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FALL 2008 SEMIANNUAL WATER QUALITY MONITORING REPORT

JACKSON COUNTY MUNICIPAL SOLID WASTE LANDFILL JACKSON COUNTY, NORTH CAROLINA

Prepared for
Jackson County Solid Waste Department

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1.0 INTRODUCTION

The Jackson County Solid Waste Department maintains a closed Municipal Solid Waste Landfill (MSWLF) located approximately three-quarters of a mile west of Dillsboro, North Carolina, north of Old Dillsboro Road (Old U.S. 74). The approximate location of the landfill is shown in Figure 1. The landfill is governed by the North Carolina Department of Environment and Natural Resources (DENR), Division of Waste Management (DWM), under Permit No. 50-02. The landfill permit requires semiannual monitoring of groundwater and surface-water quality.

This report serves as the second semiannual groundwater and surface water monitoring report for 2008. This report provides an evaluation of groundwater and surface-water quality. Statistical analyses of groundwater quality data and groundwater flow direction are also provided.

On a semi-annual basis water samples are collected from select monitoring points. One sampling event occurs during the spring and the other during the fall. The analytical suite associated with this sampling event and the next three sampling events is as follows:

- ***Fall 2008*** - Sulfide, Cyanide, and Appendix II constituents including metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), and herbicides.
- ***Spring 2009*** – Appendix I Metals and VOCs
- ***Fall 2009*** – Appendix II Metals and VOCs
- ***Spring 2010*** – Appendix I Metals and VOCs

Each sampling event is conducted and reported in accordance with the requirements stipulated in the DENR Solid Waste Management Rules codified under Title 15A Subchapter 13B of the North Carolina Administrative Code (15A NCAC 13B).

This report contains the following items:

- Groundwater level measurements and corresponding elevations for the landfill monitoring wells
- An illustration of groundwater and surface-water sampling locations

- Generalized groundwater flow direction map
- Summary of groundwater and surface-water analytical results
- Statistical analyses for metals and VOCs
- Sampling logs
- Groundwater and surface water quality analytical results with chain-of-custody forms

2.0 SEMIANNUAL MONITORING

2.1 GROUNDWATER, SURFACE-WATER, AND DOMESTIC WELL SAMPLING

The closed MSWLF monitoring wells (5002-MW-01, 5002-MW-02, 5002-MW-03, 5002-MW-04, 5002-MW-05, and 5002-MW-06) and surface-water sample locations (5002-SW-01 and 5002-SW-02) were sampled from October 7 through 10, 2008 by Altamont Environmental, Inc. (Altamont). The monitoring-well and surface-water sample locations are depicted in Figure 2. Groundwater samples from two domestic water wells (DW-01 and DW-02) were collected on October 7, 2008.

Prior to collecting groundwater samples from the monitoring wells, the static water level was measured in each well. The monitoring wells were purged using low-flow techniques in accordance with the procedures described in *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures* United States Environmental Protection Agency (EPA), Groundwater Issues (April 1996). During purging, the pH, specific conductivity, dissolved oxygen, oxidation-reduction potential (ORP), turbidity, and temperature were measured and recorded approximately every three minutes. Well purging continued until these parameters stabilized for three consecutive readings. The required stabilization criteria were as follows:

- pH values within +/- 0.1 unit;
- specific conductivity values within +/- 3 percent;
- temperature, dissolved oxygen, and turbidity values within +/- 10 percent; and
- ORP values within +/- 10 millivolts.

After these criteria had been attained, a ground-water sample was collected using laboratory-supplied sample bottles by a technician wearing sterile Nitrile gloves. Collected samples were immediately placed on ice in sample coolers for transport to the laboratory. Proper chain-of-custody documentation was followed during collection and transport of each sample. A trip blank was included in the sample cooler and analyzed for Appendix II VOCs.

Surface-water samples 5002-SW-01 and 5002-SW-02 were collected at designated locations from the Tuckasegee River, which is adjacent to the southwestern border of the closed MSWLF. Sample 5002-SW-01 is representative of surface-water quality upstream of the closed MSWLF; 5002-SW-02 is representative of surface-water quality downstream from the closed MSWLF. Samples were collected in laboratory-supplied sample bottles by a technician wearing sterile new disposable Nitrile gloves. Collected samples were immediately placed on ice in sample coolers for transport to the laboratory. Proper chain-of-custody documentation was followed during collection and transport of each sample. Similar to groundwater sampling, temperature, pH, specific conductivity, dissolved oxygen, and turbidity were measured and recorded at each surface-water sampling location (see Table 1).

Field parameters and additional observations pertaining to the closed MSWLF sampling locations are provided on sampling logs, which are included in Appendix A. Groundwater and surface-water samples were analyzed by Pace Analytical Services, Inc. (Pace), a North Carolina Certified Laboratory located in Asheville, North Carolina. Altamont submitted the groundwater samples collected from the monitoring wells and the surface-water samples for analyses as follows:

- Appendix II VOCs using EPA Method 8260
- Appendix II SVOCs using EPA Method 8270
- Appendix II pesticides using EPA Method 8081
- Appendix II PCBs using EPA Method 8082
- Appendix II herbicides using EPA Method 8151A
- Appendix II metals using EPA Methods 6010, 6020, and 7470
- Sulfide and cyanide using EPA Methods 4500-S2D and 4500-CN-E

Altamont submitted the groundwater samples collected from the two domestic water wells to Pace for VOCs analyses using EPA Method 524.2.

2.2 ANALYTICAL RESULTS

The laboratory analytical results for the groundwater samples (monitoring wells 5002-MW-01 through 5002-MW-06, and domestic water wells DW-01 and DW-02) and the surface-water samples (5002-SW-01 and 5002-SW-02) collected at the closed MSWLF are compiled in Table 1. This table is displayed in

the Electronic Data Deliverable (EDD) format specified by the DENR Solid Waste Section memorandum dated October 27, 2006. The laboratory analytical report issued by Pace and chain-of-custody forms are included in Appendix B.

As stipulated in the October 27, 2006 DENR Solid Waste Section memorandum referenced above, all laboratory analytical results were reported and appropriately qualified. Non-detections (non-detects), which are values reported by the laboratory to be below Method Detection Limits (MDLs), were tabulated on Table 1 as "Below Quantitation Limit" (BQL), and were qualified with the "U" qualifier. The MDL is the minimum concentration of a substance that can be measured and reported by a laboratory with 99% confidence that the constituent concentration is greater than zero. All detections (values above the MDL) were compared to constituent-specific Solid Waste Section Limits (SWSLs) established by the DENR Solid Waste Section. The SWSL is defined as the lowest concentration of a constituent in a sample that can be quantitatively determined with suitable precision and accuracy. If a reported concentration is above the laboratory MDL but below the SWSL, the analytical result is qualified as estimated. These results are flagged with a "J" qualifier (J-flag) in Table 1.

Detected concentrations of constituents in groundwater samples were compared to the applicable Groundwater Quality Standards codified under 15A NCAC 2L (2L Standards). Detected concentrations of constituents in groundwater with no established 2L Standard were compared to the Groundwater Protection Standard (GWPS) pursuant to 15A NCAC 13B.1634. Surface-water sample detections were compared to the standard from 15A NCAC 2B.0200 surface quality standards (2B Standards).

2.2.1 Groundwater – Monitoring Wells

Analytical results for groundwater samples collected from the monitoring wells are discussed below. Analytical results are summarized in Tables 1 through 3. The laboratory reports are included in Appendix B.

2.2.1.1 Appendix II Metals (EPA Method 6010 and 7470)

Eight x metals (barium, chromium, cobalt, copper, nickel, silver, tin, and vanadium) were detected at concentrations below their SWSLs in one or more of the monitoring-well groundwater samples (Table 1). These results are considered estimates and are therefore J-flagged.

The following three metals were detected at concentrations above the associated SWSL but below the applicable 2L Standard or GWPS (Table 2):

- Barium in 5002-MW-03 (163 µg/l), 5002-MW-04 (133 µg/l), and 5002-MW-05 (198 µg/l)
- Cobalt in 5002-MW-01 (32.9 µg/l), 5002-MW-02 (33.7 µg/l), and 5002-MW-06 (18.3 ug/l)
- Zinc in 5002-MW-06 (11.6 µg/l)

The following three metals were detected at concentrations above the applicable 2L Standards or GWPSs (Table 3):

- Cadmium in 5002-MW-05 (4.3 µg/l)
- Cobalt in 5002-MW-03 (88.1 µg/l)
- Vanadium in 5002-MW-05 (5.3 µg/l) [***Note:*** This detected concentration of vanadium is also below its SWSL. Therefore, it is an estimated (J-flagged) value.]

2.2.1.2 Sulfide (EPA Method 376.2)

Sulfide was not detected in any of the groundwater samples above the associated MDL.

2.2.1.3 Cyanide (EPA Method 335.3)

Cyanide was not detected in any of the groundwater samples above the associated MDL.

2.2.1.4 Appendix II VOCs (EPA Method 8260)

Ten VOCs were detected at estimated concentrations below their respective SWSLs (J-flags) in the groundwater samples collected from the monitoring wells. These VOCs are 1,2-dichlorobenzene, 1,1-dichloroethane, chlorobenzene, chloroethane, cis-1,2-dichloroethene, o-xylene, naphthalene, tetrachloroethene, trichloroethene, and vinyl chloride (Table 1). Additionally, One VOC, o-xylene, was detected at a concentration above its MDL (1.9 µg/l in 5002-MW-06). An SWSL is not available for this compound.

The following VOCs were detected at concentrations above the associated SWSLs but below the applicable 2L Standards or GWPSs (Table 2):

- 1,1-Dichloroethane in 5002-MW-01 (7.9 µg/l), 5002-MW-06 (12.4 µg/l)

- 1,3-Dichlorobenzene in 5002-MW-01 (7.5 µg/l)
- Chlorobenzene in 5002-MW-01 (3.0 µg/l), 5002-MW-03 (11.7 µg/l), 5002-MW-04 (7.2 µg/l), and 5002-MW-05 (8.1 µg/l)
- cis-1,2-Dichloroethene in 5002-MW-01 (8.7 µg/l), 5002-MW-03 (5.1 µg/l), 5002-MW-04 (10.7 µg/l), 5002-MW-05 (21.6 µg/l), and 5002-MW-06 (7.2 µg/l)
- Methylene chloride in5002-MW-06 (3.2 µg/l)
- Trichloroethene in 5002-MW-01 (1.2 µg/l)

The following VOCs were detected at concentrations above the applicable 2L Standards or GWPSs (Table 3):

- Benzene in 5002-MW-01 (5.5 µg/l), 5002-MW-03 (1.3 µg/l), 5002-MW-04 (1.5 µg/l), 5002-MW-05 (1.2 µg/l), and 5002-MW-06 (1.8 µg/l)
- 1,4-Dichlorobenzene in 5002-MW-01 (7.6 µg/l), 5002-MW-03 (12.6 µg/l), 5002-MW-04 (9.3 µg/l), 5002-MW-05 (16.2 µg/l), and 5002-MW-06 (2.1 µg/l)
- Tetrachloroethene in 5002-MW-01 (0.7 µg/l) [***Note:*** This detected concentration is also below its SWSL. Therefore, it is an estimated (J-flagged) value.]
- Vinyl chloride in 5002-MW-04 (0.97 µg/l) and 5002-MW-05 (0.78 µg/l) [***Note:*** These detected concentrations are also below the SWSL. Therefore, they are estimated (J-flagged) values.]

2.2.1.5 Appendix II SVOCs (EPA Method 8270)

No SVOCs were detected at estimated (J-flagged) concentrations below the applicable SWSLs.

With the exception of naphthalene, no SVOCs were detected at concentrations above the associated SWSLs but below the applicable 2L Standards or GWPSs (Table 2). [***Note:*** Naphthalene was detected at a concentration above its SWSL, but below its 2L Standard. Although naphthalene is commonly classified as an SVOC, the detection was identified using EPA Method 8260. Therefore, it is reported in in Section 2.2.1.4.]

With the exception of 1,4-dichlorobenzene, no SVOCs were detected at concentrations above the applicable 2L Standards or GWPSs (Table 3). [***Note:*** 1,4-Dichlorobenzene was detected using EPA Method 8270 in three of the six monitoring wells at concentrations above the 2L Standard (1.4 ug/l). These detected concentrations were as follows: 5002-MW-03 at 6.3 µg/l, 5002-MW-04 at 5.4 µg/l, and 5002-MW-05 at 7.7 µg/l. 1,4-Dichlorobenzene was not detected using EPA Method 8270 in the

remaining three monitoring wells. As with naphthalene, 1,4-dichlorobenzene was analyzed under both EPA Methods 8260 (VOCs) and 8270 (SVOCs). This is discussed further in Section 3.1.]

2.2.1.6 Appendix II Pesticides (EPA Methods 8081 and 8041)

No Appendix II pesticides were detected in any of the monitoring wells at concentrations exceeding their associated MDLs.

2.2.1.7 PCBs (EPA Method 8082)

No Appendix II PCBs were detected in any of the monitoring wells at concentrations exceeding their associated MDLs.

2.2.1.8 Herbicides (EPA Method 8151)

One Appendix II herbicide, dinoseb, was detected in the groundwater sample from 5002-MW-04 at a concentration (0.94 µg/l) below its SWSL (1 µg/l).

2.2.2 Surface Water

The following Sections summarize detections of Appendix II constituents in the two surface-water samples (5002-SW-01 and 5002-SW-02) collected during the October 2008 sampling event.

2.2.2.1 Appendix II Metals (EPA Method 6010 and 7470)

Four metals (barium, cobalt, copper, and nickel) were detected at estimated (J-flagged) concentrations below their SWSLs in the surface-water samples. Such detections of barium, cobalt, and copper were identified in 5002-SW-01 and barium, cobalt, and nickel were identified in 5002-SW-02 (Table 1).

None of the metals detected in surface-water samples exceeded their respective 2B Standards.

2.2.2.2 Sulfide (EPA Method 376.2)

Sulfide was not detected in the surface-water samples.

2.2.2.3 Cyanide (EPA Method 335.3)

Cyanide was not detected in the surface-water samples.

2.2.2.4 Appendix II VOCs (EPA Method 8260)

One VOC, acetone, was detected in one (5002-SW-02) of the two samples at a concentration (3.9 µg/l) below its SWSL. No other VOC was detected in either surface-water sample.

No VOCs were detected in the surface-water samples at concentrations above their applicable 2B Standards.

2.2.2.5 Appendix II SVOCs (EPA Method 8270)

No Appendix II SVOCs were detected in either of the surface water samples.

2.2.2.6 , Pesticides (EPA Methods 8081 and 8041)

No Appendix II pesticides were detected in either of the surface water samples.

2.2.2.7 PCBs (EPA Method 8082)

No Appendix II PCBs were detected in either of the surface water samples.

2.2.2.8 Herbicides (EPA Method 8151)

No Appendix II herbicides were detected in either of the surface water samples.

2.2.3 Groundwater - Domestic Water Wells

Only one VOC (1,1-dichloroethane; analyzed using EPA Method 524.2) was detected in one of the two domestic well groundwater samples. 1,1-Dichloroethane was detected at 0.21 µg/l, which is an estimated value below the compound's SWSL (5 µg/l).

2.3 HYDROGEOLOGY

Groundwater occurring in the saprolite and bedrock aquifers is monitored at the closed MSWLF. Three bedrock aquifer monitoring wells, 5002-MW-01, 5002-MW-02, and 5002-MW-06, are located in the northwest portion of the site. Because these three wells are situated in a linear pattern, and groundwater flow in fractured bedrock is complex, an accurate groundwater flow direction in bedrock cannot be reliably estimated.

The remaining monitoring wells (5002-MW-03, 5002-MW-04, and 5002-MW-05) located at the southern part of the closed MSWLF, are completed in unconsolidated saprolite or partially weathered rock (PWR) aquifer (see Figure 2). Water-level data collected from these three monitoring wells (see Table 4) were used to estimate a southwestern groundwater flow direction in the shallow aquifer, toward the Tuckasegee River. Figure 3 depicts the generalized groundwater flow direction in the saprolite/PWR aquifer based on the groundwater level measurements made by Altamont from October 7 through 10, 2008. This southwesterly flow direction is similar to the directioncalculated in spring 2008 and fall 2007.

2.4 STATISTICAL ANALYSES

Typically, an analysis of variance (ANOVA) procedure is used to compare concentration data from several compliance wells with concentration data from background wells. However, as stated in a letter from Altamont to the DENR dated January 16, 2004, the Jackson County closed MSWLF does not have an adequate background well. Monitoring well 5002-MW-01 was installed by a previous consultant in a location that was considered to represent background water quality. However, historical analytical results suggest that groundwater quality at 5002-MW-01 is not representative of background groundwater conditions for the closed MSWLF. Therefore, a standard ANOVA procedure is not feasible for this landfill.

In lieu of an ANOVA procedure, Altamont performed the Student's *t*-test statistical procedure (*t*-test) to determine whether the mean concentration of a detected constituent is statistically greater than its respective 2L Standard or GWPS. The *t*-test is commonly used when comparing a time series of data (e.g., current and historic concentrations of a specific contaminant detected in samples collected from a specific well) to one given value (for example, the 2L Standard). GWPS values were used for constituents that did not have a listed 2L Standard.

The *t*-test evaluates the null hypothesis that the historical mean concentration of a detected constituent is equal to the 2L Standard. If the historical mean for a particular constituent is not statistically greater than its respective 2L Standard, then the null hypothesis is accepted. Conversely, if the historical mean for a particular constituent is statistically greater than the respective 2L Standard, then the null hypothesis is rejected and the mean concentration is acknowledged to be greater than the 2L Standard. This is

determined by comparing a computed *t*-statistic to a tabulated *t*-statistic.

The computed *t*-statistic takes into account the mean, standard deviation, number of data points (sample size), and the 2L Standard (or GWPS), as shown in the following equation:

$$t_{\text{computed}} = \frac{\text{mean} - \text{2L Standard}}{\dfrac{\text{standard deviation}}{\sqrt{\text{sample size}}}}$$

Data and calculations for the computed *t*-statistic are included in Appendix C. Historical data from as early as 1996 to October 2008 were used.

The tabulated *t*-statistic is derived from a standard *t*-distribution table and is based on the sample size and a pre-determined sensitivity value (α) for a Type I error. DENR, in 15A NCAC 13B.1632(h)(2), established α as 0.01. For each constituent, if the tabulated *t*-statistic exceeds the computed *t*-statistic, then the null hypothesis is accepted, and the historical mean concentration is considered less than the applicable standard. If the computed *t*-statistic exceeds the tabulated *t*-statistic, then the null hypothesis is rejected, and the alternate hypothesis is accepted. That is, the historical mean concentration is considered greater than the applicable standard.

The statistical analysis was performed on detected metals and VOCs. Such analysis was not performed on the remaining parameters (SVOCs, pesticides, PCBs, and Herbicides) because of the infrequency of historical data and the lack of exceedances during the October 2008 sampling event. For a given constituent, a dataset (or sample set) consisted of analytical results from all available laboratory analyses performed to date. Non-detects reported during the current sampling event were replaced with the method reporting limit (MRL) specified by the laboratory. The MDL was replaced by the MRL, because the MRL is the minimum concentration of a constituent in a sample that can be quantitatively determined by the referenced method with suitable precision and accuracy by the laboratory.

Statistical evaluation of a given constituent whose sample set contains a large number of non-detects was not conducted if the MRL exceeded the groundwater-quality standard. Altamont consulted with Dr. Arthur Lubin, an environmental statistician with the EPA, on January 9, 2004 concerning the use of

values reported as non-detects. Dr. Lubin stated that a valid statistical comparison is not possible when a sample set contains a majority of non-detect values and the detection limit (or value used to replace non-detects) is greater than the applicable groundwater standard. Dr. Lubin added that a qualitative analysis of the data is the only feasible option for this scenario.

2.4.1 Appendix II Metals

The results of the statistical analyses are included in Appendix C. Valid statistical analysis of thallium and vanadium datasets was not possible because of the large number of historical non-detects, which the MRLs exceeded the current GWPSs established for these metals. The SWSLs for both thallium and vanadium exceed the current designated water-quality standards applicable to these constituents.

Statistical analyses of all other detected metals indicated that the historical mean concentration of each metal did not exceed its respective 2L Standard or GWPS.

2.4.2 Appendix II VOCs

As shown in Appendix C, the statistical evaluation showed that the historical mean concentrations of two detected VOCs, benzene and 1,4-dichlorobenzene, were statistically greater than their respective 2L Standards in one or more of the monitoring wells.

The historical mean concentration of benzene in five of the monitoring wells (5002-MW-01, and 5002-MW-03 through 5002-MW-06) is statistically greater than the respective 2L groundwater standard of 1 µg/l. However, use of the *t*-test to evaluate concentrations of benzene in three of the monitoring wells, 5002-MW-02, 5002-MW-03, and 5002-MW-04, is not valid. Benzene has never been detected in 5002-MW-02. For monitoring wells 5002-MW-03 and 5002-MW-04, the sample sets contain a majority of historical non-detect values that exceed the current 2L Standard.

The historical mean concentration of 1,4-dichlorobenzene in each of the monitoring wells, with the exception of 5002-MW-02, is statistically greater than its respective 2L groundwater standard of 1.4 µg/l. Use of the *t*-test to evaluate concentrations of 1,4-dichlorobenzene in 5002-MW-02 is not valid, because the sample set contains a majority of historical non-detect values that exceed the current 2L Standard.

Statistical analysis of the other VOCs (tetrachloroethene and vinyl chloride) that showed exceedances of

their 2L standard or GWPS was not possible because of the large number of non-detects in the sample sets that showed MRLs above the applicable standards.

3.0 SUMMARY

The second semiannual groundwater monitoring event of 2008 was conducted from October 7 through 10, 2008 at the Jackson County closed MSWLF.

3.1 GROUNDWATER – MONITORING WELLS

3.1.1 Appendix II Metals

Four metals (barium, cadmium, cobalt, and zinc) were detected above SWSLs in the groundwater samples collected from one or more of the monitoring wells during the October 2008 water-quality monitoring event. Of these four metals, cadmium and cobalt were detected at concentrations exceeding their respective 2L Standards (see Table 3). The cadmium concentration detected in 5002-MW-05 (4.3 µg/l) exceeded its 2L Standard of 1.75 µg/l. Historically, cadmium has been detected intermittently at low levels in groundwater samples collected from monitoring wells at the closed MSWLF. The cadmium concentrations detected in the groundwater samples collected from 5002-MW-05 during the sampling events conducted in October 2007 and April 2008 also exceeded the 1.75 µg/l 2L Standard. Statistical analyses of historical concentrations of cadmium, however, indicate that the historical mean concentrations of cadmium in the groundwater collected from each of the monitoring wells are below the 2L Standard.

Cobalt was detected at a concentration (88.1 µg/l) above its GWPS (70 µg/l) in only one sample, the sample collected from monitoring well 5002-MW-03 (Table 3). Like cadmium, historically, cobalt has been detected intermittently at low levels in groundwater samples collected from monitoring wells at the closed MSWLF. Statistical analyses of historical concentrations of cobalt, however, indicate that the historical mean concentrations of cobalt in the groundwater collected from each of the monitoring wells are below its GWPS.

The 5.3 µg/l concentration of vanadium detected in the groundwater sample collected from 5002-MW-05 exceeds the GWPS of 3.5 µg/l, but it is below the metal's SWSL of 25 µg/l. Vanadium was also detected at a concentration of 2.5 µg/l in the sample collected from 5002-MW-06. The concentration detected in

the sample collected from 5002-MW-06 is below the metal's GWPS and SWSL. Historically, vanadium has been intermittently detected in monitoring well samples at the closed MSWLF. In April 2008, its detected concentration in 5002-MW-5 exceeded the GWPS. A statistical analysis was not performed on vanadium, because of the high number of non-detects where the MRL/SWSL was greater than the GWPS.

All of the groundwater samples were collected using low-flow sampling techniques, except for the sample from 5002-MW-05. The sample from this well was collected with a disposable bailer. The well is bent and the down-hole pump used for the low-flow sampling cannot be lowered to the appropriate depth. Great care was taken during the bailing of 5002-MW-5 and the turbidity value associated with the sample [4.06 nephelometric turbidity units (NTUs)] is relatively low for a bailed well. The range of turbidity values for the groundwater samples collected during the October 2008 sampling event ranged from 0.42 NTUs to 24.2 NTUs. Again, these are reasonably low values and therefore it does not appear that the metal results reflect the influence of elevated turbidity.

3.1.2 Appendix II VOCs

Of the eight VOCs (1,1-dichloroethane, 1,3-dichlorobenzene, 1,4-dichlorobenzene, benzene, chlorobenzene, cis-1,2-dichloroethene, methylene chloride, and trichloroethene) detected above SWSLs in groundwater samples collected from the monitoring wells at the site, only benzene, vinyl chloride, and 1,4-dichlorobenzene were detected at concentrations in excess of their respective 2L Standards. Concentrations of benzene detected in five groundwater samples (5002-MW-01 at 5.5 µg/l; 5002-MW-03 at 1.3 µg/l; 5002-MW-04 at 1.5 µg/l; 5002-MW-05 at 1.2 µg/l; and 5002-MW-06 at 1.8 µg/l) exceeded the compound's 2L Standard of 1.0 µg/l. Statistical analysis, using the Student's *t*-test, revealed that the mean concentration of benzene is significantly greater than the 2L Standard in monitoring wells 5002-MW-01, 5002-MW-05, and 5002-MW-06, which indicates that there may be contamination of groundwater by benzene in the vicinity of each of these wells. The datasets for 5002-MW-03 and 5002-MW-04 were not statistically evaluated as they each contained a majority of historical non-detects with associated MRLs that were greater than benzene's 2L Standard. The dataset for 5002-MW-02 was not evaluated because benzene has never been detected in this monitoring well.

A review of historical groundwater data since October 1996, indicates that the concentrations of benzene have fluctuated between 2.5 μg/L and 14 μg/L in 5002-MW-1. Detected benzene concentrations in 5002-MW-6 (installed in March 2004) have ranged from 1.8 μg/L to 6.4 μg/L. 5002-MW-1 and 5002-MW-6 are bedrock wells located in the northwest portion of the landfill. Assuming that the bedrock aquifer is unconfined at the landfill, recharge of groundwater to bedrock is presumably from the overlying saprolite aquifer. The Tuckaseegee River, located adjacent to the landfill to the southwest, represents a major drainage for this area. It is likely that groundwater in the bedrock aquifer discharges to the river. Benzene is a volatile compound that may attenuate. Therefore, it is probable that the concentration of benzene is significantly reduced at the discharge zone into the stream. Groundwater collected from the downgradient bedrock well, 5002-MW-2, did not contain concentrations of VOCs above the laboratory reporting limit, and VOCs were not detected in the surface-water samples.

The other Appendix II VOC that was detected at concentrations above its SWSL and 2L Standard was 1,4-dichlorobenzene. Exceedances for this compound were identified in each of the monitoring wells, except for 5002-MW-02. The concentrations that exceeded the 2L standard ranged from 2.1 through 16.2 μg/l. Historically, this compound has been detected at concentrations comparable to those described here; although the results for the compound from the April 2008 sampling event were relatively low. The statistical analysis indicates that the historical mean concentrations of 1,4-dichlorobenzene are significantly greater than the 2L Standard in all of the monitoring wells, except for 5002-MW-02. The dataset for 5002-MW-02 was not statistically evaluated, as it contained a majority of historical non-detects with associated MRLs that were greater than 1,4-dichlorobenzene's 2L Standard.

The boiling point of 1,4-dichloroebenzene is 174 degrees Celsius and therefore is on the heavy end of a VOC analysis and the light end of a SVOC analysis. Because 1,4-dichlorobenzene has both volatile and semi-volatile characteristics, it was included in both the VOCs (EPA Method 8260) and SVOCs (EPA Method 8270) analyses. The results described above are from the VOC analysis. The results from the SVOC analysis were not entirely consistent with the ones from the VOC analyses (as shown on Table 1). Commonly the values were lower for the SVOC analysis, which also consistently showed higher MDLs and MRLs. Altamont reviewed these results with Pace Laboratories. The lab personnel explained that the VOC 1,4-dichlorobenzene results encompasses the volatile characteristics of the compound, whereas the SVOCs analysis takes into account the compound's semi-volatile aspects. The values are generally

higher for the VOC analysis because the compound is predominantly volatile. Therefore, for the purpose of data evaluation, VOC results are given more weight (are considered to better reflect groundwater quality) than the SVOC results.

Two additional VOCs, tetrachloroethene and vinyl chloride, were detected in one or more of the groundwater samples collected from monitoring wells and the detected concentrations exceed the water quality standards. Tetrachloroethene was detected in one monitoring well sample 5002-MW-01 at a concentration (0.7 µg/l) that equaled its 2L Standard. Vinyl chloride was detected in two monitoring wells (5002-MW-04 at 0.97 µg/l and 5002-MW-05 at 0.78 µg/l) at concentrations above its 2L Standard of 0.015 µg/l. All three of these exceedances were below the applicable SWSLs. Statistical analyses of the tetrachloroethene and vinyl chloride datasets were not applicable because of the historical lack of detections of the compounds in groundwater samples.

3.1.3 Remaining Appendix II Analyses for Monitoring Well Samples and VOCs for Domestic Water Well Samples

No Appendix II SVOCs, pesticides, PCBs, or herbicides were detected in any of the monitoring well samples at concentrations exceeding their associated 2L Standards or GWPS.

Similarly, no VOCs, analyzed using EPA Method 524.2, were detected in either of the domestic well groundwater samples at concentrations exceeding their associated 2L Standards or SWSLs.

3.2 SURFACE WATER

3.2.1 Appendix II Metals, Sulfide, and Cyanide

No metals, sulfide, or cyanide were detected above applicable SWSLs or 2B Standards in either of the surface water samples collected from the Tuckasegee River.

3.2.2 Appendix II VOCs, SVOCs, Pesticides, PCBs, and Herbicides

No VOCs, SVOCs, pesticides, PCBs, or herbicides were detected at concentrations above their applicable SWSLs or 2B Standards in surface water samples collected either upstream or downstream of the landfill.

Altamont will continue to monitor groundwater quality at the Jackson County closed MSWLF on a semiannual basis. The next sampling event is scheduled for April 2009 and will include laboratory analyses for Appendix I Metals and VOCs. The second 2009 sampling event, scheduled for October 2009, will consist of analysis for Appendix II Metals and VOCs.