Shaw Environmental & Infrastructure, Inc.

# GROUNDWATER MONITORING REPORT
# MAY 2005 ANNUAL SAMPLING EVENT
# ZILKER PARK LANDFILL PROJECT
# AUSTIN, TEXAS

Prepared for:
City of Austin
Department of Public Works
P.O. Box 1088
Austin, Texas 78767

Prepared by:
Shaw Environmental, Inc.
8501 N. Mopac,
Suite 320
Austin, Texas 78759

July 2005

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## TABLE OF CONTENTS

## LIST OF TABLES

## 1.0 INTRODUCTION

This report presents the results of annual groundwater sampling and analysis performed by Shaw Environmental, Inc, (Shaw) on May 23-25, 2005 at the Zilker Park Landfill site. The groundwater monitoring was conducted under Supplemental Amendment #3 to the original professional service agreement between the City of Austin (COA) and EMCON, a subsidiary of the Shaw Group. Activities consisted of the collection and analysis of groundwater samples from on-site monitoring wells installed as part of Phase I of the Zilker Park Landfill Remediation Project (C.I.P. Project No. 480-497-0604).

### 1.1 PROJECT BACKGROUND

The Zilker Park Landfill site is the location of the former Butler Landfill. The landfill is located on the south shore of Town Lake and extends west of Mopac highway from Dry Creek eastward about 2,500 feet into Zilker Park. The Butler Landfill was operated by the COA from 1948 to 1967. Municipal waste disposed at the landfill was used to fill an old gravel pit that had been mined for sand and gravel from low terrace deposits of the Colorado River. The Edwards Limestone underlies the terrace deposits in all areas of the landfill.

The COA installed a monitoring well (MW-1) in the fill area of the landfill in 1984. During Phase I of the Zilker Park Landfill Remediation Project, an additional six (6) monitoring wells were installed at the landfill site in March 1998. Figure 1 (Appendix B) presents a monitoring well location map. In early 2003, additional fill material (i.e., soil) was added to the top of the landfill to improve surface drainage at the site. Due to additional fill, several monitoring wells were extended to match the new ground surface elevation at each location in early October 2003. The May 2005 monitoring event represents the 5$^{th}$ sampling event performed at the landfill site since the installation of the six (6) monitoring wells (MW-2 through MW-7). As per the work scope outlined in Supplemental Amendment #3, subsequent groundwater sampling will be conducted annually for the next 2 years.

## 2.0 SAMPLING AND ANALYSIS PROCEDURES

On May 23-25, 2005, Shaw sampling personnel collected groundwater samples from six (6) on-site monitoring wells (MW-1, MW-2, MW-3, MW-5, MW-6, and MW-7). Monitoring well MW-4 was not sampled due to the lack of groundwater in the well. A groundwater sample was collected from Well MW-1, however, due to the sample quality the sample was not submitted for chemical analysis. The sample quality was compromised due to the present of an orange colored bacterial growth, possibly iron bacteria. The following presents the sampling methodologies and analytical methods utilized to collect and analyze the groundwater samples.

### 2.1 LOW-FLOW GROUNDWATER SAMPLING

Prior to groundwater sampling, water levels were measured in monitoring wells using a tape equipped with an electric water level senor. Water levels were measured to the nearest 0.01 ft from the top of PVC well casing. Monitoring well water level data presented on Table 1 (Appendix A) indicate that water elevations measured in wells MW-1 through MW-7 during the May 2005 monitoring event were similar to those measured during previous sampling events.

Low-flow sampling techniques were utilized to collect groundwater samples following applicable procedures outlined in USEPA (1996) and TCEQ (1999) guidance. The objective of low-flow sampling was to purge and sample the wells in a manner that minimizes stress (drawdown) to the groundwater system and, thereby, limit the introduction of suspended solids and better ensure the collection of representative groundwater samples. The method involves sampling groundwater without disturbing the stagnant water above the pump intake by pumping a well at low flow rates while maintaining minimal drawdown of the water column within the well. A gas-driven bladder pump with dedicated bladder and tubing was placed within the screened interval of each well and the wells were purged at low flow rates of less than 1 liter per minute (L/min).

During low-flow purging, the water quality indicator parameters pH, specific conductance, dissolved oxygen, oxidation-reduction potential, and temperature were measured using an in-line flow-through cell and standardized equipment. Table 2 (Appendix A) presents a summary of the field parameter measurements. Stabilization of these parameters was used to determine when formation water was accessed during purging and when sample collection was appropriate. Minimum purge volume was equivalent to at least twice the combined volumes of the pump and tubing. A stable water level could not be maintain in monitoring well MW-1 during low-flow purging, even at a very low flow rate of about 30 ml/sec. Based on the presence of high quantities of bacterial growth in the sample collected from MW-1, the well screen may be partially clogged by slime or a biofilm that may capture chemicals, minerals and other particles such as sand, clays and silts, thereby reducing the groundwater yield to the well.

Samples were collected by pumping groundwater directly into laboratory provided bottles containing appropriate preservatives, then sealed and labeled. Container and container closure material used were appropriate (i.e., polyethylene, glass) for the analyses to be performed on the samples. The containers were labeled with the sample number, date and time of collection, and preservative used.

Sample containers were placed securely on ice in insulated coolers as the samples were collected. The samples remained in the possession of Shaw sampling personnel and were shipped directly to Certes Environmental Laboratory in Dallas, Texas at the completion of the sampling event. Chain-of-custody forms were prepared for the samples and copies of the forms are included in Appendix C.

## 2.2 SAMPLE ANALYSIS

Based on recommendations presented in the groundwater monitoring report for the April 2004 sampling event (Shaw 2004), groundwater samples collected during the May 2005 sampling event were analyzed for a reduced suite of parameters. These analytical parameters are presented on the analytical laboratory reports presented in Appendix C and include those groups of chemical constituents that have been detected in the groundwater samples during previous events. These included the following metallic and organic constituents:

- Volatile Organic Compounds (VOCs) using EPA Method 8260B;
- Organochlorine Pesticides (OCPs) using EPA Method 8081A; and
- Total metals (aluminum, arsenic, barium, cadmium, chromium, iron, lead, manganese, mercury, selenium, silver, and zinc) using EPA Methods 6010B and 7470A.

## 3.0 ANALYTICAL RESULTS

A summary of the analytical results for the May 2005 sampling event is presented on Table 3 (Appendix A). Included on Table 3 is a summary of the analytical results for previous sampling events performed in October 1997 (MW-1 only), March 1998 (MW-2 through MW-7), and October 2003, January 2004, and April 2004 (MW-1 through MW-3 and MW-5 through MW-7). The analytical report prepared by Certes for the May 2005 sampling event is included in Appendix C.

Analytical results for the samples collected in October 2003, January 2004, April 2004, and May 2005 were reported based on the analytical laboratory's method detection limits (MDLs) adjusted for sample-specific factors. This adjusted MDL is reported on the laboratory reports as the sample quantitation limit (SQL), as per the Texas Commission on Environmental Quality (TCEQ) guidance (TRRP-13). Concentrations detected between the SQL and the reporting limit (RL) (i.e., adjusted method quantitation limit) are flagged with a "J" on the analytical report. The presence of constituents flagged with a J is certain but the concentration of such constituents is uncertain and estimated by the laboratory. Detected concentrations above the RL are quantifiable and are not flagged with a qualifier. Samples collected in October 1997 and March 1998 were reported based on the laboratory's RLs, which are higher than the SQLs, and therefore no concentrations were flagged with the J qualifier.

To evaluate the groundwater analytical data, detected concentrations were compared to the Texas Risk Reduction Program (TRRP) Tier 1 residential groundwater protective concentration levels (PCLs). The groundwater PCLs ($^{GW}$GW) are based on federal primary maximum contaminant levels (MCLs) promulgated under the Safe Drinking Water Act or, if MCLs are not available for a constituent, risk-based levels based on groundwater ingestion. TRRP Tier 1 PCLs are included on Table 3 and concentrations that exceed the PCLs are highlighted on the table.

The analytical results for groundwater samples collected in May 2005 do not reflect any major abnormalities from the analytical data for samples collected during the previous sampling event in April 2004. The VOCs chlorobenzene, 1,4-dichlorobenzene, and methylene chloride were detected at least once in the groundwater samples collected in May 2005. All detected VOC values were estimated concentrations detected below the RL and flagged with a "J". These estimated concentrations were well below the $^{GW}$GW PCLs.

Methylene chloride is commonly used by analytical laboratories, is a common laboratory contaminant, was detected at low concentrations below the RL (i.e., J-flagged). Its presence in the samples is likely due to laboratory cross-contamination.

Organochlorine pesticides were not detected in any ground water sample collected from the on-site monitoring wells during the May 2005 monitoring event.

The metals aluminum, arsenic, barium, cadmium, chromium, lead, manganese, and selenium were detected at least once in samples collected during the May 2005 sampling event. Detected values for cadmium, chromium, and lead were estimated concentrations detected below the RL and flagged with a "J". Mercury, silver and zinc were not detected in the samples.

Aluminum was detected in the laboratory method blank indicating that its presence in the samples may be due to laboratory cross-contamination, although the detected values were detected above the RL at greater concentrations than in the blank sample, which reported an estimated aluminum concentration below the RL and flagged with a "J".

The analytical data for the May 2005 sampling event indicate that the total arsenic concentrations of 0.0142 mg/l in MW-3, 0.0394 mg/l in MW-5 and 0.0434 mg/l in MW-7 and the manganese concentrations of 2.1 mg/l in MW-5 and 1.69 mg/l in MW-7 were detected above $^{GW}$GW PCLs of 0.01 mg/l and 1.1 mg/l, respectively. All other detected total metal concentrations were below PCLs.

## 4.0 CONCLUSIONS AND RECOMMENDATIONS

### 4.1 CONCLUSIONS

The following conclusions are based on the findings of the groundwater monitoring event conducted at the Zilker Park Landfill in April 2004.

- Water level data indicate that water elevations measured in wells MW-1 through MW-7 during the May 2005 monitoring event were similar to those measured during previous sampling events.

- Estimated J-flagged concentrations were detected below $^{GW}$GW PCLs in groundwater samples collected in May 2005 for the VOCs chlorobenzene, 1,4-dichlorobenzene, and methylene chloride. The presence of constituents flagged with a "J" is certain but the concentration of such constituents is uncertain and estimated by the laboratory.

- Low-level detection of methylene chloride was likely due to laboratory contamination and these results are not representative of natural groundwater.

- Organochlorine pesticides were not detected in any ground water sample collected from the on-site monitoring wells during the May 2005 sampling event.

- The metals aluminum, arsenic, barium, cadmium, chromium, lead, manganese, and selenium were detected at least once in samples collected during the May 2005 sampling event.

- The total arsenic concentrations of 0.0142 mg/l in MW-3, 0.0394 mg/l in MW-5 and 0.0434 mg/l in MW-7 and the manganese concentrations of 2.1 mg/l in MW-5 and 1.69 mg/l in MW-7 were detected above $^{GW}$GW PCLs of 0.01 mg/l and 1.1 mg/l, respectively. All other detected total metal concentrations were below PCLs.

### 4.2 RECOMMENDATIONS

As per the work scope outlined in Supplemental Amendment #3, subsequent groundwater sampling will be conducted annually for the next 2 years. The development of bacterial growth in MW-1 has caused biofouling of the monitoring well. These bacteria, such as iron bacteria, can form a gel-like slime or biofilm that captures chemicals, minerals and other particles such as sand, clays and silts. Minerals, such as iron, oxidize and get trapped in the biofilm. This bacterial growth has likely clogged the well screen and has reduced the yield of the well such

that purging at very low pumping rates (less than 30 ml/min) causes significant water level drawdown in the well and the well will pump dry. The bacterial growth has also compromised groundwater sample quality due its high quantity in the collected sample. Because of the well deterioration, Shaw recommends that this well be removed from the groundwater monitoring network for the site. Other existing wells will be utilized to detect any changes in groundwater quality associated with the landfill.

## 5.0 REFERENCES


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Shaw Environmental, Inc. (Shaw). 2004. Groundwater Monitoring Report, April 2004 Sampling Event, Zilker Park Landfill Project, Austin, Texas. Shaw Project No. 803957.

Texas Commission on Environmental Quality (TCEQ). 1999. Guidelines for Low-Flow Purging and Sampling of Groundwater Monitor Wells. TCEQ Voluntary Cleanup Program (VCP) Guidance, October 1999.

United States Environmental Protection Agency (USEPA). 1996. Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures. EPA/540/S-95/504, April 1996.

**TABLE 1**

**Well Guaging Data for Zilker Park Landfill Monitoring Wells**

| Well ID No. | TOC Elevation (ft msl) | New TOC Elevation (ft msl) [1] | Depth to Groundwater (ft) [2] | | | | | Groundwater Elevation (ft msl) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | May 98 | Oct 03 | Jan 04 | Apr 04 | May 05 | May 98 | Oct 03 | Jan 04 | Apr 04 | May 05 |
| MW-1 | 451.0 | --- | 10.60 | 17.79 | 15.16 | 7.87 | 15.54 | 440.40 | 433.21 | 435.84 | 443.13 | 435.46 |
| MW-2 | 465.7 | --- | 34.71 | 35.71 | 35.72 | 34.97 | 35.44 | 430.99 | 429.99 | 429.98 | 430.73 | 430.26 |
| MW-3 | 457.6 | 460.4 | 26.73 | 32.62 | 32.67 | 31.98 | 31.92 | 430.87 | 424.98 | 427.73 | 428.42 | 428.48 |
| MW-4 | 464.0 | 466.4 | 31.85 | Dry | Dry | Dry | Dry | 432.15 | --- | --- | --- | --- |
| MW-5 | 457.0 | --- | 26.20 | 28.72 | 28.83 | 28.63 | 28.40 | 430.80 | 428.28 | 428.17 | 428.37 | 428.60 |
| MW-6 | 454.2 | --- | 25.15 | 26.00 | 26.10 | 25.98 | 26.07 | 429.05 | 428.20 | 428.10 | 428.22 | 428.13 |
| MW-7 | 455.1 | 457.8 | 26.63 | 30.89 | 30.81 | 30.04 | 29.91 | 428.47 | 424.21 | 426.99 | 427.76 | 427.89 |

TOC = Top of PVC well casing

[1] Monitoring wells extended and constructed with new above-ground (stickup) completion.

[2] Measured from TOC.

**TABLE 2**
**Summary of Field Water Quality Indicator Parameters**
**Recorded for Zilker Park Landfill Monitoring Wells**

| Well ID No. | Date | Temperature (degree C) | Specific Conductance (uS/cm) | pH | ORP (mV) | DO (mg/l) |
|---|---|---|---|---|---|---|
| MW-1 | 10/30/03 | 23.56 | 2.503 | 6.29 | -112.1 | 0.38 |
| | 01/30/04 | 19.70 | 1.211 | 6.39 | -135.0 | 1.56 |
| | 04/21/04 | 20.53 | 0.984 | 6.85 | -142.6 | 0.98 |
| | 05/25/05 | 34.52 | 1.359 | 6.03 | -13.6 | 0.83 |
| MW-2 | 10/29/03 | 22.83 | 1.191 | 6.53 | 135.0 | 2.36 |
| | 01/29/04 | 21.17 | 1.002 | 6.70 | 272.9 | 3.71 |
| | 04/21/04 | 22.15 | 1.021 | 6.89 | 117.9 | 3.77 |
| | 05/23/05 | 23.8 | 0.987 | 6.04 | 270.6 | 2.02 |
| MW-3 | 10/28/03 | 22.29 | 0.953 | 6.72 | -82.0 | 0.95 |
| | 01/29/04 | 18.17 | 0.978 | 6.79 | -76.6 | 1.67 |
| | 04/21/04 | 22.00 | 1.045 | 6.97 | -188.9 | 0.70 |
| | 05/23/05 | 26.76 | 0.831 | 6.34 | -32.6 | 0.44 |
| MW-4 | 10/28/03 | na | na | na | na | na |
| | 01/30/04 | na | na | na | na | na |
| | 04/21/04 | na | na | na | na | na |
| | 05/23/05 | na | na | na | na | na |
| MW-5 | 10/29/03 | 23.42 | 1.533 | 6.38 | -122.1 | 0.34 |
| | 01/30/04 | 21.73 | 1.423 | 6.63 | -118.6 | 1.90 |
| | 04/22/04 | 22.06 | 1.410 | 6.93 | -137.0 | 1.04 |
| | 05/25/05 | 23.05 | 1.215 | 6.38 | -94.8 | 0.93 |
| MW-6 | 10/30/03 | 23.56 | 1.366 | 6.54 | -103.2 | 0.37 |
| | 01/30/04 | 21.41 | 1.106 | 6.70 | -94.2 | 1.51 |
| | 04/22/04 | 22.91 | 1.000 | 7.02 | -95.2 | 0.87 |
| | 05/25/05 | 22.74 | 0.787 | 6.56 | -51.1 | 0.92 |
| MW-7 | 10/28/03 | 25.77 | 1.523 | 6.58 | -118.7 | 0.42 |
| | 01/30/04 | 19.71 | 1.195 | 6.78 | -73.1 | 0.78 |
| | 04/22/04 | 21.36 | 0.776 | 7.23 | -116.5 | 0.63 |
| | 04/22/04 | 25.73 | 1.237 | 5.87 | -90.4 | 0.92 |

na = Not measured

# APPENDIX A

# TABLES

**TABLE 3**
**Summary of Analytical Results for Zilker Park Landfill Groundwater Samples**

| Chemical Constituents (mg/l) | TRRP $^{GW}$GW PCL | MW-1 | | | | | MW-2 | | | | | MW-3 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Oct 1997 | Oct 2003 | Jan 2004 | Apr 2004 | May 2005 | Mar 1998 | Oct 2003 | Jan 2004 | Apr 2004 | May 2005 | Mar 1998 | Oct 2003 | Jan 2004 | Apr 2004 | May 2005 |
| ***VOCs*** | | | | | | | | | | | | | | | | |
| Acetone | 2.4 | <0.100 | **0.00735J,B** | <0.00371 | **0.0370J,B** | na | <0.100 | <0.00371 | **0.00781J** | **0.0173J,B** | <0.0178 | <0.100 | <0.00371 | **0.0319J** | **0.0153J,B** | <0.0178 |
| Acrolein | 0.012 | na | <0.00135 | <0.00135 | **0.0209J** | na | na | <0.00135 | <0.00135 | **0.0115J** | <0.0198 | na | <0.00135 | <0.00135 | **0.00781J** | <0.0198 |
| Acrylonitrile | 0.0017 | na | <0.0024 | <0.0024 | **0.00338J** | na | na | <0.0024 | <0.0024 | <0.0024 | <0.00838 | na | <0.0024 | <0.0024 | **0.00312J** | <0.00838 |
| 2-Butanone (MEK) | 15 | <0.050 | <0.00226 | <0.00226 | **0.0156J,B** | na | <0.050 | <0.00226 | <0.00226 | **0.00727J,B** | <0.00899 | <0.050 | <0.00226 | **0.00381J** | **0.0147J,B** | <0.00899 |
| Chlorobenzene | 0.1 | **0.010** | **0.00568** | **0.00185J** | **0.00163J** | na | <0.005 | <0.00059 | <0.00059 | <0.00059 | <0.00116 | <0.005 | <0.00059 | <0.00059 | <0.00059 | <0.00116 |
| 1,3-Dichlorobenzene | 0.73 | <0.005 | **0.00118J** | <0.00166 | <0.00166 | na | <0.005 | <0.00166 | <0.00166 | <0.00166 | <0.000912 | <0.005 | <0.00166 | <0.00166 | <0.00166 | <0.000912 |
| 1,4-Dichlorobenzene | 0.075 | na | **0.00115J** | <0.00067 | <0.00067 | na | <0.005 | <0.00067 | <0.00067 | <0.00067 | <0.00106 | <0.005 | <0.00067 | <0.00067 | <0.00067 | **0.00111J** |
| Dichlorodifluoromethane | 4.9 | na | <0.00122 | <0.00122 | <0.00122 | na | na | <0.00122 | <0.00122 | <0.00122 | <0.00099 | na | <0.00122 | <0.00122 | <0.00122 | <0.00099 |
| 2-Hexanone | 1.5 | <0.05 | <0.00217 | <0.00217 | **0.00928J,B** | na | <0.05 | <0.00217 | <0.00217 | **0.00500J,B** | <0.00435 | <0.05 | <0.00217 | <0.00217 | **0.00796J,B** | <0.00435 |
| Methylene chloride | 0.005 | <0.005 | **0.00146J** | <0.00082 | **0.00357J** | na | <0.005 | **0.00160J** | **0.00105J** | **0.00296J** | **0.00223J** | <0.005 | **0.00156J** | **0.00102J** | **0.00387J** | <0.002 |
| 4-Methyl-2-pentanone | 2.0 | <0.05 | <0.00148 | <0.00148 | **0.00754J** | na | <0.05 | <0.00148 | <0.00148 | **0.00444J** | <0.00442 | <0.05 | <0.00148 | <0.00148 | **0.00708J** | <0.00442 |
| Vinyl acetate | 24 | <0.05 | <0.0021 | <0.0021 | **0.00272J** | na | <0.05 | <0.0021 | <0.0021 | <0.0021 | <0.00365 | <0.05 | <0.0021 | <0.0021 | **0.00245J** | <0.00365 |
| Vinyl chloride | 0.002 | <0.002 | <0.00086 | <0.00086 | <0.00086 | na | <0.002 | <0.00086 | <0.00086 | <0.00086 | <0.00078 | <0.002 | <0.00086 | <0.00086 | <0.00086 | <0.00078 |
| ***PAHs*** | --- | *ND* | *ND* | *ND* | *ND* | na | *ND* | *ND* | *ND* | *ND* | na | *ND* | *ND* | *ND* | *ND* | na |
| ***Pesticides*** | | | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.0038 | <0.000022 | na | na | **0.0000900J** | na | <0.000022 | <0.000030 | na | <0.000030 | <0.000030 | <0.000022 | <0.000030 | na | <0.000030 | <0.000030 |
| 4,4'-DDE | 0.0027 | <0.000015 | na | na | **0.0000800J** | na | <0.000015 | <0.000029 | na | <0.000029 | <0.000029 | <0.000015 | <0.000029 | na | <0.000029 | <0.000029 |
| ***Herbicides*** | --- | *ND* | na | *ND* | *ND* | na | *ND* | *ND* | *ND* | *ND* | na | *ND* | *ND* | *ND* | *ND* | na |
| ***Metals*** | | | | | | | | | | | | | | | | |
| Aluminum, total | 240 | **0.037** | na | na | <0.0084 | na | **219** | **5.20** | na | **3.65** | **1.80B** | **34.7** | **0.952** | na | **2.72** | **2.66B** |
| dissolved | | na | na | na | <0.0084 | na | na | **4.53** | na | <0.0084 | na | na | **0.788** | na | <0.0084 | na |
| Arsenic, total | 0.01 | <0.030 | na | **0.0041J** | <0.0017 | na | **0.078** | <0.0024 | <0.0024 | <0.0017 | <0.0017 | **0.088** | **0.0114** | **0.0214** | **0.0182** | **0.0142** |
| dissolved | | na | na | <0.0024 | <0.0017 | na | na | <0.0024 | **0.0028J** | <0.0017 | na | na | **0.0090J** | **0.0139J** | <0.0017 | na |
| Barium, total | 2.0 | **0.69** | na | **0.348** | **0.271** | na | **2.59** | **0.122** | **0.110** | **0.120** | **0.124** | **0.650** | **0.133** | **0.194** | **0.215** | **0.178** |
| dissolved | | na | na | **0.372** | **0.256** | na | na | **0.116** | **0.107** | **0.110** | na | na | **0.138** | **0.169** | **0.174** | na |
| Cadmium, total | 0.005 | <0.005 | na | <0.0004 | <0.00085 | na | **0.006** | <0.0004 | <0.0004 | <0.00085 | **0.00085J** | <0.005 | <0.0004 | <0.0004 | <0.00085 | <0.00085 |
| dissolved | | na | na | <0.0004 | <0.00085 | na | na | <0.0004 | <0.0004 | <0.00085 | na | na | <0.0004 | <0.0004 | <0.00085 | na |
| Chromium, total | 0.1 | <0.005 | na | **0.0005J** | **0.00105J,B** | na | **0.210** | **0.0062** | **0.0024J** | **0.00535B** | **0.0009J** | **0.037** | **0.0012J** | **0.0012J** | **0.00355B** | **0.0023J** |
| dissolved | | na | na | <0.0005 | **0.00090J** | na | na | **0.0051J** | **0.0012J** | **0.00165J** | na | na | **0.0014J** | <0.0005 | <0.00085 | na |
| Iron, total | --- | **14.2** | na | na | **5.03** | na | **273** | **5.15** | na | **3.32** | **1.89** | **62.6** | **4.85** | na | **10.8** | **10.3** |
| dissolved | | na | na | na | **0.931** | na | na | **3.50** | na | **0.0057J** | na | na | **3.48** | na | **0.327** | na |
| Lead, total | 0.015 | <0.015 | na | **0.0084J** | <0.0019 | na | **0.270** | <0.00271 | <0.00271 | **0.00490J** | **0.00190J** | <0.015 | <0.00271 | <0.00271 | **0.00335J** | <0.0019 |
| dissolved | | na | na | <0.00271 | <0.0019 | na | na | **0.0034J** | <0.00271 | <0.0019 | na | na | <0.00271 | <0.00271 | <0.0019 | na |
| Manganese, total | 1.1 | **0.39** | na | na | **0.650** | na | **8.04** | **0.0605** | na | **0.0565** | **0.0268** | **3.96** | **0.297** | na | **0.652** | **0.769** |
| dissolved | | na | na | na | **0.614** | na | na | **0.0415** | na | **0.0216** | na | na | **0.297** | na | **0.512** | na |
| Mercury, total | 0.002 | <0.0005 | na | <0.000028 | <0.000028 | na | **0.0013** | <0.000028 | <0.000028 | <0.000028 | <0.000028 | <0.0005 | <0.000028 | <0.000028 | <0.000028 | <0.000028 |
| dissolved | | na | na | <0.000028 | <0.000028 | na | na | <0.000028 | <0.000028 | <0.000028 | na | na | <0.000028 | <0.000028 | <0.000028 | na |
| Selenium, total | 0.05 | <0.040 | na | **0.0056J** | <0.00665 | na | <0.040 | <0.0047 | <0.0047 | <0.00665 | <0.00235 | <0.040 | <0.0047 | <0.0047 | <0.00665 | <0.00235 |
| dissolved | | na | na | <0.0047 | **0.00845J** | na | na | <0.0047 | <0.0047 | <0.00665 | na | na | <0.0047 | <0.0047 | <0.00665 | na |
| Silver, total | 0.12 | <0.010 | na | <0.00083 | <0.00065 | na | <0.010 | <0.00083 | <0.00083 | <0.00065 | <0.00065 | <0.010 | **0.0015J** | <0.00083 | <0.00065 | <0.00065 |
| dissolved | | na | na | **0.0040J** | <0.00065 | na | na | **0.0014J** | <0.00083 | <0.00065 | na | na | **0.0012J** | <0.00083 | <0.00065 | na |
| Zinc, total | 7.3 | **0.099** | na | na | **0.0087J,B** | na | **0.950** | <0.0004 | na | **0.0074J,B** | <0.00165 | **0.140** | **0.0058J** | na | **0.0070J,B** | <0.00165 |
| dissolved | | na | na | na | **0.0058J,B** | na | na | <0.0004 | na | <0.00165 | na | na | **0.0006J** | na | <0.00165 | na |

Notes:
na = Not analyzed
*ND* - Not detected
J = Estimated concentration; detected below the laboratory Reporting Limit
B = Analyte detected in laboratory method blank
= Detected concentration is above TRRP $^{GW}$GW PCL

**TABLE 3**
**Summary of Analytical Results for Zilker Park Landfill Groundwater Samples**

| Chemical Constituents (mg/l) | TRRP $^{GW}$GW PCL | MW-4 | | | | | MW-5 | | | | | MW-6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mar 1998 | Oct 2003 | Jan 2004 | Apr 2004 | May 2005 | Mar 1998 | Oct 2003 | Jan 2004 | Apr 2004 | May 2005 | Mar 1998 | Oct 2003 | Jan 2004 | Apr 2004 | May 2005 |
| ***VOCs*** | | | | | | | | | | | | | | | | |
| Acetone | 2.4 | <0.100 | na | na | na | na | <0.100 | <0.00371 | **0.00988J** | **0.00474J,B** | <0.0178 | <0.100 | **0.00383J,B** | **0.0130J** | **0.00387J,B** | <0.0178 |
| Acrolein | 0.012 | na | na | na | na | na | na | <0.00135 | <0.00135 | <0.00135 | <0.0198 | na | <0.00135 | <0.00135 | <0.00135 | <0.0198 |
| Acrylonitrile | 0.0017 | na | na | na | na | na | na | <0.0024 | <0.0024 | <0.0024 | <0.00838 | na | <0.0024 | <0.0024 | <0.0024 | <0.00838 |
| 2-Butanone (MEK) | 15 | <0.050 | na | na | na | na | <0.050 | <0.00226 | <0.00226 | <0.00226 | <0.00899 | <0.050 | <0.00226 | <0.00226 | <0.00226 | <0.00899 |
| Chlorobenzene | 0.1 | <0.005 | na | na | na | na | <0.005 | <0.00059 | <0.00059 | <0.00059 | <0.00116 | <0.005 | **0.0152** | **0.00863** | **0.00628** | <0.00116 |
| 1,3-Dichlorobenzene | 0.73 | <0.005 | na | na | na | na | <0.005 | <0.00166 | <0.00166 | <0.00166 | <0.000912 | <0.005 | <0.00166 | <0.00166 | <0.00166 | <0.000912 |
| 1,4-Dichlorobenzene | 0.075 | <0.005 | na | na | na | na | <0.005 | <0.00067 | <0.00067 | <0.00067 | <0.00106 | <0.005 | **0.00286J** | **0.00171J** | **0.00107J** | <0.00106 |
| Dichlorodifluoromethane | 4.9 | na | na | na | na | na | na | **0.00149J** | <0.00122 | <0.00122 | <0.00099 | na | <0.00122 | <0.00122 | <0.00122 | <0.00099 |
| 2-Hexanone | 1.5 | <0.05 | na | na | na | na | <0.05 | <0.00217 | <0.00217 | <0.00217 | <0.00435 | <0.05 | <0.00217 | <0.00217 | <0.00217 | <0.00435 |
| Methylene chloride | 0.005 | <0.005 | na | na | na | na | <0.005 | **0.00177J** | <0.00082 | **0.00740J** | **0.00252J** | <0.005 | **0.00131J** | **0.00144J** | **0.00714J** | **0.00214J** |
| 4-Methyl-2-pentanone | 2.0 | <0.05 | na | na | na | na | <0.05 | <0.00148 | <0.00148 | <0.00148 | <0.00442 | <0.05 | <0.00148 | <0.00148 | <0.00148 | <0.00442 |
| Vinyl acetate | 24 | <0.05 | na | na | na | na | <0.05 | <0.0021 | <0.0021 | <0.0021 | <0.00365 | <0.05 | <0.0021 | <0.0021 | <0.0021 | <0.00365 |
| Vinyl chloride | 0.002 | <0.002 | na | na | na | na | <0.002 | <0.00086 | **0.00089J** | <0.00086 | <0.00078 | <0.002 | <0.00086 | <0.00086 | <0.00086 | <0.00078 |
| ***PAHs*** | --- | *ND* | na | na | na | na | *ND* | *ND* | *ND* | *ND* | na | *ND* | *ND* | *ND* | *ND* | na |
| ***Pesticides*** | | | | | | | | | | | | | | | | |
| 4,4'-DDD | 0.0038 | <0.000022 | na | na | na | na | <0.000022 | <0.000030 | na | <0.000030 | <0.000030 | <0.000022 | <0.000030 | na | <0.000030 | <0.000030 |
| 4,4'-DDE | 0.0027 | <0.000015 | na | na | na | na | <0.000015 | <0.000029 | na | <0.000029 | <0.000029 | <0.000015 | <0.000029 | na | <0.000029 | <0.000029 |
| ***Herbicides*** | --- | *ND* | na | na | na | na | *ND* | *ND* | *ND* | *ND* | na | *ND* | *ND* | *ND* | *ND* | na |
| ***Metals*** | | | | | | | | | | | | | | | | |
| Aluminum, total | 240 | **4.12** | na | na | na | na | **145** | **0.277** | na | **0.372** | **1.41B** | **98.6** | **0.331** | na | **0.58** | **0.385B** |
| dissolved | | na | na | na | na | na | na | **0.186** | na | <0.0084 | na | na | **0.323** | na | <0.0084 | na |
| Arsenic, total | 0.01 | <0.030 | na | na | na | na | **0.150** | **0.0401** | **0.0506** | **0.0416** | **0.0394** | **0.031** | **0.00620J** | **0.0054J** | <0.0017 | **0.0088** |
| dissolved | | na | na | na | na | na | na | **0.0281J** | **0.0396J** | **0.0122** | na | na | **0.0052J** | **0.0044J** | <0.0017 | na |
| Barium, total | 2.0 | **0.200** | na | na | na | na | **2.25** | **0.399** | **0.469** | **0.430** | **0.422** | **1.27** | **0.400** | **0.356** | **0.292** | **0.297** |
| dissolved | | na | na | na | na | na | na | **0.343** | **0.379** | **0.262** | na | na | **0.366** | **0.344** | **0.272** | na |
| Cadmium, total | 0.005 | <0.005 | na | na | na | na | **0.006** | <0.0004 | <0.0004 | <0.00085 | <0.00085 | <0.005 | <0.0004 | <0.0004 | <0.00085 | <0.00085 |
| dissolved | | na | na | na | na | na | na | <0.0004 | <0.0004 | <0.00085 | na | na | <0.0004 | <0.0004 | <0.00085 | na |
| Chromium, total | 0.1 | **0.008** | na | na | na | na | **0.220** | **0.00070J** | **0.0010J** | **0.00130J,B** | <0.00085 | **0.130** | **0.0012J** | <0.0005 | **0.00180J,B** | <0.00085 |
| dissolved | | na | na | na | na | na | na | <0.0005 | **0.0009J** | <0.00085 | na | na | **0.0012J** | **0.0011J** | <0.00085 | na |
| Iron, total | --- | **5.98** | na | na | na | na | **281** | **16.3** | na | **16.4** | **18.6** | **112** | **4.73** | na | **3.53** | **3.24** |
| dissolved | | na | na | na | na | na | na | **10.9** | na | **1.30** | na | na | **3.61** | na | **0.358** | na |
| Lead, total | 0.015 | <0.015 | na | na | na | na | **0.200** | <0.00271 | <0.00271 | **0.00295J** | <0.0019 | **0.120** | <0.00271 | <0.00271 | <0.0019 | <0.0019 |
| dissolved | | na | na | na | na | na | na | <0.00271 | <0.00271 | **0.00195J** | na | na | <0.00271 | <0.00271 | **0.00290J** | na |
| Manganese, total | 1.1 | **0.460** | na | na | na | na | **7.75** | **1.64** | na | **1.82** | **2.1** | **2.06** | **0.288** | na | **0.299** | **0.254** |
| dissolved | | na | na | na | na | na | na | **0.288** | na | **1.67** | na | na | **0.288** | na | **0.302** | na |
| Mercury, total | 0.002 | <0.0005 | na | na | na | na | <0.0005 | <0.000028 | <0.000028 | <0.000028 | <0.000028 | <0.0005 | <0.000028 | <0.000028 | <0.000028 | <0.000028 |
| dissolved | | na | na | na | na | na | na | <0.000028 | <0.000028 | <0.000028 | na | na | <0.000028 | <0.000028 | <0.000028 | na |
| Selenium, total | 0.05 | <0.040 | na | na | na | na | <0.040 | <0.0047 | <0.0047 | <0.00665 | **0.007** | <0.040 | <0.0047 | <0.0047 | <0.00665 | <0.00235 |
| dissolved | | na | na | na | na | na | na | <0.0047 | <0.0047 | <0.00665 | na | na | <0.0047 | <0.0047 | <0.00665 | na |
| Silver, total | 0.12 | <0.010 | na | na | na | na | <0.010 | **0.00090J** | <0.00083 | <0.00065 | <0.00065 | <0.010 | **0.0014J** | <0.00083 | <0.00065 | <0.00065 |
| dissolved | | na | na | na | na | na | na | **0.0015J** | <0.00083 | <0.00065 | na | na | **0.00150J** | <0.00083 | <0.00065 | na |
| Zinc, total | 7.3 | <0.050 | na | na | na | na | **0.560** | <0.0004 | na | <0.00165 | <0.00165 | **0.340** | <0.0004 | na | <0.00165 | <0.00165 |
| dissolved | | na | na | na | na | na | na | <0.0004 | na | <0.00165 | na | na | <0.0004 | na | <0.00165 | na |

Notes:
na = Not analyzed
*ND* - Not detected
J = Estimated concentration; detected belov
B = Analyte detected in laboratory method b
= Detected concentration is above T

**TABLE 3**
**Summary of Analytical Results for Zilker Park Landfill Groundwater Samples**

| Chemical Constituents (mg/l) | TRRP $^{GW}$GW PCL | MW-7 | | | | |
|---|---|---|---|---|---|---|
| | | Mar 1998 | Oct 2003 | Jan 2004 | Apr 2004 | May 2005 |
| ***VOCs*** | | | | | | |
| Acetone | 2.4 | <0.100 | **0.00669J,B** | **0.0101J** | **0.00995J,B** | <0.0178 |
| Acrolein | 0.012 | na | <0.00135 | <0.00135 | **0.00778J** | <0.0198 |
| Acrylonitrile | 0.0017 | na | <0.0024 | <0.0024 | **0.00269J** | <0.00838 |
| 2-Butanone (MEK) | 15 | <0.050 | <0.00226 | <0.00226 | **0.0115J,B** | <0.00899 |
| Chlorobenzene | 0.1 | <0.005 | <0.00059 | <0.00059 | <0.00059 | **0.00147J** |
| 1,3-Dichlorobenzene | 0.73 | <0.005 | <0.00166 | <0.00166 | <0.00166 | <0.000912 |
| 1,4-Dichlorobenzene | 0.075 | <0.005 | **0.00123J** | **0.00079J** | <0.00067 | <0.00106 |
| Dichlorodifluoromethane | 4.9 | na | <0.00122 | <0.00122 | <0.00122 | <0.00099 |
| 2-Hexanone | 1.5 | <0.05 | <0.00217 | <0.00217 | **0.00620J,B** | <0.00435 |
| Methylene chloride | 0.005 | <0.005 | **0.00171J** | <0.00082 | **0.00272J** | <0.002 |
| 4-Methyl-2-pentanone | 2.0 | <0.05 | <0.00148 | <0.00148 | **0.00565J** | <0.00442 |
| Vinyl acetate | 24 | <0.05 | <0.0021 | <0.0021 | **0.00268J** | <0.00365 |
| Vinyl chloride | 0.002 | <0.002 | <0.00086 | <0.00086 | <0.00086 | <0.00078 |
| ***PAHs*** | --- | *ND* | *ND* | *ND* | *ND* | na |
| ***Pesticides*** | | | | | | |
| 4,4'-DDD | 0.0038 | <0.000022 | <0.000030 | na | <0.000030 | <0.000030 |
| 4,4'-DDE | 0.0027 | <0.000015 | <0.000029 | na | <0.000029 | <0.000029 |
| ***Herbicides*** | --- | *ND* | *ND* | *ND* | *ND* | na |
| ***Metals*** | | | | | | |
| Aluminum, total | 240 | **186** | **1.60** | na | **0.276** | **1.03B** |
| dissolved | | na | **0.691** | na | <0.0084 | na |
| Arsenic, total | 0.01 | **0.073** | **0.0246** | **0.0131** | **0.0087** | **0.0434** |
| dissolved | | na | **0.0139** | **0.0106J** | <0.0017 | na |
| Barium, total | 2.0 | **1.39** | **0.316** | **0.211** | **0.129** | **0.543** |
| dissolved | | na | **0.25** | **0.187** | **0.118** | na |
| Cadmium, total | 0.005 | <0.005 | <0.0004 | <0.0004 | <0.00085 | <0.00085 |
| dissolved | | na | <0.0004 | <0.0004 | <0.00085 | na |
| Chromium, total | 0.1 | **0.160** | **0.0025J** | **0.0010J** | **0.00160J,B** | <0.00085 |
| dissolved | | na | **0.0433** | <0.0005 | **0.00170J** | na |
| Iron, total | --- | **220** | **9.87** | na | **3.22** | **19.5** |
| dissolved | | na | **3.62** | na | **0.151** | na |
| Lead, total | 0.015 | **0.150** | <0.00271 | <0.00271 | **0.00500J** | **0.00265J** |
| dissolved | | na | <0.00271 | <0.00271 | <0.0019 | na |
| Manganese, total | 1.1 | **5.23** | **0.968** | na | **0.690** | **1.69** |
| dissolved | | na | **0.906** | na | **0.464** | na |
| Mercury, total | 0.002 | <0.0005 | <0.000028 | <0.000028 | <0.000028 | <0.000028 |
| dissolved | | na | <0.000028 | <0.000028 | <0.000028 | na |
| Selenium, total | 0.05 | <0.040 | **0.0048J** | <0.0047 | <0.00665 | **0.0125** |
| dissolved | | na | <0.0047 | <0.0047 | **0.0106J** | na |
| Silver, total | 0.12 | <0.010 | **0.0012J** | <0.00083 | <0.00065 | <0.00065 |
| dissolved | | na | **0.00090J** | <0.00083 | **0.00085J** | na |
| Zinc, total | 7.3 | **0.550** | <0.0004 | na | **0.0492B** | <0.00165 |
| dissolved | | na | <0.0004 | na | **0.0117B** | na |

Notes:
na = Not analyzed
*ND* - Not detected
J = Estimated concentration; detected belov
B = Analyte detected in laboratory method b
= Detected concentration is above T

# APPENDIX B

# FIGURES

| | | |
|---|---|---|
| DRAWING NUMBER | zilker/mr.dwg | |
| APPROVED BY | JM | 12/11/2003 |
| CHECKED BY | MR | 12/11/2003 |
| DRAWN BY | TFR | 12/11/2003 |
| OFFICE | Austin, Texas | |

DRY CREEK
BRIDGE
MW–6
MW–5
MOPAC Southbound lanes
MOPAC (LOOP 1) Northbound lanes
STRATFORD DRIVE
TOWN LAKE
AUSTIN NATURE & SCIENCE CENTER
COLUMNS
MW–4
MW–7
WATER SURFACE
FORMER BUTLER LANDFILL
HIKE & BIKE TRAIL
EDGE OF ROAD
STRATFORD DRIVE
MOPAC EXPRESSWAY
MW–3
MW–1
BOTANICAL GARDENS
POND
MW–2
LOU NEFF ROAD
ZILKER ZEPHYR TRAIN TRACK
BARTON SPRINGS ROAD
ZILKER PARK

## LEGEND

- HIKE & BIKE TRAIL
- ZILKER ZEPHYR TRAIN TRACK
- PROPERTY LINE
- BOUNDARY OF EDWARDS AQUIFER RECHARGE ZONE
- APPROXIMATE FILL BOUNDARY
- TX DOT SOIL BORING
- MONITORING WELL LOCATION

N

0 200 400

APPROXIMATE SCALE IN FEET

Shaw®
8501 North Mopac Expressway
Suite 320
Austin, Texas 78759
(512) 928-8051
fax(512) 928-0077

FIGURE 1

MONITORING WELL LOCATION MAP

CITY OF AUSTIN
ZILKER LANDFILL REMEDIATION

# APPENDIX C

# ANALYICAL LABORATORY REPORTS