

17-11-06

Report
2002 Annual Groundwater Monitoring
Gate J-28/Museum of Flight
Tukwila, Washington

May 24, 2002

Prepared for

The Boeing Company
Seattle, WA)

 **LANDAU**
ASSOCIATES
130 2nd Avenue South
Edmonds, WA 98020
(425) 778-0907

TABLE OF CONTENTS

	<u>Page</u>
1.0 INTRODUCTION	1-1
1.1 BACKGROUND	1-1
2.0 FIELD INVESTIGATION ACTIVITIES	2-1
2.1 WATER LEVEL MEASUREMENTS	2-1
2.2 GROUNDWATER SAMPLING	2-1
2.3 GROUNDWATER ANALYSIS	2-2
3.0 GROUNDWATER MONITORING RESULTS	3-1
3.1 GROUNDWATER ELEVATIONS AND FLOW DIRECTION	3-1
3.2 GROUNDWATER ANALYTICAL RESULTS	3-1
3.2.1 Monitoring Well DC-MW-7	3-1
3.2.2 Monitoring Well DC-MW-8	3-2
3.2.3 Monitoring Well DC-MW-9	3-2
4.0 EVALUATION	4-1
5.0 CONCLUSIONS AND RECOMMENDATIONS	5-1
6.0 USE OF THIS REPORT	6-1
7.0 REFERENCES	7-1

LIST OF FIGURES

<u>Figure</u>	<u>Title</u>
1	Vicinity Map
2	Monitoring Well Locations
3	Groundwater Elevation Contours

LIST OF TABLES

<u>Table</u>	<u>Title</u>
1	Groundwater Analytical Results, Gate J-28, Museum of Flight
2	Groundwater Elevations, Gate J-28, Museum of Flight

1.0 INTRODUCTION

This report summarizes the results of 4 quarters of groundwater monitoring completed in March 2002 at the Museum of Flight property formerly identified as Gate J-28 at The Boeing Company (Boeing) Developmental Center, 9725 East Marginal Way South, in Tukwila, Washington (Figure 1). The purpose of this and prior reports is to provide a basis for the Washington State Department (Ecology) to determine that no further action is necessary at a portion of the Developmental Center that has been donated to the Museum of Flight.

The groundwater monitoring was performed in accordance with Section 3.3 of the monitoring well DC-MW-9 installation report (Landau Associates 2001a) and Boeing's Developmental Center groundwater monitoring plan (Boeing 2001). Samples from three groundwater monitoring wells were collected and analyzed quarterly for one year as requested by Ecology (Ecology 2001). Background information and a description of the site are provided in the remainder of this section. A description of the field activities performed during this investigation is provided in Section 3.0. Section 4.0 presents the results of the groundwater monitoring. Groundwater quality is evaluated in Section 5.0.

1.1 BACKGROUND

In 2001, GeoEngineers collected soil and groundwater samples from direct-push borings located at Gate J-28 of the Boeing Developmental Center as part of a phase II environmental site assessment for the Museum of Flight. No soil samples contained detectable concentrations of diesel-range petroleum hydrocarbons. Oil-range petroleum hydrocarbons were detected in only one soil sample from this area. The soil sample collected from boring B-9 at a depth of 12 ft contained 490 mg/kg oil-range petroleum hydrocarbons. Diesel-range petroleum hydrocarbons were measured at a concentration of 6.9 mg/L in a groundwater sample collected from boring B-10 (GeoEngineers 2001). No sources for this material have been identified.

Subsequently, a groundwater quality investigation including installation and sampling of two groundwater monitoring wells near the 9-04 building, DC-MW-7 and DC-MW-8, was conducted. The results from the initial sampling of these wells were summarized in a report submitted to Ecology (Landau Associates 2001b). Based on the results of this investigation Ecology determined that the TPH in the soil no longer poses a threat to human health or the environment. In a letter to Boeing, Ecology issued a determination of no further action for the soil but required additional groundwater monitoring (Ecology, 2001). The groundwater monitoring requirements included installation of an additional well, DC-MW-9, at the location of former soil boring B-10 and quarterly groundwater monitoring for TPH for a minimum of one year at this well and wells DC-MW-7 and DC-MW-8. Monitoring well DC-MW-9

was installed in July 2001. The well installation and results from the initial sampling of this well were documented in a report submitted to Ecology (Landau Associates 2001a). Four quarterly groundwater monitoring events at all three wells (DC-MW-7, DC-MW-8, and DC-MW-9) have now been completed. Although analysis for gasoline-related compounds was not required by Ecology, the analysis for these compounds was also performed during most of the monitoring events.

2.0 FIELD INVESTIGATION ACTIVITIES

This section describes water level measurements, groundwater sampling, and groundwater analyses conducted on a quarterly basis at wells DC-MW-7, DC-MW-8, and DC-MW-9. The first quarterly monitoring event was conducted in June 2001 at wells DC-MW-7 and DC-MW-8 and in July 2001 at well DC-MW-9. The second, third, and fourth quarterly monitoring events occurred in September 2001, December 2001, and March 2002, respectively. In addition to the quarterly sampling events, initial groundwater monitoring activities conducted at wells DC-MW-7 and DC-MW-8 in April 2001 are described. Field activities were conducted in accordance with Boeing's Developmental Center groundwater monitoring plan (Boeing 2001) and the monitoring well installation work plan (Landau Associates 2001c). Monitoring well locations are shown on Figure 2.

2.1 WATER LEVEL MEASUREMENTS

Static water levels in the wells were measured in April 2001 (wells DC-MW-7 and DC-MW-8 only) and during each quarterly monitoring event prior to well purging and sampling. The depth to groundwater was measured to the nearest 0.01 ft using a battery operated water level indicator. Elevations at the top of PVC casing were surveyed by Boeing at monitoring wells DC-MW-7 and DC-MW-8 and by Landau Associates at DC-MW-9 to convert depth of groundwater measurements to groundwater elevations. Well elevations were surveyed to the nearest 0.01 ft.

2.2 GROUNDWATER SAMPLING

Four quarterly groundwater sampling events were conducted (June 12 through July 30, 2001; September 4, 2001; December 3, 2001; and March 13, 2002). In addition, an initial sampling event was conducted on April 23, 2001 following installation of monitoring wells DC-MW-7 and DC-MW-8. Prior to sample collection, each well was purged until the pH, conductivity, and dissolved oxygen parameters had stabilized. Purging and sample collection were conducted using dedicated bladder pumps installed by Boeing and low-flow sampling techniques, as described in Boeing's groundwater monitoring plan.

The samples were collected in appropriate containers, labeled, logged on a chain-of-custody (COC) document, and kept on ice until delivered to the laboratory. Sample containers, preservatives, and holding times were appropriate for the types of samples collected and the specified analytical methods.

2.3 GROUNDWATER ANALYSIS

The groundwater samples were submitted to Analytical Resources, Inc. (ARI) laboratory located in Seattle, Washington. During each quarterly monitoring event, the samples were analyzed for gasoline-range petroleum hydrocarbons using the NWTPH-Gx method; and diesel-range and motor oil-range petroleum hydrocarbons using the NWTPH-Dx method. During the first, third, and fourth monitoring events, benzene, ethylbenzene, toluene, and xylenes (BETX) were analyzed in samples from each well using U.S. Environmental Protection Agency (EPA) Method 8021 or EPA Method 8260. During the initial April 2001 sampling event, polycyclic aromatic hydrocarbons (PAHs) were analyzed in samples from wells DC-MW-7 and DC-MW-8 using EPA Method 8270 with selected ion monitoring (SIM), in addition to NWTPH-Gx, NWTPH-Dx, and BETX analyses.

3.0 GROUNDWATER MONITORING RESULTS

This section presents the results for water level measurements and analytical testing performed during each quarterly and the initial April 2001 groundwater monitoring events.

3.1 GROUNDWATER ELEVATIONS AND FLOW DIRECTION

Groundwater elevation results from groundwater monitoring were used to evaluate groundwater flow direction. Groundwater elevation contours were plotted using data from wells DC-MW-8, DC-MW-9, and DC-MW-2 for the June 2001 monitoring event. The contours are shown on Figure 3. As shown on this figure, the groundwater has a southwesterly flow direction within the vicinity of Gate J-28. Subsequent groundwater elevation results at wells DC-MW-7, DC-MW-8, and DC-MW-9 are consistent with a southwesterly flow direction.

3.2 GROUNDWATER ANALYTICAL RESULTS

This section presents the groundwater analytical results for each monitoring event. Petroleum hydrocarbon and BETX results are summarized in tabular format in Table 1. PAH results for wells DC-MW-7 and DC-MW-8 are presented in the groundwater quality investigation report (Landau Associates 2001b). VOC results for well DC-MW-9 are presented in the DC-MW-9 installation report (Landau Associates 2001a). A data quality evaluation for each set of analytical data was performed by Landau Associates. The evaluation was performed in accordance with the procedures and requirements specified in Section 3.0 of Landau Associates' work plan (Landau Associates 2001c). Based on the data quality evaluation, no data were qualified or rejected, and the data were determined acceptable for use.

3.2.1 MONITORING WELL DC-MW-7

During the initial and first three quarterly sampling events, no gasoline-range, diesel-range, or motor oil-range petroleum hydrocarbons were detected at well DC-MW-7. During the the fourth quarterly monitoring event, gasoline-range and diesel-range petroleum hydrocarbons were detected at 0.44 mg/L and 0.26 mg/L, respectively. These concentrations, however, are below the MTCA Method A cleanup levels for groundwater (0.8 mg/L gasoline-range organics and 0.5 mg/L diesel-range organics).

Diesel-related compounds were analyzed for at well DC-MW-7 during the April 2001 monitoring event. Naphthalene, 1-methylnaphthalene, and acenaphthylene were detected at concentrations of 1.0 µg/L, 1.0 µg /L, and 0.12 µg /L, respectively. These concentrations are significantly below MTCA Method A cleanup levels for groundwater and MTCA Method B cleanup levels protective of surface water.

Gasoline-related compounds ethylbenzene and m,p-xylene were detected at well DC-MW-7 during the initial April 2001 and the fourth quarterly monitoring events. Ethylbenzene was detected at concentrations of 1.7 µg/L and 11 µg/L, which are significantly below the MTCA Method A cleanup level for groundwater (700 µg/L) and MTCA Method B cleanup level protective of surface water (6,910 µg/L). m,p-Xylene was detected at concentrations of 1.9 µg/L and 3.1 µg/L, which are also significantly below the MTCA Method A cleanup level for groundwater (1,000 µg/L).

3.2.2 MONITORING WELL DC-MW-8

Over the course of the initial and four quarterly monitoring events, diesel-range petroleum hydrocarbons have been detected at concentrations ranging between 0.50 mg/L and 0.66 mg/L. These concentrations are slightly above the MTCA Method A cleanup level of 0.5 mg/L for diesel-range organics. Diesel-related compounds (e.g., PAHs) were analyzed for at this well during the April 2001 monitoring event, but were not detected. No motor oil-range petroleum hydrocarbons, gasoline-range petroleum hydrocarbons, or gasoline-related compounds have been detected at well DC-MW-8 during the monitoring events.

3.2.3 MONITORING WELL DC-MW-9

Diesel-range petroleum hydrocarbons, gasoline-range petroleum hydrocarbons, and gasoline-related compounds have been detected at well DC-MW-9 during each of the four quarterly monitoring events. The concentration of the gasoline-range petroleum hydrocarbons ranged between 1.8 mg/L and 3.5 mg/L. The concentration of diesel-range petroleum hydrocarbons ranged from 1.1 mg/L to 4.1 mg/L. These gasoline-range and diesel-range petroleum hydrocarbon concentrations exceed the MTCA Method A cleanup levels of 0.8 mg/L and 0.5 mg/L, respectively. None of the concentrations of the gasoline-related compounds (e.g., BETX) exceeded the MTCA Method A cleanup levels for groundwater or the MTCA Method B cleanup levels protective of surface water.

4.0 EVALUATION

An evaluation of the groundwater elevations at DC-MW-7, DC-MW-8, and DC-MW-2 in June 2001 and at each of the three wells during subsequent monitoring events indicates that the general direction of groundwater flow in this area is to the southwest (Figure 3). Subsequently, well DC-MW-9 is upgradient of well DC-MW-7. Well DC-MW-8 is cross-gradient from the other two wells. The analytical results for wells DC-MW-7 and DC-MW-9 indicate that concentrations of both gasoline-range and diesel-range petroleum hydrocarbons are present above regulatory criteria in the upgradient direction (i.e., at DC-MW-9), but these concentrations rapidly decrease to concentrations below the regulatory criteria in the downgradient direction (i.e., at DC-MW-7). Although diesel-range petroleum hydrocarbons were detected at well DC-MW-8, these concentrations were only slightly above regulatory criteria. No well exists immediately downgradient of well DC-MW-8; however, based on the results for wells DC-MW-7 and DC-MW-9, it is likely that the diesel-range hydrocarbon concentrations at well DC-MW-8 decrease to concentrations below the regulatory criteria just a short distance downgradient of the well. Based on the available information, the apparent source of contaminants detected in groundwater is upgradient of this area.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the evaluation of the analytical results presented above, the source of the petroleum hydrocarbons and associated constituents appears to be upgradient of the Gate J-28 area. This conclusion is adequately demonstrated by the initial and four quarterly monitoring events with similar results during each event; therefore, we recommend no further groundwater monitoring at these wells and no other remedial actions at the property.

6.0 USE OF THIS REPORT

This report has been prepared for the exclusive use of The Boeing Company for specific application to the Gate J-28 area. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Landau Associates. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Landau Associates, shall be at the user's sole risk. Landau Associates warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

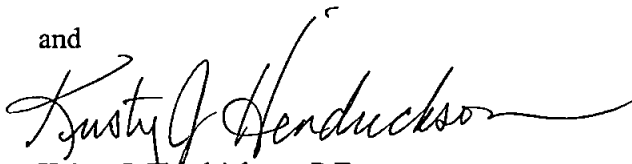
This document has been prepared under the supervision and direction of the following key staff.

LANDAU ASSOCIATES, INC.



Stacy J. Fischer
Project Geologist

and



Kristy J. Hendrickson, P.E.
Principal

7.0 REFERENCES

Boeing. 2001. *Developmental Center Groundwater Monitoring Plan*.

Ecology. 2001. Letter to Carl Bach, The Boeing Company, re: *No Further Action Determination for Soils at Gate J-28 Area, Boeing Developmental Center (WAD 093 639 946)*. Byung Maeng, Washington State Department of Ecology. June 28.

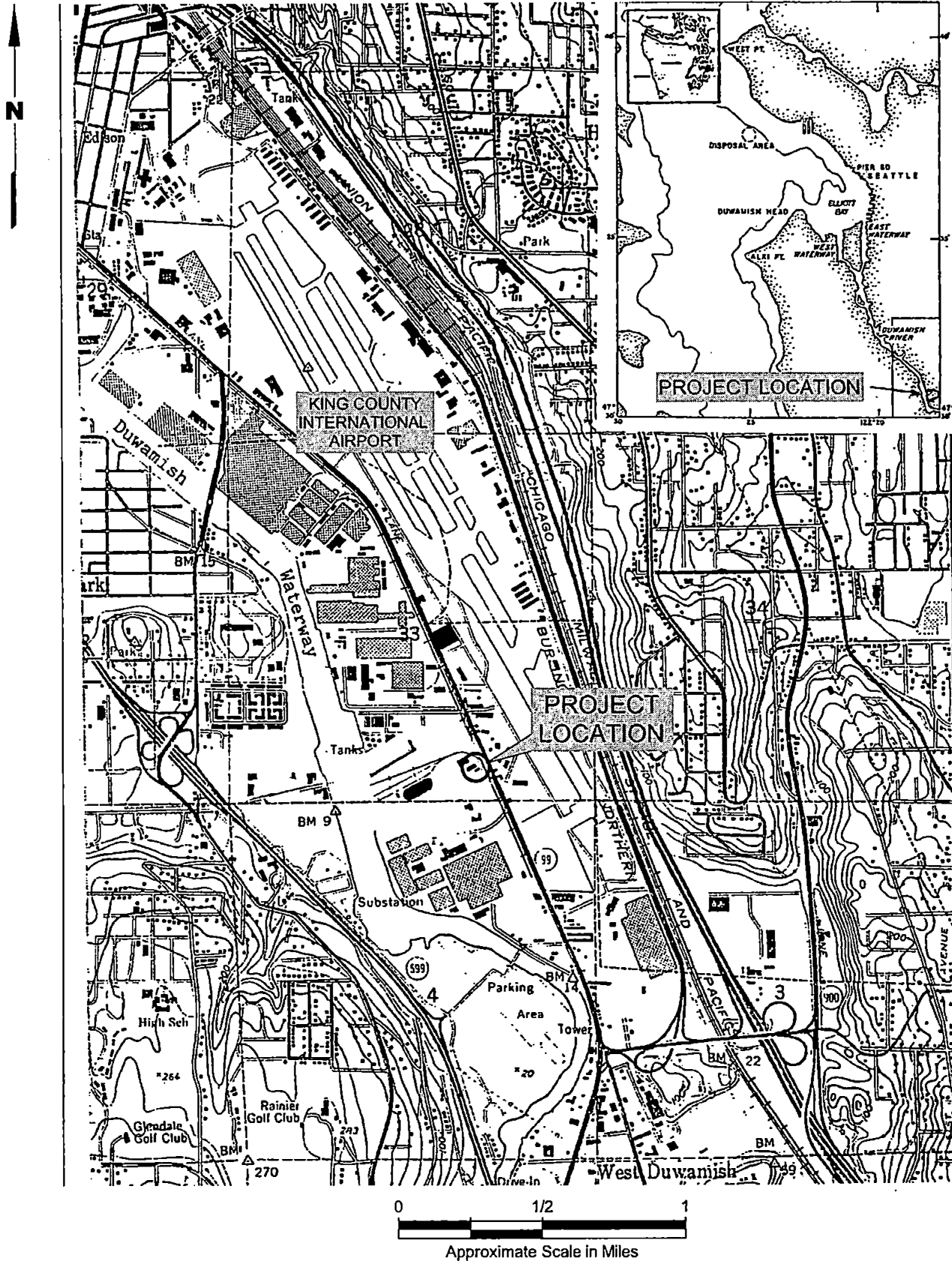
GeoEngineers. 2001. *Draft Report, Phase II Environmental Site Assessment, 9725 East Marginal Way South, Seattle, Washington*. February 8.

Landau Associates. 2001a. *Report, Monitoring Well DC-MW-9 Installation, Gate J-28/Developmental Center, Tukwila, Washington*. Prepared for The Boeing Company. August 30.

Landau Associates. 2001b. *Report, Groundwater Quality Investigation, Gate J-28, Boeing Developmental Center, Tukwila, Washington*. May 31.

Landau Associates. 2001c. *Work Plan, Monitoring Well Installation, Gate J-28, Boeing Developmental Center, Tukwila, Washington*. Prepared for The Boeing Company. March 26.

Boeing/Gate J28 2002 Annual Groundwater Monitoring Report [T:\025\0911031\Gate_J28_2002 Annual GWMM Report\Fig1.dwg (A) Figure 1" 5/17/2002



Source: U.S.G.S. 7.5 Minute Series (Topographic) Map: Seattle South Quadrangle.



The Boeing Company
Tukwila, Washington

Vicinity Map

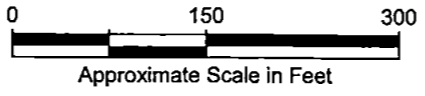
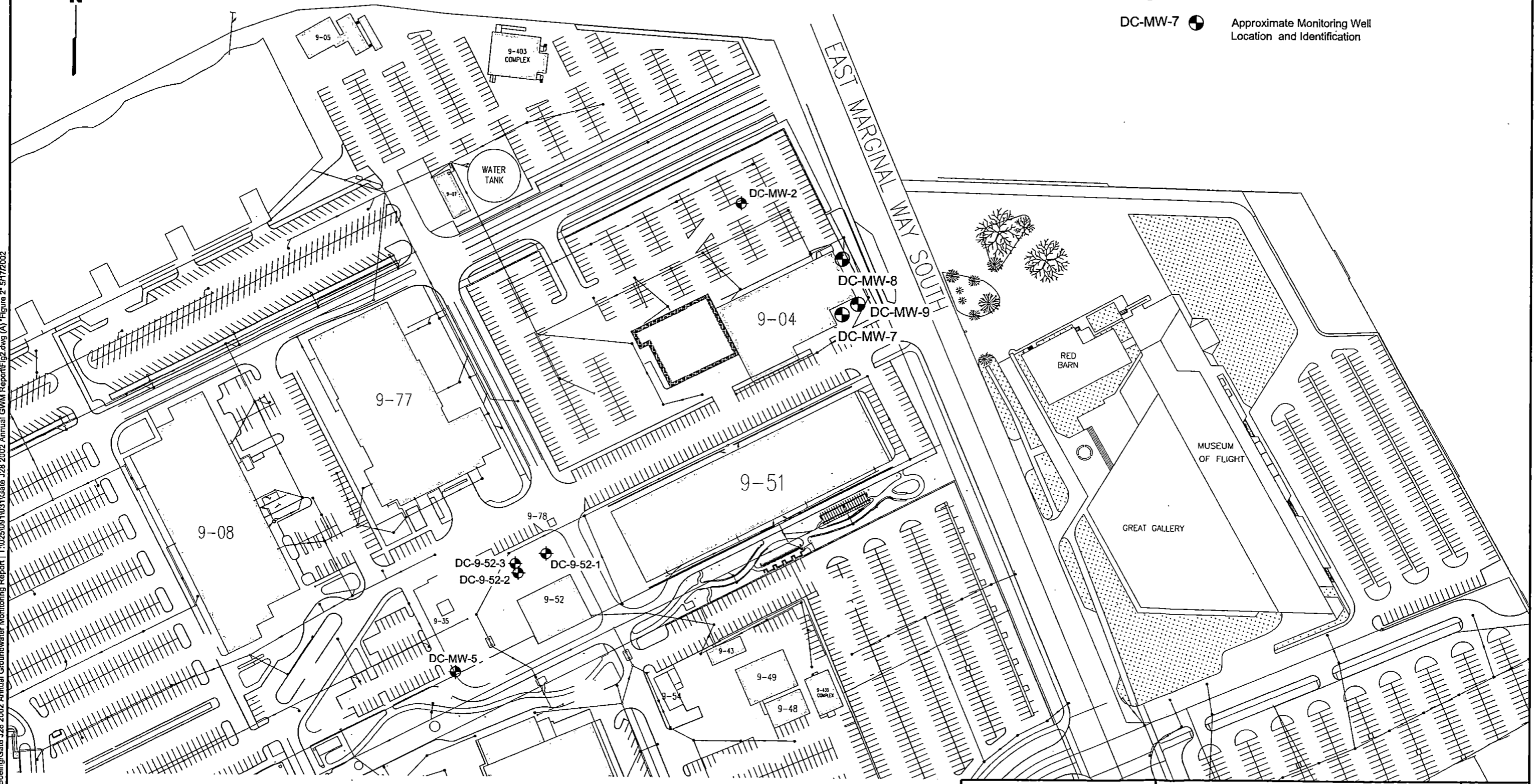
Figure
1

Boeing/Gate_128 2002 Annual Groundwater Monitoring Report I.T:\025\091031\Gate_128 2002 Annual GMM Report\Fig2.dwg (A) Figure 2 5/17/2002



Legend

DC-MW-7  Approximate Monitoring Well Location and Identification



The Boeing Company
Tukwila, Washington



Monitoring Well Locations

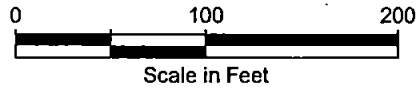
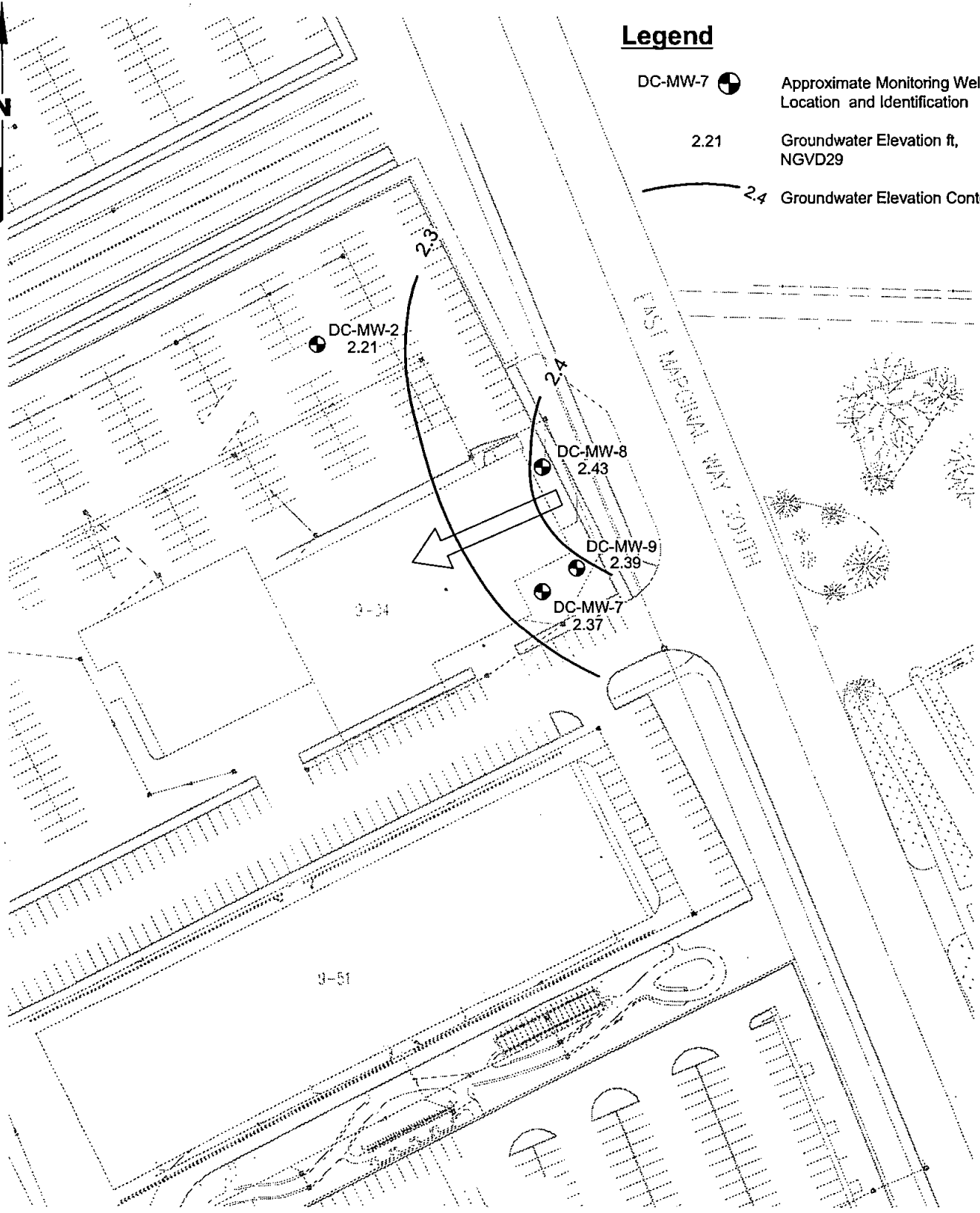
Figure
2

Boeing/Gate J28 2002 Annual Groundwater Monitoring Report | T:\025\091031\Gale J28 2002 Annual GWM Report\Figs.dwg (A) "Figure 3" 5/24/2002



Legend

- DC-MW-7  Approximate Monitoring Well Location and Identification
- 2.21 Groundwater Elevation ft, NGVD29
-  2.4 Groundwater Elevation Contour



The Boeing Company
Tukwila, Washington

**Groundwater Elevation
Contours - Dec. 2001**

Figure
3

TABLE 1
GROUNDWATER ANALYTICAL RESULTS
GATE J-28, MUSEUM OF FLIGHT

Well Identification	Data Package No.	Sampling Event	Sample Collection Date	PETROLEUM HYDROCARBONS (mg/L)			BTEX (µg/L)				
				Gasoline Range	Diesel Range	Motor Oil Range	Benzene	Toluene	Ethyl-benzene	m,p-Xylene	o-Xylene
MW-7	DA16B	--	4/23/01	0.25 U	0.25 U	0.50 U	1.0 U	1.0 U	1.7	1.9	1.0 U
MW-7	DF50A	1st Quarter	6/12/01	0.25 U	0.25 U	0.50 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
MW-7	DO10A	2nd Quarter	9/4/01	0.25 U	0.25 U	0.50 U	NA	NA	NA	NA	NA
MW-7	DW60A	3rd Quarter	12/3/01	0.25 U	0.25 U	0.50 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
MW-7	EE21C	4th Quarter	3/13/02	0.44	0.26	0.50 U	1.0 U	1.0 U	11	3.1	1.0 U
MW-8	DA16A	--	4/23/01	0.25 U	0.66	0.50 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
MW-8	DF50B	1st Quarter	6/12/01	0.25 U	0.60	0.50 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
MW-8	DO10C	2nd Quarter	9/4/01	0.25 U	0.68	0.50 U	NA	NA	NA	NA	NA
MW-8	DW60C	3rd Quarter	12/3/01	0.25 U	0.50	0.50 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
MW-8	EE21A	4th Quarter	3/13/02	0.25 U	0.56	0.50 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
MW-9	DK52A	1st Quarter	7/30/01	3.1	1.1	0.50 U	1.0 U	1.0	100	20	1.0 U
MW-9	DO10B	2nd Quarter	9/4/01	3.5	1.8	0.50 U	NA	NA	NA	NA	NA
MW-9	DW60B	3rd Quarter	12/3/01	1.8	1.3	0.50 U	1.1	1.2	24	13	1.0 U
MW-9	EE21B	4th Quarter	3/13/02	3.0	4.1	0.50 U	4.0 U	3.0 U	58	18	2.0 U

NA = Not analyzed.

U = Indicates compound was analyzed for, but not detected at the given reporting limit.

TABLE 2
GROUNDWATER ELEVATIONS
GATE J-28, MUSEUM OF FLIGHT

Well Identification	Top of PVC Casing Elevation	Groundwater Elevations					
		4/23/01	6/12/01	7/30/01	9/9/01	12/3/01	3/13/02
DC-MW-7	13.69	2.75	2.62	NM	2.37	3.73	3.66
DC-MW-8	13.92	2.81	2.69	NM	2.43	3.84	3.80
DC-MW-9	13.85	NM	NM	2.49	2.39	3.85	3.78

NM = Not Measured

Note: Vertical Datum - NVGD 1229.