Mr. John Geroch
California Regional Water Quality Control Board
Los Angeles Region
320 W. 4th Street, Suite 200
Los Angeles, California 90013

ARCADIS G&M, Inc.
1400 No. Harbor Boulevard
Suite 700
Fullerton, California 92835-4127
Tel 714.278.0992
Fax 714.278.0051
www.arcadis-us.com
Environmental

Subject:
Addendum to the Building 2
In-Situ Reactive Zone Pilot Test Workplan
Former C-6 Facility, Los Angeles, California

Date:
July 31, 2002

Contact:
James K. Nguyen, P.E.

Phone:
Ext. 3026

Email:
jnguyen@arcadis-us.com

Dear Mr. Geroch:

ARCADIS has prepared this Addendum to the *Building 2 In-Situ Reactive Zone Pilot Test Workplan* (Workplan) to address groundwater impact in the C-Sand located at the Building 2 Area of the former Boeing C-6 facility (site). The site is located at 19503 South Normandie Avenue in Los Angeles, California (Figure 1). The original Workplan was submitted to the California Regional Water Quality Control Board (CRWQCB) on August 15, 2001 and subsequently approved on May 17, 2002. The purpose of this addendum is to incorporate the C-Sand into the *in-situ* reactive zone (IRZ) pilot test. The objectives and general concept for conducting the C-Sand pilot test are consistent with that presented in the Workplan as are the monitoring and amendment programs.

The sections included in this addendum are (1) results of the C-Sand investigation, and (2) pilot test program in the C-Sand.

1.0 Results of the C-Sand Investigation

The C-Sand investigation has been completed at the site and ranged in depth from approximately 100 to 125 feet below ground surface (bgs). The investigation has defined the extent of volatile organic compounds (VOCs) in the C-Sand groundwater. Also, the investigation defined the extent of elevated concentrations of trichloroethene (TCE) (defined as concentrations exceeding 5, 000 µg/L). Figure 1 illustrates the extent of TCE impact.

In addition, the investigation confirmed the depth to the Lower Bellflower Aquitard. The Lower Bellflower Aquitard consists of fine-grained materials (clay and silt) at approximately 125 feet bgs and extends beyond a depth of 130 feet, which is the maximum depth investigated at the site. The geology in the C-Sand zone consists of a fine- to medium-grained sand.

To address the VOC-impacted groundwater in the C-Sand (approximately 100 to 125 feet bgs), the pilot test described in the approved Workplan will be expanded. The expansion of the pilot test is discussed in the section below.

2.0 Building 2 Pilot Test Expansion

The C-sand pilot program will be integrated into the overall Building 2 pilot test program described in the approved August 2001 Workplan. Approximately 20 IRZ amendment points and 5 monitoring wells will be installed in the targeted source-area within the C-Sand. All baseline sampling, amendment addition, and groundwater monitoring will be conducted in accordance with the approved Workplan. Sections 2.1 and 2.2 describe the amendment point and monitoring well layout and construction details.

2.1 IRZ Amendment Point Layout/Installation

Temporary IRZ amendment points will be installed within the C-Sand source-area zone to deliver carbohydrate solution. The source-area zone is defined as the area where concentrations of TCE are above 5,000 µg/L. Based on the groundwater data, the specific targeted aerial extent is within the C-Sand from approximately 100-125 ft bgs with an area of approximately 9,000 square feet.

Preliminary design calculations using estimations of soil permeability (10^{-4} to 10^{-5} centimeter per second), groundwater flow velocity (average velocity of 15 feet per year), and anticipated amendment half-life resulted in a per point radius of influence (ROI) of 15 feet. Therefore, 20 amendment points will be spaced approximately 30 feet apart to establish a treatment line that is perpendicular to the direction of groundwater flow. In addition, the treatment lines will be spaced on 45-foot centers; this spacing is based on a minimum one-year travel time between lines. Figure 2 illustrates the proposed locations of the IRZ amendment points.

The IRZ amendment points will be installed using a hollow-stem-auger drill rig. A 1.5-inch diameter schedule 40 polyvinyl chloride (PVC) casing with 0.01-inch slotted screen from approximately 100 to 125 feet bgs will be inserted into the 8-inch diameter borehole. Clean sand will be placed in the borehole to approximately 1 foot above the well screen and 38 feet of bentonite chips will then be placed above the sand and hydrated in place to create a seal around the PVC casing. The top of this bentonite will be approximately 5 feet above groundwater. Volclay grout will then be placed in the annular space to ground surface.

A construction permit will be obtained from the Los Angeles County Department of Health Services for the amendment points prior to installation. The typical amendment point construction detail is shown in Figure 3.

2.2 Monitoring Well Layout/Installation

Five new monitoring wells will be installed to monitor the progress of the pilot study program in the C-Sand. These wells will consist of single wells and are identified as IRZ-C-MW1, CMW-001, IRZ-C-MWZ, CMW-002, and CMW-026 (Figure 2). The locations and rationale for each of these wells are summarized below.

- IRZ-C-MW1: The purpose of this well is to monitor groundwater from a background location (upgradient of the treatment area). This will be a single well casing to monitor the C-Sand and will be located approximately 30 feet upgradient of the first treatment row.
- CMW-026: The purpose of this well is to monitor groundwater in the C-Sand. The well will be located at the estimated edge of the zone of influence, approximately 15 downgradient of amendment point IRZ-C10.
- IRZ-C-MW2, CMW-001, and CMW-002: The purpose of these wells is to monitor groundwater in the C-Sand and to assess if the reactive zone has traveled outside the treatment area. IRZ-C-MW2 will be located approximately 90 feet downgradient of the furthest downgradient treatment row. Wells CMW-001 and CMW-002 will be located approximately 450 and 560 feet downgradient from the furthest downgradient treatment row, respectively.

The groundwater monitoring wells will be installed using a hollow-stem-auger drill rig. A 4-inch diameter schedule 40 PVC casing with 0.01-inch slotted screen from 100 to 125 feet will be inserted into the 10-inch diameter borehole. Clean sand will be placed in the borehole to approximately 2 foot above the well screen and 38 feet of bentonite chips will then be placed above the sand and hydrated in place to create a seal. Volclay grout will then be placed in the annular space to ground surface.

Well construction permits will be obtained from the Los Angeles County Department of Health Service prior to installation. Typical monitoring well construction is presented in Figure 3.

In summary, this addendum addresses IRZ pilot test in the C-Sand. The overall objectives and pilot test program are consistent with the Workplan submitted to the CRWQCB in August 2001. Materials handling, health and Safety, analytical techniques, and reporting are discussed in the August 2001 Workplan and related correspondence.

BOE-C6-0008957

If you have any questions concerning this project please feel free to contact Mr. Jim Nguyen at (714) 278-0992.

Sincerely,

ARCADIS G&M, Inc.

Olivia Edwards
Project Scientist

James Nguyen, P.E.
Project Manager

REGISTERED PROFESSIONAL ENGINEER
JAMES K. NGUYEN
NO. C055942
EXP. 12/31/04
CIVIL
STATE OF CALIFORNIA

Frank Lenzo, P.E.
Project Advisor

Attachment:
Table 1 – Carbohydrate Addition and Groundwater Monitoring Schedule for In-Situ Reactive Zone Pilot Test
Figure 1 – TCE Distribution in C-Sand Groundwater, May 2002
Figure 2 – Building 2 – Proposed IRZ Amendment Points and Monitoring Well Layout
Figure 3 – Typical Construction Details for IRZ Amendment Points and Monitoring Wells

Copies:
Stephanie Sibbett, Boeing Realty Corporation
Scott Zachary, Haley & Aldrich
Project File

Table

Table 1
Carbohydrate Addition and Groundwater Monitoring Schedule for In-situ Reactive Zone Pilot Test
Former Boeing C-6 Facility (Building 2 Area), Los Angeles, California

			Week								
					0	2	6	12	16	21	36
		Workplan Approved	IRZ Amendment Point and Monitoring Well Installation	Baseline Monitoring	Carbohydrate Addition	Process Monitoring (5)	Performance Monitoring	Performance Monitoring	Performance Monitoring	Performance Monitoring	Performance Monitoring
		5/17/02	9/3/02-10/4/02	10/7/02	10/8/02-10/25/02	11/08/02	12/06/02	1/17/03	02/14/03	03/21/03	07/04/03
Amendment Addition					X						
Field Parameters	**EPA Analytical Method**										
Dissolved oxygen	NA(1),(2)			x			x	x	x	x	x
Oxidation reduction potential (ORP)	NA(1)			x			x	x	x	x	x
pH	NA(1)			x		x (2)	x	x	x	x	x
Temperature	NA(1)			x			x	x	x	x	x
Specific conductance	NA(1)			x			x	x	x	x	x
Iron, ferrous	NA(2)			x			x	x	x	x	x
Hydrogen sulfide	NA(2)			x			x	x	x	x	x
Sulfides	NA(2)			x			x	x	x	x	x
Laboratory Analysis											
Volatile Organic Compounds	8260			x			x	x	x	x	x
Total organic carbon (TOC)	9060 Modified			x		x	x	x	x	x	x
Manganese, total	6010A			x						x	x
Manganese, dissolved	6010A			x			x	x	x	x	x
Iron, total	6010A			x						x	x
Sulfate	375.4			x			x	x	x	x	x
Nitrate	353.2			x			x	x	x	x	x
Nitrite	353.2			x						x	x
Chloride	325.2			x						x	x
Permanent Gases											
Dissolved Oxygen	VaporTech(3)			x			x	x	x	x	x
Carbon dioxide	VaporTech(3)			x			x	x	x	x	x
Nitrogen	VaporTech(3)			x			x	x	x	x	x
Methane	VaporTech(3)			x			x	x	x	x	x
Ethane	VaporTech(3)			x			x	x	x	x	x
Ethene	VaporTech(3)			x			x	x	x	x	x
Tracer											
Bromide	320.1			x			x	x	x	x	x
Well To be Sampled (4, 5)				1,2,3,4,5,6,7,8,9		(5)	1,3,7	1,2,3,4,5,6,7,8,9	1,2,3,7	1,2,3,4,5,6,7,8,9	4,5,6

Notes:

(1) NA - not applicable. Parameters will be measured in the field using a YSI 6000 Water Quality Transmitter unit.

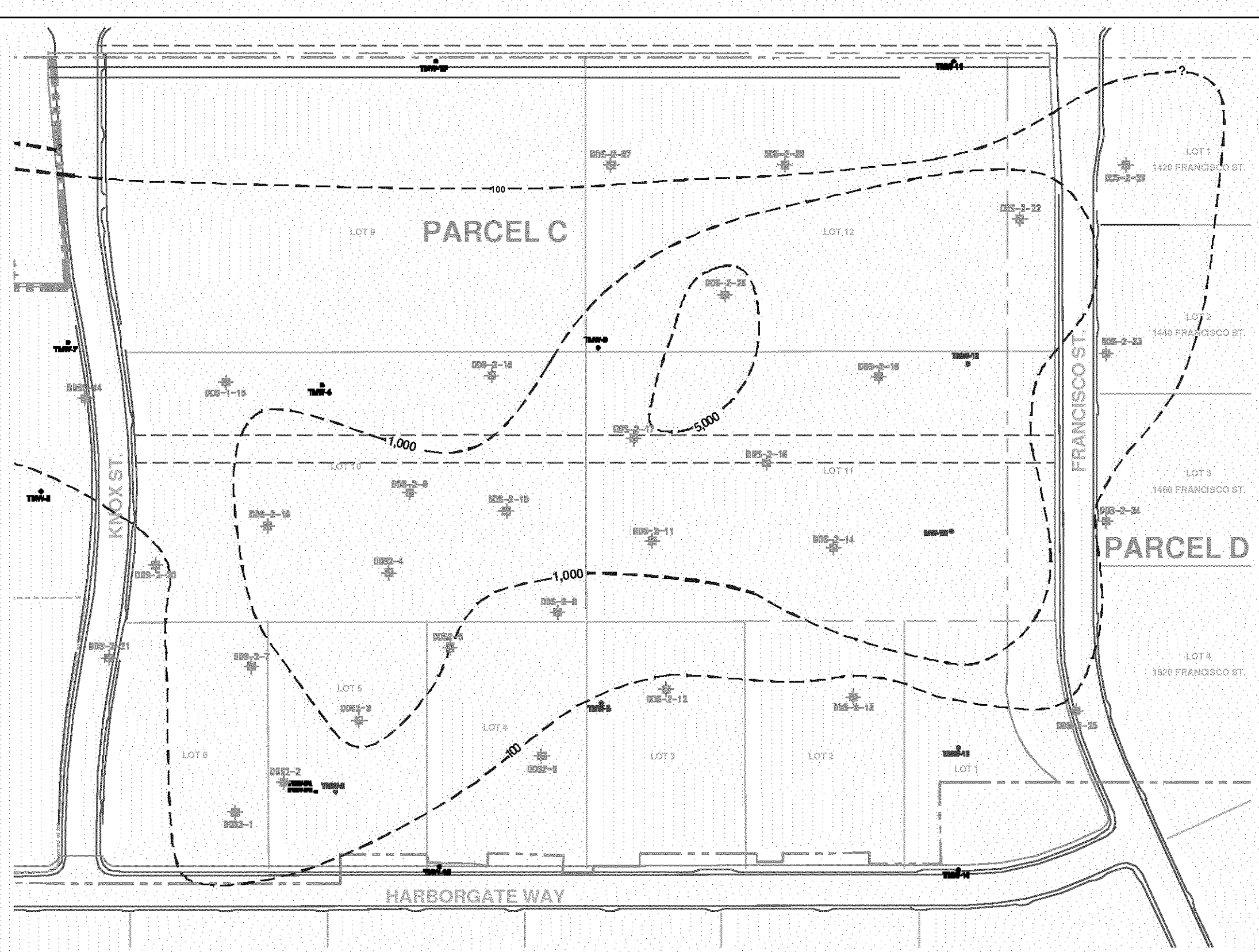
(2) NA - not applicable. Parameters will be measured in the field using a Hach test kit.

(3) Method developed by VaporTech, Inc.

(4) 1: IRZ-MW-1; 2: IRZ-MW-2; 3: IRZ-MW-3; 4: IRZ-MW-4; 5:CMW001; 6:CMW002; 7:CMW0026; 8:IRZ-C-MW1; 9:IRZ-CMW2

(5) The performance monitoring events will be conducted in weeks 2, 6, 12, 16 and 21 for TOC and pH. IRZ-2, IRZ-37, IRZ-95, and IRZ-C10 will be sampled as part of these events.
During the baseline event, IRZ-2, IRZ-37, IRZ-95, and IRZ-C10 will be sampled for TOC, pH and VOCs.

Figures



LEGEND

TCE CONCENTRATION IN GROUNDWATER (C-SAND)

N

0 40 80 160
FEET

G:\DRAWINGS\APROJECT\BOEING\TORRANCE\28882007-BASE.DWG

ARCADIS

HALEY & ALDRICH
UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

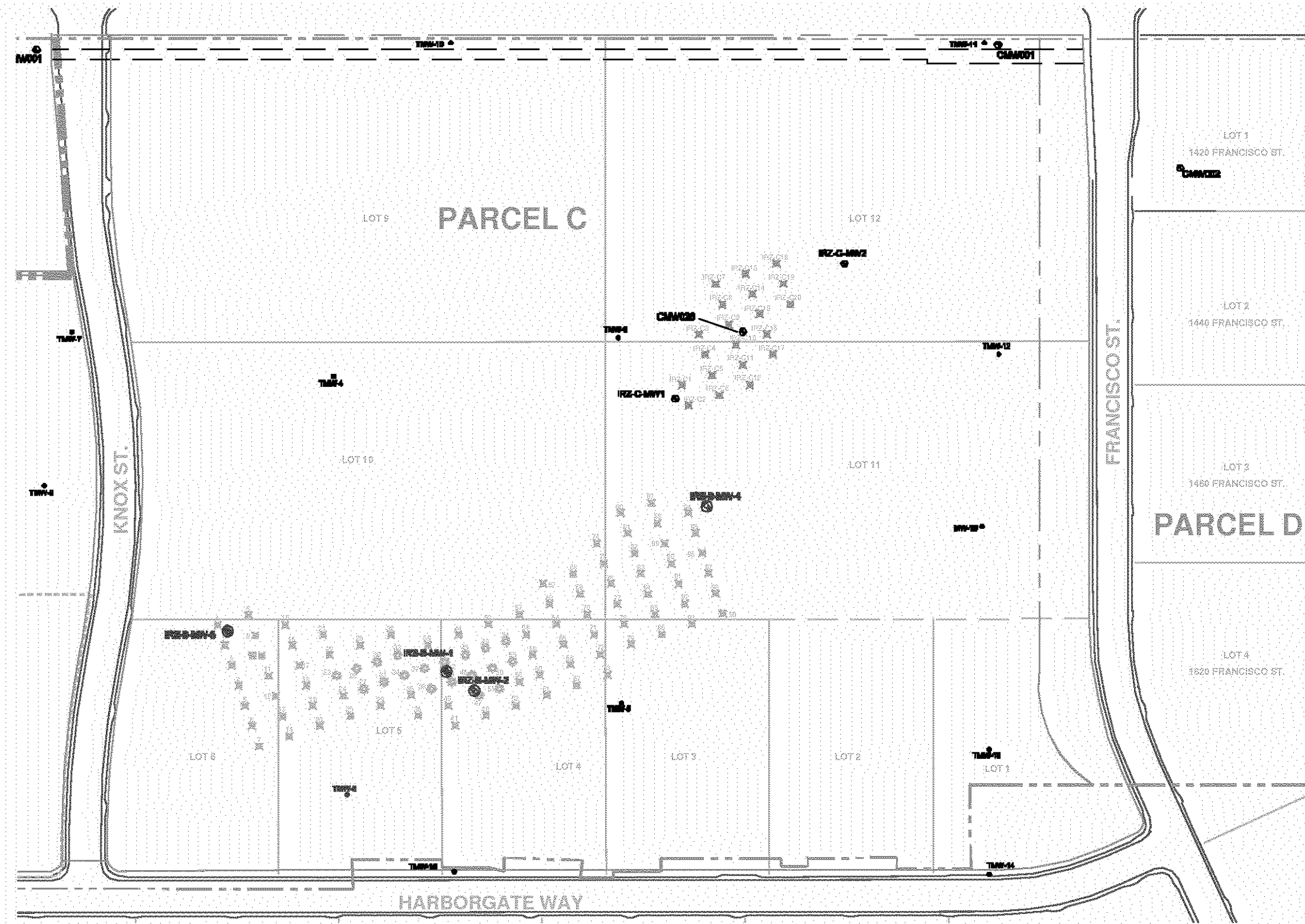
BOEING REALTY CORPORATION
FORMER C-6 FACILITY
LOS ANGELES, CALIFORNIA

FIGURE: 1

TCE DISTRIBUTION IN C-SAND GROUNDWATER, MAY 2002

SCALE: AS SHOWN | PROJECT: 28882-002
DRAWN: SAL | REVIEWED: RMF | DATE: 2 JULY 2002

BOE-C6-0008963



LEGEND

- IRZ-B-MW-4 — APPROVED MONITORING WELL
- IRZ-B-MW2 — PROPOSED C-SAND MONITORING WELL
- IRZ-C2 — PROPOSED C-SAND AMENDMENT POINT
- 0159 — APPROVED AMENDMENT POINT
- TMW-8 — EXISITING MONITORING WELL

N

0 40 80 160
FEET

G:\DRAWINGS\APROJECT\BOEING\TORRANCE\28882005-BASE.DWG

ARCADIS

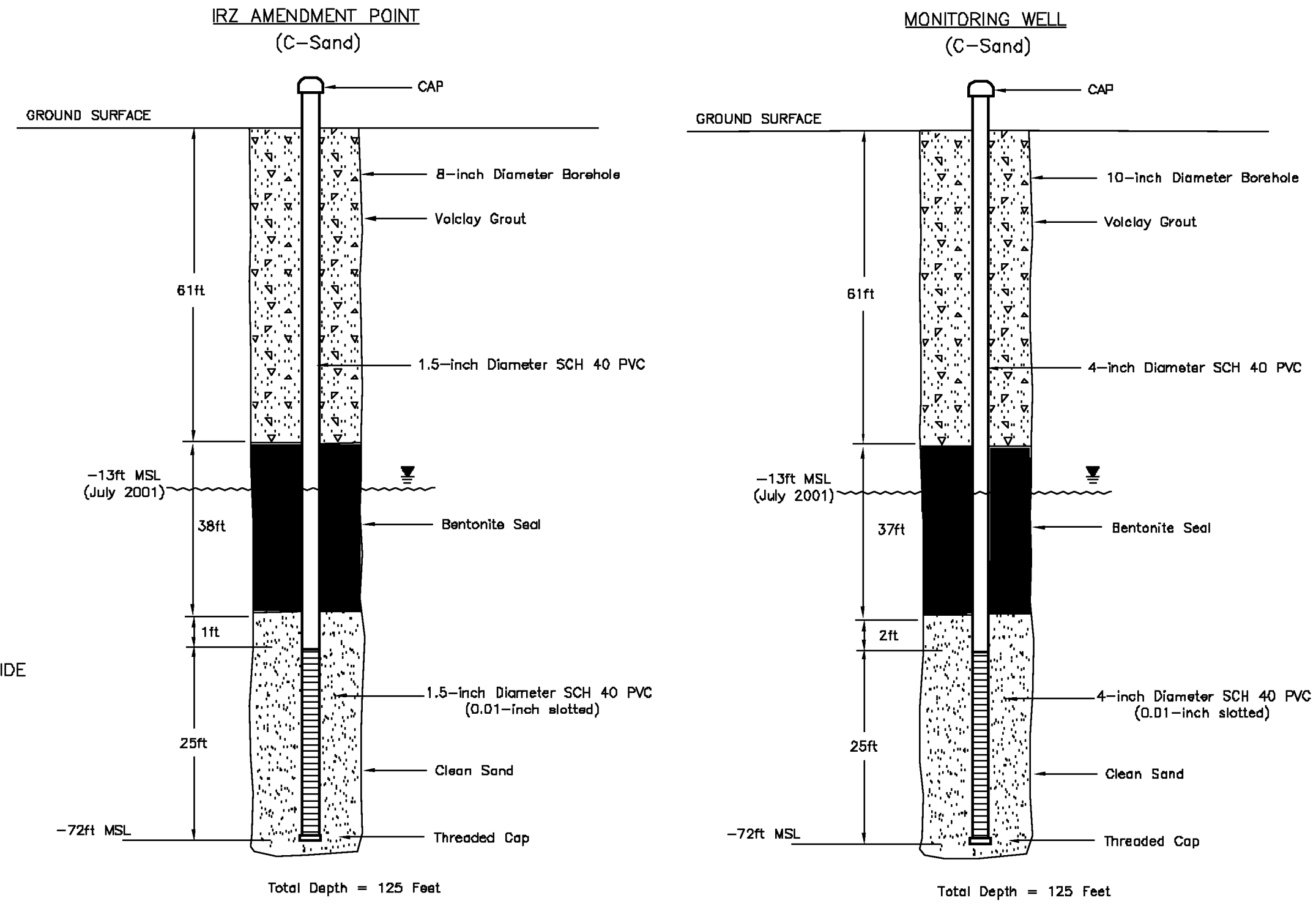
HALEY & ALDRICH
UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

BOEING REALTY CORPORATION
FORMER C-6 FACILITY
LOS ANGELES, CALIFORNIA

FIGURE: 2

BUILDING 2 - PROPOSED IRZ AMENDMENT POINTS AND MONITORING WEL LAYOUT

SCALE: AS SHOWN		PROJECT: 28882-002
DRAWN: SAL	REVIEWED: RMF	DATE: 2 JULY 2002



LEGEND

PVC POLYVINYL CHLORIDE
SCH SCHEDULE
ft FEET

NOT TO SCALE

ARCADIS

TYPICAL CONSTRUCTION DETAILS FOR IRZ AMENDMENT POINTS AND MONITORING WELLS

BOEING REALTY CORPORATION
FORMER C-6 FACILITY (BUILDING 2 AREA)
LOS ANGELES, CALIFORNIA

FIGURE
3

DATE: 07/10/2002 14:23 | PRJ#: CA000595.01.01 | DWG: G:\drawings\aproject\boeing\torrance\IRZ AMENDMENT POINTS | FILE: | CHK: E. OLMA | PM: JIM NGUYEN | ART: SGANDHI

BOE-C6-0008964