63E+02	I	7.50E-02	I	7.80E-06	I	1.69E+02	I	3.23E-01	I	7.88E-03	S	25	I	409.34	9	617.20	9	8,501	9			1.0E+00	1
100425	Styrene	7.76E+02	I	7.10E-02	I	8.00E-06	I	3.10E+02	I	1.13E-01	I	2.75E-03	S	25	I	416.31	10	636.00	10	8,737	10			1.0E+00	1
105679	2,4-Dimethylphenol	2.09E+02	I	5.84E-02	I	8.09E-06	I	7.87E+03	I	8.20E-05	I	2.00E-06	S	25	I	484.13	10	707.60	10	11,329	10			7.0E-02	13
106423	p-Xylene	3.89E+02	I	7.69E-02	I	8.44E-06	I	1.85E+02	I	3.11E-01	I	7.58E-03	S	26	I	411.52	9	616.20	9	8,525	9			7.0E+00	13
106467	1,4-Dichlorobenzene	8.17E+02	I	6.90E-02	I	7.80E-06	I	7.38E+01	I	9.96E-02	I	2.43E-03	S	25	I	447.21	10	684.75	10	9,271	10	8.0E-06	I		

CAS No	Chemical	Organic carbon partition coefficient, K_{oc} (cm^3/g)		Diffusivity in air, D_a (cm^2/s)		Diffusivity in water, D_w (cm^2/s)		Pure component water solubility, S (mg/L)		Henry's law constant H' (unitless)		Henry's law constant at reference temperature, H (atm-m^3/mol)		Henry's law constant reference temperature, T_R (°C)		Normal boiling point, T_b (°K)		Critical temperature, T_c (°K)		Enthalpy of vaporization at the normal boiling point, ΔH_v (cal/mol)		Unit risk factor, URF ($\mu g/m^3)^{-1}$		Reference conc., RfC (mg/m^3)	
106478	p-Chloroaniline	8.61E+01	1	4.83E-02	1	1.01E-05	1	5.30E+03	1	1.36E-06	1	3.32E-07	6	25	1	503.65	10	754.00	10	11,689	10			1.4E-02	13
107062	1,2-Dichloroethane	1.74E+01	1	1.04E-01	1	9.90E-06	1	8.52E+03	1	4.01E-02	1	9.78E-04	5	25	1	356.65	9	561.00	9	7,643	9	2.6E-05	1		
108054	Vinyl acetate	5.25E+00	1	8.50E-02	1	9.20E-06	1	2.00E+04	1	2.10E-02	1	5.12E-04	5	25	1	345.65	10	519.13	10	7,800	10			2.0E-01	1
108383	m-Xylene	4.07E+02	1	7.00E-02	1	7.80E-06	1	1.61E+02	1	3.01E-01	1	7.34E-03	5	25	1	412.27	9	617.05	9	8,523	9			7.0E+00	13
108883	Toluene	1.82E+02	1	8.70E-02	1	8.60E-06	1	5.26E+02	1	2.72E-01	1	6.63E-03	5	25	1	383.78	9	591.79	9	7,930	9			4.0E-01	1
108907	Chlorobenzene	2.19E+02	1	7.30E-02	1	8.70E-06	1	4.72E+02	1	1.52E-01	1	3.71E-03	5	25	1	404.87	9	632.40	9	8,410	9			2.0E-02	1
108952	Phenol	2.88E+01	1	8.20E-02	1	9.10E-06	1	8.28E+04	1	1.63E-05	1	3.98E-07	5	25	1	455.02	9	694.20	9	10,920	9			2.1E+00	13
111444	Bis(2-chloroethyl)ether	1.55E+01	1	6.82E-02	1	7.53E-06	1	1.72E+04	1	7.34E-04	1	1.80E-05	5	25	1	451.15	9	659.79	11	9,000	12	3.3E-04	1		
115297	Endosulfan	2.14E+03	1	1.15E-02	1	4.55E-06	1	5.10E-01	1	4.59E-04	1	1.12E-05	5	25	1	674.40	8	942.94	11	14,000	12			2.1E-02	13
117817	Bis(2-ethylhexyl)phthalate	1.51E+07	1	3.51E-02	1	3.66E-06	1	3.40E-01	1	4.18E-06	1	1.02E-07	5	25	1	657.15	10	806.00	10	15,999	10	4.0E-06	13		
117840	Di-n-octyl phthalate	8.32E+07	1	1.51E-02	1	3.58E-06	1	2.00E-02	1	2.74E-03	1	6.68E-05	5	25	1	704.09	8	962.22	11	15,000	12			2.0E-02	13
118741	Hexachlorobenzene	8.50E+04	1	5.42E-02	1	5.81E-06	1	6.20E+00	1	8.41E-02	1	1.32E-03	5	25	1	582.55	10	825.00	10	14,447	10	4.6E-04	1		
120127	Anthracene	2.95E+04	1	3.24E-02	1	7.74E-06	1	4.34E-02	1	2.67E-03	1	6.51E-05	5	25	1	615.18	10	873.00	10	13,121	10			1.1E+00	13
120821	1,2,4-Trichlorobenzene	1.78E+03	1	3.00E-02	1	8.23E-06	1	3.00E+02	1	5.62E-02	1	1.42E-03	5	25	1	486.15	10	725.00	10	10,471	10			2.0E-03	1
120832	2,4-Dichlorophenol	1.47E+02	1	3.48E-02	1	8.77E-06	1	4.50E+03	1	1.30E-04	1	3.13E-06	5	25	1	482.15	9	708.17	11	11,000	12			1.1E-02	13
121142	2,4-Dinitrotoluene	8.55E+01	1	2.03E-01	1	7.08E-06	1	2.70E+02	1	3.80E-06	1	9.23E-08	5	25	1	590.00	10	814.00	10	13,467	10	1.9E-04	13		
124481	Chlorodibromomethane	6.31E+01	1	1.90E-02	1	1.05E-05	1	2.60E+03	1	3.21E-02	1	7.83E-04	5	25	1	416.14	8	678.20	11	8,000	12	2.4E-05	13		
127184	Tetrachloroethylene	1.55E+02	1	7.20E-02	1	8.20E-06	1	2.00E+02	1	3.54E-01	1	1.84E-02	5	25	1	394.40	9	620.20	9	8,268	9	5.8E-07	1		
129000	Pyrene	1.05E+05	1	2.72E-02	1	7.24E-06	1	1.35E-01	1	4.51E-04	1	1.10E-05	5	25	1	667.95	10	936.00	10	14,370	10			1.1E-01	13
156592	cis-1,2-Dichloroethylene	3.55E+01	1	7.36E-02	1	1.13E-05	1	3.50E+03	1	1.67E-01	1	4.07E-03	5	25	1	333.65	10	544.00	10	7,192	10			3.5E-02	13
156605	trans-1,2-Dichloroethylene	5.25E+01	1	7.07E-02	1	1.19E-05	1	6.30E+03	1	3.85E-01	1	9.38E-03	5	25	1	320.65	10	516.50	10	6,717	10			7.0E-02	13
193395	Indeno(1,2,3-cd)pyrene	3.47E+06	1	1.90E-02	1	5.56E-06	1	2.20E-05	1	9.56E-05	1	2.60E-06	6	25	1	809.15	7	1078.24	11	17,000	12	2.1E-04	13		
205992	Benzo(b)fluoranthene	1.23E+06	1	2.26E-02	1	5.56E-06	1	1.50E-03	1	4.55E-03	1	1.11E-04	5	25	1	715.90	8	969.27	11	15,000	12	2.1E-04	13		
206440	Fluoranthene	1.07E+05	1	3.02E-02	1	6.35E-06	1	2.06E-01	1	6.50E-04	1	1.61E-05	5	25	1	655.95	10	905.00	10	13,815	10			1.4E-01	13
207089	Benzo(k)fluoranthene	1.23E+06	1	2.26E-02	1	5.56E-06	1	8.00E-04	1	3.40E-05	1	8.29E-07	5	25	1	753.15	7	1019.70	11	16,000	12	2.1E-05	13		
218019	Chrysene	3.98E+05	1	2.48E-02	1	6.21E-06	1	1.80E-03	1	3.88E-03	1	9.46E-05	5	25	1	714.15	10	979.00	10	16,455	10	2.1E-06	13		
309002	Aldrin	2.45E+06	1	1.32E-02	1	4.66E-06	1	1.80E-01	1	8.97E-03	1	1.70E-04	5	25	1	603.01	8	839.37	11	13,000	12	4.9E-03	1		
319846	alpha-HCH (alpha-BHC)	1.23E+03	1	1.42E-02	1	7.34E-06	1	2.00E+00	1	4.35E-04	1	1.06E-05	5	25	1	596.55	7	839.36	11	13,000	12	1.8E-03	1		
319857	beta-HCH (beta-BHC)	1.26E+03	1	1.42E-02	1	7.34E-06	1	2.40E-01	1	3.05E-05	1	7.44E-07	5	25	1	596.55	7	839.36	11	13,000	12	5.3E-04	1		
542756	1,3-Dichloropropene	4.57E+01	1	8.26E-02	1	1.00E-05	1	2.80E+03	1	7.26E-01	1	1.77E-02	5	25	1	381.15	9	567.38	11	7,000	12	3.7E-05	1	2.0E-02	1
606202	2,6-Dinitrotoluene	8.92E+01	1	3.27E-02	1	7.26E-06	1	1.82E+02	1	3.08E-06	1	7.48E-07	5	25	1	556.00	10	770.00	10	12,938	10	1.9E-04	13		
621647	N-Nitrosodi-n-propylamine	2.40E+01	1	5.45E-02	1	8.17E-06	1	9.89E+03	1	9.23E-05	1	2.25E-06	5	25	1	509.60	8	746.87	11	11,000	12	2.0E-03	13		
1024573	Heptachlor epoxide	8.32E+04	1	1.32E-02	1	4.23E-06	1	2.00E-01	1	3.90E-04	1	9.51E-06	5	25	1	613.96	8	848.76	11	13,000	12	2.6E-03	1		
7439976	Mercury (elemental)	5.20E+01	2	3.07E-02	1	6.30E-06	1	5.62E-02	14	4.67E-01	1	1.14E-02	5	25	1	629.88	9	1750.00	9	14,127	9			3.0E-04	1
8001352	Toxaphene	2.57E+05	1	1.16E-02	1	4.34E-06	1	7.40E-01	1	2.48E-04	1	6.00E-06	5	25	1	657.15	9	873.31	11	14,000	12	3.2E-04	1		
11096825	Aroclor 1260 (PCB-1260)	2.00E+05	3	1.56E-02	4	4.32E-06	4	8.00E-02	3	1.89E-01	6	4.60E-03	3	25	3	402.50	3	539.37	11	19,000	12	1.0E-04	3		
11097691	Aroclor 1254 (PCB-1254)	2.00E+05	3	1.56E-02	4	6.00E-06	4	5.70E-02	3	9.20E-02	6	2.00E-03	3	25	3	377.50	3	512.27	11	19,000	12	1.0E-04	3		
12674112	Aroclor 1016 (PCB-1016)	3.30E+04	3	2.22E-02	4	6.42E-06	4	4.20E-01	3	1.19E-02	6	2.90E-04	3	25	3	340.50	3	475.22	11	18,000	12	1.0E-04	3		
53469219	Aroclor 1242 (PCB-1242)	3.30E+04	3	2.14E-02	4	5.31E-06	4	3.40E-01	3	2.13E-02	6	5.20E-04	3	25	3	345.50	3	482.20	11	18,000	12	1.0E-04	3		

LEGEND:

1 = Soil Screening Level (SSL) Guidance Documents, U. S. EPA (1996a and b).
2 = SSL Guidance Documents (U. S. EPA, 1996a and b); value is the soil-water partition coefficient (K_d) at pH = 6.8.
3 = ATSDR draft Toxicity Profile for PCBs, August 1995.
4 = Estimation using the U. S. EPA WATER8 model.
5 = Unitless Henry's law constant divided by 41.
6 = Henry's law constant in units of atm-m^3/mol multiplied by 41.
7 = U. S. EPA Superfund Chemical Data Matrix.
8 = Estimation based on the Quantitative Structure Activity Relationship method of Stein and Brown (1994).
9 = CRC Handbook of Chemistry and Physics, CRC Press (1994).
10 = Design Institute for Physical Property Data, The American Institute for Chemical Engineers, on-line data search, 1997.
11 = Estimation based on Lyman et al. (1990), Equations 12-4 and 12-5.
12 = Estimation based on Lyman et al. (1990), Equation 13-16; Antoine coefficients estimated by boiling point using the U. S. EPA CHEMDAT8 model.
13 = Route-to-Route extrapolation based on the procedures in U. S. EPA (1996b).
14 = The Merck Index, Eleventh Edition, Merck & Co., Inc. 1989.

APPENDIX B

SUMMARY OF UNIT RISK CHARACTERIZATION INCIDENTAL INGESTION

Table B-1
Summary of Unit-Risk Characterization
On-Site Construction Worker
Via Incidental Ingestion of Soils

Intake Equation

$$\frac{CS \times EF \times ED \times CF \times IR}{BW \times AT}$$

IRs	Ingestion rate of soil	480	mg/day
CF	Conversion factor	1.0E-006	kg/mg
EF	Exposure frequency	250	days/year
EDn	Exposure duration for non-carcinogens	1	year
EDc	Exposure duration for carcinogens	1	year
BW	Body weight	70	kg
ATc	Average time for carcinogens (lifetime)	25550	day
ATn	Average time for non-carcinogens (EDn x 365)	365	day
CS	Concentration of chemicals in soil	csv	(see below)

Chemical Concentrations

Compound	CS (mg/kg)
1,1-dichloroethane	1.0E+000
1,1-dichloroethene	1.0E+000
1,1,1-trichloroethane	1.0E+000
1,1,2-trichloroethane	1.0E+000
1,2-dichlorobenzene	1.0E+000
1,2-dichloroethane	1.0E+000
1,2-dichloropropane	1.0E+000
1,4-dichlorobenzene	1.0E+000
2-butanone	1.0E+000
2,4-dichlorophenol	1.0E+000
4-methyl-2-pentanone	1.0E+000
4,4-ddd	1.0E+000
4,4-dde	1.0E+000
4,4-ddt	1.0E+000
acetone	1.0E+000
antimony	1.0E+000
aroclor 1254	1.0E+000
arsenic	1.0E+000
barium	1.0E+000
benzene	1.0E+000
benzo(a)anthracene	1.0E+000
benzo(a)pyrene	1.0E+000
benzo(b)fluoranthene	1.0E+000
beryllium	1.0E+000
bis(2-ethylhexyl)phthalate	1.0E+000
bromodichloromethane	1.0E+000
bromoform	1.0E+000

Compound	CS (mg/kg)
cadmium	1.0E+000
carbon disulfide	1.0E+000
carbon tetrachloride	1.0E+000
chlorobenzene	1.0E+000
chloroform	1.0E+000
chromium iii	1.0E+000
chromium vi	1.0E+000
chrysene	1.0E+000
cis-1,2-dichloroethene	1.0E+000
copper	1.0E+000
cumene	1.0E+000
cyanide	1.0E+000
di-n-butylphthalate	1.0E+000
di-n-octylphthalate	1.0E+000
dibromochloromethane	1.0E+000
endosulfan	1.0E+000
endrin	1.0E+000
ethylbenzene	1.0E+000
gamma-bhc	1.0E+000
hydrogen sulfide	1.0E+000
indeno(1,2,3-cd)pyrene	1.0E+000
manganese	1.0E+000
mercury	1.0E+000
methylene chloride	1.0E+000
molybdenum	1.0E+000
nickel	1.0E+000
phenol	1.0E+000

Compound	CS (mg/kg)
pyrene	1.0E+000
selenium	1.0E+000
silver	1.0E+000
strontium	1.0E+000
tetrachloroethene	1.0E+000
toluene	1.0E+000
trans-1,2-dichloroethene	1.0E+000
trichloroethene	1.0E+000
trichlorofluoromethane	1.0E+000
trichlorotrifluoroethane	1.0E+000
vanadium	1.0E+000
vinyl acetate	1.0E+000
vinyl chloride	1.0E+000
xylene, m-	1.0E+000
xylene, o-	1.0E+000
xylene, p-	1.0E+000
zinc	1.0E+000

Table B-1 (cont.)
Summary of Unit Risk Characterization
On-Site Construction Worker
Via Incidental Ingestion of Soils

Compound	Non-Carcinogenic Calculation			Carcinogenic Calculation		
	CDI (mg/kg-d)	RfD (mg/kg-d)	UH (unitless)	CDI (mg/kg-d)	CSF (mg/kg-d)u-1	UR (unitless)
1,1-dichloroethane	4.70E-006	1.00E+000	4.70E-006	6.71E-008	5.70E-003	3.82E-010
1,1-dichloroethene	4.70E-006	9.00E-003	5.22E-004	6.71E-008	6.00E-001	4.03E-008
1,1,1-trichloroethane	4.70E-006	NA	NA	6.71E-008	NA	NA
1,1,2-trichloroethane	4.70E-006	4.00E-002	1.17E-004	6.71E-008	7.20E-002	4.83E-009
1,2-dichlorobenzene	4.70E-006	NA	NA	6.71E-008	NA	NA
1,2-dichloroethane	4.70E-006	NA	NA	6.71E-008	7.00E-002	4.70E-009
1,2-dichloropropane	4.70E-006	NA	NA	6.71E-008	6.30E-002	4.23E-009
1,4-dichlorobenzene	4.70E-006	NA	NA	6.71E-008	4.00E-002	2.68E-009
2-butanone	4.70E-006	2.00E+000	2.35E-006	6.71E-008	NA	NA
2,4-dichlorophenol	4.70E-006	3.00E-003	1.57E-003	6.71E-008	NA	NA
4-methyl-2-pentanone	4.70E-006	8.00E-001	5.87E-006	6.71E-008	NA	NA
4,4-ddd	4.70E-006	NA	NA	6.71E-008	2.40E-001	1.61E-008
4,4-dde	4.70E-006	NA	NA	6.71E-008	3.40E-001	2.28E-008
4,4-ddt	4.70E-006	5.00E-004	9.39E-003	6.71E-008	3.40E-001	2.28E-008
acetone	4.70E-006	1.00E+000	4.70E-006	6.71E-008	NA	NA
antimony	4.70E-006	4.00E-004	1.17E-002	6.71E-008	NA	NA
aroclor 1254	4.70E-006	5.00E-005	9.39E-002	6.71E-008	NA	NA
arsenic	4.70E-006	3.00E-004	1.57E-002	6.71E-008	1.50E+000	1.01E-007
barium	4.70E-006	7.00E-002	6.71E-005	6.71E-008	NA	NA
benzene	4.70E-006	NA	NA	6.71E-008	1.00E-001	6.71E-009
benzo(a)anthracene	4.70E-006	NA	NA	6.71E-008	1.20E+000	8.05E-008
benzo(a)pyrene	4.70E-006	NA	NA	6.71E-008	1.20E+001	8.05E-007
benzo(b)fluoranthene	4.70E-006	NA	NA	6.71E-008	1.20E+000	8.05E-008
beryllium	4.70E-006	5.00E-003	9.39E-004	6.71E-008	NA	NA
bis(2-ethylhexyl)phthalate	4.70E-006	NA	NA	6.71E-008	8.40E-003	5.64E-010
bromodichloromethane	4.70E-006	2.00E-002	2.35E-004	6.71E-008	1.30E-001	8.72E-009
bromoform	4.70E-006	2.00E-002	2.35E-004	6.71E-008	7.93E-003	5.32E-010
cadmium	4.70E-006	5.00E-004	9.39E-003	6.71E-008	NA	NA
carbon disulfide	4.70E-006	1.00E-001	4.70E-005	6.71E-008	NA	NA
carbon tetrachloride	4.70E-006	NA	NA	6.71E-008	1.50E-001	1.01E-008

Table B-1 (cont.)
Summary of Unit Risk Characterization
On-Site Construction Worker
Via Incidental Ingestion of Soils

Compound	Non-Carcinogenic Calculation CDI (mg/kg-d)	RfD (mg/kg-d)	UH (unitless)	Carcinogenic Calculation CDI (mg/kg-d)	CSF (mg/kg-d)-1	UR (unitless)
chlorobenzene	4.70E-006	NA	NA	6.71E-008	NA	NA
chloroform	4.70E-006	1.00E-002	4.70E-004	6.71E-008	3.10E-002	2.08E-009
chromium iii	4.70E-006	1.00E+000	4.70E-006	6.71E-008	NA	NA
chromium vi	4.70E-006	2.00E-002	2.35E-004	6.71E-008	4.20E-001	2.82E-008
chrysene	4.70E-006	NA	NA	6.71E-008	1.20E-001	8.05E-009
cis-1,2-dichloroethene	4.70E-006	1.00E-001	4.70E-005	6.71E-008	NA	NA
copper	4.70E-006	3.70E-002	1.27E-004	6.71E-008	NA	NA
cumene	4.70E-006	4.00E-001	1.17E-005	6.71E-008	NA	NA
cyanide	4.70E-006	2.00E-002	2.35E-004	6.71E-008	NA	NA
di-n-butylphthalate	4.70E-006	1.00E+000	4.70E-006	6.71E-008	NA	NA
di-n-octylphthalate	4.70E-006	2.00E-002	2.35E-004	6.71E-008	NA	NA
dibromochloromethane	4.70E-006	2.00E-001	2.35E-005	6.71E-008	9.40E-002	6.31E-009
endosulfan	4.70E-006	6.00E-003	7.83E-004	6.71E-008	NA	NA
endrin	4.70E-006	3.00E-004	1.57E-002	6.71E-008	NA	NA
ethylbenzene	4.70E-006	NA	NA	6.71E-008	NA	NA
gamma-bhc	4.70E-006	3.00E-003	1.57E-003	6.71E-008	1.30E+000	8.72E-008
hydrogen sulfide	4.70E-006	3.00E-002	1.57E-004	6.71E-008	NA	NA
indeno(1,2,3-cd)pyrene	4.70E-006	NA	NA	6.71E-008	1.20E+000	8.05E-008
manganese	4.70E-006	5.00E-003	9.39E-004	6.71E-008	NA	NA
mercury	4.70E-006	3.00E-004	1.57E-002	6.71E-008	NA	NA
methylene chloride	4.70E-006	6.00E-002	7.83E-005	6.71E-008	1.40E-002	9.39E-010
molybdenum	4.70E-006	4.00E-002	1.17E-004	6.71E-008	NA	NA
nickel	4.70E-006	2.00E-002	2.35E-004	6.71E-008	NA	NA
phenol	4.70E-006	6.00E-001	7.83E-006	6.71E-008	NA	NA
pyrene	4.70E-006	3.00E-001	1.57E-005	6.71E-008	NA	NA
selenium	4.70E-006	5.00E-003	9.39E-004	6.71E-008	NA	NA
silver	4.70E-006	5.00E-003	9.39E-004	6.71E-008	NA	NA
strontium	4.70E-006	6.00E-001	7.83E-006	6.71E-008	NA	NA
tetrachloroethene	4.70E-006	1.00E-001	4.70E-005	6.71E-008	5.10E-002	3.42E-009
toluene	4.70E-006	2.00E+000	2.35E-006	6.71E-008	NA	NA

Summary of Unit Risk Characterization
On-Site Construction Worker
Via Incidental Ingestion of Soils

Compound	Non-Carcinogenic Calculation		
	CDI (mg/kg-d)	RfD (mg/kg-d)	UH (unitless)
trans-1,2-dichloroethene	4.70E-006	2.00E-001	2.35E-005
trichloroethene	4.70E-006	NA	NA
trichlorofluoromethane	4.70E-006	7.00E-001	6.71E-006
trichlorotrifluoroethane	4.70E-006	3.00E+000	1.57E-006
vanadium	4.70E-006	7.00E-003	6.71E-004
vinyl acetate	4.70E-006	1.00E+000	4.70E-006
vinyl chloride	4.70E-006	NA	NA
xylene, m-	4.70E-006	6.67E-002	7.04E-005
xylene, o-	4.70E-006	NA	NA
xylene, p-	4.70E-006	2.67E-001	1.76E-005
zinc	4.70E-006	3.00E-001	1.57E-005
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA

Compound	Carcinogenic Calculation		
	CDI (mg/kg-d)	CSF (mg/kg-d)-1	UR (unitless)
trans-1,2-dichloroethene	6.71E-008	NA	NA
trichloroethene	6.71E-008	1.50E-002	1.01E-009
trichlorofluoromethane	6.71E-008	NA	NA
trichlorotrifluoroethane	6.71E-008	NA	NA
vanadium	6.71E-008	NA	NA
vinyl acetate	6.71E-008	NA	NA
vinyl chloride	6.71E-008	2.70E-001	1.81E-008
xylene, m-	6.71E-008	NA	NA
xylene, o-	6.71E-008	NA	NA
xylene, p-	6.71E-008	NA	NA
zinc	6.71E-008	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA

APPENDIX C

SUMMARY OF UNIT RISK CHARACTERIZATION
DERMAL CONTACT WITHS SOILS

Table C-1
Summary of Unit Risk Characterization
On-Site Construction Worker
Via Dermal Contact with Soils

Intake Equation = $\frac{CS \times CF \times EF \times ED \times AF \times ABS \times SA}{BW \times AT}$

SA	Surface area of exposed skin	3760	cm2/day
AF	Adherence Factor	1	mg/cm2
ABS	Absorption factor	csv	(see below)
CF	Conversion factor	1.0E-006	kg/mg
EF	Exposure frequency	250	days/year
EDn	Exposure duration for non-carcinogens	1	year
EDc	Exposure duration for carcinogens	1	year
BW	Body weight	70	kg
ATc	Average time for carcinogens (lifetime)	25550	day
ATn	Average time for non-carcinogens (EDn x 365)	365	day
CS	Concentration of chemicals in soil	csv	(see below)

Chemical Concentrations

Compound	ABS (unitless)	CS (mg/kg)	Compound	ABS (unitless)	CS (mg/kg)	Compound	ABS (unitless)	CS (mg/kg)
1,1-dichloroethane	1.00E-001	1.00E+000	carbon disulfide	1.00E-001	1.00E+000	silver	1.00E-002	1.00E+000
1,1-dichloroethene	1.00E-001	1.00E+000	carbon tetrachloride	1.00E-001	1.00E+000	strontium	1.00E-003	1.00E+000
1,1,1-trichloroethane	1.00E-002	1.00E+000	chlorobenzene	1.00E-001	1.00E+000	tetrachloroethene	1.00E-001	1.00E+000
1,1,2-trichloroethane	1.00E-001	1.00E+000	chloroform	1.00E-001	1.00E+000	toluene	1.00E-001	1.00E+000
1,2-dichlorobenzene	1.00E-001	1.00E+000	chromium iii	1.00E-002	1.00E+000	trans-1,2-dichloroethene	1.00E-001	1.00E+000
1,2-dichloroethane	1.00E-001	1.00E+000	chromium vi	1.00E-004	1.00E+000	trichloroethene	1.00E-001	1.00E+000
1,2-dichloropropane	1.00E-001	1.00E+000	chrysene	1.00E-002	1.00E+000	trichlorofluoromethane	1.00E-001	1.00E+000
1,4-dichlorobenzene	1.00E-001	1.00E+000	cis-1,2-dichloroethene	1.00E-001	1.00E+000	trichlorotrifluoroethane	1.00E-002	1.00E+000
2-butanone	1.00E-001	1.00E+000	copper	1.00E-002	1.00E+000	vanadium	1.00E-002	1.00E+000
2,4-dichlorophenol	1.00E-001	1.00E+000	cumene	1.00E-002	1.00E+000	vinyl acetate	1.00E-001	1.00E+000
4-methyl-2-pentanone	1.00E-001	1.00E+000	cyanide	1.00E-002	1.00E+000	vinyl chloride	1.00E-001	1.00E+000
4,4-ddd	5.00E-002	1.00E+000	di-n-butylphthalate	1.00E-001	1.00E+000	xylene, m-	1.00E-002	1.00E+000
4,4-dde	5.00E-002	1.00E+000	di-n-octylphthalate	1.00E-001	1.00E+000	xylene, o-	1.00E-002	1.00E+000
4,4-ddt	5.00E-002	1.00E+000	dibromochloromethane	1.00E-001	1.00E+000	xylene, p-	1.00E-002	1.00E+000
acetone	1.00E-001	1.00E+000	endosulfan	5.00E-002	1.00E+000	zinc	1.00E-002	1.00E+000
antimony	1.00E-002	1.00E+000	endrin	5.00E-002	1.00E+000	NA	NA	NA
aroclor 1254	1.00E-001	1.00E+000	ethylbenzene	1.00E-001	1.00E+000	NA	NA	NA
arsenic	3.00E-002	1.00E+000	gamma-bhc	5.00E-002	1.00E+000	NA	NA	NA
barium	1.00E-002	1.00E+000	hydrogen sulfide	1.00E-003	1.00E+000	NA	NA	NA
benzene	1.00E-001	1.00E+000	indeno(1,2,3-cd)pyrene	1.00E-001	1.00E+000	NA	NA	NA
benzo(a)anthracene	1.50E-001	1.00E+000	manganese	1.00E-003	1.00E+000	NA	NA	NA
benzo(a)pyrene	1.50E-001	1.00E+000	mercury	1.00E-002	1.00E+000	NA	NA	NA
benzo(b)fluoranthene	1.50E-001	1.00E+000	methylene chloride	1.00E-001	1.00E+000	NA	NA	NA
beryllium	1.00E-002	1.00E+000	molybdenum	1.00E-002	1.00E+000	NA	NA	NA
bis(2-ethylhexyl)phthalate	1.00E-001	1.00E+000	nickel	1.00E-002	1.00E+000	NA	NA	NA
bromodichloromethane	1.00E-001	1.00E+000	phenol	1.00E-001	1.00E+000	NA	NA	NA
bromoform	1.00E-001	1.00E+000	pyrene	1.50E-001	1.00E+000	NA	NA	NA
cadmium	1.00E-003	1.00E+000	selenium	1.00E-002	1.00E+000	NA	NA	NA

Table C-1 (cont.)
Summary of Unit Risk Characterization
On-Site Construction Worker
Via Dermal Contact with Soils

Compound	Non-Carcinogenic Calculation		
	CDI (mg/kg-d)	RfD (mg/kg-d)	UH (unitless)
1,1-dichloroethane	3.68E-006	9.00E-001	4.09E-006
1,1-dichloroethene	3.68E-006	8.10E-003	4.54E-004
1,1,1-trichloroethane	3.68E-007	NA	NA
1,1,2-trichloroethane	3.68E-006	3.60E-002	1.02E-004
1,2-dichlorobenzene	3.68E-006	NA	NA
1,2-dichloroethane	3.68E-006	NA	NA
1,2-dichloropropane	3.68E-006	NA	NA
1,4-dichlorobenzene	3.68E-006	NA	NA
2-butanone	3.68E-006	1.80E+000	2.04E-006
2,4-dichlorophenol	3.68E-006	2.70E-003	1.36E-003
4-methyl-2-pentanone	3.68E-006	7.20E-001	5.11E-006
4,4-ddd	1.84E-006	NA	NA
4,4-dde	1.84E-006	NA	NA
4,4-ddt	1.84E-006	4.50E-004	4.09E-003
acetone	3.68E-006	9.00E-001	4.09E-006
antimony	3.68E-007	6.00E-005	6.13E-003
aroclor 1254	3.68E-006	4.50E-005	8.18E-002
arsenic	1.10E-006	2.85E-004	3.87E-003
barium	3.68E-007	6.37E-002	5.78E-006
benzene	3.68E-006	NA	NA
benzo(a)anthracene	5.52E-006	NA	NA
benzo(a)pyrene	5.52E-006	NA	NA
benzo(b)fluoranthene	5.52E-006	NA	NA
beryllium	3.68E-007	5.00E-005	7.36E-003
bis(2-ethylhexyl)phthalate	3.68E-006	NA	NA
bromodichloromethane	3.68E-006	1.80E-002	2.04E-004
bromoform	3.68E-006	1.80E-002	2.04E-004
cadmium	3.68E-008	2.50E-005	1.47E-003
carbon disulfide	3.68E-006	9.00E-002	4.09E-005
carbon tetrachloride	3.68E-006	NA	NA

Compound	Carcinogenic Calculation		
	CDI (mg/kg-d)	CSF (mg/kg-d)-u	UR (unitless)
1,1-dichloroethane	5.26E-008	5.70E-003	3.00E-010
1,1-dichloroethene	5.26E-008	6.00E-001	3.15E-008
1,1,1-trichloroethane	5.26E-009	NA	NA
1,1,2-trichloroethane	5.26E-008	7.20E-002	3.78E-009
1,2-dichlorobenzene	5.26E-008	NA	NA
1,2-dichloroethane	5.26E-008	7.00E-002	3.68E-009
1,2-dichloropropane	5.26E-008	6.30E-002	3.31E-009
1,4-dichlorobenzene	5.26E-008	4.00E-002	2.10E-009
2-butanone	5.26E-008	NA	NA
2,4-dichlorophenol	5.26E-008	NA	NA
4-methyl-2-pentanone	5.26E-008	NA	NA
4,4-ddd	2.63E-008	2.40E-001	6.31E-009
4,4-dde	2.63E-008	3.40E-001	8.93E-009
4,4-ddt	2.63E-008	3.40E-001	8.93E-009
acetone	5.26E-008	NA	NA
antimony	5.26E-009	NA	NA
aroclor 1254	5.26E-008	NA	NA
arsenic	1.58E-008	1.50E+000	2.37E-008
barium	5.26E-009	NA	NA
benzene	5.26E-008	1.00E-001	5.26E-009
benzo(a)anthracene	7.88E-008	1.33E+000	1.05E-007
benzo(a)pyrene	7.88E-008	1.33E+001	1.05E-006
benzo(b)fluoranthene	7.88E-008	1.33E+000	1.05E-007
beryllium	5.26E-009	NA	NA
bis(2-ethylhexyl)phthalate	5.26E-008	8.40E-003	4.41E-010
bromodichloromethane	5.26E-008	1.30E-001	6.83E-009
bromoform	5.26E-008	7.93E-003	4.17E-010
cadmium	5.26E-010	NA	NA
carbon disulfide	5.26E-008	NA	NA
carbon tetrachloride	5.26E-008	1.50E-001	7.88E-009

Table C-1 (cont.)
Summary of Unit Risk Characterization
On-Site Construction Worker
Via Dermal Contact with Soils

Compound	Non-Carcinogenic Calculation			Carcinogenic Calculation		
	CDI (mg/kg-d)	RfD (mg/kg-d)	UH (unitless)	CDI (mg/kg-d)	CSF (mg/kg-d)-1	UR (unitless)
chlorobenzene	3.68E-006	NA	NA	5.26E-008	NA	NA
chloroform	3.68E-006	1.00E-002	3.68E-004	5.26E-008	3.10E-002	1.63E-009
chromium iii	3.68E-007	4.50E-001	8.18E-007	5.26E-009	NA	NA
chromium vi	3.68E-009	9.00E-003	4.09E-007	5.26E-011	4.20E-001	2.21E-011
chrysene	3.68E-007	NA	NA	5.26E-009	1.20E-001	6.31E-010
cis-1,2-dichloroethene	3.68E-006	9.00E-002	4.09E-005	5.26E-008	NA	NA
copper	3.68E-007	2.22E-002	1.66E-005	5.26E-009	NA	NA
cumene	3.68E-007	3.20E-001	1.15E-006	5.26E-009	NA	NA
cyanide	3.68E-007	1.44E-002	2.55E-005	5.26E-009	NA	NA
di-n-butylphthalate	3.68E-006	9.00E-001	4.09E-006	5.26E-008	NA	NA
di-n-octylphthalate	3.68E-006	1.80E-002	2.04E-004	5.26E-008	NA	NA
dibromochloromethane	3.68E-006	1.80E-001	2.04E-005	5.26E-008	9.40E-002	4.94E-009
endosulfan	1.84E-006	5.40E-003	3.41E-004	2.63E-008	NA	NA
endrin	1.84E-006	2.70E-004	6.81E-003	2.63E-008	NA	NA
ethylbenzene	3.68E-006	NA	NA	5.26E-008	NA	NA
gamma-bhc	1.84E-006	2.91E-003	6.32E-004	2.63E-008	1.30E+000	3.42E-008
hydrogen sulfide	3.68E-008	6.00E-003	6.13E-006	5.26E-010	NA	NA
indeno(1,2,3-cd)pyrene	3.68E-006	NA	NA	5.26E-008	1.20E+000	6.31E-008
manganese	3.68E-008	2.00E-004	1.84E-004	5.26E-010	NA	NA
mercury	3.68E-007	4.50E-005	8.18E-003	5.26E-009	NA	NA
methylene chloride	3.68E-006	6.00E-002	6.13E-005	5.26E-008	1.40E-002	7.36E-010
molybdenum	3.68E-007	1.52E-002	2.42E-005	5.26E-009	NA	NA
nickel	3.68E-007	1.00E-003	3.68E-004	5.26E-009	NA	NA
phenol	3.68E-006	5.40E-001	6.81E-006	5.26E-008	NA	NA
pyrene	5.52E-006	1.29E-001	4.28E-005	7.88E-008	NA	NA
selenium	3.68E-007	4.85E-003	7.59E-005	5.26E-009	NA	NA
silver	3.68E-007	1.05E-003	3.50E-004	5.26E-009	NA	NA
strontium	3.68E-008	1.20E-001	3.07E-007	5.26E-010	NA	NA
tetrachloroethene	3.68E-006	9.00E-002	4.09E-005	5.26E-008	5.10E-002	2.68E-009
toluene	3.68E-006	2.00E+000	1.84E-006	5.26E-008	NA	NA

Table C-1 (cont.)
Summary of Unit Risk Characterization
On-Site Construction Worker
Via Dermal Contact with Soils

Compound	Non-Carcinogenic Calculation		
	CDI (mg/kg-d)	RfD (mg/kg-d)	UH (unitless)
trans-1,2-dichloroethene	3.68E-006	1.80E-001	2.04E-005
trichloroethene	3.68E-006	NA	NA
trichlorofluoromethane	3.68E-006	6.30E-001	5.84E-006
trichlorotrifluoroethane	3.68E-007	2.40E+000	1.53E-007
vanadium	3.68E-007	3.50E-004	1.05E-003
vinyl acetate	3.68E-006	9.00E-001	4.09E-006
vinyl chloride	3.68E-006	NA	NA
xylene, m-	3.68E-007	5.34E-002	6.89E-006
xylene, o-	3.68E-007	NA	NA
xylene, p-	3.68E-007	2.14E-001	1.72E-006
zinc	3.68E-007	9.00E-002	4.09E-006
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA

Compound	Carcinogenic Calculation		
	CDI (mg/kg-d)	CSF (mg/kg-d)[illegible]u	UR (unitless)
trans-1,2-dichloroethene	5.26E-008	NA	NA
trichloroethene	5.26E-008	1.50E-002	7.88E-010
trichlorofluoromethane	5.26E-008	NA	NA
trichlorotrifluoroethane	5.26E-009	NA	NA
vanadium	5.26E-009	NA	NA
vinyl acetate	5.26E-008	NA	NA
vinyl chloride	5.26E-008	2.70E-001	1.42E-008
xylene, m-	5.26E-009	NA	NA
xylene, o-	5.26E-009	NA	NA
xylene, p-	5.26E-009	NA	NA
zinc	5.26E-009	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA

APPENDIX D

SUMMARY OF UNIT RISK CHARACTERIZATION
INHALATION OF PARTICULATES AND VOLATILES

Table D-1
Summary of Unit Risk Characterization
On-Site Construction Worker
Via Inhalation of Particulates and Volatiles

Intake Equation = $\frac{CS \times (1/VF + 1/PEF) \times EF \times ED \times ET \times IR}{BW \times AT}$

IR	Inhalation rate of gases	3.3	m3/h
EF	Exposure frequency	250	days/year
EDn	Exposure duration for non-carcinogens	1	year
EDc	Exposure duration for carcinogens	1	year
BW	Body weight	70	kg
ATc	Average time for carcinogens (lifetime)	25550	days
ATn	Average time for non-carcinogens (EDn x 365)	365	days
ET	Exposure time	12	h/d
CS	Concentration of chemicals in soil	csv	(see below)
VF	Volatilization Factor	csv	(see below)
PEF	Particulate Emission Factor	csv	(see below)

Chemical Concentrations

Compound	VF (m3/kg)	PEF (m3/kg)	Cs (mg/kg)
1,1-dichloroethane	4.8E+004	5.4E+009	1.0E+000
1,1-dichloroethene	2.7E+004	5.4E+009	1.0E+000
1,1,1-trichloroethane	5.0E+004	5.4E+009	1.0E+000
1,1,2-trichloroethane	1.5E+005	5.4E+009	1.0E+000
1,2-dichlorobenzene	3.8E+005	5.4E+009	1.0E+000
1,2-dichloroethane	7.2E+004	5.4E+009	1.0E+000
1,2-dichloropropane	7.8E+004	5.4E+009	1.0E+000
1,4-dichlorobenzene	3.3E+005	5.4E+009	1.0E+000
2-butanone	NA	5.4E+009	1.0E+000
2,4-dichlorophenol	NA	5.4E+009	1.0E+000
4-methyl-2-pentanone	NA	5.4E+009	1.0E+000
4,4-ddd	NA	5.4E+009	1.0E+000
4,4-dde	6.7E+008	5.4E+009	1.0E+000
4,4-ddt	NA	5.4E+009	1.0E+000
acetone	6.0E+004	5.4E+009	1.0E+000
antimony	NA	5.4E+009	1.0E+000
aroclor 1254	1.4E+007	5.4E+009	1.0E+000
arsenic	NA	5.4E+009	1.0E+000
barium	NA	5.4E+009	1.0E+000
benzene	6.0E+004	5.4E+009	1.0E+000
benzo(a)anthracene	NA	5.4E+009	1.0E+000
benzo(a)pyrene	NA	5.4E+009	1.0E+000
benzo(b)fluoranthene	1.2E+008	5.4E+009	1.0E+000
beryllium	NA	5.4E+009	1.0E+000
bis(2-ethylhexyl)phthalate	NA	5.4E+009	1.0E+000
bromodichloromethane	1.9E+005	5.4E+009	1.0E+000
bromoform	5.7E+005	5.4E+009	1.0E+000
cadmium	NA	5.4E+009	1.0E+000

Compound	VF (m3/kg)	PEF (m3/kg)	Cs (mg/kg)
carbon disulfide	2.1E+004	5.4E+009	1.0E+000
carbon tetrachloride	4.7E+004	5.4E+009	1.0E+000
chlorobenzene	1.6E+005	5.4E+009	1.0E+000
chloroform	5.6E+004	5.4E+009	1.0E+000
chromium iii	NA	5.4E+009	1.0E+000
chromium vi	NA	5.4E+009	1.0E+000
chrysene	NA	5.4E+009	1.0E+000
cis-1,2-dichloroethene	6.0E+004	5.4E+009	1.0E+000
copper	NA	5.4E+009	1.0E+000
cumene	2.5E+005	5.4E+009	1.0E+000
cyanide	NA	5.4E+009	1.0E+000
di-n-butylphthalate	NA	5.4E+009	1.0E+000
di-n-octylphthalate	1.6E+009	5.4E+009	1.0E+000
dibromochloromethane	3.9E+005	5.4E+009	1.0E+000
endosulfan	2.2E+007	5.4E+009	1.0E+000
endrin	NA	5.4E+009	1.0E+000
ethylbenzene	1.4E+005	5.4E+009	1.0E+000
gamma-bhc	NA	5.4E+009	1.0E+000
hydrogen sulfide	NA	5.4E+009	1.0E+000
indeno(1,2,3-cd)pyrene	NA	5.4E+009	1.0E+000
manganese	NA	5.4E+009	1.0E+000
mercury	6.7E+004	5.4E+009	1.0E+000
methylene chloride	4.0E+004	5.4E+009	1.0E+000
molybdenum	NA	5.4E+009	1.0E+000
nickel	NA	5.4E+009	1.0E+000
phenol	NA	5.4E+009	1.0E+000
pyrene	1.0E+008	5.4E+009	1.0E+000
selenium	NA	5.4E+009	1.0E+000

Compound	VF (m3/kg)	PEF (m3/kg)	Cs (mg/kg)
silver	NA	5.4E+009	1.0E+000
strontium	NA	5.4E+009	1.0E+000
tetrachloroethene	5.9E+004	5.4E+009	1.0E+000
toluene	9.8E+004	5.4E+009	1.0E+000
trans-1,2-dichloroethene	4.9E+004	5.4E+009	1.0E+000
trichloroethene	7.8E+004	5.4E+009	1.0E+000
trichlorofluoromethane	3.4E+004	5.4E+009	1.0E+000
trichlorotrifluoroethane	3.2E+004	5.4E+009	1.0E+000
vanadium	NA	5.4E+009	1.0E+000
vinyl acetate	6.0E+004	5.4E+009	1.0E+000
vinyl chloride	1.4E+004	5.4E+009	1.0E+000
xylene, m-	1.7E+005	5.4E+009	1.0E+000
xylene, o-	1.7E+005	5.4E+009	1.0E+000
xylene, p-	1.6E+005	5.4E+009	1.0E+000
zinc	NA	5.4E+009	1.0E+000
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA

Table D-1 (cont.)
Summary of Unit Risk Characterization
On-Site Construction Worker
Via Inhalation of Particulates and Volatiles

	Non-Carcinogenic Calculation		
Compound	CDI (mg/kg-d)	RfD (mg/kg-d)	UH (unitless)
1,1-dichloroethane	3.69E-006	1.43E+000	2.58E-006
1,1-dichloroethene	6.43E-006	9.00E-003	7.15E-004
1,1,1-trichloroethane	3.55E-006	NA	NA
1,1,2-trichloroethane	1.21E-006	4.00E-002	3.02E-005
1,2-dichlorobenzene	4.67E-007	NA	NA
1,2-dichloroethane	2.45E-006	NA	NA
1,2-dichloropropane	2.27E-006	3.71E-003	6.11E-004
1,4-dichlorobenzene	5.28E-007	7.14E-001	7.40E-007
2-butanone	3.28E-011	2.86E+000	1.15E-011
2,4-dichlorophenol	3.28E-011	3.00E-003	1.09E-008
4-methyl-2-pentanone	3.28E-011	2.29E-001	1.44E-010
4,4-ddd	3.28E-011	NA	NA
4,4-dde	2.96E-010	NA	NA
4,4-ddt	3.28E-011	5.00E-004	6.56E-008
acetone	2.93E-006	1.00E+000	2.93E-006
antimony	3.28E-011	4.00E-004	8.20E-008
aroclor 1254	1.27E-008	5.00E-005	2.54E-004
arsenic	3.28E-011	3.00E-004	1.09E-007
barium	3.28E-011	1.43E-003	2.30E-008
benzene	2.92E-006	NA	NA
benzo(a)anthracene	3.28E-011	NA	NA
benzo(a)pyrene	3.28E-011	NA	NA
benzo(b)fluoranthene	1.48E-009	NA	NA
beryllium	3.28E-011	5.00E-003	6.56E-009
bis(2-ethylhexyl)phthalate	3.28E-011	NA	NA
bromodichloromethane	9.44E-007	2.00E-002	4.72E-005
bromoform	3.06E-007	2.00E-002	1.53E-005
cadmium	3.28E-011	5.00E-004	6.56E-008
carbon disulfide	8.46E-006	2.00E-001	4.23E-005
carbon tetrachloride	3.75E-006	NA	NA

	Carcinogenic Calculation		
Compound	CDI (mg/kg-d)	CSF (mg/kg-d)-1	UR (unitless)
1,1-dichloroethane	5.27E-008	5.70E-003	3.00E-010
1,1-dichloroethene	9.19E-008	1.20E+000	1.10E-007
1,1,1-trichloroethane	5.06E-008	NA	NA
1,1,2-trichloroethane	1.73E-008	7.20E-002	1.24E-009
1,2-dichlorobenzene	6.67E-009	NA	NA
1,2-dichloroethane	3.50E-008	7.00E-002	2.45E-009
1,2-dichloropropane	3.24E-008	6.30E-002	2.04E-009
1,4-dichlorobenzene	7.55E-009	4.00E-002	3.02E-010
2-butanone	4.69E-013	NA	NA
2,4-dichlorophenol	4.69E-013	NA	NA
4-methyl-2-pentanone	4.69E-013	NA	NA
4,4-ddd	4.69E-013	2.40E-001	1.13E-013
4,4-dde	4.23E-012	3.40E-001	1.44E-012
4,4-ddt	4.69E-013	3.40E-001	1.59E-013
acetone	4.19E-008	NA	NA
antimony	4.69E-013	NA	NA
aroclor 1254	1.81E-010	NA	NA
arsenic	4.69E-013	1.20E+001	5.63E-012
barium	4.69E-013	NA	NA
benzene	4.18E-008	1.00E-001	4.18E-009
benzo(a)anthracene	4.69E-013	3.90E-001	1.83E-013
benzo(a)pyrene	4.69E-013	3.90E+000	1.83E-012
benzo(b)fluoranthene	2.11E-011	3.90E-001	8.25E-012
beryllium	4.69E-013	8.40E+000	3.94E-012
bis(2-ethylhexyl)phthalate	4.69E-013	8.40E-003	3.94E-015
bromodichloromethane	1.35E-008	1.30E-001	1.75E-009
bromoform	4.38E-009	3.90E-003	1.71E-011
cadmium	4.69E-013	1.50E+001	7.03E-012
carbon disulfide	1.21E-007	NA	NA
carbon tetrachloride	5.36E-008	1.50E-001	8.05E-009

Table D-1 (cont.)
Summary of Unit Risk Characterization
On-Site Construction Worker
Via Inhalation of Particulates and Volatiles

	Non-Carcinogenic Calculation		
Compound	CDI (mg/kg-d)	RfD (mg/kg-d)	UH (unitless)
chlorobenzene	1.13E-006	NA	NA
chloroform	3.14E-006	1.00E-002	3.14E-004
chromium iii	3.28E-011	1.00E+000	3.28E-011
chromium vi	3.28E-011	2.00E-002	1.64E-009
chrysene	3.28E-011	NA	NA
cis-1,2-dichloroethene	2.95E-006	1.00E-001	2.95E-005
copper	3.28E-011	3.70E-002	8.87E-010
cumene	7.12E-007	2.57E-002	2.77E-005
cyanide	3.28E-011	2.00E-002	1.64E-009
di-n-butylphthalate	3.28E-011	1.00E+000	3.28E-011
di-n-octylphthalate	1.44E-010	2.00E-002	7.22E-009
dibromochloromethane	4.52E-007	2.00E-001	2.26E-006
endosulfan	7.89E-009	6.00E-003	1.32E-006
endrin	3.28E-011	3.00E-004	1.09E-007
ethylbenzene	1.29E-006	NA	NA
gamma-bhc	3.28E-011	3.00E-003	1.09E-008
hydrogen sulfide	3.28E-011	3.00E-002	1.09E-009
indeno(1,2,3-cd)pyrene	3.28E-011	NA	NA
manganese	3.28E-011	5.00E-003	6.56E-009
mercury	2.64E-006	8.57E-005	3.07E-002
methylene chloride	4.42E-006	8.57E-001	5.15E-006
molybdenum	3.28E-011	4.00E-002	8.20E-010
nickel	3.28E-011	2.00E-002	1.64E-009
phenol	3.28E-011	6.00E-001	5.47E-011
pyrene	1.74E-009	3.00E-001	5.81E-009
selenium	3.28E-011	5.00E-003	6.56E-009
silver	3.28E-011	5.00E-003	6.56E-009
strontium	3.28E-011	6.00E-001	5.47E-011
tetrachloroethene	2.97E-006	1.00E-001	2.97E-005
toluene	1.80E-006	2.00E+000	9.02E-007

	Carcinogenic Calculation		
Compound	CDI (mg/kg-d)	CSF (mg/kg-d) -1	UR (unitless)
chlorobenzene	1.61E-008	NA	NA
chloroform	4.48E-008	1.90E-002	8.52E-010
chromium iii	4.69E-013	NA	NA
chromium vi	4.69E-013	5.10E+002	2.39E-010
chrysene	4.69E-013	3.90E-002	1.83E-014
cis-1,2-dichloroethene	4.21E-008	NA	NA
copper	4.69E-013	NA	NA
cumene	1.02E-008	NA	NA
cyanide	4.69E-013	NA	NA
di-n-butylphthalate	4.69E-013	NA	NA
di-n-octylphthalate	2.06E-012	NA	NA
dibromochloromethane	6.46E-009	9.40E-002	6.07E-010
endosulfan	1.13E-010	NA	NA
endrin	4.69E-013	NA	NA
ethylbenzene	1.85E-008	NA	NA
gamma-bhc	4.69E-013	1.10E+000	5.16E-013
hydrogen sulfide	4.69E-013	NA	NA
indeno(1,2,3-cd)pyrene	4.69E-013	3.90E-001	1.83E-013
manganese	4.69E-013	NA	NA
mercury	3.77E-008	NA	NA
methylene chloride	6.31E-008	3.50E-003	2.21E-010
molybdenum	4.69E-013	NA	NA
nickel	4.69E-013	9.10E-001	4.27E-013
phenol	4.69E-013	NA	NA
pyrene	2.49E-011	NA	NA
selenium	4.69E-013	NA	NA
silver	4.69E-013	NA	NA
strontium	4.69E-013	NA	NA
tetrachloroethene	4.24E-008	2.10E-002	8.90E-010
toluene	2.58E-008	NA	NA

Table D-1 (cont.)
Summary of Unit Risk Characterization
On-Site Construction Worker
Via Inhalation of Particulates and Volatiles

Compound	Non-Carcinogenic Calculation		
	CDI (mg/kg-d)	RfD (mg/kg-d)	UH (unitless)
trans-1,2-dichloroethene	3.61E-006	2.00E-001	1.81E-005
trichloroethene	2.25E-006	NA	NA
trichlorofluoromethane	5.21E-006	7.00E-001	7.44E-006
trichlorotrifluoroethane	5.52E-006	8.57E+000	6.43E-007
vanadium	3.28E-011	7.00E-003	4.69E-009
vinyl acetate	2.92E-006	5.71E-002	5.11E-005
vinyl chloride	1.28E-005	NA	NA
xylene, m-	1.03E-006	6.67E-002	1.55E-005
xylene, o-	1.02E-006	NA	NA
xylene, p-	1.13E-006	2.67E-001	4.23E-006
zinc	3.28E-011	3.00E-001	1.09E-010
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA

Compound	Carcinogenic Calculation		
	CDI (mg/kg-d)	CSF (mg/kg-d)-1	UR (unitless)
trans-1,2-dichloroethene	5.16E-008	NA	NA
trichloroethene	3.21E-008	1.00E-002	3.21E-010
trichlorofluoromethane	7.44E-008	NA	NA
trichlorotrifluoroethane	7.88E-008	NA	NA
vanadium	4.69E-013	NA	NA
vinyl acetate	4.17E-008	NA	NA
vinyl chloride	1.83E-007	2.70E-001	4.94E-008
xylene, m-	1.47E-008	NA	NA
xylene, o-	1.46E-008	NA	NA
xylene, p-	1.61E-008	NA	NA
zinc	4.69E-013	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA

Table D-2
Summary of Unit Risk Characterization
On-Site Operations/Office Personnel
Via Inhalation of Outdoor Air

Intake Equation

$$\frac{CS \times (1/VF + 1/PEF) \times EF \times ED \times ET \times IR}{BW \times AT}$$

IR	Inhalation rate of gases	1.25	m3/h
EF	Exposure frequency	250	days/year
EDn	Exposure duration for non-carcinogens	25	year
EDc	Exposure duration for carcinogens	25	year
BW	Body weight	70	kg
ATc	Average time for carcinogens (lifetime)	25550	days
ATn	Average time for non-carcinogens (EDn x 365)	9125	days
ET	Exposure time (Outdoor)	1	h/day
CS	Concentration of chemicals in soil	csv	(see below)
VF	Volatilization Factor	csv	(see below)
PEF	Particulate Emission Factor	csv	(see below)

Chemical Concentrations

Compound	VF (m3/kg)	PEF (m3/kg)	Cs (mg/kg)
1,1-dichloroethane	4.78E+004	5.37E+009	1.00E+000
1,1-dichloroethene	2.74E+004	5.37E+009	1.00E+000
1,1,1-trichloroethane	4.97E+004	5.37E+009	1.00E+000
1,1,2-trichloroethane	1.46E+005	5.37E+009	1.00E+000
1,2-dichlorobenzene	3.77E+005	5.37E+009	1.00E+000
1,2-dichloroethane	7.18E+004	5.37E+009	1.00E+000
1,2-dichloropropane	7.76E+004	5.37E+009	1.00E+000
1,4-dichlorobenzene	3.33E+005	5.37E+009	1.00E+000
2-butanone	NA	5.37E+009	1.00E+000
2,4-dichlorophenol	NA	5.37E+009	1.00E+000
4-methyl-2-pentanone	NA	5.37E+009	1.00E+000
4,4-ddd	NA	5.37E+009	1.00E+000
4,4-dde	6.68E+008	5.37E+009	1.00E+000
4,4-ddt	NA	5.37E+009	1.00E+000
acetone	6.00E+004	5.37E+009	1.00E+000
antimony	NA	5.37E+009	1.00E+000
aroclor 1254	1.39E+007	5.37E+009	1.00E+000
arsenic	NA	5.37E+009	1.00E+000
barium	NA	5.37E+009	1.00E+000
benzene	6.02E+004	5.37E+009	1.00E+000
benzo(a)anthracene	NA	5.37E+009	1.00E+000
benzo(a)pyrene	NA	5.37E+009	1.00E+000
benzo(b)fluoranthene	1.22E+008	5.37E+009	1.00E+000
beryllium	NA	5.37E+009	1.00E+000
bis(2-ethylhexyl)phthalate	NA	5.37E+009	1.00E+000
bromodichloromethane	1.87E+005	5.37E+009	1.00E+000
bromoform	5.75E+005	5.37E+009	1.00E+000

Compound	VF (m3/kg)	PEF (m3/kg)	Cs (mg/kg)
cadmium	NA	5.37E+009	1.00E+000
carbon disulfide	2.08E+004	5.37E+009	1.00E+000
carbon tetrachloride	4.69E+004	5.37E+009	1.00E+000
chlorobenzene	1.56E+005	5.37E+009	1.00E+000
chloroform	5.61E+004	5.37E+009	1.00E+000
chromium iii	NA	5.37E+009	1.00E+000
chromium vi	NA	5.37E+009	1.00E+000
chrysene	NA	5.37E+009	1.00E+000
cis-1,2-dichloroethene	5.98E+004	5.37E+009	1.00E+000
copper	NA	5.37E+009	1.00E+000
cumene	2.47E+005	5.37E+009	1.00E+000
cyanide	NA	5.37E+009	1.00E+000
di-n-butylphthalate	NA	5.37E+009	1.00E+000
di-n-octylphthalate	1.58E+009	5.37E+009	1.00E+000
dibromochloromethane	3.90E+005	5.37E+009	1.00E+000
endosulfan	2.24E+007	5.37E+009	1.00E+000
endrin	NA	5.37E+009	1.00E+000
ethylbenzene	1.36E+005	5.37E+009	1.00E+000
gamma-bhc	NA	5.37E+009	1.00E+000
hydrogen sulfide	NA	5.37E+009	1.00E+000
indeno(1,2,3-cd)pyrene	NA	5.37E+009	1.00E+000
manganese	NA	5.37E+009	1.00E+000
mercury	6.68E+004	5.37E+009	1.00E+000
methylene chloride	3.99E+004	5.37E+009	1.00E+000
molybdenum	NA	5.37E+009	1.00E+000
nickel	NA	5.37E+009	1.00E+000
phenol	NA	5.37E+009	1.00E+000

Compound	VF (m3/kg)	PEF (m3/kg)	Cs (mg/kg)
pyrene	1.03E+008	5.37E+009	1.00E+000
selenium	NA	5.37E+009	1.00E+000
silver	NA	5.37E+009	1.00E+000
strontium	NA	5.37E+009	1.00E+000
tetrachloroethene	5.94E+004	5.37E+009	1.00E+000
toluene	9.76E+004	5.37E+009	1.00E+000
trans-1,2-dichloroethene	4.88E+004	5.37E+009	1.00E+000
trichloroethene	7.84E+004	5.37E+009	1.00E+000
trichlorofluoromethane	3.38E+004	5.37E+009	1.00E+000
trichlorotrifluoroethane	3.19E+004	5.37E+009	1.00E+000
vanadium	NA	5.37E+009	1.00E+000
vinyl acetate	6.03E+004	5.37E+009	1.00E+000
vinyl chloride	1.38E+004	5.37E+009	1.00E+000
xylene, m-	1.71E+005	5.37E+009	1.00E+000
xylene, o-	1.72E+005	5.37E+009	1.00E+000
xylene, p-	1.56E+005	5.37E+009	1.00E+000
zinc	NA	5.37E+009	1.00E+000

Table D-2 (cont.)
Summary of Unit Risk Characterization
On-Site Operations/Office Personnel
Via Inhalation of Outdoor Air

	HQ Calculation		
Compound	CDI (mg/kg-day)	RfD (mg/kg-day)	UH (unitless)
1,1-dichloroethane	2.6E-007	1.43E-001	1.79E-006
1,1-dichloroethene	4.5E-007	9.00E-003	4.96E-005
1,1,1-trichloroethane	2.5E-007	2.86E-001	8.62E-007
1,1,2-trichloroethane	8.4E-008	4.00E-003	2.10E-005
1,2-dichlorobenzene	3.2E-008	5.71E-002	5.68E-007
1,2-dichloroethane	1.7E-007	NA	NA
1,2-dichloropropane	1.6E-007	1.14E-003	1.38E-004
1,4-dichlorobenzene	3.7E-008	2.29E-001	1.61E-007
2-butanone	2.3E-012	2.86E-001	7.98E-012
2,4-dichlorophenol	2.3E-012	3.00E-003	7.60E-010
4-methyl-2-pentanone	2.3E-012	2.29E-002	9.97E-011
4,4-ddd	2.3E-012	NA	NA
4,4-dde	2.1E-011	NA	NA
4,4-ddt	2.3E-012	5.00E-004	4.56E-009
acetone	2.0E-007	1.00E-001	2.04E-006
antimony	2.3E-012	4.00E-004	5.70E-009
aroclor 1254	8.8E-010	2.00E-005	4.41E-005
arsenic	2.3E-012	3.00E-004	7.60E-009
barium	2.3E-012	1.43E-004	1.60E-008
benzene	2.0E-007	NA	NA
benzo(a)anthracene	2.3E-012	NA	NA
benzo(a)pyrene	2.3E-012	NA	NA
benzo(b)fluoranthene	1.0E-010	NA	NA
beryllium	2.3E-012	5.00E-003	4.56E-010
bis(2-ethylhexyl)phthalate	2.3E-012	2.00E-002	1.14E-010
bromodichloromethane	6.6E-008	2.00E-002	3.28E-006
bromoform	2.1E-008	2.00E-002	1.06E-006
cadmium	2.3E-012	5.00E-004	4.56E-009
carbon disulfide	5.9E-007	2.00E-001	2.94E-006
carbon tetrachloride	2.6E-007	7.00E-004	3.72E-004

	ILCR Calculation		
Compound	CDI (mg/kg-day)	CSF g/kg-day)-u	UR (unitless)
1,1-dichloroethane	9.1E-008	5.70E-003	5.21E-010
1,1-dichloroethene	1.6E-007	NA	NA
1,1,1-trichloroethane	8.8E-008	NA	NA
1,1,2-trichloroethane	3.0E-008	7.20E-002	2.16E-009
1,2-dichlorobenzene	1.2E-008	NA	NA
1,2-dichloroethane	6.1E-008	7.00E-002	4.26E-009
1,2-dichloropropane	5.6E-008	6.30E-002	3.55E-009
1,4-dichlorobenzene	1.3E-008	4.00E-002	5.24E-010
2-butanone	8.1E-013	NA	NA
2,4-dichlorophenol	8.1E-013	NA	NA
4-methyl-2-pentanone	8.1E-013	NA	NA
4,4-ddd	8.1E-013	2.40E-001	1.95E-013
4,4-dde	7.4E-012	3.40E-001	2.50E-012
4,4-ddt	8.1E-013	3.40E-001	2.77E-013
acetone	7.3E-008	NA	NA
antimony	8.1E-013	NA	NA
aroclor 1254	3.1E-010	7.70E+000	2.42E-009
arsenic	8.1E-013	1.20E+001	9.77E-012
barium	8.1E-013	NA	NA
benzene	7.3E-008	1.00E-001	7.25E-009
benzo(a)anthracene	8.1E-013	3.90E-001	3.17E-013
benzo(a)pyrene	8.1E-013	3.90E+000	3.17E-012
benzo(b)fluoranthene	3.7E-011	3.90E-001	1.43E-011
beryllium	8.1E-013	8.40E+000	6.84E-012
bis(2-ethylhexyl)phthalate	8.1E-013	8.40E-003	6.84E-015
bromodichloromethane	2.3E-008	1.30E-001	3.04E-009
bromoform	7.6E-009	3.90E-003	2.96E-011
cadmium	8.1E-013	1.50E+001	1.22E-011
carbon disulfide	2.1E-007	NA	NA
carbon tetrachloride	9.3E-008	5.30E-002	4.94E-009

Table D-2 (cont.)
Summary of Unit Risk Characterization
On-Site Operations/Office Personnel
Via Inhalation of Outdoor Air

	HQ Calculation		
Compound	CDI (mg/kg-day)	RfD (mg/kg-day)	UH (unitless)
chlorobenzene	7.8E-008	5.71E-003	1.37E-005
chloroform	2.2E-007	1.00E-002	2.18E-005
chromium iii	2.3E-012	1.50E+000	1.52E-012
chromium vi	2.3E-012	3.00E-003	7.60E-010
chrysene	2.3E-012	NA	NA
cis-1,2-dichloroethene	2.0E-007	1.00E-002	2.05E-005
copper	2.3E-012	3.70E-002	6.16E-011
cumene	4.9E-008	1.14E-001	4.33E-007
cyanide	2.3E-012	2.00E-002	1.14E-010
di-n-butylphthalate	2.3E-012	1.00E-001	2.28E-011
di-n-octylphthalate	1.0E-011	2.00E-002	5.01E-010
dibromochloromethane	3.1E-008	2.00E-002	1.57E-006
endosulfan	5.5E-010	6.00E-003	9.14E-008
endrin	2.3E-012	3.00E-004	7.60E-009
ethylbenzene	9.0E-008	2.86E-001	3.14E-007
gamma-bhc	2.3E-012	3.00E-004	7.60E-009
hydrogen sulfide	2.3E-012	2.86E-004	7.98E-009
indeno(1,2,3-cd)pyrene	2.3E-012	4.00E-002	5.70E-011
manganese	2.3E-012	4.60E-002	4.95E-011
mercury	1.8E-007	8.57E-005	2.14E-003
methylene chloride	3.1E-007	8.57E-001	3.58E-007
molybdenum	2.3E-012	5.00E-003	4.56E-010
nickel	2.3E-012	2.00E-002	1.14E-010
phenol	2.3E-012	6.00E-001	3.80E-012
pyrene	1.2E-010	3.00E-002	4.04E-009
selenium	2.3E-012	5.00E-003	4.56E-010
silver	2.3E-012	5.00E-003	4.56E-010
strontium	2.3E-012	6.00E-001	3.80E-012
tetrachloroethene	2.1E-007	1.00E-002	2.06E-005
toluene	1.3E-007	1.14E-001	1.10E-006

	ILCR Calculation		
Compound	CDI (mg/kg-day)	CSF g/kg-day)-u	UR (unitless)
chlorobenzene	2.8E-008	NA	NA
chloroform	7.8E-008	1.90E-002	1.48E-009
chromium iii	8.1E-013	NA	NA
chromium vi	8.1E-013	5.10E+002	4.15E-010
chrysene	8.1E-013	3.10E-003	2.52E-015
cis-1,2-dichloroethene	7.3E-008	NA	NA
copper	8.1E-013	NA	NA
cumene	1.8E-008	NA	NA
cyanide	8.1E-013	NA	NA
di-n-butylphthalate	8.1E-013	NA	NA
di-n-octylphthalate	3.6E-012	NA	NA
dibromochloromethane	1.1E-008	9.40E-002	1.05E-009
endosulfan	2.0E-010	NA	NA
endrin	8.1E-013	NA	NA
ethylbenzene	3.2E-008	NA	NA
gamma-bhc	8.1E-013	1.10E+000	8.95E-013
hydrogen sulfide	8.1E-013	NA	NA
indeno(1,2,3-cd)pyrene	8.1E-013	3.90E-001	3.17E-013
manganese	8.1E-013	NA	NA
mercury	6.5E-008	NA	NA
methylene chloride	1.1E-007	3.50E-003	3.83E-010
molybdenum	8.1E-013	NA	NA
nickel	8.1E-013	9.10E-001	7.41E-013
phenol	8.1E-013	NA	NA
pyrene	4.3E-011	NA	NA
selenium	8.1E-013	NA	NA
silver	8.1E-013	NA	NA
strontium	8.1E-013	NA	NA
tetrachloroethene	7.4E-008	2.10E-002	1.55E-009
toluene	4.5E-008	NA	NA

Table D-2 (cont.)
Summary of Unit Risk Characterization
On-Site Operations/Office Personnel
Via Inhalation of Outdoor Air

	HQ Calculation		
Compound	CDI (mg/kg-day)	RfD (mg/kg-day)	UH (unitless)
trans-1,2-dichloroethene	2.5E-007	2.00E-002	1.25E-005
trichloroethene	1.6E-007	7.35E-003	2.12E-005
trichlorofluoromethane	3.6E-007	2.00E-001	1.81E-006
trichlorotrifluoroethane	3.8E-007	8.57E+000	4.47E-008
vanadium	2.3E-012	7.00E-003	3.26E-010
vinyl acetate	2.0E-007	5.71E-002	3.55E-006
vinyl chloride	8.9E-007	NA	NA
xylene, m-	7.2E-008	2.00E+000	3.58E-008
xylene, o-	7.1E-008	2.00E+000	3.56E-008
xylene, p-	7.8E-008	NA	NA
zinc	2.3E-012	3.00E-001	7.60E-012
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA

	ILCR Calculation		
Compound	CDI (mg/kg-day)	CSF g/kg-day)-u	UR (unitless)
trans-1,2-dichloroethene	9.0E-008	NA	NA
trichloroethene	5.6E-008	1.00E-002	5.57E-010
trichlorofluoromethane	1.3E-007	NA	NA
trichlorotrifluoroethane	1.4E-007	NA	NA
vanadium	8.1E-013	NA	NA
vinyl acetate	7.2E-008	NA	NA
vinyl chloride	3.2E-007	2.70E-001	8.57E-008
xylene, m-	2.6E-008	NA	NA
xylene, o-	2.5E-008	NA	NA
xylene, p-	2.8E-008	NA	NA
zinc	8.1E-013	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA

Table D-3 (cont.)
Summary of Unit Risk Characterization
On-Site Operations/Office Personnel
Via Inhalation of Indoor Air (Vapor Intrusion)

	HQ Calculation		
Compound	CDI (mg/kg-day)	RfD (mg/kg-day)	UH (unitless)
1,1-dichloroethane	2.03E-005	1.43E-001	1.42E-004
1,1-dichloroethene	6.19E-005	9.00E-003	6.88E-003
1,1,1-trichloroethane	1.81E-005	2.86E-001	6.32E-005
1,1,2-trichloroethane	2.67E-006	4.00E-003	6.68E-004
1,2-dichlorobenzene	3.20E-007	5.71E-002	5.60E-006
1,2-dichloroethane	9.59E-006	NA	NA
1,2-dichloropropane	7.73E-006	1.14E-003	6.76E-003
1,4-dichlorobenzene	4.00E-007	2.29E-001	1.75E-006
2-butanone	NA	2.86E-001	NA
2,4-dichlorophenol	2.43E-008	3.00E-003	8.11E-006
4-methyl-2-pentanone	NA	2.29E-002	NA
4,4-ddd	3.00E-012	NA	NA
4,4-dde	2.79E-012	NA	NA
4,4-ddt	2.66E-012	5.00E-004	5.33E-009
acetone	1.22E-005	1.00E-001	1.22E-004
antimony	NA	4.00E-004	NA
aroclor 1254	2.41E-010	2.00E-005	1.21E-005
arsenic	NA	3.00E-004	NA
barium	NA	1.43E-004	NA
benzene	1.24E-005	NA	NA
benzo(a)anthracene	NA	NA	NA
benzo(a)pyrene	NA	NA	NA
benzo(b)fluoranthene	NA	NA	NA
beryllium	NA	5.00E-003	NA
bis(2-ethylhexyl)phthalate	1.61E-014	2.00E-002	8.05E-013
bromodichloromethane	2.32E-006	2.00E-002	1.16E-004
bromoform	7.43E-007	2.00E-002	3.72E-005
cadmium	NA	5.00E-004	NA
carbon disulfide	1.02E-004	2.00E-001	5.09E-004
carbon tetrachloride	2.03E-005	7.00E-004	2.90E-002

	ILCR Calculation		
Compound	CDI (mg/kg-day)	CSF g/kg-day)-u	UR (unitless)
1,1-dichloroethane	7.25E-006	5.70E-003	4.13E-008
1,1-dichloroethene	2.21E-005	NA	NA
1,1,1-trichloroethane	6.45E-006	NA	NA
1,1,2-trichloroethane	9.54E-007	7.20E-002	6.87E-008
1,2-dichlorobenzene	1.14E-007	NA	NA
1,2-dichloroethane	3.42E-006	7.00E-002	2.40E-007
1,2-dichloropropane	2.76E-006	6.30E-002	1.74E-007
1,4-dichlorobenzene	1.43E-007	4.00E-002	5.71E-009
2-butanone	NA	NA	NA
2,4-dichlorophenol	8.68E-009	NA	NA
4-methyl-2-pentanone	NA	NA	NA
4,4-ddd	1.07E-012	2.40E-001	2.57E-013
4,4-dde	9.97E-013	3.40E-001	3.39E-013
4,4-ddt	9.51E-013	3.40E-001	3.23E-013
acetone	4.34E-006	NA	NA
antimony	NA	NA	NA
aroclor 1254	8.62E-011	7.70E+000	6.64E-010
arsenic	NA	1.20E+001	NA
barium	NA	NA	NA
benzene	4.43E-006	1.00E-001	4.43E-007
benzo(a)anthracene	NA	3.90E-001	NA
benzo(a)pyrene	NA	3.90E+000	NA
benzo(b)fluoranthene	NA	3.90E-001	NA
beryllium	NA	8.40E+000	NA
bis(2-ethylhexyl)phthalate	5.75E-015	8.40E-003	4.83E-017
bromodichloromethane	8.29E-007	1.30E-001	1.08E-007
bromoform	2.65E-007	3.90E-003	1.04E-009
cadmium	NA	1.50E+001	NA
carbon disulfide	3.64E-005	NA	NA
carbon tetrachloride	7.25E-006	5.30E-002	3.84E-007

Table D-3 (cont.)
Summary of Unit Risk Characterization
On-Site Operations/Office Personnel
Via Inhalation of Indoor Air (Vapor Intrusion)

	HQ Calculation		
Compound	CDI (mg/kg-day)	RfD (mg/kg-day)	UH (unitless)
chlorobenzene	1.84E-006	5.71E-003	3.22E-004
chloroform	1.46E-005	1.00E-002	1.46E-003
chromium iii	NA	1.50E+000	NA
chromium vi	NA	3.00E-003	NA
chrysene	NA	NA	NA
cis-1,2-dichloroethene	1.34E-005	1.00E-002	1.34E-003
copper	NA	3.70E-002	NA
cumene	NA	1.14E-001	NA
cyanide	NA	2.00E-002	NA
di-n-butylphthalate	1.31E-011	1.00E-001	1.31E-010
di-n-octylphthalate	1.75E-013	2.00E-002	8.73E-012
dibromochloromethane	1.22E-006	2.00E-002	6.12E-005
endosulfan	3.32E-009	6.00E-003	5.54E-007
endrin	4.79E-010	3.00E-004	1.60E-006
ethylbenzene	2.23E-006	2.86E-001	7.79E-006
gamma-bhc	9.67E-009	3.00E-004	3.22E-005
hydrogen sulfide	NA	2.86E-004	NA
indeno(1,2,3-cd)pyrene	NA	4.00E-002	NA
manganese	NA	4.60E-002	NA
mercury	NA	8.57E-005	NA
methylene chloride	2.81E-005	8.57E-001	3.28E-005
molybdenum	NA	5.00E-003	NA
nickel	NA	2.00E-002	NA
phenol	2.62E-008	6.00E-001	4.37E-008
pyrene	7.23E-011	3.00E-002	2.41E-009
selenium	NA	5.00E-003	NA
silver	NA	5.00E-003	NA
strontium	NA	6.00E-001	NA
tetrachloroethene	1.16E-005	1.00E-002	1.16E-003
toluene	4.52E-006	1.14E-001	3.96E-005

	ILCR Calculation		
Compound	CDI (mg/kg-day)	CSF g/kg-day) u	UR (unitless)
chlorobenzene	6.57E-007	NA	NA
chloroform	5.20E-006	1.90E-002	9.88E-008
chromium iii	NA	NA	NA
chromium vi	NA	5.10E+002	NA
chrysene	NA	3.10E-003	NA
cis-1,2-dichloroethene	4.80E-006	NA	NA
copper	NA	NA	NA
cumene	NA	NA	NA
cyanide	NA	NA	NA
di-n-butylphthalate	4.68E-012	NA	NA
di-n-octylphthalate	6.24E-014	NA	NA
dibromochloromethane	4.37E-007	9.40E-002	4.11E-008
endosulfan	1.19E-009	NA	NA
endrin	1.71E-010	NA	NA
ethylbenzene	7.95E-007	NA	NA
gamma-bhc	3.46E-009	1.10E+000	3.80E-009
hydrogen sulfide	NA	NA	NA
indeno(1,2,3-cd)pyrene	NA	3.90E-001	NA
manganese	NA	NA	NA
mercury	NA	NA	NA
methylene chloride	1.00E-005	3.50E-003	3.51E-008
molybdenum	NA	NA	NA
nickel	NA	9.10E-001	NA
phenol	9.36E-009	NA	NA
pyrene	2.58E-011	NA	NA
selenium	NA	NA	NA
silver	NA	NA	NA
strontium	NA	NA	NA
tetrachloroethene	4.16E-006	2.10E-002	8.73E-008
toluene	1.61E-006	NA	NA

Table D-3 (cont.)
Summary of Unit Risk Characterization
On-Site Operations/Office Personnel
Via Inhalation of Indoor Air (Vapor Intrusion)

	HQ Calculation		
Compound	CDI (mg/kg-day)	RfD (mg/kg-day)	UH (unitless)
trans-1,2-dichloroethene	2.85E-006	2.00E-002	NA
trichloroethene	1.02E-006	7.35E-003	NA
trichlorofluoromethane	NA	2.00E-001	NA
trichlorotrifluoroethane	NA	8.57E+000	NA
vanadium	NA	7.00E-003	NA
vinyl acetate	1.98E-006	5.71E-002	NA
vinyl chloride	3.28E-005	NA	NA
xylene, m-	2.48E-007	2.00E+000	NA
xylene, o-	2.46E-007	2.00E+000	NA
xylene, p-	2.79E-007	NA	NA
zinc	NA	3.00E-001	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA

	ILCR Calculation		
Compound	CDI (mg/kg-day)	CSF g/kg-day)-u	UR (unitless)
trans-1,2-dichloroethene	1.02E-006	NA	NA
trichloroethene	3.66E-007	1.00E-002	NA
trichlorofluoromethane	NA	NA	NA
trichlorotrifluoroethane	NA	NA	NA
vanadium	NA	NA	NA
vinyl acetate	7.08E-007	NA	NA
vinyl chloride	1.17E-005	2.70E-001	NA
xylene, m-	8.87E-008	NA	NA
xylene, o-	8.78E-008	NA	NA
xylene, p-	9.96E-008	NA	NA
zinc	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA

Table D-4
Summary of Unit Risk Characterization
On-Site Daycare Child
Via Inhalation of Outdoor Air

Intake Equation = $\frac{CS \times (1/VF + 1/PEF) \times EF \times ED \times ET \times IR}{BW \times AT}$

IR	Inhalation rate of gases	0.60	m³/h
EF	Exposure frequency	250	days/year
EDn	Exposure duration for non-carcinogens	5	year
EDc	Exposure duration for carcinogens	5	year
BW	Body weight	15	kg
ATc	Average time for carcinogens (lifetime)	25550	days
ATn	Average time for non-carcinogens (EDn x 365)	1825	days
ET	Exposure time (Outdoor)	1	h/day
CS	Concentration of chemicals in soil	csv	(see below)
VF	Volatilization Factor	csv	(see below)
PEF	Particulate Emission Factor	csv	(see below)

Chemical Concentrations

Compound	VF (m3/kg)	PEF (m3/kg)	Cs (mg/kg)	Cs (mg/kg)
1,1-dichloroethane	4.78E+004	5.37E+009	1.00E+000	1.00E+000
1,1-dichloroethene	2.74E+004	5.37E+009	1.00E+000	1.00E+000
1,1,1-trichloroethane	4.97E+004	5.37E+009	1.00E+000	1.00E+000
1,1,2-trichloroethane	1.46E+005	5.37E+009	1.00E+000	1.00E+000
1,2-dichlorobenzene	3.77E+005	5.37E+009	1.00E+000	1.00E+000
1,2-dichloroethane	7.18E+004	5.37E+009	1.00E+000	1.00E+000
1,2-dichloropropane	7.76E+004	5.37E+009	1.00E+000	1.00E+000
1,4-dichlorobenzene	3.33E+005	5.37E+009	1.00E+000	1.00E+000
2-butanone	NA	5.37E+009	1.00E+000	1.00E+000
2,4-dichlorophenol	NA	5.37E+009	1.00E+000	1.00E+000
4-methyl-2-pentanone	NA	5.37E+009	1.00E+000	1.00E+000
4,4-ddd	NA	5.37E+009	1.00E+000	1.00E+000
4,4-dde	6.68E+003	5.37E+009	1.00E+000	1.00E+000
4,4-ddt	NA	5.37E+009	1.00E+000	1.00E+000
acetone	6.00E+004	5.37E+009	1.00E+000	1.00E+000
antimony	NA	5.37E+009	1.00E+000	1.00E+000
aroclor 1254	1.39E+007	5.37E+009	1.00E+000	1.00E+000
arsenic	NA	5.37E+009	1.00E+000	1.00E+000
barium	NA	5.37E+009	1.00E+000	1.00E+000
benzene	6.02E+004	5.37E+009	1.00E+000	1.00E+000
benzo(a)anthracene	NA	5.37E+009	1.00E+000	1.00E+000
benzo(a)pyrene	NA	5.37E+009	1.00E+000	1.00E+000
benzo(b)fluoranthene	1.22E+008	5.37E+009	1.00E+000	1.00E+000
beryllium	NA	5.37E+009	1.00E+000	1.00E+000
bis(2-ethylhexyl)phthalate	NA	5.37E+009	1.00E+000	1.00E+000
bromodichloromethane	1.87E+005	5.37E+009	1.00E+000	1.00E+000
bromoform	5.75E+005	5.37E+009	1.00E+000	1.00E+000

Compound	VF (m3/kg)	PEF (m3/kg)	Cs (mg/kg)
cadmium	NA	5.37E+009	1.00E+000
carbon disulfide	1.39E+007	5.37E+009	1.00E+000
carbon tetrachloride	NA	5.37E+009	1.00E+000
chlorobenzene	NA	5.37E+009	1.00E+000
chloroform	6.02E+004	5.37E+009	1.00E+000
chromium iii	NA	5.37E+009	1.00E+000
chromium vi	NA	5.37E+009	1.00E+000
chrysene	1.22E+008	5.37E+009	1.00E+000
cis-1,2-dichloroethene	NA	5.37E+009	1.00E+000
copper	NA	5.37E+009	1.00E+000
cumene	1.87E+005	5.37E+009	1.00E+000
cyanide	5.75E+005	5.37E+009	1.00E+000
di-n-butylphthalate	NA	5.37E+009	1.00E+000
di-n-octylphthalate	2.08E+004	5.37E+009	1.00E+000
dibromochloromethane	4.69E+004	5.37E+009	1.00E+000
endosulfan	1.56E+005	5.37E+009	1.00E+000
endrin	5.61E+004	5.37E+009	1.00E+000
ethylbenzene	NA	5.37E+009	1.00E+000
gamma-bhc	NA	5.37E+009	1.00E+000
hydrogen sulfide	NA	5.37E+009	1.00E+000
indeno(1,2,3-cd)pyrene	5.98E+004	5.37E+009	1.00E+000
manganese	NA	5.37E+009	1.00E+000
mercury	2.47E+005	5.37E+009	1.00E+000
methylene chloride	NA	5.37E+009	1.00E+000
molybdenum	NA	5.37E+009	1.00E+000
nickel	1.58E+009	5.37E+009	1.00E+000
phenol	3.90E+005	5.37E+009	1.00E+000

Compound	VF (m3/kg)	PEF (m3/kg)	Cs (mg/kg)
pyrene	1.03E+008	5.37E+009	1.00E+000
selenium	NA	5.37E+009	1.00E+000
silver	NA	5.37E+009	1.00E+000
strontium	NA	5.37E+009	1.00E+000
tetrachloroethene	5.94E+004	5.37E+009	1.00E+000
toluene	9.76E+004	5.37E+009	1.00E+000
trans-1,2-dichloroethene	4.88E+004	5.37E+009	1.00E+000
trichloroethene	7.84E+004	5.37E+009	1.00E+000
trichlorofluoromethane	3.38E+004	5.37E+009	1.00E+000
trichlorotrifluoroethane	3.19E+004	5.37E+009	1.00E+000
vanadium	NA	5.37E+009	1.00E+000
vinyl acetate	6.03E+004	5.37E+009	1.00E+000
vinyl chloride	1.38E+004	5.37E+009	1.00E+000
xylene, m-	1.71E+005	5.37E+009	1.00E+000
xylene, o-	1.72E+005	5.37E+009	1.00E+000
xylene, p-	1.56E+005	5.37E+009	1.00E+000
zinc	NA	5.37E+009	1.00E+000

Table D-4 (cont.)
Summary of Unit Risk Characterization
On-Site Daycare Child
Via Inhalation of Outdoor Air

	HQ Calculation		
Compound	CDI (mg/kg-day)	RfD (mg/kg-day)	UH (unitless)
1,1-dichloroethane	5.7E-007	1.43E-001	4.01E-006
1,1-dichloroethene	1.0E-006	9.00E-003	1.11E-004
1,1,1-trichloroethane	5.5E-007	2.86E-001	1.93E-006
1,1,2-trichloroethane	1.9E-007	4.00E-003	4.70E-005
1,2-dichlorobenzene	7.3E-008	5.71E-002	1.27E-006
1,2-dichloroethane	3.8E-007	NA	NA
1,2-dichloropropane	3.5E-007	1.14E-003	3.09E-004
1,4-dichlorobenzene	8.2E-008	2.29E-001	3.60E-007
2-butanone	5.1E-012	2.86E-001	1.79E-011
2,4-dichlorophenol	5.1E-012	3.00E-003	1.70E-009
4-methyl-2-pentanone	5.1E-012	2.29E-002	2.23E-010
4,4-ddd	5.1E-012	NA	NA
4,4-dde	4.6E-011	NA	NA
4,4-ddt	5.1E-012	5.00E-004	1.02E-008
acetone	4.6E-007	1.00E-001	4.56E-006
antimony	5.1E-012	4.00E-004	1.28E-008
aroclor 1254	2.0E-009	2.00E-005	9.87E-005
arsenic	5.1E-012	3.00E-004	1.70E-008
barium	5.1E-012	1.43E-004	3.57E-008
benzene	4.5E-007	NA	NA
benzo(a)anthracene	5.1E-012	NA	NA
benzo(a)pyrene	5.1E-012	NA	NA
benzo(b)fluoranthene	2.3E-010	NA	NA
beryllium	5.1E-012	5.00E-003	1.02E-009
bis(2-ethylhexyl)phthalate	5.1E-012	2.00E-002	2.55E-010
bromodichloromethane	1.5E-007	2.00E-002	7.34E-006
bromoform	4.8E-008	2.00E-002	2.38E-006
cadmium	5.1E-012	5.00E-004	1.02E-008
carbon disulfide	1.3E-006	2.00E-001	6.58E-006
carbon tetrachloride	5.8E-007	7.00E-004	8.34E-004

	ILCR Calculation		
Compound	CDI (mg/kg-day)	CSF g/kg-day)-u	UR (unitless)
1,1-dichloroethane	4.1E-008	5.70E-003	2.33E-010
1,1-dichloroethene	7.1E-008	NA	NA
1,1,1-trichloroethane	3.9E-008	NA	NA
1,1,2-trichloroethane	1.3E-008	7.20E-002	9.66E-010
1,2-dichlorobenzene	5.2E-009	NA	NA
1,2-dichloroethane	2.7E-008	7.00E-002	1.91E-009
1,2-dichloropropane	2.5E-008	6.30E-002	1.59E-009
1,4-dichlorobenzene	5.9E-009	4.00E-002	2.35E-010
2-butanone	3.6E-013	NA	NA
2,4-dichlorophenol	3.6E-013	NA	NA
4-methyl-2-pentanone	3.6E-013	NA	NA
4,4-ddd	3.6E-013	2.40E-001	8.75E-014
4,4-dde	3.3E-012	3.40E-001	1.12E-012
4,4-ddt	3.6E-013	3.40E-001	1.24E-013
acetone	3.3E-008	NA	NA
antimony	3.6E-013	NA	NA
aroclor 1254	1.4E-010	7.70E+000	1.09E-009
arsenic	3.6E-013	1.20E+001	4.38E-012
barium	3.6E-013	NA	NA
benzene	3.2E-008	1.00E-001	3.25E-009
benzo(a)anthracene	3.6E-013	3.90E-001	1.42E-013
benzo(a)pyrene	3.6E-013	3.90E+000	1.42E-012
benzo(b)fluoranthene	1.6E-011	3.90E-001	6.41E-012
beryllium	3.6E-013	8.40E+000	3.06E-012
bis(2-ethylhexyl)phthalate	3.6E-013	8.40E-003	3.06E-015
bromodichloromethane	1.0E-008	1.30E-001	1.36E-009
bromoform	3.4E-009	3.90E-003	1.33E-011
cadmium	3.6E-013	1.50E+001	5.47E-012
carbon disulfide	9.4E-008	NA	NA
carbon tetrachloride	4.2E-008	5.30E-002	2.21E-009

Table D-4 (cont.)
Summary of Unit Risk Characterization
On-Site Daycare Child
Via Inhalation of Outdoor Air

	HQ Calculation		
Compound	CDI (mg/kg-day)	RfD (mg/kg-day)	UH (unitless)
chlorobenzene	1.8E-007	5.71E-003	3.07E-005
chloroform	4.9E-007	1.00E-002	4.88E-005
chromium iii	5.1E-012	1.50E+000	3.40E-012
chromium vi	5.1E-012	3.00E-003	1.70E-009
chrysene	5.1E-012	NA	NA
cis-1,2-dichloroethene	4.6E-007	1.00E-002	4.59E-005
copper	5.1E-012	3.70E-002	1.38E-010
cumene	1.1E-007	1.14E-001	9.69E-007
cyanide	5.1E-012	2.00E-002	2.55E-010
di-n-butylphthalate	5.1E-012	1.00E-001	5.11E-011
di-n-octylphthalate	2.2E-011	2.00E-002	1.12E-009
dibromochloromethane	7.0E-008	2.00E-002	3.51E-006
endosulfan	1.2E-009	6.00E-003	2.05E-007
endrin	5.1E-012	3.00E-004	1.70E-008
ethylbenzene	2.0E-007	2.86E-001	7.04E-007
gamma-bhc	5.1E-012	3.00E-004	1.70E-008
hydrogen sulfide	5.1E-012	2.86E-004	1.79E-008
indeno(1,2,3-cd)pyrene	5.1E-012	4.00E-002	1.28E-010
manganese	5.1E-012	4.60E-002	1.11E-010
mercury	4.1E-007	8.57E-005	4.78E-003
methylene chloride	6.9E-007	8.57E-001	8.01E-007
molybdenum	5.1E-012	5.00E-003	1.02E-009
nickel	5.1E-012	2.00E-002	2.55E-010
phenol	5.1E-012	6.00E-001	8.51E-012
pyrene	2.7E-010	3.00E-002	9.04E-009
selenium	5.1E-012	5.00E-003	1.02E-009
silver	5.1E-012	5.00E-003	1.02E-009
strontium	5.1E-012	6.00E-001	8.51E-012
tetrachloroethene	4.6E-007	1.00E-002	4.61E-005
toluene	2.8E-007	1.14E-001	2.46E-006

	ILCR Calculation		
Compound	CDI (mg/kg-day)	CSF g/kg-day)-u	UR (unitless)
chlorobenzene	1.3E-008	NA	NA
chloroform	3.5E-008	1.90E-002	6.62E-010
chromium iii	3.6E-013	NA	NA
chromium vi	3.6E-013	5.10E+002	1.86E-010
chrysene	3.6E-013	3.10E-003	1.13E-015
cis-1,2-dichloroethene	3.3E-008	NA	NA
copper	3.6E-013	NA	NA
cumene	7.9E-009	NA	NA
cyanide	3.6E-013	NA	NA
di-n-butylphthalate	3.6E-013	NA	NA
di-n-octylphthalate	1.6E-012	NA	NA
dibromochloromethane	5.0E-009	9.40E-002	4.72E-010
endosulfan	8.8E-011	NA	NA
endrin	3.6E-013	NA	NA
ethylbenzene	1.4E-008	NA	NA
gamma-bhc	3.6E-013	1.10E+000	4.01E-013
hydrogen sulfide	3.6E-013	NA	NA
indeno(1,2,3-cd)pyrene	3.6E-013	3.90E-001	1.42E-013
manganese	3.6E-013	NA	NA
mercury	2.9E-008	NA	NA
methylene chloride	4.9E-008	3.50E-003	1.72E-010
molybdenum	3.6E-013	NA	NA
nickel	3.6E-013	9.10E-001	3.32E-013
phenol	3.6E-013	NA	NA
pyrene	1.9E-011	NA	NA
selenium	3.6E-013	NA	NA
silver	3.6E-013	NA	NA
strontium	3.6E-013	NA	NA
tetrachloroethene	3.3E-008	2.10E-002	6.92E-010
toluene	2.0E-008	NA	NA

Table D-4 (cont.)
Summary of Unit Risk Characterization
On-Site Daycare Child
Via Inhalation of Outdoor Air

	HQ Calculation		
Compound	CDI (mg/kg-day)	RfD (mg/kg-day)	UH (unitless)
trans-1,2-dichloroethene	5.6E-007	2.00E-002	2.81E-005
trichloroethene	3.5E-007	7.35E-003	4.75E-005
trichlorofluoromethane	8.1E-007	2.00E-001	4.05E-006
trichlorotrifluoroethane	8.6E-007	8.57E+000	1.00E-007
vanadium	5.1E-012	7.00E-003	7.29E-010
vinyl acetate	4.5E-007	5.71E-002	7.95E-006
vinyl chloride	2.0E-006	NA	NA
xylene, m-	1.6E-007	2.00E+000	8.02E-008
xylene, o-	1.6E-007	2.00E+000	7.97E-008
xylene, p-	1.8E-007	NA	NA
zinc	5.1E-012	3.00E-001	1.70E-011
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA

	ILCR Calculation		
Compound	CDI (mg/kg-day)	CSF g/kg-day) u	UR (unitless)
trans-1,2-dichloroethene	4.0E-008	NA	NA
trichloroethene	2.5E-008	1.00E-002	2.49E-010
trichlorofluoromethane	5.8E-008	NA	NA
trichlorotrifluoroethane	6.1E-008	NA	NA
vanadium	3.6E-013	NA	NA
vinyl acetate	3.2E-008	NA	NA
vinyl chloride	1.4E-007	2.70E-001	3.84E-008
xylene, m-	1.1E-008	NA	NA
xylene, o-	1.1E-008	NA	NA
xylene, p-	1.3E-008	NA	NA
zinc	3.6E-013	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA

Table D-5
Summary of Unit Risk Characterization
On-Site Daycare Child
Via Inhalation of Indoor Air (Vapor Intrusion)

Intake Equation

$$\frac{CS \times A \times EF \times ED \times ET \times IR}{BW \times AT}$$

IR	Inhalation rate of gases	0.60	m3/h
EF	Exposure frequency	250	days/year
EDn	Exposure duration for non-carcinogens	5	year
EDc	Exposure duration for carcinogens	5	year
BW	Body weight	15	kg
ATc	Average time for carcinogens (lifetime)	25550	days
ATn	Average time for non-carcinogens (EDn x 365)	1825	days
ET	Exposure time (Outdoor)	7	h/day
CS	Concentration of chemicals in soil	csv	(see below)
A	Alpha - Soil to indoor air conversion factor (J&E model)	csv	(see below)

Chemical Concentrations

Compound	No Liner A (unitless)	Liner A (unitless)	Cs (mg/kg)
1,1-dichloroethane	2.37E-001	2.37E-004	1.00E+000
1,1-dichloroethene	7.23E-001	7.23E-004	1.00E+000
1,1,1-trichloroethane	2.11E-001	2.11E-004	1.00E+000
1,1,2-trichloroethane	3.12E-002	3.12E-005	1.00E+000
1,2-dichlorobenzene	3.74E-003	3.74E-006	1.00E+000
1,2-dichloroethane	1.12E-001	1.12E-004	1.00E+000
1,2-dichloropropane	9.03E-002	9.03E-005	1.00E+000
1,4-dichlorobenzene	4.67E-003	4.67E-006	1.00E+000
2-butanone	NA	NA	1.00E+000
2,4-dichlorophenol	2.84E-004	2.84E-007	1.00E+000
4-methyl-2-pentanone	NA	NA	1.00E+000
4,4-ddd	3.50E-008	3.50E-011	1.00E+000
4,4-dde	3.26E-008	3.26E-011	1.00E+000
4,4-ddt	3.11E-008	3.11E-011	1.00E+000
acetone	1.42E-001	1.42E-004	1.00E+000
antimony	NA	NA	1.00E+000
aroclor 1254	2.82E-006	2.82E-009	1.00E+000
arsenic	NA	NA	1.00E+000
barium	NA	NA	1.00E+000
benzene	1.45E-001	1.45E-004	1.00E+000
benzo(a)anthracen	NA	NA	1.00E+000
benzo(a)pyrene	NA	NA	1.00E+000
benzo(b)fluoranthene	NA	NA	1.00E+000
beryllium	NA	NA	1.00E+000
bis(2-ethylhexyl)phthalate	1.88E-010	1.88E-013	1.00E+000
bromodichloromethane	2.71E-002	2.71E-005	1.00E+000
bromoform	8.68E-003	8.68E-006	1.00E+000

Compound	No Liner A (unitless)	Liner A (unitless)	Cs (mg/kg)
cadmium	NA	NA	1.00E+000
carbon disulfide	1.19E+000	1.19E-003	1.00E+000
carbon tetrachloride	2.37E-001	2.37E-004	1.00E+000
chlorobenzene	2.15E-002	2.15E-005	1.00E+000
chloroform	1.70E-001	1.70E-004	1.00E+000
chromium iii	NA	NA	1.00E+000
chromium vi	NA	NA	1.00E+000
chrysene	NA	NA	1.00E+000
cis-1,2-dichloroethene	1.57E-001	1.57E-004	1.00E+000
copper	NA	NA	1.00E+000
cumene	NA	NA	1.00E+000
cyanide	NA	NA	1.00E+000
di-n-butylphthalate	1.53E-007	1.53E-010	1.00E+000
di-n-octylphthalate	2.04E-009	2.04E-012	1.00E+000
dibromochloromethane	1.43E-002	1.43E-005	1.00E+000
endosulfan	3.88E-005	3.88E-008	1.00E+000
endrin	5.59E-006	5.59E-009	1.00E+000
ethylbenzene	2.60E-002	2.60E-005	1.00E+000
gamma-bhc	1.13E-004	1.13E-007	1.00E+000
hydrogen sulfide	NA	NA	1.00E+000
indeno(1,2,3-cd)pyrene	NA	NA	1.00E+000
manganese	NA	NA	1.00E+000
mercury	NA	NA	1.00E+000
methylene chloride	3.28E-001	3.28E-004	1.00E+000
molybdenum	NA	NA	1.00E+000
nickel	NA	NA	1.00E+000
phenol	3.06E-004	3.06E-007	1.00E+000

Compound	No Liner A (unitless)	Liner A (unitless)	Cs (mg/kg)
pyrene	8.44E-007	8.44E-010	1.00E+000
selenium	NA	NA	1.00E+000
silver	NA	NA	1.00E+000
strontium	NA	NA	1.00E+000
tetrachloroethene	1.36E-001	1.36E-004	1.00E+000
toluene	5.28E-002	5.28E-005	1.00E+000
trans-1,2-dichloroethene	2.33E-001	2.33E-004	1.00E+000
trichloroethene	8.38E-002	8.38E-005	1.00E+000
trichlorofluoromethane	NA	NA	1.00E+000
trichlorotrifluoroethane	NA	NA	1.00E+000
vanadium	NA	NA	1.00E+000
vinyl acetate	1.62E-001	1.62E-004	1.00E+000
vinyl chloride	2.68E+000	2.68E-003	1.00E+000
xylene, m-	2.03E-002	2.03E-005	1.00E+000
xylene, o-	2.01E-002	2.01E-005	1.00E+000
xylene, p-	2.28E-002	2.28E-005	1.00E+000
zinc	NA	NA	1.00E+000
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA
	NA	NA	NA

Table D-5 (cont.)
Summary of Unit Risk Characterization
On-Site Daycare Child
Via Inhalation of Indoor Air (Vapor Intrusion)

	HQ Calculation		
Compound	CDI (mg/kg-day)	RfD (mg/kg-day)	UH (unitless)
1,1-dichloroethane	4.55E-005	1.43E-001	3.18E-004
1,1-dichloroethene	1.39E-004	9.00E-003	1.54E-002
1,1,1-trichloroethane	4.05E-005	2.86E-001	1.42E-004
1,1,2-trichloroethane	5.98E-006	4.00E-003	1.50E-003
1,2-dichlorobenzene	7.17E-007	5.71E-002	1.26E-005
1,2-dichloroethane	2.15E-005	NA	NA
1,2-dichloropropane	1.73E-005	1.14E-003	1.52E-002
1,4-dichlorobenzene	8.96E-007	2.29E-001	3.92E-006
2-butanone	NA	2.86E-001	NA
2,4-dichlorophenol	5.45E-008	3.00E-003	1.82E-005
4-methyl-2-pentanone	NA	2.29E-002	NA
4,4-ddd	6.71E-012	NA	NA
4,4-dde	6.25E-012	NA	NA
4,4-ddt	5.96E-012	5.00E-004	1.19E-008
acetone	2.72E-005	1.00E-001	2.72E-004
antimony	NA	4.00E-004	NA
aroclor 1254	5.41E-010	2.00E-005	2.70E-005
arsenic	NA	3.00E-004	NA
barium	NA	1.43E-004	NA
benzene	2.78E-005	NA	NA
benzo(a)anthracene	NA	NA	NA
benzo(a)pyrene	NA	NA	NA
benzo(b)fluoranthene	NA	NA	NA
beryllium	NA	5.00E-003	NA
bis(2-ethylhexyl)phthalate	3.61E-014	2.00E-002	1.80E-012
bromodichloromethane	5.20E-006	2.00E-002	2.60E-004
bromoform	1.66E-006	2.00E-002	8.32E-005
cadmium	NA	5.00E-004	NA
carbon disulfide	2.28E-004	2.00E-001	1.14E-003
carbon tetrachloride	4.55E-005	7.00E-004	6.49E-002

	ILCR Calculation		
Compound	CDI (mg/kg-day)	CSF g/kg-day)-u	UR (unitless)
1,1-dichloroethane	3.25E-006	5.70E-003	1.85E-008
1,1-dichloroethene	9.90E-006	NA	NA
1,1,1-trichloroethane	2.89E-006	NA	NA
1,1,2-trichloroethane	4.27E-007	7.20E-002	3.08E-008
1,2-dichlorobenzene	5.12E-008	NA	NA
1,2-dichloroethane	1.53E-006	7.00E-002	1.07E-007
1,2-dichloropropane	1.24E-006	6.30E-002	7.79E-008
1,4-dichlorobenzene	6.40E-008	4.00E-002	2.56E-009
2-butanone	NA	NA	NA
2,4-dichlorophenol	3.89E-009	NA	NA
4-methyl-2-pentanone	NA	NA	NA
4,4-ddd	4.79E-013	2.40E-001	1.15E-013
4,4-dde	4.47E-013	3.40E-001	1.52E-013
4,4-ddt	4.26E-013	3.40E-001	1.45E-013
acetone	1.95E-006	NA	NA
antimony	NA	NA	NA
aroclor 1254	3.86E-011	7.70E+000	2.97E-010
arsenic	NA	1.20E+001	NA
barium	NA	NA	NA
benzene	1.99E-006	1.00E-001	1.99E-007
benzo(a)anthracene	NA	3.90E-001	NA
benzo(a)pyrene	NA	3.90E+000	NA
benzo(b)fluoranthene	NA	3.90E-001	NA
beryllium	NA	8.40E+000	NA
bis(2-ethylhexyl)phthalate	2.58E-015	8.40E-003	2.16E-017
bromodichloromethane	3.71E-007	1.30E-001	4.83E-008
bromoform	1.19E-007	3.90E-003	4.64E-010
cadmium	NA	1.50E+001	NA
carbon disulfide	1.63E-005	NA	NA
carbon tetrachloride	3.25E-006	5.30E-002	1.72E-007

Table D-5 (cont.)
Summary of Unit Risk Characterization
On-Site Daycare Child
Via Inhalation of Indoor Air (Vapor Intrusion)

	HQ Calculation		
Compound	CDI (mg/kg-day)	RfD (mg/kg-day)	UH (unitless)
chlorobenzene	4.12E-006	5.71E-003	7.22E-004
chloroform	3.26E-005	1.00E-002	3.26E-003
chromium iii	NA	1.50E+000	NA
chromium vi	NA	3.00E-003	NA
chrysene	NA	NA	NA
cis-1,2-dichloroethene	3.01E-005	1.00E-002	3.01E-003
copper	NA	3.70E-002	NA
cumene	NA	1.14E-001	NA
cyanide	NA	2.00E-002	NA
di-n-butylphthalate	2.93E-011	1.00E-001	2.93E-010
di-n-octylphthalate	3.91E-013	2.00E-002	1.96E-011
dibromochloromethane	2.74E-006	2.00E-002	1.37E-004
endosulfan	7.44E-009	6.00E-003	1.24E-006
endrin	1.07E-009	3.00E-004	3.57E-006
ethylbenzene	4.99E-006	2.86E-001	1.75E-005
gamma-bhc	2.17E-008	3.00E-004	7.22E-005
hydrogen sulfide	NA	2.86E-004	NA
indeno(1,2,3-cd)pyrene	NA	4.00E-002	NA
manganese	NA	4.60E-002	NA
mercury	NA	8.57E-005	NA
methylene chloride	6.29E-005	8.57E-001	7.34E-005
molybdenum	NA	5.00E-003	NA
nickel	NA	2.00E-002	NA
phenol	5.87E-008	6.00E-001	9.78E-008
pyrene	1.62E-010	3.00E-002	5.40E-009
selenium	NA	5.00E-003	NA
silver	NA	5.00E-003	NA
strontium	NA	6.00E-001	NA
tetrachloroethene	2.61E-005	1.00E-002	2.61E-003
toluene	1.01E-005	1.14E-001	8.86E-005

	ILCR Calculation		
Compound	CDI (mg/kg-day)	CSF g/kg-day) u	UR (unitless)
chlorobenzene	2.95E-007	NA	NA
chloroform	2.33E-006	1.90E-002	4.42E-008
chromium iii	NA	NA	NA
chromium vi	NA	5.10E+002	NA
chrysene	NA	3.10E-003	NA
cis-1,2-dichloroethene	2.15E-006	NA	NA
copper	NA	NA	NA
cumene	NA	NA	NA
cyanide	NA	NA	NA
di-n-butylphthalate	2.10E-012	NA	NA
di-n-octylphthalate	2.79E-014	NA	NA
dibromochloromethane	1.96E-007	9.40E-002	1.84E-008
endosulfan	5.32E-010	NA	NA
endrin	7.66E-011	NA	NA
ethylbenzene	3.56E-007	NA	NA
gamma-bhc	1.55E-009	1.10E+000	1.70E-009
hydrogen sulfide	NA	NA	NA
indeno(1,2,3-cd)pyrene	NA	3.90E-001	NA
manganese	NA	NA	NA
mercury	NA	NA	NA
methylene chloride	4.49E-006	3.50E-003	1.57E-008
molybdenum	NA	NA	NA
nickel	NA	9.10E-001	NA
phenol	4.19E-009	NA	NA
pyrene	1.16E-011	NA	NA
selenium	NA	NA	NA
silver	NA	NA	NA
strontium	NA	NA	NA
tetrachloroethene	1.86E-006	2.10E-002	3.91E-008
toluene	7.23E-007	NA	NA

Table D-5 (cont.)
Summary of Unit Risk Characterization
On-Site Daycare Child
Via Inhalation of Indoor Air (Vapor Intrusion)

	HQ Calculation		
Compound	CDI (mg/kg-day)	RfD (mg/kg-day)	UH (unitless)
trans-1,2-dichloroethene	6.38E-006	2.00E-002	3.19E-004
trichloroethene	2.30E-006	7.35E-003	3.12E-004
trichlorofluoromethane	NA	2.00E-001	NA
trichlorotrifluoroethane	NA	8.57E+000	NA
vanadium	NA	7.00E-003	NA
vinyl acetate	4.44E-006	5.71E-002	7.77E-005
vinyl chloride	7.34E-005	NA	NA
xylene, m-	5.56E-007	2.00E+000	2.78E-007
xylene, o-	5.51E-007	2.00E+000	2.75E-007
xylene, p-	6.25E-007	NA	NA
zinc	NA	3.00E-001	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA

	ILCR Calculation		
Compound	CDI (mg/kg-day)	CSF g/kg-day)-u	UR (unitless)
trans-1,2-dichloroethene	4.56E-007	NA	NA
trichloroethene	1.64E-007	1.00E-002	1.64E-009
trichlorofluoromethane	NA	NA	NA
trichlorotrifluoroethane	NA	NA	NA
vanadium	NA	NA	NA
vinyl acetate	3.17E-007	NA	NA
vinyl chloride	5.24E-006	2.70E-001	1.42E-006
xylene, m-	3.97E-008	NA	NA
xylene, o-	3.93E-008	NA	NA
xylene, p-	4.46E-008	NA	NA
zinc	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA

APPENDIX E

SUMMARY OF UNIT RISK CALCULATIONS

Table E-1A
Summary of Unit Risk Calculations
On-Site Construction Worker

Chemicals of Concern	Unit Hazard Quotient – Soil				Unit Incremental Lifetime Cancer Risk – Soil			
	Inhalation (unitless)	Dermal (unitless)	Ingestion (unitless)	Total (unitless)	Inhalation (unitless)	Dermal (unitless)	Ingestion (unitless)	Total (unitless)
1,1-dichloroethane	2.58E-006	4.09E-006	4.70E-006	1.14E-005	3.00E-010	3.00E-010	3.82E-010	9.82E-010
1,1-dichloroethene	7.15E-004	4.54E-004	5.22E-004	1.69E-003	1.10E-007	3.15E-008	4.03E-008	1.82E-007
1,1,1-trichloroethane	NA	NA	NA	NA	NA	NA	NA	NA
1,1,2-trichloroethane	3.02E-005	1.02E-004	1.17E-004	2.50E-004	1.24E-009	3.78E-009	4.83E-009	9.86E-009
1,2-dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
1,2-dichloroethane	NA	NA	NA	NA	2.45E-009	3.68E-009	4.70E-009	1.08E-008
1,2-dichloropropane	6.11E-004	NA	NA	6.11E-004	2.04E-009	3.31E-009	4.23E-009	9.58E-009
1,4-dichlorobenzene	7.40E-007	NA	NA	7.40E-007	3.02E-010	2.10E-009	2.68E-009	5.09E-009
2-butanone	1.15E-011	2.04E-006	2.35E-006	4.39E-006	NA	NA	NA	NA
2,4-dichlorophenol	1.09E-008	1.36E-003	1.57E-003	2.93E-003	NA	NA	NA	NA
4-methyl-2-pentanone	1.44E-010	5.11E-006	5.87E-006	1.10E-005	NA	NA	NA	NA
4,4-ddd	NA	NA	NA	NA	1.13E-013	6.31E-009	1.61E-008	2.24E-008
4,4-dde	NA	NA	NA	NA	1.44E-012	8.93E-009	2.28E-008	3.17E-008
4,4-ddt	6.56E-008	4.09E-003	9.39E-003	1.35E-002	1.59E-013	8.93E-009	2.28E-008	3.17E-008
acetone	2.93E-006	4.09E-006	4.70E-006	1.17E-005	NA	NA	NA	NA
antimony	8.20E-008	6.13E-003	1.17E-002	1.79E-002	NA	NA	NA	NA
aroclor 1254	2.54E-004	8.18E-002	9.39E-002	1.76E-001	NA	NA	NA	NA
arsenic	1.09E-007	3.87E-003	1.57E-002	1.95E-002	5.63E-012	2.37E-008	1.01E-007	1.24E-007
barium	2.30E-008	5.78E-006	6.71E-005	7.29E-005	NA	NA	NA	NA
benzene	NA	NA	NA	NA	4.18E-009	5.26E-009	6.71E-009	1.61E-008
benzo(a)anthracene	NA	NA	NA	NA	1.83E-013	1.05E-007	8.05E-008	1.86E-007
benzo(a)pyrene	NA	NA	NA	NA	1.83E-012	1.05E-006	8.05E-007	1.86E-006
benzo(b)fluoranthene	NA	NA	NA	NA	8.25E-012	1.05E-007	8.05E-008	1.86E-007
beryllium	6.56E-009	7.36E-003	9.39E-004	8.30E-003	3.94E-012	NA	NA	3.94E-012
bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	3.94E-015	4.41E-010	5.64E-010	1.01E-009
bromodichloromethane	4.72E-005	2.04E-004	2.35E-004	4.86E-004	1.75E-009	6.83E-009	8.72E-009	1.73E-008
bromoform	1.53E-005	2.04E-004	2.35E-004	4.55E-004	1.71E-011	4.17E-010	5.32E-010	9.66E-010
cadmium	6.56E-008	1.47E-003	9.39E-003	1.09E-002	7.03E-012	NA	NA	7.03E-012
carbon disulfide	4.23E-005	4.09E-005	4.70E-005	1.30E-004	NA	NA	NA	NA
carbon tetrachloride	NA	NA	NA	NA	8.05E-009	7.88E-009	1.01E-008	2.60E-008

Table E-1A (cont'd)
Summary of Unit Risk Calculations
On-Site Construction Worker

Chemicals of Concern	Unit Hazard Quotient – Soil				Unit Incremental Lifetime Cancer Risk – Soil			
	Inhalation (unitless)	Dermal (unitless)	Ingestion (unitless)	Total (unitless)	Inhalation (unitless)	Dermal (unitless)	Ingestion (unitless)	Total (unitless)
chlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
chloroform	3.14E-004	3.68E-004	4.70E-004	1.15E-003	8.52E-010	1.63E-009	2.08E-009	4.56E-009
chromium iii	3.28E-011	8.18E-007	4.70E-006	5.51E-006	NA	NA	NA	NA
chromium vi	1.64E-009	4.09E-007	2.35E-004	2.35E-004	2.39E-010	2.21E-011	2.82E-008	2.84E-008
chrysene	NA	NA	NA	NA	1.83E-014	6.31E-010	8.05E-009	8.68E-009
cis-1,2-dichloroethene	2.95E-005	4.09E-005	4.70E-005	1.17E-004	NA	NA	NA	NA
copper	8.87E-010	1.66E-005	1.27E-004	1.44E-004	NA	NA	NA	NA
cumene	2.77E-005	1.15E-006	1.17E-005	4.06E-005	NA	NA	NA	NA
cyanide	1.64E-009	2.55E-005	2.35E-004	2.60E-004	NA	NA	NA	NA
di-n-butylphthalate	3.28E-011	4.09E-006	4.70E-006	8.78E-006	NA	NA	NA	NA
di-n-octylphthalate	7.22E-009	2.04E-004	2.35E-004	4.39E-004	NA	NA	NA	NA
dibromochloromethane	2.26E-006	2.04E-005	2.35E-005	4.62E-005	6.07E-010	4.94E-009	6.31E-009	1.19E-008
endosulfan	1.32E-006	3.41E-004	7.83E-004	1.12E-003	NA	NA	NA	NA
endrin	1.09E-007	6.81E-003	1.57E-002	2.25E-002	NA	NA	NA	NA
ethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA
gamma-bhc	1.09E-008	6.32E-004	1.57E-003	2.20E-003	5.16E-013	3.42E-008	8.72E-008	1.21E-007
hydrogen sulfide	1.09E-009	6.13E-006	1.57E-004	1.63E-004	NA	NA	NA	NA
indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	1.83E-013	6.31E-008	8.05E-008	1.44E-007
manganese	6.56E-009	1.84E-004	9.39E-004	1.12E-003	NA	NA	NA	NA
mercury	3.07E-002	8.18E-003	1.57E-002	5.46E-002	NA	NA	NA	NA
methylene chloride	5.15E-006	6.13E-005	7.83E-005	1.45E-004	2.21E-010	7.36E-010	9.39E-010	1.90E-009
molybdenum	8.20E-010	2.42E-005	1.17E-004	1.42E-004	NA	NA	NA	NA
nickel	1.64E-009	3.68E-004	2.35E-004	6.03E-004	4.27E-013	NA	NA	4.27E-013
phenol	5.47E-011	6.81E-006	7.83E-006	1.46E-005	NA	NA	NA	NA
pyrene	5.81E-009	4.28E-005	1.57E-005	5.84E-005	NA	NA	NA	NA
selenium	6.56E-009	7.59E-005	9.39E-004	1.02E-003	NA	NA	NA	NA
silver	6.56E-009	3.50E-004	9.39E-004	1.29E-003	NA	NA	NA	NA
strontium	5.47E-011	3.07E-007	7.83E-006	8.13E-006	NA	NA	NA	NA
tetrachloroethene	2.97E-005	4.09E-005	4.70E-005	1.18E-004	8.90E-010	2.68E-009	3.42E-009	6.99E-009
toluene	9.02E-007	1.84E-006	2.35E-006	5.09E-006	NA	NA	NA	NA

Table E-1A (cont'd)
Summary of Unit Risk Calculations
On-Site Construction Worker

Chemicals of Concern	Unit Hazard Quotient, Soil: Inhalation (unitless)	Dermal (unitless)	Ingestion (unitless)	Total (unitless)	Unit Incremental Lifetime Cancer Risk, Soil: Inhalation (unitless)	Dermal (unitless)	Ingestion (unitless)	Total (unitless)
trans-1,2-dichloroethene	1.81E-005	2.04E-005	2.35E-005	6.20E-005	NA	NA	NA	NA
trichloroethene	NA	NA	NA	NA	3.21E-010	7.88E-010	1.01E-009	2.12E-009
trichlorofluoromethane	7.44E-006	5.84E-006	6.71E-006	2.00E-005	NA	NA	NA	NA
trichlorotrifluoroethane	6.43E-007	1.53E-007	1.57E-006	2.36E-006	NA	NA	NA	NA
vanadium	4.69E-009	1.05E-003	6.71E-004	1.72E-003	NA	NA	NA	NA
vinyl acetate	5.11E-005	4.09E-006	4.70E-006	5.99E-005	NA	NA	NA	NA
vinyl chloride	NA	NA	NA	NA	4.94E-008	1.42E-008	1.81E-008	8.17E-008
xylene, m-	1.55E-005	6.89E-006	7.04E-005	9.28E-005	NA	NA	NA	NA
xylene, o-	NA	NA	NA	NA	NA	NA	NA	NA
xylene, p-	4.23E-006	1.72E-006	1.76E-005	2.35E-005	NA	NA	NA	NA
zinc	1.09E-010	4.09E-006	1.57E-005	1.97E-005	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA

Table E-1B
Summary of Health-Based Remediation Goals
On-Site Construction Worker Scenario

Chemicals of Concern	Hazard Quotient: Total Unit HQ (unitless)	Hazard Quotient: Scaled Soil Concentration (mg/kg) HQ=0.2	Incremental Lifetime Cancer Risk: Total Unit ILCR (unitless)	Incremental Lifetime Cancer Risk: Scaled Soil Concentration (mg/kg) ILCR=1E-06
1,1-dichloroethane	1.14E-005	1.76E+004	9.82E-010	1.02E+003
1,1-dichloroethene	1.69E-003	1.18E+002	1.82E-007	5.49E+000
1,1,1-trichloroethane	NA	NA	NA	NA
1,1,2-trichloroethane	2.50E-004	8.01E+002	9.86E-009	1.01E+002
1,2-dichlorobenzene	NA	NA	NA	NA
1,2-dichloroethane	NA	NA	1.08E-008	9.24E+001
1,2-dichloropropane	6.11E-004	3.27E+002	9.58E-009	1.04E+002
1,4-dichlorobenzene	7.40E-007	2.70E+005	5.09E-009	1.97E+002
2-butanone	4.39E-006	4.55E+004	NA	NA
2,4-dichlorophenol	2.93E-003	6.83E+001	NA	NA
4-methyl-2-pentanone	1.10E-005	1.82E+004	NA	NA
4,4-ddd	NA	NA	2.24E-008	4.46E+001
4,4-dde	NA	NA	3.17E-008	3.15E+001
4,4-ddt	1.35E-002	1.48E+001	3.17E-008	3.15E+001
acetone	1.17E-005	1.71E+004	NA	NA
antimony	1.79E-002	1.12E+001	NA	NA
aroclor 1254	1.76E-001	1.14E+000	NA	NA
arsenic	1.95E-002	1.02E+001	1.24E-007	8.05E+000
barium	7.29E-005	2.74E+003	NA	NA
benzene	NA	NA	1.61E-008	6.19E+001
benzo(a)anthracene	NA	NA	1.86E-007	5.39E+000
benzo(a)pyrene	NA	NA	1.86E-006	5.39E-001
benzo(b)fluoranthene	NA	NA	1.86E-007	5.39E+000
beryllium	8.30E-003	2.41E+001	3.94E-012	2.54E+005
bis(2-ethylhexyl)phthalate	NA	NA	1.01E-009	9.95E+002
bromodichloromethane	4.86E-004	4.11E+002	1.73E-008	5.78E+001
bromoform	4.55E-004	4.40E+002	9.66E-010	1.04E+003
cadmium	1.09E-002	1.84E+001	7.03E-012	1.42E+005
carbon disulfide	1.30E-004	1.54E+003	NA	NA
carbon tetrachloride	NA	NA	2.60E-008	3.85E+001

Table E-1B (cont'd)
Summary of Health-Based Remediation Goals
On-Site Construction Worker Scenario

Chemicals of Concern	Hazard Quotient: Total Unit HQ (unitless)	Hazard Quotient: Scaled Soil Concentration (mg/kg) HQ=0.2	Incremental Lifetime Cancer Risk: Total Unit ILCR (unitless)	Incremental Lifetime Cancer Risk: Scaled Soil Concentration (mg/kg) ILCR=1E-06
chlorobenzene	NA	NA	NA	NA
chloroform	1.15E-003	1.74E+002	4.56E-009	2.19E+002
chromium iii	5.51E-006	3.63E+004	NA	NA
chromium vi	2.35E-004	8.50E+002	2.84E-008	3.52E+001
chrysene	NA	NA	8.68E-009	1.15E+002
cis-1,2-dichloroethene	1.17E-004	1.70E+003	NA	NA
copper	1.44E-004	1.39E+003	NA	NA
cumene	4.06E-005	4.93E+003	NA	NA
cyanide	2.60E-004	7.68E+002	NA	NA
di-n-butylphthalate	8.78E-006	2.28E+004	NA	NA
di-n-octylphthalate	4.39E-004	4.55E+002	NA	NA
dibromochloromethane	4.62E-005	4.33E+003	1.19E-008	8.44E+001
endosulfan	1.12E-003	1.78E+002	NA	NA
endrin	2.25E-002	8.90E+000	NA	NA
ethylbenzene	NA	NA	NA	NA
gamma-bhc	2.20E-003	9.10E+001	1.21E-007	8.24E+000
hydrogen sulfide	1.63E-004	1.23E+003	NA	NA
indeno(1,2,3-cd)pyrene	NA	NA	1.44E-007	6.96E+000
manganese	1.12E-003	1.78E+002	NA	NA
mercury	5.46E-002	3.66E+000	NA	NA
methylene chloride	1.45E-004	1.38E+003	1.90E-009	5.27E+002
molybdenum	1.42E-004	1.41E+003	NA	NA
nickel	6.03E-004	3.32E+002	4.27E-013	2.34E+006
phenol	1.46E-005	1.37E+004	NA	NA
pyrene	5.84E-005	3.42E+003	NA	NA
selenium	1.02E-003	1.97E+002	NA	NA
silver	1.29E-003	1.55E+002	NA	NA
strontium	8.13E-006	2.46E+004	NA	NA
tetrachloroethene	1.18E-004	1.70E+003	6.99E-009	1.43E+002
toluene	5.09E-006	3.93E+004	NA	NA

Table E-1B (cont'd)
Summary of Health-Based Remediation Goals
On-Site Construction Worker Scenario

Chemicals of Concern	Hazard Quotient: Total Unit HQ (unitless)	Hazard Quotient: Scaled Soil Concentration (mg/kg) HQ=0.2	Incremental Lifetime Cancer Risk: Total Unit ILCR (unitless)	Incremental Lifetime Cancer Risk: Scaled Soil Concentration (mg/kg) ILCR=1E-06
trans-1,2-dichloroethene	6.20E-005	3.23E+003	NA	NA
trichloroethene	NA	NA	2.12E-009	4.73E+002
trichlorofluoromethane	2.00E-005	1.00E+004	NA	NA
trichlorotrifluoroethane	2.36E-006	8.47E+004	NA	NA
vanadium	1.72E-003	1.16E+002	NA	NA
vinyl acetate	5.99E-005	3.34E+003	NA	NA
vinyl chloride	NA	NA	8.17E-008	1.22E+001
xylene, m-	9.28E-005	2.16E+003	NA	NA
xylene, o-	NA	NA	NA	NA
xylene, p-	2.35E-005	8.50E+003	NA	NA
zinc	1.97E-005	1.01E+004	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA

Table E-2A
Summary of Unit Risk Calculations
On-Site Operations/Office Personnel

Chemicals of Concern	Unit Hazard Quotient – Air			Unit Incremental Lifetime Cancer Risk – Air		
	Ventilation (unitless)	Intrusion (unitless)	Total (unitless)	Ventilation (unitless)	Intrusion (unitless)	Total (unitless)
1,1-dichloroethane	1.79E-006	1.42E-004	1.44E-004	5.21E-010	4.13E-008	4.18E-008
1,1-dichloroethene	4.96E-005	6.88E-003	6.93E-003	NA	NA	NA
1,1,1-trichloroethane	8.62E-007	6.32E-005	6.41E-005	NA	NA	NA
1,1,2-trichloroethane	2.10E-005	6.68E-004	6.89E-004	2.16E-009	6.87E-008	7.08E-008
1,2-dichlorobenzene	5.68E-007	5.60E-006	6.17E-006	NA	NA	NA
1,2-dichloroethane	NA	NA	NA	4.26E-009	2.40E-007	2.44E-007
1,2-dichloropropane	1.38E-004	6.76E-003	6.90E-003	3.55E-009	1.74E-007	1.77E-007
1,4-dichlorobenzene	1.61E-007	1.75E-006	1.91E-006	5.24E-010	5.71E-009	6.24E-009
2-butanone	7.98E-012	NA	7.98E-012	NA	NA	NA
2,4-dichlorophenol	7.60E-010	8.11E-006	8.11E-006	NA	NA	NA
4-methyl-2-pentanone	9.97E-011	NA	9.97E-011	NA	NA	NA
4,4-ddd	NA	NA	NA	1.95E-013	2.57E-013	4.52E-013
4,4-dde	NA	NA	NA	2.50E-012	3.39E-013	2.84E-012
4,4-ddt	4.56E-009	5.33E-009	9.88E-009	2.77E-013	3.23E-013	6.00E-013
acetone	2.04E-006	1.22E-004	1.24E-004	NA	NA	NA
antimony	5.70E-009	NA	5.70E-009	NA	NA	NA
aroclor 1254	4.41E-005	1.21E-005	5.61E-005	2.42E-009	6.64E-010	3.09E-009
arsenic	7.60E-009	NA	7.60E-009	9.77E-012	NA	9.77E-012
barium	1.60E-008	NA	1.60E-008	NA	NA	NA
benzene	NA	NA	NA	7.25E-009	4.43E-007	4.51E-007
benzo(a)anthracene	NA	NA	NA	3.17E-013	NA	3.17E-013
benzo(a)pyrene	NA	NA	NA	3.17E-012	NA	3.17E-012
benzo(b)fluoranthene	NA	NA	NA	1.43E-011	NA	1.43E-011
beryllium	4.56E-010	NA	4.56E-010	6.84E-012	NA	6.84E-012
bis(2-ethylhexyl)phthalate	1.14E-010	8.05E-013	1.15E-010	6.84E-015	4.83E-017	6.89E-015
bromodichloromethane	3.28E-006	1.16E-004	1.19E-004	3.04E-009	1.08E-007	1.11E-007
bromoform	1.06E-006	3.72E-005	3.82E-005	2.96E-011	1.04E-009	1.06E-009
cadmium	4.56E-009	NA	4.56E-009	1.22E-011	NA	1.22E-011
carbon disulfide	2.94E-006	5.09E-004	5.12E-004	NA	NA	NA
carbon tetrachloride	3.72E-004	2.90E-002	2.94E-002	4.94E-009	3.84E-007	3.89E-007

Table E-2A
Summary of Unit Risk Calculations
On-Site Operations/Office Personnel

Chemicals of Concern	Unit Hazard Quotient – Air			Unit Incremental Lifetime Cancer Risk – Air		
	Ventilation (unitless)	Intrusion (unitless)	Total (unitless)	Ventilation (unitless)	Intrusion (unitless)	Total (unitless)
chlorobenzene	1.37E-005	3.22E-004	3.36E-004	NA	NA	NA
chloroform	2.18E-005	1.46E-003	1.48E-003	1.48E-009	9.88E-008	1.00E-007
chromium iii	1.52E-012	NA	1.52E-012	NA	NA	NA
chromium vi	7.60E-010	NA	7.60E-010	4.15E-010	NA	4.15E-010
chrysene	NA	NA	NA	2.52E-015	NA	2.52E-015
cis-1,2-dichloroethene	2.05E-005	1.34E-003	1.36E-003	NA	NA	NA
copper	6.16E-011	NA	6.16E-011	NA	NA	NA
cumene	4.33E-007	NA	4.33E-007	NA	NA	NA
cyanide	1.14E-010	NA	1.14E-010	NA	NA	NA
di-n-butylphthalate	2.28E-011	1.31E-010	1.54E-010	NA	NA	NA
di-n-octylphthalate	5.01E-010	8.73E-012	5.10E-010	NA	NA	NA
dibromochloromethane	1.57E-006	6.12E-005	6.28E-005	1.05E-009	4.11E-008	4.22E-008
endosulfan	9.14E-008	5.54E-007	6.45E-007	NA	NA	NA
endrin	7.60E-009	1.60E-006	1.60E-006	NA	NA	NA
ethylbenzene	3.14E-007	7.79E-006	8.11E-006	NA	NA	NA
gamma-bhc	7.60E-009	3.22E-005	3.23E-005	8.95E-013	3.80E-009	3.80E-009
hydrogen sulfide	7.98E-009	NA	7.98E-009	NA	NA	NA
indeno(1,2,3-cd)pyrene	5.70E-011	NA	5.70E-011	3.17E-013	NA	3.17E-013
manganese	4.95E-011	NA	4.95E-011	NA	NA	NA
mercury	2.14E-003	NA	2.14E-003	NA	NA	NA
methylene chloride	3.58E-007	3.28E-005	3.31E-005	3.83E-010	3.51E-008	3.55E-008
molybdenum	4.56E-010	NA	4.56E-010	NA	NA	NA
nickel	1.14E-010	NA	1.14E-010	7.41E-013	NA	7.41E-013
phenol	3.80E-012	4.37E-008	4.37E-008	NA	NA	NA
pyrene	4.04E-009	2.41E-009	6.44E-009	NA	NA	NA
selenium	4.56E-010	NA	4.56E-010	NA	NA	NA
silver	4.56E-010	NA	4.56E-010	NA	NA	NA
strontium	3.80E-012	NA	3.80E-012	NA	NA	NA
tetrachloroethene	2.06E-005	1.16E-003	1.18E-003	1.55E-009	8.73E-008	8.89E-008
toluene	1.10E-006	3.96E-005	4.07E-005	NA	NA	NA

Table E-2A
Summary of Unit Risk Calculations
On-Site Operations/Office Personnel

Chemicals of Concern	Unit Hazard Quotient – Air			Unit Incremental Lifetime Cancer Risk – Air		
	Ventilation (unitless)	Intrusion (unitless)	Total (unitless)	Ventilation (unitless)	Intrusion (unitless)	Total (unitless)
trans-1,2-dichloroethene	1.25E-005	NA	1.25E-005	NA	NA	NA
trichloroethene	2.12E-005	NA	2.12E-005	5.57E-010	NA	5.57E-010
trichlorofluoromethane	1.81E-006	NA	1.81E-006	NA	NA	NA
trichlorotrifluoroethane	4.47E-008	NA	4.47E-008	NA	NA	NA
vanadium	3.26E-010	NA	3.26E-010	NA	NA	NA
vinyl acetate	3.55E-006	NA	3.55E-006	NA	NA	NA
vinyl chloride	NA	NA	NA	8.57E-008	NA	8.57E-008
xylene, m-	3.58E-008	NA	3.58E-008	NA	NA	NA
xylene, o-	3.56E-008	NA	3.56E-008	NA	NA	NA
xylene, p-	NA	NA	NA	NA	NA	NA
zinc	7.60E-012	NA	7.60E-012	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA

Table E-2B
Summary of Health-Based Remediation Goals
On-Site Operations/Office Personnel

Chemicals of Concern	Hazard Quotient		Incremental Lifetime Cancer Risk	
	Unit HQ (unitless)	Scaled Soil Concentration (mg/kg) HQ=0.2	Unit ILCR (unitless)	Scaled Soil Concentration (mg/kg) HQ=0.2
1,1-dichloroethane	1.44E-004	1.39E+003	4.18E-008	2.39E+001
1,1-dichloroethene	6.93E-003	2.89E+001	NA	NA
1,1,1-trichloroethane	6.41E-005	3.12E+003	NA	NA
1,1,2-trichloroethane	6.89E-004	2.90E+002	7.08E-008	1.41E+001
1,2-dichlorobenzene	6.17E-006	3.24E+004	NA	NA
1,2-dichloroethane	NA	NA	2.44E-007	4.10E+000
1,2-dichloropropane	6.90E-003	2.90E+001	1.77E-007	5.63E+000
1,4-dichlorobenzene	1.91E-006	1.05E+005	6.24E-009	1.60E+002
2-butanone	7.98E-012	2.51E+010	NA	NA
2,4-dichlorophenol	8.11E-006	2.47E+004	NA	NA
4-methyl-2-pentanone	9.97E-011	2.01E+009	NA	NA
4,4-ddd	NA	NA	4.52E-013	2.21E+006
4,4-dde	NA	NA	2.84E-012	3.52E+005
4,4-ddt	9.88E-009	2.02E+007	6.00E-013	1.67E+006
acetone	1.24E-004	1.62E+003	NA	NA
antimony	5.70E-009	3.51E+007	NA	NA
aroclor 1254	5.61E-005	3.56E+003	3.09E-009	3.24E+002
arsenic	7.60E-009	2.63E+007	9.77E-012	1.02E+005
barium	1.60E-008	1.25E+007	NA	NA
benzene	NA	NA	4.51E-007	2.22E+000
benzo(a)anthracene	NA	NA	3.17E-013	3.15E+006
benzo(a)pyrene	NA	NA	3.17E-012	3.15E+005
benzo(b)fluoranthene	NA	NA	1.43E-011	6.99E+004
beryllium	4.56E-010	4.39E+008	6.84E-012	1.46E+005
bis(2-ethylhexyl)phthalate	1.15E-010	1.74E+009	6.89E-015	1.45E+008
bromodichloromethane	1.19E-004	1.68E+003	1.11E-007	9.03E+000
bromoform	3.82E-005	5.23E+003	1.06E-009	9.39E+002
cadmium	4.56E-009	4.39E+007	1.22E-011	8.19E+004
carbon disulfide	5.12E-004	3.90E+002	NA	NA
carbon tetrachloride	2.94E-002	6.81E+000	3.89E-007	2.57E+000

Table E-2B
Summary of Health-Based Remediation Goals
On-Site Operations/Office Personnel

Chemicals of Concern	Hazard Quotient		Incremental Lifetime Cancer Risk	
	Unit HQ (unitless)	Scaled Soil Concentration (mg/kg) HQ=0.2	Unit ILCR (unitless)	Scaled Soil Concentration (mg/kg) HQ=0.2
chlorobenzene	3.36E-004	5.96E+002	NA	NA
chloroform	1.48E-003	1.35E+002	1.00E-007	9.98E+000
chromium iii	1.52E-012	1.32E+011	NA	NA
chromium vi	7.60E-010	2.63E+008	4.15E-010	2.41E+003
chrysene	NA	NA	2.52E-015	3.96E+008
cis-1,2-dichloroethene	1.36E-003	1.47E+002	NA	NA
copper	6.16E-011	3.25E+009	NA	NA
cumene	4.33E-007	4.62E+005	NA	NA
cyanide	1.14E-010	1.76E+009	NA	NA
di-n-butylphthalate	1.54E-010	1.30E+009	NA	NA
di-n-octylphthalate	5.10E-010	3.92E+008	NA	NA
dibromochloromethane	6.28E-005	3.19E+003	4.22E-008	2.37E+001
endosulfan	6.45E-007	3.10E+005	NA	NA
endrin	1.60E-006	1.25E+005	NA	NA
ethylbenzene	8.11E-006	2.47E+004	NA	NA
gamma-bhc	3.23E-005	6.20E+003	3.80E-009	2.63E+002
hydrogen sulfide	7.98E-009	2.51E+007	NA	NA
indeno(1,2,3-cd)pyrene	5.70E-011	3.51E+009	3.17E-013	3.15E+006
manganese	4.95E-011	4.04E+009	NA	NA
mercury	2.14E-003	9.37E+001	NA	NA
methylene chloride	3.31E-005	6.04E+003	3.55E-008	2.82E+001
molybdenum	4.56E-010	4.39E+008	NA	NA
nickel	1.14E-010	1.76E+009	7.41E-013	1.35E+006
phenol	4.37E-008	4.58E+006	NA	NA
pyrene	6.44E-009	3.10E+007	NA	NA
selenium	4.56E-010	4.39E+008	NA	NA
silver	4.56E-010	4.39E+008	NA	NA
strontium	3.80E-012	5.27E+010	NA	NA
tetrachloroethene	1.18E-003	1.69E+002	8.89E-008	1.13E+001
toluene	4.07E-005	4.92E+003	NA	NA

Table E-2B
Summary of Health-Based Remediation Goals
On-Site Operations/Office Personnel

Chemicals of Concern	Hazard Quotient: Unit HQ (unitless)	Hazard Quotient: Scaled Soil Concentration (mg/kg) HQ=0.2	Incremental Lifetime Cancer Risk: Unit ILCR (unitless)	Incremental Lifetime Cancer Risk: Scaled Soil Concentration (mg/kg) HQ=0.2
trans-1,2-dichloroethene	1.25E-005	1.60E+004	NA	NA
trichloroethene	2.12E-005	9.43E+003	5.57E-010	1.80E+003
trichlorofluoromethane	1.81E-006	1.11E+005	NA	NA
trichlorotrifluoroethane	4.47E-008	4.48E+006	NA	NA
vanadium	3.26E-010	6.14E+008	NA	NA
vinyl acetate	3.55E-006	5.63E+004	NA	NA
vinyl chloride	NA	NA	8.57E-008	1.17E+001
xylene, m-	3.58E-008	5.58E+006	NA	NA
xylene, o-	3.56E-008	5.62E+006	NA	NA
xylene, p-	NA	NA	NA	NA
zinc	7.60E-012	2.63E+010	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
		NA		NA

Table E-3A
Summary of Unit Risk Calculations
On-Site Daycare Child

Chemicals of Concern	Unit Hazard Quotient – Air			Unit Incremental Lifetime Cancer Risk – Air		
	Ventilation (unitless)	Intrusion (unitless)	Total (unitless)	Ventilation (unitless)	Intrusion (unitless)	Total (unitless)
1,1-dichloroethane	4.01E-006	3.18E-004	3.22E-004	2.33E-010	1.85E-008	1.87E-008
1,1-dichloroethene	1.11E-004	1.54E-002	1.55E-002	NA	NA	NA
1,1,1-trichloroethane	1.93E-006	1.42E-004	1.44E-004	NA	NA	NA
1,1,2-trichloroethane	4.70E-005	1.50E-003	1.54E-003	9.66E-010	3.08E-008	3.17E-008
1,2-dichlorobenzene	1.27E-006	1.26E-005	1.38E-005	NA	NA	NA
1,2-dichloroethane	NA	NA	NA	1.91E-009	1.07E-007	1.09E-007
1,2-dichloropropane	3.09E-004	1.52E-002	1.55E-002	1.59E-009	7.79E-008	7.95E-008
1,4-dichlorobenzene	3.60E-007	3.92E-006	4.28E-006	2.35E-010	2.56E-009	2.79E-009
2-butanone	1.79E-011	NA	1.79E-011	NA	NA	NA
2,4-dichlorophenol	1.70E-009	1.82E-005	1.82E-005	NA	NA	NA
4-methyl-2-pentanone	2.23E-010	NA	2.23E-010	NA	NA	NA
4,4-ddd	NA	NA	NA	8.75E-014	1.15E-013	2.03E-013
4,4-dde	NA	NA	NA	1.12E-012	1.52E-013	1.27E-012
4,4-ddt	1.02E-008	1.19E-008	2.21E-008	1.24E-013	1.45E-013	2.69E-013
acetone	4.56E-006	2.72E-004	2.77E-004	NA	NA	NA
antimony	1.28E-008	NA	1.28E-008	NA	NA	NA
aroclor 1254	9.87E-005	2.70E-005	1.26E-004	1.09E-009	2.97E-010	1.38E-009
arsenic	1.70E-008	NA	1.70E-008	4.38E-012	NA	4.38E-012
barium	3.57E-008	NA	3.57E-008	NA	NA	NA
benzene	NA	NA	NA	3.25E-009	1.99E-007	2.02E-007
benzo(a)anthracene	NA	NA	NA	1.42E-013	NA	1.42E-013
benzo(a)pyrene	NA	NA	NA	1.42E-012	NA	1.42E-012
benzo(b)fluoranthene	NA	NA	NA	6.41E-012	NA	6.41E-012
beryllium	1.02E-009	NA	1.02E-009	3.06E-012	NA	3.06E-012
bis(2-ethylhexyl)phthalate	2.55E-010	1.80E-012	2.57E-010	3.06E-015	2.16E-017	3.08E-015
bromodichloromethane	7.34E-006	2.60E-004	2.67E-004	1.36E-009	4.83E-008	4.96E-008
bromoform	2.38E-006	8.32E-005	8.56E-005	1.33E-011	4.64E-010	4.77E-010
cadmium	1.02E-008	NA	1.02E-008	5.47E-012	NA	5.47E-012
carbon disulfide	6.58E-006	1.14E-003	1.15E-003	NA	NA	NA
carbon tetrachloride	8.34E-004	6.49E-002	6.58E-002	2.21E-009	1.72E-007	1.74E-007

Table E-3A
Summary of Unit Risk Calculations
On-Site Daycare Child

Chemicals of Concern	Unit Hazard Quotient Air			Unit Incremental Lifetime Cancer Risk Air		
	Ventilation (unitless)	Intrusion (unitless)	Total (unitless)	Ventilation (unitless)	Intrusion (unitless)	Total (unitless)
chlorobenzene	3.07E-005	7.22E-004	7.52E-004	NA	NA	NA
chloroform	4.88E-005	3.26E-003	3.31E-003	6.62E-010	4.42E-008	4.49E-008
chromium iii	3.40E-012	NA	3.40E-012	NA	NA	NA
chromium vi	1.70E-009	NA	1.70E-009	1.86E-010	NA	1.86E-010
chrysene	NA	NA	NA	1.13E-015	NA	1.13E-015
cis-1,2-dichloroethene	4.59E-005	3.01E-003	3.06E-003	NA	NA	NA
copper	1.38E-010	NA	1.38E-010	NA	NA	NA
cumene	9.69E-007	NA	9.69E-007	NA	NA	NA
cyanide	2.55E-010	NA	2.55E-010	NA	NA	NA
di-n-butylphthalate	5.11E-011	2.93E-010	3.44E-010	NA	NA	NA
di-n-octylphthalate	1.12E-009	1.96E-011	1.14E-009	NA	NA	NA
dibromochloromethane	3.51E-006	1.37E-004	1.41E-004	4.72E-010	1.84E-008	1.89E-008
endosulfan	2.05E-007	1.24E-006	1.44E-006	NA	NA	NA
endrin	1.70E-008	3.57E-006	3.59E-006	NA	NA	NA
ethylbenzene	7.04E-007	1.75E-005	1.82E-005	NA	NA	NA
gamma-bhc	1.70E-008	7.22E-005	7.23E-005	4.01E-013	1.70E-009	1.70E-009
hydrogen sulfide	1.79E-008	NA	1.79E-008	NA	NA	NA
indeno(1,2,3-cd)pyrene	1.28E-010	NA	1.28E-010	1.42E-013	NA	1.42E-013
manganese	1.11E-010	NA	1.11E-010	NA	NA	NA
mercury	4.78E-003	NA	4.78E-003	NA	NA	NA
methylene chloride	8.01E-007	7.34E-005	7.42E-005	1.72E-010	1.57E-008	1.59E-008
molybdenum	1.02E-009	NA	1.02E-009	NA	NA	NA
nickel	2.55E-010	NA	2.55E-010	3.32E-013	NA	3.32E-013
phenol	8.51E-012	9.78E-008	9.78E-008	NA	NA	NA
pyrene	9.04E-009	5.40E-009	1.44E-008	NA	NA	NA
selenium	1.02E-009	NA	1.02E-009	NA	NA	NA
silver	1.02E-009	NA	1.02E-009	NA	NA	NA
strontium	8.51E-012	NA	8.51E-012	NA	NA	NA
tetrachloroethene	4.61E-005	2.61E-003	2.65E-003	6.92E-010	3.91E-008	3.98E-008
toluene	2.46E-006	8.86E-005	9.11E-005	NA	NA	NA

Table E-3A
Summary of Unit Risk Calculations
On-Site Daycare Child

Chemicals of Concern	Unit Hazard Quotient – Air			Unit Incremental Lifetime Cancer Risk – Air		
	Ventilation (unitless)	Intrusion (unitless)	Total (unitless)	Ventilation (unitless)	Intrusion (unitless)	Total (unitless)
trans-1,2-dichloroethene	2.81E-005	3.19E-004	3.47E-004	NA	NA	NA
trichloroethene	4.75E-005	3.12E-004	3.60E-004	2.49E-010	1.64E-009	1.89E-009
trichlorofluoromethane	4.05E-006	NA	4.05E-006	NA	NA	NA
trichlorotrifluoroethane	1.00E-007	NA	1.00E-007	NA	NA	NA
vanadium	7.29E-010	NA	7.29E-010	NA	NA	NA
vinyl acetate	7.95E-006	7.77E-005	8.56E-005	NA	NA	NA
vinyl chloride	NA	NA	NA	3.84E-008	1.42E-006	1.45E-006
xylene, m-	8.02E-008	2.78E-007	3.58E-007	NA	NA	NA
xylene, o-	7.97E-008	2.75E-007	3.55E-007	NA	NA	NA
xylene, p-	NA	NA	NA	NA	NA	NA
zinc	1.70E-011	NA	1.70E-011	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA		NA	NA		NA
	NA		NA	NA		NA
	NA		NA	NA		NA
	NA		NA	NA		NA
	NA		NA	NA		NA
	NA		NA	NA		NA
	NA		NA	NA		NA
	NA		NA	NA		NA

Table E-3B
Summary of Health-Based Remediation Goals
On-Site Daycare Child

Chemicals of Concern	Hazard Quotient		Incremental Lifetime Cancer Risk	
	Unit HQ (unitless)	Scaled Soil Concentration (mg/kg) HQ=0.2	Unit ILCR (unitless)	Scaled Soil Concentration (mg/kg) ILCR=1E-06
1,1-dichloroethane	3.22E-004	6.21E+002	1.87E-008	5.34E+001
1,1-dichloroethene	1.55E-002	1.29E+001	NA	NA
1,1,1-trichloroethane	1.44E-004	1.39E+003	NA	NA
1,1,2-trichloroethane	1.54E-003	1.30E+002	3.17E-008	3.15E+001
1,2-dichlorobenzene	1.38E-005	1.45E+004	NA	NA
1,2-dichloroethane	NA	NA	1.09E-007	9.15E+000
1,2-dichloropropane	1.55E-002	1.29E+001	7.95E-008	1.26E+001
1,4-dichlorobenzene	4.28E-006	4.68E+004	2.79E-009	3.58E+002
2-butanone	1.79E-011	1.12E+010	NA	NA
2,4-dichlorophenol	1.82E-005	1.10E+004	NA	NA
4-methyl-2-pentanone	2.23E-010	8.95E+008	NA	NA
4,4-ddd	NA	NA	2.03E-013	4.94E+006
4,4-dde	NA	NA	1.27E-012	7.86E+005
4,4-ddt	2.21E-008	9.03E+006	2.69E-013	3.72E+006
acetone	2.77E-004	7.22E+002	NA	NA
antimony	1.28E-008	1.57E+007	NA	NA
aroclor 1254	1.26E-004	1.59E+003	1.38E-009	7.23E+002
arsenic	1.70E-008	1.18E+007	4.38E-012	2.29E+005
barium	3.57E-008	5.60E+006	NA	NA
benzene	NA	NA	2.02E-007	4.95E+000
benzo(a)anthracene	NA	NA	1.42E-013	7.03E+006
benzo(a)pyrene	NA	NA	1.42E-012	7.03E+005
benzo(b)fluoranthene	NA	NA	6.41E-012	1.56E+005
beryllium	1.02E-009	1.96E+008	3.06E-012	3.26E+005
bis(2-ethylhexyl)phthalate	2.57E-010	7.78E+008	3.08E-015	3.24E+008
bromodichloromethane	2.67E-004	7.48E+002	4.96E-008	2.02E+001
bromoform	8.56E-005	2.34E+003	4.77E-010	2.10E+003
cadmium	1.02E-008	1.96E+007	5.47E-012	1.83E+005
carbon disulfide	1.15E-003	1.74E+002	NA	NA
carbon tetrachloride	6.58E-002	3.04E+000	1.74E-007	5.74E+000

Table E-3B
Summary of Health-Based Remediation Goals
On-Site Daycare Child

Chemicals of Concern	Hazard Quotient		Incremental Lifetime Cancer Risk	
	Unit HQ (unitless)	Scaled Soil Concentration (mg/kg) HQ=0.2	Unit ILCR (unitless)	Scaled Soil Concentration (mg/kg) ILCR=1E-06
chlorobenzene	7.52E-004	2.66E+002	NA	NA
chloroform	3.31E-003	6.04E+001	4.49E-008	2.23E+001
chromium iii	3.40E-012	5.88E+010	NA	NA
chromium vi	1.70E-009	1.18E+008	1.86E-010	5.38E+003
chrysene	NA	NA	1.13E-015	8.85E+008
cis-1,2-dichloroethene	3.06E-003	6.54E+001	NA	NA
copper	1.38E-010	1.45E+009	NA	NA
cumene	9.69E-007	2.06E+005	NA	NA
cyanide	2.55E-010	7.84E+008	NA	NA
di-n-butylphthalate	3.44E-010	5.81E+008	NA	NA
di-n-octylphthalate	1.14E-009	1.75E+008	NA	NA
dibromochloromethane	1.41E-004	1.42E+003	1.89E-008	5.30E+001
endosulfan	1.44E-006	1.38E+005	NA	NA
endrin	3.59E-006	5.57E+004	NA	NA
ethylbenzene	1.82E-005	1.10E+004	NA	NA
gamma-bhc	7.23E-005	2.77E+003	1.70E-009	5.87E+002
hydrogen sulfide	1.79E-008	1.12E+007	NA	NA
indeno(1,2,3-cd)pyrene	1.28E-010	1.57E+009	1.42E-013	7.03E+006
manganese	1.11E-010	1.80E+009	NA	NA
mercury	4.78E-003	4.18E+001	NA	NA
methylene chloride	7.42E-005	2.70E+003	1.59E-008	6.29E+001
molybdenum	1.02E-009	1.96E+008	NA	NA
nickel	2.55E-010	7.84E+008	3.32E-013	3.01E+006
phenol	9.78E-008	2.04E+006	NA	NA
pyrene	1.44E-008	1.39E+007	NA	NA
selenium	1.02E-009	1.96E+008	NA	NA
silver	1.02E-009	1.96E+008	NA	NA
strontium	8.51E-012	2.35E+010	NA	NA
tetrachloroethene	2.65E-003	7.53E+001	3.98E-008	2.51E+001
toluene	9.11E-005	2.20E+003	NA	NA

Table E-3B
Summary of Health-Based Remediation Goals
On-Site Daycare Child

Chemicals of Concern	Hazard Quotient		Incremental Lifetime Cancer Risk	
	Unit HQ (unitless)	Scaled Soil Concentration (mg/kg) HQ=0.2	Unit ILCR (unitless)	Scaled Soil Concentration (mg/kg) ILCR=1E-06
trans-1,2-dichloroethene	3.47E-004	5.76E+002	NA	NA
trichloroethene	3.60E-004	5.56E+002	1.89E-009	5.29E+002
trichlorofluoromethane	4.05E-006	4.94E+004	NA	NA
trichlorotrifluoroethane	1.00E-007	2.00E+006	NA	NA
vanadium	7.29E-010	2.74E+008	NA	NA
vinyl acetate	8.56E-005	2.34E+003	NA	NA
vinyl chloride	NA	NA	1.45E-006	6.88E-001
xylene, m-	3.58E-007	5.58E+005	NA	NA
xylene, o-	3.55E-007	5.63E+005	NA	NA
xylene, p-	NA	NA	NA	NA
zinc	1.70E-011	1.18E+010	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
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	NA	NA	NA	NA
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	NA	NA	NA	NA
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	NA	NA	NA	NA
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	NA	NA	NA	NA