8.4.3 Groundwater Quality

As part of the groundwater investigation, historical analytical data provided by WMTX were reviewed. In 30 TAC §330.56(e)(4), the TCEQ requests information concerning the existence of any groundwater contamination plume resulting from a permitted landfill. As evidenced by historical water-quality analyses results of samples collected from the groundwater monitoring well network from December 23, 1991 to present, there is no groundwater contamination plume present within the uppermost aquifer at the Site. Minor fluctuations in water-quality data have occurred over the years; however, no significant changes or trends of increased concentrations have been observed. Groundwater monitoring is presently conducted on a semi-annual basis.

8.4.4 Recharge/Discharge

The conceptual groundwater system in the vicinity of the Site consists of a low hydraulic conductivity surficial aquitard (surficial clay) with confined, discontinuous coarse-grained material beneath the expansion area, which overlies the uppermost bedrock unit (claystone). The claystone is underlain by a thick bedrock unit (limestone). The surficial clay unit consists primarily of fine-grained clays. The claystone and limestone bedrock deposits are generally low hydraulic conductivity units, and lack continuous coarser deposits.

As water from precipitation falls on the ground surface, infiltration enters the groundwater system and percolates slowly downward through the surficial clay or open bodies of water that might be deep enough to be connected to the surficial clay and/or coarse-grained units within the surficial clay deposits. The slow percolation of water through the fine-grained deposits generally results in the groundwater surface mimicking the surface topography.

The surface recharge characteristics of the Site and adjacent areas can be evaluated in part through soil survey information (USDA SCS, 1983). Approximately one-half of the ~~landfill~~Site property is overlain by Branyon Clay soils. These soils are thick, expansive, high clay soils that develop cracks ~~2~~ two to ~~5~~ five feet deep when dry. Infiltration is rapid when these cracks are present; however, the cracks close as the soil becomes wet and infiltration rates become very slow. The remainder of the Site is mantled by Krum Silty Clay, Houston Black Clay and Altoga Silty Clay Loam. The general area of the Site is dominated by the Branyon and Houston Black Clay Soils. The Houston Black Clay Soils have similar infiltration characteristics to the Branyon Soils. Krum Soils occur in generally narrow bands on surface drainage divides and Altoga Soils occur on parallel

steeper slopes. Krum and Altoga soils are less expansive than the Branyon and Houston Black soils, and are not subject to excessive cracking when dry. (CJI and MFG, 1995)

Recharge to the calcareous claystone unit likely occurs as infiltration during periods of high precipitation/low evapotranspiration, and possibly from seepage of intermittent streams (such as Mustang Creek) or ponds. Water movement within the claystone unit is highly variable and controlled primarily by the density and orientation of fractures, and is dependent to some degree on recharge conditions (MFG and CJI, 1995). The relatively small fluctuations associated with recharge/discharge of the claystone unit and the low effective porosity make this unit susceptible to large seasonal changes in water levels. During dry periods with little or no recharge, water levels can be expected to decline slowly as water leakage occurs at very slow rates, downward and laterally (see Section 8.4.7.2). In times of high infiltration, water levels may rise to levels where fracture density is potentially greater and the lateral flow component relatively larger, although still quite small. At such times, discharge could occur as base flow to Mustang Creek, in the south part of the permitted Site, and to the unnamed tributary, within the northern permitted ~~landfill~~Site, and by evapotranspiration.

In summary, water recharge occurs locally by vertical infiltration of precipitation and possibly seepage from surface drainage features during high flow events. Water conditions are quite variable across the Site and water levels are subject to fluctuations in response to both short-term and long-term climatic conditions. Horizontal water movement is slow and the predominant discharge mechanism is evapotranspiration. Surface drainage features can be seen on the 2002 aerial photograph included as Figure III-4-3.

8.4.5 Groundwater Level Fluctuation

Groundwater data have been collected from 1988 to the present at the Site. Over this time period, water levels from the surficial clay/upper claystone ranged from 716 to 655 feet ~~MSL~~msl, and the lower claystone/upper limestone ranged from 716 to 611 feet ~~MSL~~msl. The most noted fluctuation in water levels at the Site for any one well over this time period was approximately 39.6 feet for top of limestone in A-3D. However, the first data point is the lowest elevation by about 15 feet and has typically been approximately 30 feet higher since 1992. Fluctuations could be due to a number of reasons: 1) periodic removal of water from the wells at the Site (i.e., dewatering excavations or lowering, baildown tests); 2) excavation at the Site; or 3) normal seasonal variations within the unit. In general, water levels are at the lowest points in late summer and early fall (excluding "wet" years) about ~~1~~one to ~~3~~three months after the lowest amount of precipitation. Historical data are presented in Tables III-4.10 and III-4.11, for the surficial clay/upper claystone and lower claystone/upper limestone units, respectively.

8.4.6 Hydraulic Conductivity

Field derived hydraulic conductivity (permeability) results were obtained by in-situ hydraulic conductivity tests that were performed on July 21 to 26, 2004. The tests were attempted on all ~~twenty-two newly installed~~22 piezometers located in the expansion area; however, only ~~eighteen~~ 18 tests were completed since four piezometers were "f\dry" at the time of testing. Piezometers were tested using the variable head test methods by either the traditional "manual slug" method or "baildown" method. Test methods are described in Section 8.3.3.3. Results are presented in Table III-4.12 and Appendix III-4H.

8.4.6.1 Slug Tests

In-situ hydraulic conductivity tests were performed to determine the horizontal hydraulic conductivity of the formation materials in the vicinity of each piezometer screened interval. The primary stratigraphy in the tested piezometers consisted mainly of sands and gravels within the surficial clay unit, clays in the surficial clay unit, and claystone and limestone in the bedrock units. The hydraulic conductivities ranged from 5.4×10^{-4} to 6.9×10^{-2} cm/sec for coarse-grained deposits in the surficial clay, 7.0×10^{-8} to 7.3×10^{-6} cm/sec for the fine-grained deposits in the surficial clay/upper claystone units, and from 6.8×10^{-8} to 5.7×10^{-7} cm/sec for the lower claystone/upper limestone unit.

Previous in-situ hydraulic conductivity tests ranged from 4.9×10^{-7} to 9.6×10^{-6} cm/sec for surficial clay and/or upper claystone unit and from 5.1×10^{-8} to 9.4×10^{-5} cm/sec for the lower claystone and/or upper limestone unit. Representative values from literature (Freeze and Cherry, 1979) of hydraulic conductivities for sands and silty sands are 1 to 10^{-5} cm/sec, and silts and clays are 10^{-3} to 10^{-10} cm/sec. Representative values from literature (Freeze and Cherry, 1979) of hydraulic conductivities for limestones are 10^{-4} to 10^{-8} cm/sec, and shales (closest representative unit to claystone) are 10^{-7} to 10^{-11} cm/sec.

The calculated hydraulic conductivity values for the corresponding lithologies are within the literature range of values for piezometers. The calculated hydraulic conductivity values for the corresponding lithologies are representative of the hydrostratigraphic units beneath the Site. Test results are presented in Table III-4.12 and Appendix III-4H.

8.4.6.2 Laboratory Permeability

Samples were collected to determine the vertical and horizontal permeability of the in-situ materials below the Site. A total of ~~eighteen~~ 18 laboratory permeability tests (~~7~~ seven vertical, ~~7~~ seven horizontal, and ~~4~~ four rock)

were conducted. Six samples from the fine-grained surficial clay, nine samples from the claystone, and three samples from the limestone were tested. Vertical, horizontal, and rock laboratory permeabilities ranged from 7.1×10^{-11} cm/sec to 5.7×10^{-8} cm/sec and presented in Tables III-4.7 through III-4.9.

The horizontal and vertical laboratory permeability tests were generally the same order of magnitude. Horizontal laboratory samples ranged from 1.1×10^{-10} to 5.7×10^{-8} cm/sec with a geometric mean of 7.2×10^{-9} cm/sec. Vertical laboratory samples ranged from 7.1×10^{-11} to 1.8×10^{-8} cm/sec with a geometric mean of 2.2×10^{-9} cm/sec.

8.4.7 Hydraulic Head Relationships

As part of the site characterization activities, both horizontal and vertical hydraulic gradients were calculated, so as to better comprehend groundwater flow characteristics at the Site. Horizontal hydraulic gradients are presented in Table III-4.13 and vertical hydraulic gradients are presented in Table III-4.14.

8.4.7.1 Horizontal Hydraulic Gradient

Horizontal hydraulic gradients were calculated for the surficial clay/upper claystone and lower claystone/upper limestone groundwater flow system utilizing groundwater elevation data collected on March 16, 1992 and August 31, 2004. A summary of the calculated horizontal gradients is presented in Table III-4.13. The horizontal hydraulic gradient for the surficial clay/upper claystone, calculated from Figures III-4.24 and III-4.26, is approximately 0.017 ft/ft.

Horizontal hydraulic gradients were calculated for the lower claystone/upper limestone groundwater flow system utilizing groundwater elevation data collected on March 16, 1992 and August 31, 2004. The horizontal hydraulic gradient for the lower claystone/upper limestone, calculated from Figures III-4.25 and III-4.27, is approximately 0.014 ft/ft.

8.4.7.2 Vertical Hydraulic Gradient

Vertical hydraulic gradients were calculated using water-level data collected on August 31, 2004. A summary of the calculated vertical gradients is presented in Table III-4.14. Vertical hydraulic gradients were compared between the surficial clay and or surficial clay/upper claystone and the lower claystone/upper limestone. The vertical gradients between these units range from approximately 0.76 upward to 0.72 ft/ft downward, with an average vertical hydraulic gradient of 0.05 ft/ft downward.

8.4.8 Average Linear Flow Velocity

The average linear flow velocity of horizontal groundwater flow in surficial clay/upper claystone (shallow) was calculated to be approximately 3.6×10^{-3} feet/day (1.3 feet/year). The claystone/limestone (deep) was calculated to be approximately 9.3×10^{-4} feet/day (0.3 feet/year). Calculations and assumptions are presented in Table III-4.15. The flow is calculated based on a modification of Darcy's Law:

$$V = \frac{KI_h}{n_e}$$

Where: V = average linear velocity
K = horizontal hydraulic conductivity
I_h = horizontal hydraulic gradient
n_e = effective porosity

Surficial Clay/Upper Claystone (Shallow)

A horizontal hydraulic gradient (I_h) of approximately 0.017 ft/ft was used. The effective porosity (n_e) was estimated based on a literature value of 0.4 for clay material. Based on the in-situ hydraulic conductivity test data presented in Table III-4.12 and Appendix III-4H and previous reports, a geometric mean horizontal hydraulic conductivity (K) of 3.0×10^{-5} cm/sec (8.5×10^{-2} feet/day) was estimated from the recent and previously completed in-situ hydraulic conductivity tests. The groundwater velocity calculated for the Site is typical of groundwater velocities encountered for these types of materials.

Claystone/Limestone (Deep)

A horizontal hydraulic gradient (I_h) of approximately 0.014 ft/ft was used. The effective porosity (n_e) was estimated based on a literature value of 0.015 for the limestone material. Based on the in-situ hydraulic conductivity test data presented in Table III-4.12 and Appendix III-4H, a geometric mean horizontal hydraulic conductivity (K) of 3.7×10^{-7} cm/sec (1.0×10^{-3} feet/day) was estimated from the recent and previously completed in-situ hydraulic conductivity tests. The groundwater velocity calculated for the Site is typical of groundwater velocities encountered for these types of materials.

8.4.9 Potential Migration Pathways

In accordance with 30 TAC §330.56(d)(5)(C)(iv), the most likely pathways for pollutant migration in the event that the primary barrier liner system is penetrated requires an analysis of the hydrogeological framework of the Site.

The surficial clay and claystone are the only units that are in direct contact with the landfill footprint. The majority of the Site is fine-grained, low yield, unconsolidated materials and low yield, consolidated materials as shown and presented by the geotechnical permeability and field permeability data. Permeabilities typically ranged from 10^{-6} to 10^{-8} cm/sec for the field horizontal permeabilities and 10^{-8} to 10^{-11} cm/sec for geotechnical laboratory permeabilities (horizontal and vertical). Also, with the majority of the proposed base grades terminating in the claystone, approximately 10 to 15 feet above the top of limestone, if pollutants were to penetrate the primary barrier liner system, the fine-grained, low yield, unconsolidated materials and low yield, consolidated materials would inhibit distribution of pollutants. In addition, if groundwater flow were affected by the construction of the landfill, the groundwater flow in the vicinity of the expansion would be detected by the monitoring wells, which encompass the entire perimeter of the expansion acreage.

A minority of the Site contains coarser grained materials that potentially will conduct flow if the primary barrier liner system is penetrated. The proposed base grades are to be terminated below this coarser material; however, some of the side slopes of the waste management units (WMUs) will come in contact with this coarser grained materials. The coarse-grained units are located on the eastern portion of the expansion area; located in the northeast corner in the vicinity of E23S and in the southeastern/eastern portion to include the area surrounding borings E-32 and E-35. The full extent of the coarser grained materials to the east and northeast of the expansion area is unknown. These deposits may be discontinuous; however, the field horizontal conductivities calculated a geometric mean of 5.4×10^{-3} cm/sec.

Based on the site-specific geotechnical and hydrogeological data, the fine-grained material is a barrier to potential vertical contaminant migration pathways in the majority of the Site. Only a minority of the Site, located on the eastern edge of the expansion area, contains coarser grained materials that may be laterally discontinuous, but have the potential for migration.

9.0 GROUNDWATER MONITORING SYSTEM ~~§330.401 - .42156(e)(5) AND §330.231~~

9.1 Proposed Groundwater Monitoring Program ~~§330.401 - .421231~~

In accordance with 30 TAC §330.401 - .421~~56(e)(5)~~, this section presents the detailed plans and engineering report describing the ~~proposed~~ groundwater monitoring program to be implemented to meet the requirements of 30 TAC §330.403~~231~~ relating to Groundwater Monitoring Systems.

An enhanced groundwater monitoring well network ~~is~~ was proposed in accordance with 30 TAC §330.403~~231~~. The enhancements proposed for the ~~Williamson County RDF's~~Site's groundwater monitoring system included the installation of monitoring wells screened in the lower claystone/upper limestone unit and monitoring wells screened in the surficial clay (coarse-grained zones). The ~~proposed~~ monitoring well network was~~is~~ designed to be protective of State waters and human health and the environment in the unlikely event that a release occurs under the TCEQ's currently approved groundwater monitoring program. The ~~proposed~~ groundwater monitoring network has been developed based on the present knowledge of groundwater flow at the Site. It is anticipated that as cell construction progresses from west to east, the~~at~~ groundwater flow may be impeded in an easterly direction; however, monitoring wells ~~have been~~were included ~~proposed~~ to encompass the entire perimeter of the expansion acreage and would detect any releases from WMUs that may occur.

The final ~~proposed~~ approved groundwater monitoring network ~~will~~ consists of 36~~5~~ monitoring wells located along all perimeters of the combined present and proposed landfill footprints. Twenty-six~~five~~ of the present and ~~proposed~~ to-be-installed monitoring wells are/will be installed in the lower claystone/upper limestone unit and 10 ~~proposed~~ monitoring wells will be installed in the shallow, coarse-grained material of the surficial clay unit that is found along the eastern portion of the proposed eastern expansion property. Three wells (MW-09A, MW-11, and MW-12) in the TCEQ-approved monitoring well network are installed in the lower claystone/upper limestone unit and are the only upgradient monitoring wells in the ~~proposed~~ final approved monitoring well network due to groundwater flow. However, when the permit modification~~amendment~~ is approved, MW-09A will be decommissioned and only two wells (MW-11 and MW-12) will remain as upgradient monitoring locations. The remaining lower claystone/upper limestone unit wells and the shallow,

surficial clay unit wells are all considered downgradient to groundwater flow and landfill operations, as noted on Figure III-4.28. The ~~proposed~~ monitoring wells will be installed ~~on a phased schedule as described in when the permit amendment is approved, to collect intrawell background data (see Section 6.0 of~~ Attachment 5 of this permit application).

Eight monitoring wells (MW-06 through MW-08, MW-09A, and MW10 through MW-13) are currently utilized to satisfy the monitoring requirements for the ~~Williamson County RDF~~Site, a Type I MSW facility. These wells are all screened in the lower claystone/upper limestone unit.

See Attachment 5 for a description of the groundwater monitoring system.

~~The expansion of the groundwater monitoring network will include the installation of three lower claystone/ upper limestone unit monitoring wells (MW-14 through MW-16) along the northern perimeter of the currently permitted landfill, on the basis of flow directions indicated in June 1991 and April 1993 from former piezometers located in the northern permitted area (MFG, 1995). Present monitoring well, MW-13 will be decommissioned as cell construction begins to the north of present operations. In addition, four proposed monitoring wells (MW-17 through MW-20) will be installed along the northern perimeter of the proposed eastern expansion acreage.~~

~~The expansion of the groundwater monitoring network on the eastern expansion area will include the installation of 14 monitoring wells (MW-21 through MW-27) along the eastern perimeter. Seven monitoring wells will be screened in the lower claystone/upper limestone unit and seven monitoring wells (MW-21 through MW-27, with S suffixes) are proposed to monitor the shallow surficial clay unit.~~

~~The expansion of the groundwater monitoring network on the eastern expansion area will include the installation of nine monitoring wells (MW-28 through MW-33) along the southern perimeter. Six monitoring wells will be screened in the lower claystone/upper limestone unit and three monitoring wells (MW-28 through MW-30, with S suffixes) are proposed to monitor the shallow surficial clay unit.~~

~~The proposed S-series wells have been located only where coarse-grained material of 0.5 feet or greater is anticipated, based on borings advanced during the 2004 site investigation. Coarse-grained materials will be classified in the field by a qualified groundwater scientist. Soil will be considered coarse grained if the soils are field classified as a SM, SP, SC, GM, GP, or GC according to the USCS.~~

~~In addition, present monitoring wells, MW-09A, MW-10, and MW-13 will be decommissioned when the permit amendment is approved. Only two wells (MW-11 and MW-12) will remain as upgradient monitoring~~

~~locations for the FacilitySite. The POC will be located along the northern property perimeter; the southern perimeter boundary on the eastern expansion property; to the north of Mustang Creek on the southern portion of the permitted landfill; and along the eastern permitted boundary.~~

Figure III-4.28 depicts the permitted landfill limits of waste, the proposed waste limits of the expansion area, the POC, and the to-be-installed groundwater monitoring system.~~locations of the eight monitoring wells in the present TCEQ-approved network, and the locations of the 31 additionally proposed monitoring wells.~~ Table III-4.16 summarizes the ~~proposed~~ monitoring well network including well designation, estimated or actual well depth, well status (new or existing groundwater monitoring well), estimated or actual location, estimated or actual screen interval, and type of monitoring point (upgradient, downgradient, and/or POC).

As defined under 30 TAC §330.200(d), the POC line has been established at locations that parallel the surface projection of a vertical plane that intersects the uppermost water-bearing zone at the most immediate downgradient location from the WMUs. The ~~proposed~~ locations and number of POC wells have been selected based on several critical hydrogeologic and design parameters. These parameters are discussed in detail below.

The positions of the ~~proposed~~ POC and the monitoring wells were selected based on:

- Stratigraphic position;
- Groundwater potentiometric maps;
- Horizontal position relative to existing monitoring wells;
- Local hydraulic gradient and hydraulic conductivity; and,
- Future design considerations.

Stratigraphic Position: Vertical locations of the ~~proposed~~ monitoring wells are based on site stratigraphy and hydrogeology. The depths of the ~~proposed~~ wells and the screened intervals have been selected based on isopach and structure maps generated from data collected during the 2004 site investigation (Figures III-4.19 through III-4.23). The ~~proposed~~ monitoring wells are located vertically in the surficial clay unit (coarse-grained materials) and the lower claystone/upper limestone, based upon the geometry of the expansion area and recent and historical potentiometric surfaces in the surficial clay/upper claystone and lower claystone/upper limestone units, shown in Figures III-4.24 through III-4.27. The POC wells have been designed to be strategically positioned both spatially and vertically so as to monitor groundwater passing beneath the POC in the uppermost water-bearing zone. The ~~proposed~~ surficial clay/upper claystone monitoring wells (MW-21S through MW-30S) will be installed to a depth that encounters the entire thickness of the coarser grained materials of the surficial clay unit, which ranges in thickness from ~~1.0~~one to 20 feet on the eastern expansion

property. Based on Figures III-4.20 and III-4.21, completion elevations of the shallow wells will range between 675 to 642 feet ~~MSL~~msl. The ~~proposed~~ lower claystone/upper limestone monitoring wells (MW-14 through MW-33) will be installed to a depth that encounters the contact between the Lower Taylor Marl and the underlying Austin Chalk. Based on Figure III-4.23, completion elevations of the wells will range between 678 to 619 feet ~~MSL~~msl. The ~~proposed~~ to-be-installed monitoring wells will be screened to monitor groundwater emanating from the base of the landfill from upgradient to passing the downgradient POC. All existing and new wells are/will be constructed in accordance with TCEQ 30 TAC §330.242. Groundwater monitoring well installation will be performed under the guidance of a qualified groundwater scientist.

Groundwater Potentiometric Maps: The use of groundwater potentiometric maps was fundamental in the strategic placement of the ~~proposed~~ POC and detection monitoring wells. The monitoring well locations were based on the spatial distribution of the resultant equipotential lines on the groundwater contour maps. The monitoring wells are located horizontally in the lower claystone/upper limestone and in the surficial clay unit (coarse-grained materials) based upon the geometry of the expansion area and recent and historical potentiometric surfaces in the surficial clay/upper claystone and lower claystone/ upper limestone, shown in Figures III-4.24 through III-4.27.

Horizontal Position: Spatial distribution of the upgradient (background) and downgradient/POC wells is straightforward based on the hydrogeometry of the Site and particle flow-paths observed. See Attachment 5 for a discussion of well spacing. ~~Well spacing of the proposed lower claystone/upper limestone wells ranges from 489 to 655 feet, with an average spacing of 595 feet, which is similar to the current well spacing of the present monitoring system, ranging between 490 to 695 feet, with an average spacing of 563 feet. The well spacing for the surficial clay/upper claystone has been proposed to be the same as the lower claystone/upper limestone unit; however, additional groundwater characterization of this unit is required. Thirteen piezometers, screened within this unit, are presently located on the eastern expansion property and will have water levels recorded periodically for seasonal fluctuations and determination of whether this zone will retain groundwater throughout time.~~ The ~~proposed~~ to-be-installed monitoring wells, in conjunction with the existing monitoring network wells, are believed to be designed to adequately detect a breakthrough of constituents of concern (COCs).

Local Hydraulic Gradient and Hydraulic Conductivity: Based on the geotechnical results (Section 7.0), the clay liner will maintain a minimum permeability (hydraulic conductivity) of 1.0×10^{-7} cm/sec. The claystone and fine-grained clay, and to a lesser extent, the coarse-grained material are adjacent to a portion of the sidewalls and base of the proposed landfill expansion. The permeability of fine-grained soils and the claystone

typically ranged from 10^{-6} to 10^{-8} cm/sec for the field horizontal permeabilities and 10^{-8} to 10^{-11} cm/sec for geotechnical laboratory permeabilities (horizontal and vertical). The permeability of coarse-grained soils is on the order of 10^{-3} cm/sec (based on the geometric mean of the "slug" tests). Average horizontal hydraulic gradients ranged from approximately 0.01 to 0.02 ft/ft towards the northeast and southeast portions of the expansion area (calculated from potentiometric maps). There is also a component of vertical gradient between the surficial clay/upper claystone and lower claystone/upper limestone that has an average vertical hydraulic gradient of 0.05 ft/ft downward (assuming static conditions have been obtained).

Monitoring of the shallow surficial clay/upper claystone unit was not recommended by CJI and MFG in the Soils Investigation Report for Williamson County Landfill Permit Amendment Application No. 1405-A, completed in February 1995. The decision not to monitor the surficial clay/upper claystone unit was based on the stratigraphic data collected during their investigations and previous investigations that showed the coarse-grained deposits to be isolated occurrences on the permitted landfill. In addition, the report stated that any ephemeral water-bearing zones that developed in the clay unit after high rainfall periods would probably dissipate by evapotranspiration and to a lesser extent by slow seepage into the unfractured claystone adjacent to fractures. However, based on the widespread extent of the coarse-grained deposits along the eastern portion of the expansion area (Figure III-4.20), field horizontal permeabilities of 10^{-3}, and potential contact with the proposed side walls of the landfill, it is recommended that the surficial clay/upper claystone unit be monitored where coarse-grained deposits are encountered, as stated above.

Future Design Considerations: See Attachment 5. ~~Background and POC/downgradient monitoring well locations were selected based on the above criteria in addition to proposed and possible future design modifications. A total of 33 monitoring wells are proposed as POC wells to include: current wells (MW-06 through MW-08) and proposed wells (MW-14 through MW-33, and MW21S through MW-30S). If the landfill perimeter or cells are repositioned or modified, the POC well placements, specifically those affected by the design modifications, may also be adjusted.~~

~~Proposed new monitoring wells will be constructed once the permit amendment is approved. Piezometers E-3S, E-3D, E-4S, E-4D, E-5S, E-5D, E-6S, E-6D, E-7S, E-7D, E-23S, E-24S, and E-36S, located in the footprint of the expansion acreage, will be abandoned during the phased construction of the landfill. In addition, monitoring wells MW-09A, MW-10, and MW-13 should be abandoned once the new monitoring wells have been installed along the proposed permitted landfill boundary. Piezometers E-1D, E-1S, E-2S, E-8D, E-8S, E-9D, and E-9S will continue to be used for piezometric purposes.~~

~~The monitoring well network described above should be more than adequate to provide early indications of releases to groundwater from the landfill. As discussed elsewhere in this report, lateral groundwater flow in the claystone unit is probably quite small and very slow and groundwater flow within the gravel and sand lenses, within the lower portion of the surficial clay unit, are limited in lateral extent and potentially effected by variable climatic conditions. In addition, the net lateral flux of groundwater may actually be inward toward the landfill during active operations and possibly for some time afterwards, until such time as the effects of eliminating recharge within the landfill footprint are balanced and a new hydraulic equilibrium has developed. Periodic water-level monitoring and evaluation of flow directions will aid in documenting such changes, and making timely adjustments in the monitoring well network, if necessary.~~

9.2 Monitoring Well Construction ~~§330.421242~~

The proposed enhancement to the present groundwater monitoring network will meet all of the requirements of 30 TAC §330.421~~242~~, related to monitoring well drilling and completion specifications. Each monitoring well location will be drilled by a Texas-licensed driller and supervised by a qualified geologist or engineer. During drilling of the monitoring well, a log of the boring shall be made by a qualified geologist or engineer who is familiar with the geology of the area.

Each well will be installed using HSA or a combination of HSA/rock coring drilling methods and sampled using either a five~~5~~-foot CME sampler or a ~~5~~five-foot NQ rock core sampler, or equivalent sampling equipment, until the desired depth is achieved. The monitoring wells that will be installed in the base of claystone/top of limestone unit should be advanced through the unconsolidated material using a six~~6~~-inch or ~~8~~eight-inch diameter HSA. When consolidated material is encountered, sampling should be conducted using a rock core barrel. Water will be required during the rock coring procedures and can be obtained from the on-site water tank supplied by city water from JWSC.

When groundwater is encountered, drilling will be stopped and water-level measurements will be recorded on drilling logs. Drilling will then resume and the borings will be augured to the desired depth. All monitoring wells in the surficial clay/upper claystone unit will be installed directly into ~~6.0~~six- or ~~8.0~~eight-inch diameter boreholes once the augers are removed. All monitoring wells in the base of claystone/top of limestone unit will be installed into ~~6~~six ~~4.0 or 5.0~~ inch diameter boreholes.

Each monitoring well will be constructed with ~~2~~two-inch I.D., flush-threaded, Schedule 40 PVC screen and casing. The 0.010-inch machined slotted screen will generally be 10 feet in length for the coarse-grained

deposits in the surficial clay unit and 15 feet in length for the lower claystone/upper limestone unit. The filter pack will be constructed of 12/20 silica sand and installed from the bottom of the borehole to approximately two feet above the PVC screen. The remaining annular space will be sealed using bentonite chips. The bentonite chips will be placed on top of the filter pack to approximately two feet bgs and hydrated with water.

The surface completion for each monitoring well will consist of a four4-foot by 4four-foot square by 6six-inch thick concrete pad, reinforced with rebar; and protected by either a 4- or 6six-inch diameter steelanodized aluminum protective cover with lock (approximately 3.5 feet above the concrete pad). The surface completion will also include four steel guard posts (one at each corner of the concrete pad, filled with concrete, and painted yellow); and pea gravel will be placed in between the PVC well and protective casing. A 3/8-inch diameter weep hole will be drilled through the protective casing (approximately 2two inches above the top of the concrete pad) to prevent moisture buildup inside the protective casing. A brass marker will also be placed on the concrete pad and will be used for the surveyed vertical elevation of the concrete pad at each well.

9.3 Background Monitoring §330.405233(dc)

See the In accordance with site-specific GWSAP (Part III, Attachment 11), for details regarding background monitoring at each new monitoring point will occur. A minimum of eight statistically independent groundwater samples from each new background well and new downgradient/POC well shall be collected to enable establishment of background concentrations. The new monitoring wells will be sampled and analyzed for background constituents listed in Table III-11.3 of the GWSAP. This background constituent list consists of all constituents listed in Table 1 of 30 TAC §330.241, as well as, additional constituents chosen by the Site.

In addition, upgradient monitoring wells, MW-11 through MW-13, are presently used for background testing and monitoring background water quality that has not been affected by leakage from any WMUs, pursuant to 30 TAC §330.231(a)(1). Monitoring wells (MW-11 and MW-12) are monitoring background groundwater flow approaching the Site from the west. MW-13 is presently defined as an upgradient monitoring point; but will most likely be redefined as a downgradient well once landfill operations develop to the north. The permitted landfill and the proposed eastern expansion are located over a groundwater divide, with groundwater flow documented as generally flowing from west to east with radial flow to the north and south. Based on groundwater data from August 31, 2004, MW09A, appears to be on a groundwater "high" and is also defined as an upgradient well in the TCEQ approved groundwater monitoring network. As future landfill development occurs, there will be no additional monitoring well locations on the Site that can be defined as upgradient of present or proposed WMUs, based on the present groundwater flow regime.

9.4 Detection Monitoring ~~§330.407234~~

As this Site is currently operating under a TCEQ-approved GWSAP, groundwater monitoring will continue to be operated in accordance with 30 TAC §330.401--.419~~234~~ and the proposed GWSAP located in Attachment 11 of this permit application. The procedures for acquiring samples from this system, the analysis of those samples, and the management of the water-quality data resulting from these analyses are presented in the modified GWSAP (Attachment 11 of this application). ~~The upgradient monitoring wells will continue to monitor background water quality that has not been affected by leakage from any WMUs, pursuant to 30 TAC §330.231(a)(1), and the present and proposed downgradient monitoring system will include a sufficient number of wells allowing for a determination of groundwater quality passing the POC, pursuant to 30 TAC § 330.231(a)(2).~~

~~The location of three proposed on-site ponds, defined as A, B, and C, are located between the proposed waste footprint and several proposed monitoring wells. These ponds are to be used only as temporary collection areas for storm water runoff and are designed to drain. The ponds are unlined and no greater than five feet in depth; not intended to retain water. These ponds will only contain water during a rainfall event and for a short time thereafter until the storm water has either drained as runoff, or has infiltrated into the ground. These ponds are not anticipated to retain water for long periods of time and based on the site specific geotechnical data will not be recharge zones to the underlying ground water system. Permeabilities of the soils surrounding the ponds are on the order of 10^{-8} to 10^{-10} cm/sec.~~

~~In addition, the depths of the top of screened intervals for the proposed monitoring wells in close proximity to these ponds are no shallower than 15 feet bgs. The average top of screened depth for proposed monitoring wells in the coarse-grained surficial clay, along the eastern perimeter, is 18.8 feet bgs. The average top of screened depth for the lower claystone/upper limestone monitoring wells is 41.3 feet bgs with the shallowest top of screened depth of 20 feet bgs, adjacent to Pond A. These ponds are not anticipated to serve as recharge points for ground water based on low soil permeabilities between the base of the proposed ponds and the top of the screened intervals. The effectiveness of the adjacent monitoring wells to accurately detect potential escape of leachate from the FacilitySite in the case of liner breach is not expected to be compromised.~~

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~~10.0~~11.0 STANDARD OF CARE

The conclusions and recommendations contained in this report are based upon professional opinions with regard to the subject matter. These opinions have been arrived at in accordance with currently accepted hydrogeologic and engineering standards and practices applicable to this location.

FOR PERMIT PURPOSES ONLY

WILLIAMSON COUNTY
RECYCLING & DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION NO. 1405B

GROUNDWATER CHARACTERIZATION REPORT

PART III, ATTACHMENT 5

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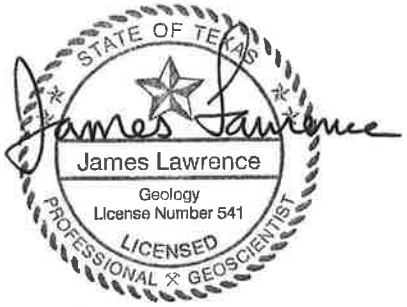

7-1-2011

GROUNDWATER CHARACTERIZATION REPORT
ATTACHMENT 5

As the supervising geologist, I have reviewed all of the documentation in this report and found it to be conducted in accordance with the regulations outlined in 30 TAC §330, Subchapter J.

James Lawrence

James Lawrence
Professional Geologist (TX #541)

Date: July 1, 2011

7-1-2011

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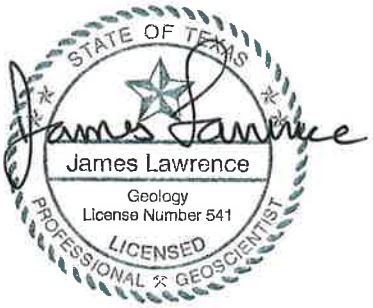
APPENDICES

Appendix A Groundwater Chemical Analyses



7-1-2011

1.0 RELEVANT GROUNDWATER MONITORING DATA ~~§330.56(e)(1)~~

In accordance with 30 Texas Administrative Code (TAC) Section (§) 330.~~56~~63(e)(~~1~~5)(E), this section presents a tabulation of relevant groundwater monitoring data from wells on site or on adjacent municipal solid waste landfill unit(s), if applicable.

Over the course of the operational history of the groundwater monitoring system, wells have been abandoned and new wells have been added to improve the monitoring network as the Williamson County Recycling & Disposal Facility (the "Site")~~landfill~~ expands operations. In 1983, three monitoring wells (MW-01 through MW-03) were installed on the ~~permitted landfill~~Site. In November 1991, Southwestern Laboratories installed four monitoring wells (MW-04 through MW-07). Three wells (MW-01 through MW-03) were plugged and abandoned by Rust Lichliter/Jameson in January 1996 and piezometer P-J was converted to MW-09. During this same field effort, Rust Lichliter/Jameson installed five monitoring wells (MW-08, and MW-10 through MW-13) in general accordance with the approved Permit Amendment No. 1405-A. Monitoring wells, MW-04 and MW-05, remain at the Site, but were removed from the detection monitoring network at this time. On October 7, 2003, MW-09 that was damaged, was plugged and abandoned and MW-09A was installed as a replacement well.

Historical water-level elevations and groundwater chemistry analyses results are available for the ~~Williamson County Recycling & Disposal Facility (RDF) (the "~~Site~~")~~ from the 13 past and present monitoring wells (see Figure III-5.1, for locations). Groundwater elevations are listed in Tables III-5.1 and III-5.2.

Table III-5.3 presents groundwater chemical analyses data for the most recent sampling event at the Site, conducted on July 15, 2004. A database of laboratory analytical data, for the groundwater chemical analyses performed at the Site, is displayed in Appendix A of this attachment.

Data required to assess all site-specific parameters for background and detection monitoring, as suggested by the Texas Commission ~~O~~on Environmental Quality (TCEQ) Municipal Solid Waste (MSW) division, is presented in Appendix A. A discussion regarding the background groundwater quality is located in Part III, Attachment 11 (Groundwater Sampling and Analysis Plan (GWSAP)), Section 4.0. The detection monitoring program is discussed in Part III, Attachment 11, Section 5.0.

The ~~most recent~~ groundwater data obtained during the second semi-annual monitoring period in 2004 are summarized in Table III-5.3 and Attachment A. The trace metals and indicator parameter data for

monitoring wells MW-06, MW-07, MW-08, MW-09A, and MW-10 were evaluated using the combined Shewhart-CUSUM (cumulative sum) control chart method. The data from the second semi-annual event sampled in 2004 were compared to the historical data at each well. The background includes groundwater data obtained from September 1996 through March 2001 for each of the wells, except for MW-09A, which began background monitoring in November 2003 and obtained the fourth round of data ~~during this event~~. The background range was tested for increasing trends using Sen's Test.

For the constituents statistically compared, there is a verified control limit exceedance for manganese at monitoring well MW-07. The manganese CUSUM value at MW-07 (143 µg/L) exceeds the normal control limit of 122 µg/L, while the actual manganese concentration determined at MW-07 (82.0 µg/L) is below the control limit. Control limit exceedances detected, but not yet verified in accordance with the statistical plan, are antimony, barium, nitrate, and total organic carbon (TOC) at MW-07. The antimony concentration determined at MW-07 (3.1 µg/L) exceeds the nonparametric prediction limit of 3.0 µg/L. Antimony has not been detected in the groundwater at MW-07 prior to this monitoring event. The barium concentration determined at MW-07 (29 µg/L) exceeds the normal control limit of 27.0 µg/L, but is consistent with concentrations determined at upgradient wells MW-11 (21 µg/L), MW-12 (100 µg/L), and MW-13 (74 µg/L). The nitrate concentration determined at MW07 (8.3 mg/L) exceeds the normal control of 0.59 mg/L. The TOC CUSUM value at MW-07 (3.6 mg/L) exceeds the normal control limit of 2.8 mg/L, while the actual TOC concentration determined at MW-07 (2.3 µg/L) is below the control limit. These exceedances are not statistically significant unless substantiated by subsequent monitoring events. The current monitoring data did not confirm a previous verified control limit exceedance for iron at monitoring well MW-07. A slight increasing trend was detected in the background data for TOC at MW07. This trend does not appear to be related to landfill operations.

There were no organic compounds detected in the groundwater during the second semi-annual monitoring event in 2004. Historically, there have been no verified detections of volatile organic compounds (VOCs) in the groundwater at ~~Williamson County RDF~~the Site.

2.0 SITE HYDROGEOLOGY §330.56(e)(2)

This section identifies the uppermost aquifer and any lower aquifers that are hydraulically connected to it beneath the ~~facility~~Site, including groundwater flow direction and rate, and the basis for such identification, as required by 30 TAC §330.56(e)(2).

2.1 Uppermost Aquifer

The uppermost water-bearing unit at the ~~Williamson County Landfill~~Site is the surficial clay/weathered, upper calcareous claystone and the lower claystone/upper limestone. Water was encountered, or saturated conditions have developed, in all of the piezometers and monitoring wells completed in this unit, with the exception of E-24S on the proposed expansion property. Groundwater occurrence within the unconsolidated sediments of the Site are found in the surficial clay deposits that are primarily comprised of clay and, to a lesser extent, sand and gravel deposits that occur in the lower portion of the unit, located primarily on the eastern and northern portions of the Site. Below the surficial clay, the calcareous claystone and limestone strata have very small primary effective porosities and hydraulic conductivities. The extent of saturation and the capability to transmit water within the claystone and limestone units are primarily dependent on the development of interconnected secondary features associated with fractures and weathering processes. For this reason, the occurrence of water and the water transmitting properties of the claystone are variable (MFG, 1995).

Based on the potentiometric surface maps for the surficial clay/upper claystone (Figure III-5.6) and the lower claystone/upper limestone (Figure III-5.7), the horizontal gradients are approximately 0.015 feet/foot (ft/ft) to the north and southeast for the surficial clay/upper claystone and 0.018 to 0.011 ft/ft to the north, southeast, and south for the lower claystone/upper limestone unit. A comparison of water measurements over time, in piezometers completed at different depths within the claystone, suggests that vertical gradient (downward and upward) are often evident during times of rapid water-level fluctuation, as a consequence of the usually more rapid water-level response in the shallower piezometers to changes in evapotranspiration rates or precipitation (MFG, 1995).

Water movement in the claystone unit is controlled by the density and orientation of fractures, but is also dependent on recharge conditions. Water recharge occurs locally by vertical infiltration of precipitation and possibly seepage from surface drainage features during high flow events. Water conditions are quite variable across the Site and water levels are subject to fluctuations in response to both short-term and long-term climatic conditions (MFG, 1995). Horizontal water movement is slow with discharge largely occurring through evapotranspiration. The primary hydraulic conductivity of the unfractured rock is on the order of 10^{-11} to 10^{-10} centimeters per second (cm/sec), which is indicative of minimal flow potential (on the order of 0.3 ft per year). Field hydraulic conductivity data give some indication of the range of increases in hydraulic conductivity, and consequently flow velocities, associated with varying degrees of fracture development and interconnection in rock that is otherwise relatively impermeable (MFG, 1995).

Groundwater velocities can be calculated for the uppermost water-bearing unit beneath the Site using the standard average linear velocity formula (Freeze and Cherry, 1979):

$$V_h = (K_h / n_e)i_h \quad \textbf{(1)}$$

where: V_h = horizontal groundwater velocity
K_h = overall average hydraulic conductivity
i_h = average horizontal gradient
n_e = estimated effective porosity (Freeze & Cherry, 1979)

The horizontal hydraulic gradient, i_h, is calculated using the formula:

$$i_h = d_h / d_l \quad \textbf{(2)}$$

where: i_h = horizontal hydraulic gradient (ft/ft)
d_h = difference in hydraulic head (feet)
d_l = distance between wells

The average linear flow velocity of horizontal groundwater flow in the surficial clay/upper claystone was calculated to be approximately 3.6×10^{-3} ft/day (1.3 ft/year) and the average linear flow velocity in the lower claystone/upper limestone was calculated to be approximately 9.3×10^{-4} ft/day (0.3 ft/year), based on previous and the most recent investigations. Assumptions are presented in the following sections.

Surficial Clay/Upper Claystone

From previous investigations, the average horizontal hydraulic gradient in the shallow flow system (claystone unit) was calculated to be 0.0135 ft/ft to the south across the existing Site. Using the representative horizontal hydraulic gradient of 0.0135 ft/ft, a geometric mean hydraulic conductivity (K) of 1.29×10^{-6} cm/sec (0.0037 ft/day) from nine site-specific field hydraulic conductivity tests of the claystone, and an effective porosity of 0.015, the average linear velocity within the shallow flow system is estimated to be a conservative 3.29×10^{-3} ft/day (1.2 ft/yr).

From the most recent investigation of the eastern expansion property, the average horizontal hydraulic gradient in the shallow flow system (surficial clay/upper claystone unit) was calculated to be 0.017 ft/ft to the east. Using the representative horizontal hydraulic gradient of 0.017 ft/ft, a geometric mean hydraulic conductivity (K) of 3.0×10^{-5} cm/sec (8.5×10^{-2} feet/day) from the recent and previously completed in-situ hydraulic conductivity tests, and an estimated effective porosity (n_e) of 0.4, based on a literature value of for clay material, the average linear flow velocity of horizontal groundwater flow in the surficial

clay/upper claystone unit was calculated to be approximately 3.6 x 10^{-3} feet/day (1.3 ft/year), the same as previously calculated.

Lower Claystone/Upper Limestone

From the most recent investigation of the eastern expansion property, the average horizontal hydraulic gradient in the lower claystone/upper limestone unit was calculated to be 0.014 ft/ft to the east. Using the representative horizontal hydraulic gradient of 0.014 ft/ft, a geometric mean horizontal hydraulic conductivity (K) of 3.7 x 10^{-7} cm/sec (1.0_x_10^{-3} ft/day) estimated from the previous and most recently completed in-situ hydraulic conductivity tests, and an estimated effective porosity (n_e) of 0.015 based on previous investigations and on a literature value for the limestone material, the average linear flow velocity of horizontal groundwater flow in the lower claystone/upper limestone unit was calculated to be approximately 9.3 x 10^{-4} ft/day (0.3 ft/year).

The velocities calculated using the observed gradients (Figures III-5.6 and t III-5.7), which are based on the horizontal component (or potentiometric surface) of the three-dimensional flow system in the surficial clay/upper claystone and lower claystone/upper limestone units, reflect the overall direction of subsurface water flow. On a small scale, water actually moves along fractures, which may or may not be aligned with the overall "horizontal" gradient. Thus, an individual water molecule may travel through a series of interconnected fractures at different velocities and in a variety of directions. Nevertheless, the overall gradient reflects the direction in which the bulk of subsurface water moves under fracture flow conditions, and the velocities based on this gradient are most applicable to estimating subsurface travel times (MFG, 1995).

2.2 Hydraulically Connected Lower Aquifers

The unweathered limestone strata of the Austin Chalk are not anticipated to contain or transmit appreciable volumes of water because of the general absence of significant secondary features. These strata represent the top of an approximately 600-foot thick aquitard separating the claystone/limestone units and the underlying Edwards aquifer. Water-level data from Site piezometers and monitoring wells and information from area water well logs provide good verification that a substantial aquitard separates the shallow claystone/limestone units from the first aquifer, the Edwards, at a depth of about 615 feet below ground (bgs). The average potentiometric surface of the Edwards aquifer, in close proximity to the Site, is approximately 587 feet MSL (Senger et al, 1990), which is 102 feet below the average

potentiometric surface of the surficial clay/upper claystone and 97 feet below the average potentiometric surface of the lower claystone/top of limestone (Taylor Group/Austin Chalk).

Examination of Water Well Reports submitted by licensed water well drillers for deep wells in the vicinity of the ~~Williamson County RDF~~ Site indicates a relatively uniform stratigraphy that can be easily seen in the well logs prepared by the drillers. The log for State well no. ZK58-20-902, which is located approximately along strike north of the Site, exhibits the following inferred stratigraphy below the surface gravel and clay (logged to 18 feet bgs): the Austin Chalk (approximately 420 feet of chalk, limestone and marl), underlain by the Eagle Ford (approximately 45 feet of dark shale), underlain by the Buda Limestone (approximately 30 feet), and the Del Rio Clay (approximately 85 feet of blue clay). The Edwards aquifer comprises the underlying Georgetown Formation and several deeper units. The Eagle Ford, Buda Limestone, and the Del Rio Clay are not known to yield water to wells in the area. These units are composed of very fine-grained strata characteristic of confining beds. Groundwater may occur in the Austin Chalk in the upper, weathered portion where it outcrops (Brune & Duffin, 1983) but its characteristics at depth in the unweathered state, such as observed at the ~~Williamson County RDF~~ Site, are more typical of an aquitard.

Water-level data collected since 1988 from piezometers and monitoring wells are presented in Tables III-5.1 and III-5.2. The water level data for piezometers at the existing Site exhibit a clear seasonal variation that is highly dependent on rainfall and the effects of evapotranspiration. The range of water-level fluctuation is generally about 10 to 15 feet between the lows in late summer-early fall lows and highs in late spring-early summer. Water levels in piezometers completed at different depths within the clay-claystone sequence, either as nested piezometers or in separate boreholes, typically exhibit similar patterns and magnitudes of water-level change through time (MFG, 1995).

3.0 GROUNDWATER MONITORING SYSTEM ~~§330.56(e)(3)~~

Per 30 TAC §330.~~63~~56(~~f~~e)(~~1~~3), Figure III-5.8, is a topographic map showing the delineation of the waste management area, property boundary, proposed "point of compliance" (POC), and proposed location of groundwater monitoring wells~~, and to the extent possible, the upper and lower aquifers as presented in the previous section~~.

3.1 Consideration for Groundwater Monitoring System Design

The geologic regime in which the landfill is being developed consists of one hydrostatic unit, with three stratigraphic units (surficial clay, claystone and limestone) from ground surface down to approximately 592 feet msl. All three units are confined and act as one aquitard unit overlying the Edwards aquifer approximately 600 to 700 feet bgs.

The groundwater monitoring network design proposed herein is based on a consistent approach in evaluating: 1) the groundwater flow direction and geologic structure of the monitorable stratum, 2) receptor locations in relation to source locations, 3) determining the landfill design, components, and layout in relation to the hydrogeologic regime and receptors, and 4) evaluating migration pathways. These criteria were evaluated to design the currently approved monitoring network and the enhancements proposed herein.

3.1.1 Groundwater Flow

The preferential groundwater flow direction is horizontally within the relatively higher permeability unconsolidated surficial clay.

Claystone underlies the surficial unconsolidated unit. Flow within the claystone is estimated to be primarily through secondary porosity features. Laboratory permeability tests (horizontal and vertical) performed on the claystone deposits ranged from 7.1×10^{-11} cm/sec to 3.4×10^{-8} cm/sec.

Limestone underlies the claystone unit. Flow within the limestone is also estimated to be primarily through secondary porosity features. Laboratory rock permeability tests performed on the limestone deposits ranged from 4.5×10^{-10} cm/sec to 1.1×10^{-9} cm/sec.

The hydraulic conductivity of the lower claystone and upper limestone was evaluated from in-situ hydraulic conductivity tests performed in nine piezometers installed during the 2004 groundwater investigation. In-situ hydraulic conductivities for the lower claystone and upper limestone ranged from 6.8×10^{-8} cm/sec to 5.7×10^{-7} cm/sec, with a calculated geometric mean of 2.2×10^{-7} cm/sec.

Based upon depth-to-water data collected from the monitoring wells and piezometers, groundwater elevations in the surficial clay/upper claystone range from approximately 695 feet msl to 658 feet msl and in the lower claystone/upper limestone range from approximately 702 feet msl to 640 feet msl. Groundwater elevation data indicate that groundwater movement in all the units are radially outward towards the north, east and southerly directions.

In general, the units beneath the Site consist of one hydrostatic unit, with three stratigraphic units (surficial clay, claystone, and limestone) down to approximately 592 feet msl, as seen in Table III-4.6. All three units are confined and act as one aquitard unit to the Edwards aquifer, approximately 600 to 700 feet bgs (100 to 0 feet msl). Technically, the three units are unconfined; however, when analyzed for field permeability tests may show semi-confined or confined conditions. These units are not hydraulically connected with the underlying Edwards aquifer, which is a major aquifer in central Williamson County and Central Texas based on site stratigraphy. In the vicinity of the Site, the upper Edwards aquifer units are at a depth of approximately 615 feet bgs, separated from the coarse grained surficial clay and lower claystone units by approximately 390 feet of the Austin Group, which has a low to moderate infiltration capacity that generally does not transport groundwater through the unit unless fractures are aligned. The Austin Group is underlain by the Eagle Ford Group, which is approximately 70 feet thick at the Site and is considered relatively impermeable. Below the Eagle Ford is the Buda Limestone and the Del Rio Clay, both of which do not yield water in the vicinity of the Site. The average potentiometric surface of the Edwards aquifer, in close proximity to the Site, is approximately 587 feet msl (Senger et al, 1990), which is 102 feet below the average potentiometric surface of the surficial clay/upper claystone and 97 feet below the average potentiometric surface of the lower claystone/upper limestone.

3.1.2 Receptors

Critical receptors to groundwater flow located down-gradient of a landfill could include public drinking water wells, individual drinking water wells or livestock wells, and surface water bodies. Regional water use from the Austin Chalk and the Taylor Group is almost exclusively by individuals for domestic, livestock, and/or domestic irrigation purposes (CJI and MFG, 1995). Water withdrawn from the Edwards-Trinity aquifer is largely used for irrigation in the northwestern part of the aquifer (including Williamson County) where soil conditions are particularly favorable for farming (Ryder, 1996).

A water well records search of State records was performed, and is included in Appendix III-4B. The search revealed six water wells (Map ID 2, 5, and 6) within a one-mile radius of the proposed permit

boundary of the Site (Appendix III-4B). Five of the wells are completed for domestic use and one well is unused. The two nearest water wells identified in the water well records search (Map ID 5), are located approximately 4,700 feet north of the Site as shown in Appendix III-4B. The depths of the five domestic wells range from 640 to 820 feet bgs and are completed in the Edwards aquifer. The unused well, drilled to a depth of 2,919 feet bgs, most likely is completed in the Trinity aquifer. In addition to the wells identified in the water-well records search, there are four wells identified on the 1987 United States Geological Survey (USGS) Hutto, Tex. quadrangle map within one mile of the Site and two hand-dug wells. One of the wells is located near the abandoned house located in the southeast corner of the Site and one well is located along the northern perimeter of the Site.

The rural area around the Site is served by the Jonah Water Supply Corporation (JWSC), which obtains its water supply from six deep wells completed in the Edwards aquifer. The closest JWSC well to the Site is located 3½ miles to the west. All of the JWSC wells are located up-gradient of the Site (CJI and MFG, 1995). The City of Hutto has three wells completed in the Edwards aquifer. The three Hutto wells are all within, or immediately adjacent to, the Hutto city limits, or about three miles south of the Site.

Surface water drainage features closest to the Site include Brushy Creek, Mustang Creek, and an unnamed tributary of the San Gabriel River. Brushy Creek in Williamson County rises three miles northwest of Leander in southwestern Williamson County and flows east for sixty-nine miles, through southern Williamson County and southwestern Milam County, to its mouth on the San Gabriel River, five miles north of Rockdale and approximately 33 miles to the northeast of the Site. Brushy Creek flows southeast approximately four miles south of the Site along the Williamson – Travis county line. Mustang Creek, one of the tributaries of Brushy Creek, rises four miles northwest of Hutto in south central Williamson County and runs southeast for twenty miles to its mouth on Brushy Creek, six miles southeast of Taylor. Mustang Creek is an intermittent stream that flows from northwest to southeast across the southern portion of the permitted landfill.

The Site lies on the drainage divide between Mustang Creek and an unnamed tributary to the San Gabriel River, which is located in the northern portion of the permitted landfill. Surface drainage from more than three-fourths of the Site is southwest toward Mustang Creek, and the remainder of the drainage is to the north, toward the unnamed tributary of the San Gabriel River (Hydro-Search and MFG, 1990). These features can be seen on the 2002 aerial photograph included as Figure III-4-3.

Given the locations of these potential receptors in relation to the groundwater flow direction and other factors described herein, the groundwater monitoring system was designed with monitoring wells effectively spaced to be protective of the receptors down-gradient of the Site.

3.2 Landfill Feature Design and Layout

3.2.1 Landfill Liner Type, Depth of Excavation, and Sumps

Existing landfill cells are a combination of pre- and post—Subtitle D. Proposed landfill cells at this facility will utilize Subtitle D liner systems. The layout and elevations of the Site landfill cells in relation to the uppermost groundwater bearing zone was considered when designing the groundwater monitoring system layout. The Landfill base grades are excavated in either the surficial clay unit or underlying claystone unit. Thus, portions of the surficial clay/upper claystone stratigraphic units will be removed from the Site as landfill development progresses. Removal of portions of the surficial clay/upper claystone stratigraphic unit from Site may partly redirect groundwater flow around the perimeter of the Site. Placement of monitoring wells in locations that would likely intercept this re-directed groundwater was considered in the design of the groundwater monitoring system.

The location of leachate sumps was also considered in the design of the groundwater monitoring system. Leachate sump locations are shown in Figure II-5.8. Leachate sumps and the underlying liner system will generally be keyed into the surficial clay/claystone. Because the lined sumps will be keyed into this low permeability formation that is not in contact with the uppermost groundwater bearing zone at the facility, the sump locations do not influence the layout of the groundwater monitoring well system layout.

3.2.2 Storm Water Ponds

The location of three proposed on-site ponds, defined as A, B, and C, are located between the proposed waste footprint and several to-be-installed monitoring wells. These ponds are to be used only as temporary collection areas for storm water runoff and are designed to only contain water during a rainfall event and for a short time thereafter until the storm water has drained as runoff. Based on the site-specific geotechnical data the ponds will not be recharge zones to the underlying ground-water system. Permeabilities of the soils surrounding the ponds are on the order of 10^{-8} to 10^{-10} cm/sec.

In addition, the depths of the top of screened intervals for the to-be-installed monitoring wells in close proximity to these ponds are no shallower than 15 feet bgs. The average top-of-screened depth for these monitoring wells in the coarse-grained surficial clay, along the eastern perimeter, is 18.8 feet bgs. The

average top-of-screened depth for the lower claystone/upper limestone monitoring wells is 41.3 feet bgs with the shallowest top-of-screened depth of 20 feet bgs, adjacent to Pond A. These ponds are not anticipated to serve as recharge points for ground water based on low soil permeabilities between the base of the proposed ponds and the top of the screened intervals. The effectiveness of the adjacent monitoring wells to accurately detect potential escape of leachate from the Facility Site in the case of liner breach is not expected to be compromised.

~~**Stormwater within 72 hoursSindicate the ponds will not cause significant**~~

3.2.3 Most Likely Pathway for Pollutant Migration

The most likely pathway for pollutant migration from the Site, in the unlikely event that waste constituents migrate through the liner system, is within the relatively permeable surficial clay/upper claystone stratigraphic units. The only documented aquifer in the vicinity of the site that is typically used as a potable water source is the Edwards Aquifer, which is separated by approximately 1,200 feet of low permeability formations between Site landfill activities and the liner system sideslope. The surficial clay/upper claystone unit has not been documented as a usable source of water in the area surrounding the Site.

3.3~~1~~ Well Locations

The surficial clay/calcareous claystone and potentially the weathered limestone are considered the uppermost water-bearing unit at the Site. Although the claystone/limestone unit is not even a moderately transmissive unit, it is the only strata available to monitor subsurface water for the entire Site. However, in the northern and eastern portions of the Site, gravel and sand lenses in the lower portion of the surficial clay are anticipated to be transmissive and potentially monitored throughout the year, unless evapotranspiration rates exceed recharge to the gravel and sand lenses.

Eight monitoring wells (MW-06 through MW-08, MW-09A, and MW10 through MW-13, as shown on Figure III-5.8) are currently utilized to satisfy the monitoring requirements for the ~~Williamson County RDF~~ Site, a Type I MSW facility. All monitoring wells are screened in the ~~lower claystone/upper limestone unit.~~upper surficial clay (course-grained zones) and lower claystone/upper limestone units.

Based on TCEQ approval of Permit Amendment 1405A, monitoring wells MW-l, MW-2, and MW-3, shown on Figure III-5.8, were plugged and abandoned in accordance with applicable State regulations due to the lack of construction documentation. Former upgradient well MW-4 was removed from the

monitoring well network because of anomalous water levels exhibited by this well, relative to other wells and piezometers at the Site, and MW-5 was removed from the monitoring well network because it was not in a down-gradient position of the ~~landfill~~Site landfill activities based on apparent groundwater flow directions observed from December 1991 to December 1994. MW-4 and MW-5 have been maintained as piezometers for potential future incorporation in the monitoring network in the event that groundwater flow conditions dictate their use.

Additional monitoring well locations are ~~proposed and~~ discussed in Section 5.0 of this report. The construction of the ~~recommended~~ to-be-installed monitoring wells for the expanded Site landfill footprint are recommended to be installed once the permit amendment is approved and once waste has been place within 1,000 feet of the installed well location.

4.0 IDENTIFICATION OF CONTAMINATION ENTERING THE GROUNDWATER ~~§330.56(e)(4)~~

In accordance with 30 TAC §330.56(e)(4), this section is intended to describe any plume(s) of contamination that has entered the groundwater from the ~~landfill facility~~Site. Groundwater monitoring has been conducted at the ~~Williamson County RDF~~Site since April 1988. The present detection monitoring program includes all of the parameters listed in Table I of 30 TAC §330.241. ~~During the last 16 years of monitoring, T~~there have been no verified detections of hazardous constituents in the groundwater. Therefore, this section is not applicable at this time. Historical analytical data can be found in Appendix A.

5.0 PROPOSED GROUNDWATER MONITORING PROGRAM ~~§330.56(e)(5)~~

In accordance with 30 TAC §330.6356(fe)~~(5)~~, this section presents the detailed plans and engineering report describing the ~~proposed~~ groundwater monitoring program to be implemented to meet the requirements of 30 TAC §330.403~~231~~ relating to Groundwater Monitoring Systems.

~~An enhanced groundwater monitoring well network is proposed in accordance with 30 TAC~~ §330.403~~231~~. The enhancements proposed for the ~~Williamson County RDF's~~Site's groundwater monitoring system include the installation of monitoring wells screened ~~in the~~ in the lower claystone/upper limestone unit and monitoring wells screened in the surficial clay/lower limestone (coarse-grained zones). The ~~proposed~~ to-be-installed monitoring well network is designed to be protective of State waters, ~~and~~ human health, and the environment in the unlikely event that a release occurs under the TCEQ's currently approved groundwater monitoring program. The ~~proposed~~ to-be-

installed groundwater monitoring network has been developed based on the present knowledge of groundwater flow at the Site. It is anticipated that as cell construction progresses from west to east that groundwater flow may be impeded in an easterly direction; however, the monitoring wells ~~have been~~were proposed to ~~-~~encompass the entire perimeter of the expansion acreage and would detect any releases from WMUs that may occur.

The final ~~proposed~~ groundwater monitoring network will consist of 3~~6~~5 monitoring wells located along all perimeter~~s~~ of the ~~combined present and proposed~~ landfill footprint~~s~~. Twenty-six~~five~~ of the ~~present and proposed~~ monitoring wells are/will be installed in the lower claystone/upper limestone unit and 10 ~~proposed~~ monitoring wells will be installed in the shallow, coarse-grained material of the surficial clay unit that is found along the eastern portion of the ~~proposed eastern expansion~~ property. Three wells (MW-09A, MW-11, and MW-12) in the TCEQ-approved monitoring well network are installed in the lower claystone/upper limestone unit and are the only upgradient monitoring wells in the ~~proposed~~ monitoring well network due to groundwater flow. However, ~~when the permit amendment is approved,~~ MW-09A will be decommissioned and only two wells (MW-11 and MW-12) will remain as upgradient monitoring locations. The remaining lower claystone/upper limestone unit wells and the shallow, surficial clay unit wells are all considered downgradient to groundwater flow and landfill operations, as noted on Figure III-5.8. The ~~proposed~~ monitoring wells will be installed on a phased schedule, ~~when the permit amendment is approved,~~ to collect intrawell background data (see Section 6.0). Wells will be installed when waste placement occurs within 1,000 feet of a to-be-installed well location.

Eight monitoring wells (MW-06 through MW-08, MW-09A, and MW10 through MW-13) are currently utilized to satisfy the monitoring requirements for the ~~Williamson County RDF, a Type I MSW facility~~Site. These wells are all screened in the lower claystone/upper limestone unit.

The expansion of the groundwater monitoring network will include the installation of three lower claystone/ upper limestone unit monitoring wells (MW-14 through MW-16) along the northern perimeter of the ~~currently permitted~~ landfill, on the basis of flow directions indicated in June 1991 and April 1993 from former piezometers located in the northern permitted area (MFG, 1995). Present monitoring well, MW-13 will be decommissioned as cell construction begins to the north of present operations. In addition, four ~~proposed~~ monitoring wells (MW-17 through MW-20) will be installed along the northern perimeter of the proposed eastern expansion acreage.

The expansion of the groundwater monitoring network on the eastern perimeter~~expansion area~~ will include ~~the~~ installation of 14 monitoring wells (MW-21 through MW-2~~8~~7) along the eastern perimeter. Eight~~Seven~~ monitoring wells will be screened in the lower claystone/upper limestone unit and eight~~seven~~ monitoring wells (MW-21 through MW-2~~8~~7, with S suffixes) ~~are proposed~~will be installed to monitor the shallow surficial clay unit.

The expansion of the groundwater monitoring network on the eastern ~~expansion~~ area will include the installation of nine monitoring wells (MW-2~~9~~8 through MW-3~~6~~3) along the southern perimeter. Eight~~Six~~ monitoring wells will be screened in the lower claystone/upper limestone unit and two~~three~~ monitoring wells (MW-28 ~~-~~through MW-30, with S suffixes) ~~are proposed~~will be installed to monitor the shallow surficial clay unit. Existing monitoring wells MW-6 and MW-7 will be plugged because wells in this area have to be re-spaced ~~-~~in order to comply with Subchapter J well spacing requirements.

The ~~proposed~~ S-series wells have been located only where coarse-grained material of 0.5 feet or greater is anticipated, based on borings advanced during the 2004 site investigation. Coarse-grained materials will be classified in the field by a qualified groundwater scientist. Soil will be considered coarse grained if the soils are field classified as a SM, SP, SC, GM, GP, or GC according to the USCS.

In addition, present monitoring wells, MW-09A, MW-10, and MW-13 will be decommissioned~~ when the permit amendment is approved~~. Only two wells (MW-11 and MW-12) will remain as upgradient monitoring locations for the ~~Facility~~Site. The POC will be located along the northern property perimeter; the southern perimeter boundary on the eastern expansion property; to the north of Mustang Creek on the southern portion of the permitted landfill; and along the eastern permitted boundary.

Figure III-5.8 depicts the permitted landfill limits of waste, the ~~proposed~~ waste limits of the expansion area, the POC, locations of the eight monitoring wells in the present TCEQ-approved network, and the locations of the 31 additional to-be-installed~~ly proposed~~ monitoring wells. Table III-5.4 summarizes the ~~proposed~~ monitoring well network including well designation, estimated or actual well depth, well status (new or existing groundwater monitoring well), estimated or actual location, estimated or actual screen interval, and type of monitoring point (upgradient, downgradient, and/or POC).

As defined under 30 TAC §330.200(d), the POC line has been established at locations that parallel the surface projection of a vertical plane that intersects the uppermost water-bearing zone at the most immediate downgradient location from the WMUs. The ~~proposed~~ locations and number of POC wells

have been selected based on several critical hydrogeologic and design parameters. These parameters are discussed in detail below.

The positions of the ~~proposed~~ POC and the monitoring wells were selected based on:

- Stratigraphic position;
- Groundwater potentiometric maps;
- Horizontal position relative to existing monitoring wells;
- Local hydraulic gradient and hydraulic conductivity; and,
- Future design considerations.

Stratigraphic Position: Vertical locations of the ~~proposed~~ monitoring wells are based on site stratigraphy and hydrogeology. The depths of the ~~proposed~~ wells and the screened intervals have been selected based on isopach and structure maps generated from data collected during the 2004 site investigation (Figures III-5.3 through III-5.6). The ~~proposed~~ monitoring wells are located vertically in the surficial clay unit (coarse-grained materials) and the lower claystone/upper limestone, based upon the geometry of the expansion area and recent and historical potentiometric surfaces in the surficial clay/upper claystone and lower claystone/upper limestone units, shown in Figures III-5.6 through III-5.7. The POC wells have been designed to be strategically positioned both spatially and vertically so as to monitor groundwater passing beneath the POC in the uppermost water-bearing zone. The ~~proposed~~ surficial clay/upper claystone monitoring wells (MW-21S through MW-30S) will be installed to a depth that encounters the entire thickness of the coarser grained materials of the surficial clay unit, which ranges in thickness from 1.0 to 20 feet on the eastern expansion property. Based on Figures III-5.3 through III-5.5, completion elevations of the shallow wells will range between 675 to 642 feet msl~~MSL~~. The ~~proposed~~ lower claystone/upper limestone monitoring wells (MW-14 through MW-3~~6~~3) will be installed to a depth that encounters the contact between the Lower Taylor Marl and the underlying Austin Chalk. Based on Figures III-5.3 through III-5.5, completion elevations of the wells will range between 678 to 619 feet msl~~MSL~~. The monitoring wells will be screened to monitor groundwater emanating from the base of the landfill from upgradient to passing the downgradient POC. All existing and new wells are/will be constructed in accordance with TCEQ 30 TAC §330.242. Groundwater monitoring well installation will be performed under the guidance of a qualified groundwater scientist.

Groundwater Potentiometric Maps: The use of groundwater potentiometric maps was fundamental in the strategic placement of the ~~proposed~~ POC and detection monitoring wells. The monitoring well locations

were based on the spatial distribution of the resultant equipotential lines on the groundwater contour maps. The monitoring wells are located horizontally in the lower claystone/upper limestone and in the surficial clay unit (coarse-grained materials) based upon the geometry of the expansion area and recent and historical potentiometric surfaces in the surficial clay/upper claystone and lower claystone/ upper limestone, shown in Figures III-5.6 through III-5.7.

Horizontal Position: Spatial distribution of the upgradient (background) and downgradient/POC wells is straight forward based on the hydrogeometry of the Site and particle flow-paths observed. Well spacing along the POC is 600 feet or less~~of the proposed lower claystone/upper limestone wells ranges from 489 to 655 feet, with an average spacing of 595 feet, which is similar to the current well spacing of the present monitoring system, ranging between 490 to 695 feet, with an average spacing of 563 feet~~. The well spacing for the surficial clay/upper claystone has been ~~proposed~~ to be the same as the lower claystone/upper limestone unit~~.; however, additional groundwater characterization of this unit is required. Thirteen piezometers, screened within this unit, are presently located on the eastern expansion property and will have water levels recorded periodically for seasonal fluctuations and determination of whether this zone will retain groundwater throughout time.~~ The ~~proposed~~ monitoring wells~~, in conjunction with the existing monitoring network wells~~, are believed to be designed to adequately detect a breakthrough of constituents of concern (COCs).

Local Hydraulic Gradient and Hydraulic Conductivity: Based on the geotechnical results (Section 7.0, Attachment 4 of this application), the clay liner will maintain a minimum permeability (hydraulic conductivity) of 1.0×10^{-7} cm/sec. The claystone and fine-grained clay, and to a lesser extent, the coarse-grained material are adjacent to a portion of the sidewalls and base of the ~~proposed~~ landfill expansion. The permeability of fine-grained soils and the claystone typically ranged from 10^{-6} to 10^{-8} cm/sec for the field horizontal permeabilities and 10^{-8} to 10^{-11} cm/sec for geotechnical laboratory permeabilities (horizontal and vertical). The permeability of coarse-grained soils is on the order of 10^{-3} cm/sec (based on the geometric mean of the "slug" tests). Average horizontal hydraulic gradients ranged from approximately 0.01 to 0.02 ft/ft towards the northeast and southeast portions of the expansion area (calculated from potentiometric maps). There is also a component of vertical gradient between the surficial clay/upper claystone and lower claystone/upper limestone that has an average vertical hydraulic gradient of 0.05 ft/ft downward (assuming static conditions have been obtained).

Monitoring of the shallow surficial clay/upper claystone unit was not recommended by CJI and MFG in the Soils Investigation Report for Williamson County Landfill Permit Amendment Application No. 1405-

A, completed in February 1995. The decision not to monitor the surficial clay/upper claystone unit was based on the stratigraphic data collected during their investigations and previous investigations that showed the coarse-grained deposits to be isolated occurrences on the permitted landfill. In addition, the report stated that any ephemeral water-bearing zones that developed in the clay unit after high rainfall periods would probably dissipate by evapotranspiration and to a lesser extent by slow seepage into the unfractured claystone adjacent to fractures. However, based on the widespread extent of the coarse-grained deposits along the eastern portion of the expansion area, field horizontal permeabilities of 10^{-3}, and potential contact with the ~~proposed~~ side walls of the landfill, it is recommended that the surficial clay/upper claystone unit be monitored where coarse-grained deposits are encountered, as stated above.

Future Design Considerations: Background and POC/downgradient monitoring well locations were selected based on the above criteria in addition to ~~proposed and~~ possible future design modifications. A total of 33 ~~monitoring wells are proposed as~~ POC wells ~~to~~ will include: current wells (MW-06 through MW-08) and to be installed ~~proposed~~ wells (MW-14 through MW-33, and MW21S through MW-30S). If the landfill perimeter or cells ~~-~~are repositioned or modified, the POC well placements, specifically those affected by the design modifications, may also be adjusted.

To be installed~~Proposed new~~ monitoring wells will be constructed once the permit amendment has been approved and once waste has been placed within 1,000 feet of the to be installed well location. Piezometers~~——~~ E-3S, E-3D, E-4S, E-4D, E-5S, E-5D, E-6S, E-6D, E-7S, E-7D, E-23S, E-24S, and E-36S, located in the footprint of the expansion acreage, will be abandoned during the phased construction of the landfill. In addition, monitoring wells MW-09A, MW-10, and MW-13 should be abandoned once the new monitoring wells have been installed along the ~~proposed~~ permitted landfill boundary. Piezometers E-1D, E-1S, E-2S,~~——~~E-8D, E-8S, E-9D, and E-9S will continue to be used for piezometric purposes.

The monitoring well network described above should be more than adequate to provide early indications of releases to groundwater from the landfill. As discussed elsewhere in this report, lateral groundwater flow in the claystone unit is probably quite small and very slow and groundwater flow within the gravel and sand lenses, within the lower portion of the surficial clay unit, are limited in lateral extent and potentially affected by variable climatic conditions. In addition, the net lateral flux of groundwater may actually be inward toward the landfill during active operations and possibly for some time afterwards, until such time as the effects of eliminating recharge within the landfill footprint are balanced and a new hydraulic equilibrium has developed. Periodic water-level monitoring and evaluation of flow directions

will aid in documenting such changes, and making timely adjustments in the monitoring well network, if necessary.

5.1 Background Monitoring ~~§330.233(c)~~

See ~~In accordance with~~ the site-specific GWSAP (Part III, Attachment 11), for details regarding how groundwater monitoring will be conducted.~~background monitoring at each new monitoring point will occur. A minimum of eight statistically independent groundwater samples from each new background well and new downgradient/POC well shall be collected to enable establishment of background concentrations. The new monitoring wells will be sampled and analyzed for background constituents listed in Table III-11.3 of the GWSAP. This background constituent list consists of all constituents listed in Table 1 of 30 TAC §330.241, as well as, additional constituents chosen by the Site.~~

~~In addition, U~~upgradient monitoring wells, MW-11 through MW-13, are ~~presently~~ used for background testing and monitoring background water quality that has not been affected by leakage from any WMUs~~, pursuant to 30 TAC §330.231(a)(1)~~. Monitoring wells (MW-11 and MW-12) are monitoring background groundwater flow approaching the Site from the west. MW-13 is presently defined as an upgradient monitoring point; but will be plugged~~most likely be redefined as a downgradient well~~ once landfill operations develop to the north. The Site is ~~permitted landfill and the proposed eastern expansion are~~ located over a groundwater divide, with groundwater flow documented as generally flowing from west to east with radial flow to the north and south. Based on groundwater data from August 31, 2004, MW09A, appears to be on a groundwater "high" and is also defined as an upgradient well in the TCEQ-approved groundwater monitoring network. As future landfill development occurs, there will be no additional monitoring well locations on the Site that can be defined as upgradient of present or ~~proposed~~ to be installed WMUs, based on the present groundwater flow regime.

5.2 Detection Monitoring ~~§330.234~~

See~~As this Site is currently operating under a TCEQ approved GWSAP, groundwater monitoring will continue to be operated in accordance with 30 TAC §330.234 and the proposed GWSAP located in Attachment 11 of this permit application. The procedures for acquiring samples from this system, the analysis of those samples, and the management of the water quality data resulting from these analyses are presented in the modified GWSAP (~~ Attachment 11 of this application for details regarding detection monitoring. ~~). The upgradient monitoring wells will continue to monitor background water quality that has not been affected by leakage from any WMUs, pursuant to 30 TAC §330.231(a)(1), and the present~~

~~and proposed downgradient monitoring system will include a sufficient number of wells allowing for a determination of groundwater quality passing the POC, pursuant to 30 TAC § 330.231(a)(2).~~

6.0 DETECTION AND IDENTIFICATION OF HAZARDOUS CONSTITUENTS IN THE GROUNDWATER ~~§330.56(E)(6-8)~~

~~In accordance with 30 TAC §330.56(e)(6-8), detection monitoring has been established at the permitted Site and parameters were selected, in part, from the listing of organic and inorganic constituents found in Table 1 of 30 TAC §330.241.~~ The site-specific detection monitoring program and parameter list~~, which was compiled pursuant to 30 TAC §330.234,~~ can be found in ~~Section 5.0 and Table III-11.4 in~~ the GWSAP (Attachment 11 of this application).

Groundwater monitoring has been conducted at the ~~Williamson County RDF~~Site since April 1988 at all monitoring wells at the Site. All of the present wells at the Site have completed background groundwater quality analyses, except MW-09A, which is a replacement well for damaged well MW-09 that was plugged and abandoned in October 2003.

~~For the additional proposed monitoring well network (see Section 5.0), in order to establish intrawell background concentrations for each constituent listed in Table III-11.3 in the GWSAP (Attachment 11 of this application), eight (8) statistically independent samples will be collected from each monitoring in the groundwater monitoring system. The background time window will be established following collection of the minimum number of samples in all wells, therefore some wells may have more than eight samples in the background depending on the well production and analyte sampling frequency.~~

~~After the establishment of background groundwater quality (Section 4.0, Attachment 11 of this application), the detection monitoring frequency for all constituents previously identified in Table III-11.4 in the GWSAP (Attachment 11 of this application) will be semiannual during the active life, closure, and post-closure care periods of the Site. This sampling frequency meets the appropriate time interval criteria for sample independence.~~

~~Statistical analysis will be conducted in accordance with 30 TAC §330.233(f) and (g). The facility~~Site Statistical Plan was prepared by Dr. Robert Gibbons, Ph.D. and titled ~~*"Statistical Methods for Groundwater Monitoring at the Williamson County Landfill"* dated March 1999. The Statistical Plan describes the methodologies and strategies for groundwater analysis based on the site-specific background data set collected from the Site.~~

~~In accordance with §330.233(g)(3), the technique used for intrawell comparisons is the combined Shewhart-CUSUM control chart, using the DUMPStat® program. This control chart procedure will detect releases both in terms of the constituent concentration and cumulative increases. Background data are tested for existing trends using Sen's slope test. Many ground water monitoring parameters are not detected at a frequency great enough to generate the combined Shewhart-CUSUM control charts. For constituents detected less than 25% of the time monitored at a particular well, nonparametric prediction limits are used once sufficient background data are available.~~

During the ~~last 16 years of~~ background and detection monitoring, there have been no verified detections of hazardous constituents ~~listed in Table I of 30 TAC §330.241~~ in the groundwater. Historical analytical data can be found in Appendix A.

~~**IF IN THE FUTURE DETECTION MONITORING ESTABLISHES EXCEEDANCES OF THE HAZARDOUS CONSTITUENTS LISTED IN TABLE I OF 30 TAC §330.241, THE SITE SHALL SUBMIT SUFFICIENT INFORMATION, SUPPORTING DATA, AND ANALYSES TO ESTABLISH AN ASSESSMENT MONITORING PROGRAM THAT MEETS THE REQUIREMENTS OF 30 TAC §330.235 AND AS DEFINED IN SECTION 6.0 IN THE GWSAP (ATTACHMENT 11 OF THIS APPLICATION).**~~

7.0 REFERENCES

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STATE OF TEXAS
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7-1-2011

TABLE III-5.4

RECOMMENDED GROUNDWATER MONITORING WELL CONSTRUCTION
WILLIAMSON COUNTY RECYCLING & DISPOSAL FACILITY
WILLIAMSON COUNTY, TEXAS

Monitoring Well I.D.	Actual or Estimated Ground Elevation (ft MSL)	Actual or Estimated Depth of Well [1] (ft bgs)	Well Status/ Location [2]	Monitored Unit [3]	Actual or Estimated Coordinate Location [4]		Estimated Base of Landfill (ft MSL)	Estimated Screen Interval				
					Northing	Easting		Depth Top (ft bgs)	Depth Bottom (ft bgs)	Elevation Top (ft MSL)	Elevation Bottom (ft MSL)	Type [5]
Present Monitoring Well Network												
MW-06	685.21	35.0	~~Existing~~ To be plugged	Lo CS/LS	10191281.76	3171645.51	N/A	20	30	665.2	655.2	DG, POC
MW-07	684.42	51.0	~~Existing~~ To be plugged	Lo CS/LS	10191093.75	3172465.37	N/A	38.5	48.5	645.9	635.9	DG, POC
MW-08	689.40	39.0	Existing	Lo CS/LS	10191355.93	3171034.12	N/A	28.0	38.0	661.4	651.4	DG, POC
MW-09A	712.76	50.0	~~Existing~~ To be plugged	Lo CS/LS	10193137.06	3171907.21	680	36.0	46.0	676.8	666.8	UG
MW-10	718.40	49.0	~~Existing~~ To be plugged	Lo CS/LS	10193627.97	3171704.33	685	26.5	46.5	691.9	671.9	DG
MW-11	723.30	51.5	Existing	Lo CS/LS	10193641.95	3170548.28	680	28.0	48.0	695.3	675.3	UG
MW-12	724.80	52.5	Existing	Lo CS/LS	10193429.55	3170025.77	N/A	15.0	50.0	709.8	674.8	UG
MW-13	711.70	45.0	~~Existing~~ To be plugged	Lo CS/LS	10193847.66	3171087.94	684	13.5	43.5	698.2	668.2	UG
Additional Proposed/Not Installed Monitoring Well Locations												
Permitted Landfill												
PMW-14	~~685~~686	30	Northern	Lo CS/LS	~~10195291.49~~ 10,195,338	~~3170411.04~~ 3,170,393	670	~~15~~16	~~30~~31	670	655	DG, POC
PMW-15	681	~~36~~37	Northern	Lo CS/LS	~~10195528.45~~ 10,195,535	~~3171023.34~~ 3,170,950	666	~~21~~22	~~36~~37	660	645	DG, POC
PMW-16	~~680~~676	38	Northern	Lo CS/LS	~~10195705.58~~ 10,195,723	~~3171479.04~~ 3,171,510	666	~~23~~19	~~38~~34	657	642	DG, POC

TABLE III-5.4

RECOMMENDED GROUNDWATER MONITORING WELL NETWORK
WILLIAMSON COUNTY RECYCLING & DISPOSAL FACILITY
WILLIAMSON COUNTY, TEXAS

Monitoring Well I.D.	Actual or Estimated Ground Elevation (ft MSL)	Actual or Estimated Depth of Well [1] (ft bgs)	Well Status/ Location [2]	Monitored Unit [3]	Actual or Estimated Coordinate Location [4]		Estimated Base of Landfill (ft MSL)	Estimated Screen Interval				Type [5]
					Northing	Easting		Depth Top (ft bgs)	Depth Bottom (ft bgs)	Elevation Top (ft MSL)	Elevation Bottom (ft MSL)	
Eastern Expansion												
PMW-17	~~687~~686	51	Northern	Lo CS/LS	~~10196014.39~~ 10,196,004	~~3172011.73~~ 3,171,987	666	36	51	~~651~~649	~~636~~634	DG, POC
PMW-18	690	57	Northern	Lo CS/LS	~~10196233.01~~ 10,196,222	~~3172567.49~~ 3,172,536	658	42	57	648	633	DG, POC
PMW-19 (Piez E-2D)	6~~89.79~~90	89	Northern	Lo CS/LS	~~10196452.72~~ 10,196,436	~~3173126.02~~ 3,173,085	654	45	60	644.79	629.79	DG, POC
PMW-20	~~686~~687	63	Northern	Lo CS/LS	~~10196672.01~~ 10,196,652	~~3173683.47~~ 3,173,635	656	48	63	638	623	DG, POC
PMW-21S	690	34	Eastern	SC	~~10196167.87~~ 10,196,213	~~3174057.55~~ 3,174,039	658	24	34	666	656	DG, POC
PMW-21	690	69	Eastern	Lo CS/LS	~~10196167.87~~ 10,196,213	~~3174057.55~~ 3,174,039	658	54	69	636	621	DG, POC
PMW-22S	692	40	Eastern	SC	~~10195609.52~~ 10,195,665	~~3174279.76~~ 3174257	666	30	40	662	652	DG, POC
PMW-22	692	68	Eastern	Lo CS/LS	~~10195609.52~~ 10,198,665	~~3174279.76~~ 3,174,257	666	53	68	639	624	DG, POC
PMW-23S	~~690~~692	48	Eastern	SC	~~10195222.77~~ 10,195,263	~~3174745.90~~ 3,174,700	668	38	48	652	642	DG, POC
PMW-23	~~690~~692	71	Eastern	Lo CS/LS	~~10195222.77~~ 10,195,263	~~3174745.90~~ 3,174,700	668	56	71	634	619	DG, POC
PMW-24S	~~689~~690	~~25~~26	Eastern	SC	~~10194687.63~~ 10,194,737	~~3174945.72~~ 3,174,926	672	~~15~~16	~~25~~26	674	664	DG, POC
PMW-24	~~689~~690	64	Eastern	Lo CS/LS	~~10194687.63~~ 10,194,737	~~3174945.72~~ 3,174,926	672	49	64	640	625	DG, POC

TABLE III-5.4

RECOMMENDED GROUNDWATER MONITORING WELL NETWORK
WILLIAMSON COUNTY RECYCLING & DISPOSAL FACILITY
WILLIAMSON COUNTY, TEXAS

Monitoring Well I.D.	Actual or Estimated Ground Elevation (ft MSL)	Actual or Estimated Depth of Well [1] (ft bgs)	Well Status/ Location [2]	Monitored Unit [3]	Actual or Estimated Coordinate Location [4]		Estimated Base of Landfill (ft MSL)	Estimated Screen Interval				Type [5]
					Northing	Easting		Depth Top (ft bgs)	Depth Bottom (ft bgs)	Elevation Top (ft MSL)	Elevation Bottom (ft MSL)	
PMW-25S	~~691~~692	26	Eastern	SC	~~10194128.39~~ 10,194,188	~~3175161.62~~ 3,175,144	668	16	26	675	665	DG, POC
PMW-25	~~691~~692	63	Eastern	Lo CS/LS	~~10194128.39~~ 10,194,188	~~3175161.62~~ 3,175,144	668	48	63	643	628	DG, POC
PMW-26S	~~691~~692	27	Eastern	SC	~~10193567.73~~ 10,193,638	~~3175398.71~~ 3,175,356	660	17	27	674	664	DG, POC
PMW-26	~~691~~692	63	Eastern	Lo CS/LS	~~10193567.73~~ 10,193,638	~~3175398.71~~ 3,175,356	660	48	63	643	628	DG, POC
PMW-27S (Piez E-34S)	69~~0.402~~	28	Eastern	SC	~~10192967.49~~ 10,193,095	~~3175637.33~~ 3,175,587	654	18	28	672.40	662.40	DG, POC
PMW-27	690	65	Eastern	Lo CS/LS	~~10192967.49~~ 10,193,095	~~3175637.33~~ 3,175,587	654	50	65	640	625	DG, POC
PMW-28S	690	25	Southern	SC	~~10192409.88~~ 10,192,547	~~3175816.62~~ 3,175,805	652	15	25	675	665	DG, POC
PMW-28	690	65	Southern	Lo CS/LS	~~10192409.88~~ 10,192,547	~~3175816.62~~ 3,175,805	652	50	65	640	625	DG, POC
PMW-29S	691	26	Southern	SC	~~10192176.96~~ 10,192,206	~~3175263.02~~ 3,175,324	652	16	26	675	665	DG, POC
PMW-29	691	58	Southern	Lo CS/LS	~~10192176.96~~ 10,192,206	~~3175263.02~~ 3,175,324	652	43	58	648	633	DG, POC
PMW-30S	693	28	Southern	SC	~~10191957.76~~ 10,191,984	~~3174705.79~~ 3,174,777	654	18	28	675	665	DG, POC
PMW-30	693	55	Southern	Lo CS/LS	~~10191957.76~~ 10,191,984	~~3174705.79~~ 3,174,777	654	40	55	653	638	DG, POC

TABLE III-5.4

RECOMMENDED GROUNDWATER MONITORING WELL NETWORK
WILLIAMSON COUNTY RECYCLING & DISPOSAL FACILITY
WILLIAMSON COUNTY, TEXAS

Monitoring Well I.D.	Actual or Estimated Ground Elevation (ft MSL)	Actual or Estimated Depth of Well [1] (ft bgs)	Well Status/ Location [2]	Monitored Unit [3]	Actual or Estimated Coordinate Location [4]		Estimated Base of Landfill (ft MSL)	Estimated Screen Interval				Type [5]
					Northing	Easting		Depth Top (ft bgs)	Depth Bottom (ft bgs)	Elevation Top (ft MSL)	Elevation Bottom (ft MSL)	
PMW-31	~~695~~694	55	Southern	Lo CS/LS	~~10191739.30~~ 10,191,770	~~3174150.43~~ 3,174,228	654	40	55	655	640	DG, POC
PMW-32	696	57	Southern	Lo CS/LS	~~10191519.13~~ 10,191,553	~~3173590.73~~ 3,173,679	658	42	57	654	639	DG, POC
PMW-33	~~692~~693	52	Southern	Lo CS/LS	~~10191297.74~~ 10,191,344	~~3173027.95~~ 3,173,127	658	~~37~~38	~~52~~53	655	640	DG, POC
PMW-34	686	51.0	Southern	Lo CS/LS	10,191,127	3,172,578	N/A	40	48	646	636	DG, POC
PMW-35	684	35.0	Southern	Lo CS/LS	10,191,172	3,171,999	N/A	19	30	665	655	DG, POC
PMW-36	689	37.0	Southern	Lo CS/LS	10,191,304	3,171,425	N/A	28	36.0	661	651	DG, POC

NOTES:

1 Estimated depths are approximate and dependent on subsurface conditions encountered during drilling/well installation.

2 Wells are defined as Existing or Northern, Southern, or Eastern for proposed wells along perimeters of landfill footprint.

3 SC S-series wells will be installed in the surficial clay zone (gravel) zone, which may or may not include the upper claystone.
Lo CS/LS wells will be installed in the lower claystone/upper limestone

4 Locations of proposed wells are approximate and dependent on accessibility. Actual coordinates will be surveyed after wells are installed. "Nested" (or paired) shallow/deep wells shown in this table with identical coordinates will be installed approximately 10 feet apart, depending on field conditions.

5 UG = Well screened upgradient from the existing landfill with respect to groundwater flow.
DG = Well screened downgradient from the expansion property with respect to groundwater flow.
POC = Point of compliance well.

WILLIAMSON COUNTY
RECYCLING & DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION MSW 1405B
WILLIAMSON COUNTY, TEXAS

GROUNDWATER SAMPLING & ANALYSIS PLAN (GWSAP)

PART III, ATTACHMENT 11

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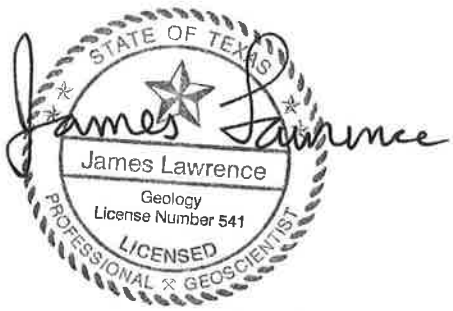

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7-1-2011

1.0 INTRODUCTION

On October 9, 1993, the State of Texas promulgated regulations governing all aspects of municipal solid waste management (30 Texas Administrative Code (TAC), Chapter (§) 330). Subchapter I, §330.233 requires that the owners or operators of Municipal Solid Waste Landfills (MSWLFs) prepare and submit a Groundwater Sampling and Analysis Plan (GWSAP) to the Texas Commission on Environmental Quality (TCEQ or Commission). The purpose of this document is to satisfy the requirements of the above-listed regulations as they pertain to the permitted Williamson County Recycling & Disposal Facility ("Site"~~RDF~~) and proposed expansion area ~~(the "Site")~~, and also additional regulations as described below.

Additional Solid Waste rules (Subchapter 330 of ~~(~~the TAC) were adopted in March of 2006, including Subchapter J. The Subchapter J rule is entitled "Groundwater Monitoring and Corrective Action", and encompasses new solid waste rules 30 TAC 330.401 through 30 TAC 330.421. This document incorporates changes to make this GWSAP compliant with Subchapter J.

~~**2.0 The Site GWSAP has been divided into two sections. This document provides information concerning the Detection Monitoring Program, which includes sampling and analysis methodologies, the establishment of background groundwater quality (Section 4), and detection monitoring procedures (Section 5). The second part of the GWSAP cites the statistical plan prepared by Dr. Robert Gibbons on behalf of Waste Management, Inc. (WMI) entitled "*Statistical Methods for Groundwater Monitoring at the Williamson County Landfill*", dated March 1999. This document was submitted to the TCEQ as an addendum to the GWSAP in a cover letter dated March 17, 1999. A copy of the document is included in Appendix A.**~~

2.0 GROUNDWATER SAMPLING PROCEDURES ~~§330.233(b)(1) and (2)~~

Prior to well purging and sampling, field set-up procedures should be in place to ensure: 1) the collection of representative groundwater samples; ~~and (~~2) protection against the introduction of contamination into, or between wells; and, 3) the proper management and disposal of purge and rinsate fluids.

~~**The following subsections summarize specific tasks involved in sampling of the groundwater monitoring system.**~~

~~**Health and Safety**~~

~~**A Health and Safety Guidance Document for sampling personnel will be provided by the sample collection subcontractor who is solely responsible for the content of the Health and Safety Plan.**~~

~~**Equipment Decontamination**~~

~~All equipment used for the collection of groundwater samples will be decontaminated prior to use at each well location unless the equipment is dedicated to a specific well. An appropriate decontamination procedure consists of scrubbing all equipment with a solution of Alconox (or similar non-phosphate detergent) and deionized or distilled water and triple rinsing with deionized or distilled water. Decontamination will be sufficient to avoid (and prevent) the introduction of any contaminant into a well and to not allow any contaminant to be transported between wells that will create false sample results or otherwise harm the environment. Decontamination water will be collected, stored, and disposed in the same manner as the well purge water (see Section 2.5).~~

2.1 Well Inspection

Prior to performing any purging or sampling, each monitoring well will be inspected to assess its integrity. The condition of each well, including the well pad, will be evaluated for any physical damage that may have been caused by the operation of site equipment or other vehicular traffic. The security of each well will be assessed to confirm that no outside source constituents have been introduced to the well. All inspection information, as well as the date and time, general weather conditions, and sampling personnel identification, will be documented in the Field Comments section of the Field Information Form (FIF) (Figure 2-1). If it has been determined that the integrity of the well has, or may have been, compromised, the necessary information will be documented and the TCEQ notified. No additional actions will be taken without the approval of the TCEQ.

2.2 Sample Collection

For sample collection each monitoring well in the ground water monitoring system will have a dedicated sampling device (i.e. a QED Well Wizard (or equivalent) bladder pump or a Teflon or stainless steel bailer). If a non-dedicated sampling device is used it will be decontaminated prior to use unless it is intended for single use (i.e disposable). If a bailer is used for sampling, the bailer should be lowered gently into and through the water in order to avoid turbulence that may affect sample results, particularly for volatile organic compounds (VOCs). Sampling will proceed from wells with higher water elevations to those with lower elevations as determined from the prior sampling event. If contamination is known to exist at certain locations, non-contaminated wells will be sampled prior to those wells which are known to be contaminated.

2.2.1 Purging/Bailing

Prior to sampling at each well location, water will be evacuated until a minimum of three well volumes has been purged, until the well has been pumped or bailed dry, or until an appropriate amount of water has been purged to achieve the collection of a representative sample. If low-

flow purging has been approved by the TCEQ, the procedures described in EPA/540/S-95/504 (Puls and Barcelona, 1996) will be followed. This will allow for samples to be drawn from the water bearing unit, not from stagnant water left in the screen between sampling events. If the well contains less than three well volumes, the well will be pumped or bailed dry, allowed to recover and immediately sampled. If sufficient water is not available for sampling within seven days of purging for slowly recovering wells, the well will be considered dry and the well will not be sampled during that sampling event. As discussed in Section 2.2, a dedicated sampling device or a properly decontaminated (or disposable) bailer will be utilized for this task.

Purged groundwater will be stored and disposed of as appropriate. Purged groundwater will be managed as uncontaminated water and discharged to the ground surface to prevent ponding of water on or near the pad. Purged groundwater may be discharged directly to the ground surface only after the receipt of the analytical results demonstrates that concentrations of all constituents are at or below background values. Purged groundwater that has been demonstrated through chemical analyses to contain constituents above background will be handled in a manner similar to leachate including recirculation into the landfill.

2.2.2 Equipment Decontamination

All equipment used for the collection of ground water samples will be decontaminated prior to use at each well location unless the equipment is dedicated to a specific well or disposable. An appropriate decontamination procedure consists of scrubbing all equipment with a solution of Alconox and de-ionized or distilled water and triple rinsing with de-ionized or distilled water. If a non-dedicated pump is used, sufficient deionized or distilled water should be run through the pump and hose to ensure the removal of all fluids, which may be present from previous sampling. Decontamination will be sufficient to avoid the introduction of any contaminant into a well and to not allow any contaminant to be transported between wells that will create false sample results or otherwise harm the environment. Decontamination water will be managed the same as detailed in Section 2.2.1.

2.2.3 Water Level Measurements

Prior to groundwater purging and sampling, water level measurements will be taken at each well location utilizing ~~using~~ a portable ~~electronic~~ water level indicator, fiberglass tape, or other suitable measuring device. Water level measurements will be collected over a period of time short enough to avoid temporal variations in water levels. Water level readings ~~Water levels will be measured from a permanent, clearly marked location at the top of the well riser or dedicated sampling device cap. Measurements~~ will be recorded to the nearest hundredth of a foot and will be taken from a standard reference point that is clearly marked on the well. ~~.~~

Water level measurement activities will proceed from the sampling point with the highest recorded water level measurement to the one with the lowest recorded water level measurement (as determined from the prior sampling event). If Site wells are known to be contaminated, water level measurements will proceed from wells least likely to be contaminated to those wells known to be contaminated, regardless of recorded water levels. To further prevent cross-contamination between sampling points, the measuring instrument will be ~~properly~~ decontaminated between well locations following the procedures previously discussed in Section 2.2.2.

2.2.4 Calibration of Field Measurement Devices

Before going to the field, all measuring devices will be cleaned and checked for any malfunctions. The sampling team must calibrate all meters, measuring devices, instruments, etc. before using them in the field. This is necessary to ensure the working order of these devices, and to ensure the integrity of the values measured. If available, manufacturers' calibration procedures will be followed.

2.3 Sample Preservation and Filtering

In accordance with 30 TAC §330.405(c), groundwater samples collected as part of the monitoring program will not be filtered in the field or the laboratory prior to laboratory analysis.

The appropriate sample container and preservative requirement for each analyte is listed on Table 2-III.11.1. Pre-labeled containers will be supplied by the laboratory or sampling personnel for each sampling event. The labels will contain the site identification, sample ID, date collected and sample type. The appropriate preservatives will be added to each sample container based on the required analytical method.

2.4 Sample Shipment~~Collection~~

After collection and sample preservation, the sample bottles will be wiped clean and placed into an insulated, plastic-shelled cooler or other suitable shipping container with ice or frozen ice packs and ice. The temperature of the samples will be recorded when the cooler (shipping container) arrives at the analytical laboratory to assure that the appropriate sample temperature was maintained as close as possible to four degrees Celsius (°C) during shipment. All samples included in the cooler will be packed in such a manner to minimize the potential for container breakage. Volatile Organic Analysis (VOA) vials should never be placed directly on the ice packs. A Chain of Custody Form (COC) (Figure 2-2) should be sealed in a water resistant bag and placed with the appropriate sample bottle set. The cooler will then be properly sealed with a custody seal and sent to the appropriate laboratory or a designated analytical laboratory. All shipments will be scheduled for next day delivery. The Bill of Lading or receipt for analytical samples shipping container shipment(s) will be attached to the COC upon arrival at the analytical laboratory.

2.4.1 Chain -of -Custody

Appropriate COC procedures for samples will be implemented to ensure sample integrity and to provide technically and legally defensible ground water quality data. At the time each sample is collected, the COCs will be completed and placed in the shipping container. Upon arrival of the shipping container at the laboratory, the shipping container will be opened and the COC forms will be signed and time/dated by the person taking custody of the environmental samples. If the

shipping container cooler is shipped, this person will affix the bill of lading or receipt to the COC form.

~~Well Purging/Bailing~~

~~Prior to sampling at each well location, water will be evacuated until a minimum of three well volumes has been purged, until the well has been pumped or bailed dry, or until an appropriate amount of water has been purged to achieve the collection of a representative sample. Groundwater will be considered representative once pH, specific conductance and temperature have stabilized. If low flow/minimal drawdown purging has been approved by the TCEQ, the procedures described in EPA/540/S-95/504 (Puls and Barcelona, 1996) will be followed. This will ensure that samples are drawn from the water bearing unit not from stagnant water left in the screen between sampling events. If the well yields less than three well volumes, the well will be pumped or bailed dry, allowed to recover and immediately sampled. If sufficient water is not available for sampling within 24 hours of purging for slowly recovering wells, the well will be considered dry and the well will not be sampled during that sampling event. As discussed in Section 2.7.1, a dedicated sampling device, decontaminated submersible pump,or a properly decontaminated (or disposable) bailer will be utilized for this task. Purge water will be managed and disposed of properly..~~

~~Timing and Order of Sampling~~

~~The elapsed time for sample collection should be as short as possible to avoid temporal variations in water levels and water chemistry. If contamination is known to be present in one or more wells at the Site, sampling should begin at the well that is known to be least contaminated and end with the most contaminated well. Where no contamination is known, the order should generally be from the well with the highest water-level elevation to the one with the lowest elevation (upgradient to downgradient) for each group of wells completed in a water-bearing unit.~~

~~Sample Collection, Preservation, and Shipment~~

~~Sample collection, preservation and shipment to the laboratory are very important steps in the sampling~~

~~process.~~

~~3.0 Prior to sampling at each well location, water will be evacuated until a minimum of three well volumes has been purged, or until the well has been purged to dryness, or until an appropriate amount of water has been purged to achieve the collection of a representative sample in accordance with Section 2.5 above. Groundwater will be considered representative once pH, specific conductance, turbidity, and temperature have stabilized.~~

~~4.0 Each monitoring well in the groundwater monitoring system will have a dedicated sampling device (e.g., a Well Wizard bladder pump or equivalent or a Teflon or stainless steel bailer). If a non-dedicated sampling device is used, it will be properly decontaminated prior to its use. For bladder pumps, flow rates will not exceed the United States Environmental Protection Agency (USEPA) recommended 0.1 liter per minute for collection of volatile organic compounds (VOCs). The sample collection rate will be maintained between 0.1 and 0.5 liters per minute for all other organic and inorganic analytes. If dedicated or disposable sampling devices are used, it will not be necessary to decontaminate the device prior to its use nor proceed from wells with higher water elevations to those with lower elevations as determined from the prior sampling event. However, if contamination is known to exist at a location at levels that could adversely impact non-dedicated sampling equipment, the non-contaminated wells will be sampled prior to those wells which are known to be contaminated.~~

~~5.0 When sampling for analysis of VOCs, water should flow slowly from the sampling device into each sample vial until a positive meniscus is formed over the top of the container. After the cap has been tightened, the vial should be checked for air bubbles by turning it upside down and tapping with your finger. If an air bubble is seen rising to the bottom of the vial, the sample should be discarded and the process outlined above should be repeated. If no air bubbles are seen in each vial, the process is complete.~~

~~6.0 Field Measurements and Equipment Calibration~~

~~7.0 When field measurements appear to be in error, all data must be discarded, and new measurements made. If the values obtained are not within the normal ranges, such readings may result from inadequate purging, and re-purging should be considered before sampling. A line should be drawn through any error or correction, and the entry initialed and dated.~~

~~8.0 Before going to the field, all equipment must be cleaned and checked for any malfunctions. The sampling team must calibrate all meters before using them in the field. This is necessary to ensure the proper working order of the meters, and to ensure the integrity of the values measured. Manufacturers' calibration procedures must be followed. Where the manufacturer has provided no calibration procedures, the appropriate EPA procedures will be followed.~~

~~9.0 pH. Calibrate the pH meter using pH 7 and pH 10 buffers, and a pH 4 buffer as a check, or with pH 7 and pH 4 buffers, and a pH 10 buffer as a check. The choice depends on the expected pH values of the samples. The calibration for pH is temperature-corrected. Please note the actual pH of your buffers at the temperature used for calibration. A chart for this is usually provided on the buffer container. You may need to calibrate the pH 7 buffer to 6.95 or 7.03 or some point in between, depending on the temperature of your buffers. This second standard should be within 0.1 pH unit of the expected value (e.g., pH 4 buffer, calibrated to within pH 3.90 – 4.10). If not, the meter must be recalibrated.~~

~~10.0 Specific Conductance. Calibrate the specific conductance meter using standards in the range of the conductivity expected at the Site (converted to 25°C). Specific conductance must be within 5% of the expected value (e.g., 1,413 umhos/cm standard, must read between 1,342 –~~

~~1,484 umhos/cm). If the recheck of the cooled standard does not fall within these limits, the instrument must be recalibrated.~~

~~11.0 Similarly, measure and record the specific conductance of the deionized or laboratory reagent quality water being used in the field each morning. If the specific conductance of the deionized or laboratory reagent quality water is greater than 50 umhos/cm at 25°C, the suspect deionized or laboratory reagent quality water should not be used. Deionized water or reagent quality water should be obtained from an alternate source (e.g., analytical laboratory) until the problem can be corrected.~~

~~12.0 The calibration of the field instruments must be checked every four hours or after every tenth sample (whichever occurs first), and at the end of the day. Each calibration check must be recorded in the field meter log book or the Field Information Form (Figure III-11.1).~~

~~13.0 If the result of the calibration check is not within the calibration limits, the meter must be recalibrated.~~

~~14.0 Thermometers. All thermometers used for sample temperatures must adhere to standards for accuracy by the National Institute of Standards and Technology (NIST).~~

~~15.0 Sampling team members are responsible for maintaining log books for all field meters. These log books contain the same information as those for permanent lab instruments (e.g., serial number, name and model of meter, year purchased, etc.). These books also contain quality control (QC) results and maintenance performed by the factory.~~

~~16.0 Sample Containers, Preservation, Holding Times, and Filtering~~

~~17.0 The appropriate sample container, preservative requirement, and holding time for each parameter is listed in Table III-11.1. Pre-labeled containers may be supplied by the laboratory or sampling personnel for each sampling event. The appropriate preservatives will be added to each sample container based on the required analytical method. Per 30 TAC §330.233(c), groundwater samples shall not be field-filtered prior to laboratory analysis for constituents listed in §330.241.~~

~~18.0 Sample Storage and Transport~~

3.0 GROUNDWATER ANALYSIS PROCEDURES ~~§330.233(b)(3)~~

3.1 Analytical Methods/Procedures

Table 2-~~III-11.~~2 presents the methodologies used by the ~~WMI's~~ designated laboratory for each parameter or group of parameters.- All methods are USEPA approved.

3.2 Quality Assurance/Quality Control

Groundwater samples will be shipped to a NELAC (National Environmental Laboratory Accreditation Council) certified laboratory for analysis of groundwater samples.

The laboratory evaluates and reports quality control information in a report with laboratory case narrative (LCN), with qualifiers and narrative detail where appropriate such that WMTX may

ensure that all sample collection, preparation and analyses, and data management activities have been conducted in accordance with NELAC. The laboratory report (including the LCN) will report the number of samples, sampling parameters, and sample matrix, the name of the laboratory (including subcontract labs) involved in the analysis, an explanation of each failed precision and accuracy measurement determined to be outside the laboratory and/or method control limits and whether such a quality control excursion represents a positive or negative bias and the limitations these excursions have on data quality. Additionally, exceedance of sample holding times and identification of matrix interferences shall be identified in the LCN. Any dilutions implemented due to sample matrix interference will be done to the smallest dilution possible to bring the sample into control for analysis.

In addition to the exceptions listed above, the LCN report for all problems and anomalies observed will be included in the laboratory report for each sampling event. The LCN will report, at a minimum, the following information:

1. The exact number of samples, testing parameters and sample matrix.

2. The name of the laboratory involved in the analysis. If more than one laboratory is used, all laboratories shall be identified in the case narrative.

3. The test objective regarding samples.

4. Explanation of each failed precision and accuracy measurement determined to be outside of the laboratory and/or method control limits.

5 Explanation if the effect of the failed precision and accuracy measurements on the results induces a positive or negative bias.

6 Identification and explanation of problems associated with the sample results, along with the limitations these problems have on data usability.

7. A statement on the estimated uncertainty of analytical results of the samples when appropriate and/or when requested.

8 A statement of compliance and/or noncompliance with the requirements and specifications. Exceedance of holding times and identification of matrix interferences must be identified. Dilutions shall be identified and if dilutions are necessary, they must be done to the smallest dilution possible to effectively minimize matrix interferences and bring the sample into control for analysis.

9. Identification of any and all applicable quality assurance and control samples that will require special attention by the reviewer.

10. A statement on the quality control of the analytical method of the permit and the analytical recoveries information shall be provided when appropriate and/or when requested.

The analytical laboratory report for each sampling event will document the results and methods for each sample and analyte along with the quantification limits. The report will also include a copy of the chain-of-custody and an understandable correlation between the chain-of-custody and the sample results reported to the TCEQ. The analytical laboratory report will be submitted either electronically or in hard copy upon TCEQ request.

The Site shall ensure that a data reviewer consider the project data quality objectives as appropriate to determine if the results meet the project needs with respect to completeness, representativeness, and accuracy. Prior to submittal of the data to TCEQ, all analytical data will be examined to ensure that the data quality objectives are considered and met and that the results representing the samples are accurate and complete. The data will be reviewed, including the laboratory control results, the relative percent difference (RPD) of the monitor well results, and its duplicate analysis (DUP) as a measure of accuracy. The data review will include a statement

assessing data usability by a certified groundwater scientist with respect to the project data objectives (primarily a statistical evaluation of the groundwater analytical data) and, when necessary, provide comment to further explain or supplement the quality control data on the laboratory report. If WMTX determines that the analytical data may be utilized, any and all problems and corrective action that the laboratory identified during the analysis will be included in the report submitted to the TCEQ.

~~In addition to strict chain of custody procedures, field blanks and trip blanks are used to assure the integrity of the sampling and shipping process.~~ A record of laboratory sample receipt, storage and analysis procedures will be kept for each sample received. A summary of this record will be part of the laboratory analysis report. ~~A copy of the designated laboratory's Standard Operating Procedure Quality Assurance Program Plan (LSOP QAPP) has been submitted to the Commission as a separate document. Any internal quality control problem associated with the submitted sample/analyte will be identified on the Case Narrative report included with each sample's analytical client report. If at any time the Site changes analytical laboratories, the new laboratory's LSOP will be submitted by the laboratory to the TCEQ for review and acceptance of the laboratory's QA/QC procedures.~~

Field Sampling QA/QC

Field Procedures. As quality assurance procedures are an integral part of each segment of field sampling methodology, the quality assurance procedures associated with each step of the field sampling routine (e.g.., proper well purging, field sampling and preservation methodologies) have been directly incorporated into each respective field sampling subsection of this GWSAP.

Field and Trip Blanks. Trip and field blanks may be used during each round of sampling at the Site. The trip blank, containing laboratory-grade distilled water, will remain unopened and be packaged and sent from and to the laboratory in the same manner as the Site environmental samples. The trip blank will be provided by the analytical laboratory supplying the shipping container. A trip blank will accompany each cooler that contains samples for VOCs and will be

analyzed for VOCs only. The trip blank will only be included and analyzed if VOCs are included in the sampling event.

A minimum of one field blank will be prepared in the field by pouring the supplied laboratory-grade deionized or distilled water into one of the clean sample containers opened in the field. The field blank will then be sealed and shipped in the same manner as the environmental samples. Field blanks will be analyzed for the constituents listed in Table 4.1.

Duplicate Samples. During each sampling event a duplicate sample will be collected from one monitoring well and submitted to the laboratory under a different sample number. This sample will be collected and analyzed to provide a check on the precision of the laboratory techniques.

Laboratory Practical Limit. The practical quantitation (PQL) is defined as the lowest concentration reliably achieved within specified limits of precision and accuracy during routine laboratory operating and is analogous to the limit of quantitation (LOQ) definition in the most recent conditions that are available NELAC Standard. The PQL is method, instrument, and analyte specific, and may be updated as more data becomes available. The PQL must be below the groundwater protection standard established for that analyte as defined by 30 TAC §330.409(h) unless approved by the TCEQ. The precision and accuracy of the PQL shall be initially determined from the PQLs reported over the course of a minimum of eight groundwater monitoring events. The results obtained from these events shall be used to demonstrate that the PQLs meet the specified precision and accuracy as shown in the table below. The PQL will be supported by the analysis of a PQL check sample, which is a laboratory reagent grade sample matrix spiked with chemicals of concern at concentrations equal to or less than the PQL. At a minimum, a PQL check sample will be performed quarterly during the calendar year to demonstrate that the PQL continues to meet the specified limits for precision and accuracy as defined in the table below.

Constituent of Concern	**Precision (% Relative Standard**	**Accuracy**

COC	Deviation [RSD|)	(% Recovery)
Metals	10	70-130
Volatiles	20	50-150
Semi-Volatiles	30	50-150

For analytes that the established PQL cannot meet the precision and accuracy requirements in the table above, the owner/operator will ensure the laboratory will submit sufficient documentation and information to the TCEQ for precision and accuracy limits on a case by case basis. Non-detected results will be reported as less than the established PQL limit that meets these precision and accuracy requirements.

~~***Laboratory QA/QC***~~

~~**Analytical Blanks and Spikes.** The selected laboratory will use method quality control procedures that are equivalent to those described in SW-846. , Method Blanks, instrument/reagent blanks, matrix spikes, blank/water reagent spikes and surrogate spikes are typical quality control checks performed throughout the analytical laboratory. With the exception of instrument/reagent blanks and surrogate spikes, these checks are typically performed at frequency of 5% or 10% (i.e., 1 in 20 samples, 1 in 10 samples). Instrument/reagent blanks and surrogate spikes are performed on a daily or per sample (where required by method) frequency. Each of the above Quality Control (QC) checks will be compared against the Acceptance Criterion for each QC check to ensure that analytical quality is maintained.~~

~~The method blank is a blank solution which is treated as a sample for the parameter being measured, including all pretreatment/preparation procedures, and is analyzed in the same manner as the environmental samples to assess analytical accuracy and the potential for sample contamination. Instrument/reagent blanks are used on a daily basis (where used) to detect contamination or interferences in the sample treatment solvents and chemicals to ensure that none of these applied chemicals could systematically bias sample results.~~

~~Matrix spikes are environmental samples fortified with known concentrations of analytes expected to be in the sample. The percent recovery of any spiked analyte is taken as a measure of the bias of the analytical method caused by the sample matrix. Blank/reagent water spikes are blank solutions fortified with known concentrations of analytes expected to be in environmental samples. These spikes may (reagent water spikes) or may not (blank spike) be taken through the full analytical procedure prior to~~

~~analysis. The percent recovery of any spiked analyte is taken as a measure of control on the analytical procedure. Surrogate spikes, where a compound of known amount which is not expected to be in the environmental sample is added to the sample. VOC analysis uses this type of spike to measure method extraction efficiency. This spike is performed on every sample and QC sample where the analytical method requires it.~~

~~**Instrument Calibration.** Applicable instruments are calibrated using calibration standards and method specified calibration criteria. A solution containing various compounds of known concentrations is diluted and analyzed to establish calibration curves. Calibration is performed daily or per the method to monitor the accuracy and precision of the instrument. Instrument calibration is verified by analyzing a solution containing a known concentration of the pure compound(s) of interest and comparing it against the calibration curve. This standard compound is taken from the same stock as that used to develop the calibration curve. Calibration verification is typically done at a 5% frequency, or as the method requires, to check the stability of the calibration curve as well as the accuracy and precision of the system or analyst.~~

~~All standards and reagents used in laboratory procedures will be inventoried, labeled, logged and documented in accordance with the designated laboratory's documentation procedures. All stock standards purchased as certified primary solutions from reputable, commercial lab suppliers are prepared from neat chemicals with certified purity. Stock standards are combined and/or diluted into secondary dilution standards, which are then diluted into working standards.~~

~~**Instrument Maintenance.** Routine maintenance is performed and documented for all major instruments. Maintenance schedules to be followed for the major instruments are summarized in the analytical laboratory's LSOP provided to the TCEQ.~~

~~**Method Detection Limits (MDLs).** The analytical laboratory uses the procedures described in Appendix B to 40 CFR 136 to determine MDLs. Each year method specific upper and lower precision and accuracy limits are developed from historical matrix spike and duplicate data. MDLs will be checked on an annual basis to determine if a statistical difference exists between the former year's MDL and the yearly update. The appropriate outlier test will be used to determine if a statistical difference exists between the two years' mean values and adjusted, if necessary, to maintain precision and accuracy limits.~~

~~**Laboratory RLs.** The laboratory reporting limits (RLs) for volatile organic and inorganic compounds have been identified for each compound in Table III-11.3. On rare occasions, the laboratory MDL may exceed the RL listed in Table III-11.3 (usually due to matrix interference issues). In such cases, the analyte will be reported to the lowest concentration level that can be~~

4.0 ESTABLISHMENT OF BACKGROUND GROUNDWATER QUALITY

Background ground water quality will be established for all up-gradient and down-gradient wells in the ground water monitoring system. Constituents to be monitored for the establishment of background are listed in Table 3-1. This background constituent list consists of all constituents listed in Code of Federal Regulations (CFR) Part 258, Appendix 1, (30 TAC §330.419), as well as any indicator constituents chosen by the Site.

In order to establish background concentrations for each constituent listed in Table 3-1, a minimum of four statistically independent samples will be collected from each monitoring well (up-gradient and down-gradient) in the ground water monitoring system.

The statistical independence of samples will be achieved through the assignment of a proper sampling interval. Pursuant to the TCEQ guidance document, the appropriate time interval between sampling events can be estimated through the use of Site-specific ground water velocities to determine when fresh" formation groundwater will be found in the monitoring well after initial sampling. These calculated ground water velocities can be calculated for the water bearing unit beneath the Site using the standard average linear velocity formula (Freeze and Cherry, 1979):

$$V_h = = (K_h(/ n_e)i_h)/n_e \quad (1)$$

where: V_h = **horizontal groundwater velocity**

K_h = overall **average hydraulic conductivity**

i_h = **average horizontal gradient**

n_e = estimated effective porosity (Freeze & Cherry, 1979)

The horizontal hydraulic gradient, i_h, is calculated using the formula:

$$i_h = d_h / d_l d_l \quad (2)$$

where: i_h = horizontal hydraulic gradient (ft/ft)

d_h = difference in hydraulic head (feet)

d_l = distance between wells (feet)

At the Site~~Williamson County RDF permitted landfill and expansion area~~, the average horizontal hydraulic gradient in the surficial clay/upper claystone was calculated to be 0.017 ft/ft to the east. Using the representative horizontal hydraulic gradient of 0.017 ft/ft, a geometric mean hydraulic conductivity value of 3.0 x 10^{-5} cm/sec (8.5 x 10^{-2} feet/day (ft/day)) (from the 2004 field hydraulic conductivity tests and data from previous Site~~site~~ investigations), and an estimated effective porosity of 0.4 for clay (based on a literature value), the average linear velocity within the shallow surficial clay/upper claystone flow system is estimated to be 3.6 x 10^{-3} ft/day (1.3 feet/year (ft/yr)).

At the Site~~Williamson County RDF proposed expansion area~~, the recent average horizontal hydraulic gradient in the lower claystone/limestone was calculated to be 0.014 ft/ft to the east. Using the representative horizontal hydraulic gradient of 0.014 ft/ft, a geometric mean hydraulic conductivity value of 2.2 x 10^{-7} cm/sec (6.2 x 10^{-4} ft/day) from the nine Site~~site~~-specific field hydraulic conductivity tests, and an estimated effective porosity of 0.015 for limestone (based on previous investigations and a literature value), the average linear velocity within the deeper lower claystone/limestone flow system is estimated to be 5.8 x 10^{-4} ft/day (0.2 ft/yr).

At the Site ~~Williamson County RDF permitted landfill~~, the average historical horizontal hydraulic gradient in the deeper flow system (claystone unit) was calculated to be 0.0135 ft/ft to the south across the existing Site. Using the representative horizontal hydraulic gradient of 0.0135 ft/ft, a geometric mean hydraulic conductivity value of 1.29 x 10^{-6} cm/sec (0.0037 ft/day) from the nine Site~~site~~-specific field hydraulic conductivity tests of the claystone, and an effective porosity of 0.015, the average linear velocity within the claystone flow system is estimated to be 3.29 x 10^{-3} ft/day (1.2 ft/yr).

Using a groundwater velocity of 3.6 x 10^{-3} ft/day for the surficial clay/upper claystone unit and groundwater velocities between 3.29 x 10^{-3} and 5.8 x 10^{-4} ft/day for the lower claystone/limestone unit across the Site, background samples will be taken at approximately quarterly intervals to adequately characterize groundwater quality for the shallow and deep units.

In accordance with 30 TAC §330.407(a)(1), upon completion of background monitoring and during background updates, the background data will be evaluated to ensure that the data are representative of background groundwater constituent concentrations unaffected by waste management activities or other sources of contamination. The evaluation will be documented in a report and submitted to the TCEQ before the next subsequent groundwater monitoring event following the updated (or initial) background period.

5.0 DETECTION MONITORING

The Detection Monitoring Program for the Site is summarized and discussed in the following subsections.

5.1 Groundwater Detection Monitoring Parameters ~~§330. (a)~~

Parameters that will be monitored during Detection Monitoring consist of inorganic and organic constituents found in 40 CFR Part 258, Appendix I. The Site-specific detection monitoring list has been included as Table 4-1, which was compiled pursuant to 30 TAC §330.419(a) regulations. In addition to the constituents found in 40 CFR Part 258, Appendix I, other groundwater quality indicator parameters may be collected and analyzed as part of a Detection Monitoring event but will not be evaluated in accordance with the statistical methods described in Section 5.4. ~~234.~~

5.2 Groundwater Detection Monitoring Frequency

After the establishment of background groundwater quality (see Section 4.0), the detection monitoring frequency for all constituents identified in Section 5.1 will be semiannual during the active life, closure, and post-closure care periods of the Site.

5.3 Reporting Requirements

Groundwater Monitoring Statistical Report

No later than 60 days after each sampling event, WMTX shall determine whether there has been a statistically significant increase (SSI) over background of any tested constituent at any monitoring well. If there has been an initial SSI, WMTX shall notify the TCEQ, and any local pollution agency with jurisdiction that has requested to be notified, in writing within 14 days of this determination.

If an SSI over background of any tested constituent at any monitoring well has occurred, WMTX shall immediately place a notice in the operating record describing the increase and shall establish an assessment monitoring program meeting the requirements of 30 TAC§330.409 within 90 days of the date of the SSI determination notice to the TCEQ, except as provided for in the following two paragraphs:

(1) If an initial SSI (an unconfirmed SSI) over background of any tested constituent at any monitoring well has occurred, WMTX will submit the results of up to two confirmation resamples within 60 days of determining the initial SSI. The resample data may be used to statistically confirm or disprove the initial SSI determination. If one of the two confirmation resamples is determined to be in control, then the initial SSI is considered to be not statistically significant (i.e. the SSI is not confirmed). A second cinfiirmation sample is collected only if the first resample fails statistically (i.e. statistically significant). If both confirmation resamples fail statistically, then the SSI is confirmed.

(2) If an SSI (initial or confirmed) over background of any tested constituent at any monitoring well has occurred and WMTX has reasonable cause to think that a source other than a landfill unit caused the contamination or that the SSI resulted from an error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality, then WMTX may submit a report providing documentation to that effect. In making this alternate source demonstration (ASD), WMTX will notify the TCEQ, and any local pollution agency with jurisdiction that has requested to be notified, in writing within 14 days of determining a SSI over background at the compliance point, that WMTX intends to prepare and submit an ASD. Within 90 days of determining an initial SSI, WMTX will submit an ASD to the TCEQ, and any local pollution agency with jurisdiction that has requested to be notified, that demonstrates that a source other than a monitored landfill unit caused the contamination or that the SSI resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. The ASD must be prepared and certified by a groundwater scientist. WMTX will not filter the groundwater sample for constituents addressed by the ASD prior to laboratory analysis. WMTX may provide analyses of the landfill leachate to support the demonstration. WMTX will continue to monitor in accordance with the detection monitoring program established under 30 TAC §330.407.

If WMTX does not make a demonstration satisfactory to the TCEQ within 90 days after the date of the notice to the TCEQ required under this subsection, WMTX shall initiate an assessment monitoring program as required in 30 TAC §330.407(b)(1). WMTX may install additional wells at the point of compliance to further characterize the release.

Annual Report

WMTX shall submit an annual detection monitoring report within 90 days after the Site's last groundwater monitoring event in a calendar year. The annual report will include the results of all analytical data in hard-copy format on form TCEQ-0312, Groundwater Sampling Report, and in any other format requested by the TCEQ, for example, electronic format. The owner/operator

of the Site will submit the laboratory case narrative and, either 1) a laboratory checklist or 2) the laboratory quality assurance and quality control data and laboratory analytical data (which may be submitted in hard-copy or electronic format) to the TCEQ, as requested. In addition, the Site will provide an explanation for any problems encountered in the laboratory analysis. The owner/operator will ensure that all the LCN requirements have been met by the laboratory and will complete any of the LCN requirements that cannot be completed by the laboratory. The LCN is described in detail in Section 3.2.

The annual report will include the following information determined since the previously submitted annual report:

(1) A statement regarding whether a SSI has occurred over background values in any well during the previous calendar year period and the status of any events;

(2) The results of all groundwater monitoring, testing, and analytical work obtained or prepared under the requirements of this permit, including a summary of background groundwater quality values, groundwater monitoring analyses, statistical calculations, graphs, and drawings;

(3) The groundwater flow rate and direction in the uppermost water bearing unit. The groundwater flow rate and direction of groundwater flow shall be established using the data collected during the preceding calendar year's sampling events from the monitoring wells of the detection monitoring program. WMTX shall also include in the report all documentation used to determine the groundwater flow rate and direction of groundwater flow;

(4) A contour map of piezometric water levels in the uppermost aquifer based at a minimum upon concurrent measurement in all monitoring wells. All data or documentation used to establish the contour map should be included in the report;

(5) Recommendation for any changes; and

(6) Any other items requested by the TCEQ.

5.4 Statistical Analysis

The statistical method used to evaluate the groundwater data was prepared in accordance with the Site's statistical plan in this section, the EPA statistical guidance document *("Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance"*, July 1992), and ASTM standard D6312-98 (*"Standard Guide for Developing Appropriate Statistical Approaches for Ground-Water Monitoring"*).

The inorganic parameters listed in Table 4-1 will be compared to historical background data using intrawell statistics. Intrawell statistics compare new measurements to the historical data at each groundwater monitoring well independently. The statistical analysis used for this Site will be in accordance with §330.405(e)(4) and §330.405(f)(1-6), as appropriate, and will include control charts, prediction limits, confidence limit, or other valid statistical methods. For Detection Monitoring, the methodology will employ the use of combined Shewhart-CUMSUM control charts in accordance with §330.405(e)(4) or prediction limit (parametric or non-parametric) in accordance with §330.405(f)(1-6) depending on the detection frequency and distribution of the data set. Combined Shewhart-CUSUM control charts will detect releases both in terms of the constituent concentration and cumulative increases. These methods are to be utilized on Table 4-1 metals only since many of these constituents may be found naturally in soils and groundwater samples. Table 4-1 organic constituents will be evaluated based upon a verified detection of a greater than their respective PQLs since many, if not all, of these are not expected to be found naturally in groundwater. Details on verification procedures are provided in Section 5.4.1.

To remove the possibility of historical outliers and trends creating false statistical limits, the data for each well and each constituent will be tested for the existence of outliers. The DUMPStat® (or equivalent) program uses the method described by W. J. Dixon ("*Processing Data for Outliers*": *Biometrics*, 1953, 9, 74-89) to define outliers in the background data set. If a sample collected during background is found to be above the critical value for the sample of size (n-1), then the value is not used in the establishment of the statistical limit from the background data set. Outliers may be removed from consideration during the establishment of all statistical limits. The statistical outlier and trend detection procedure will be performed for those wells that have had at least five measurements for a given constituent. Once the background database is established, the procedure described above may be applied and appropriate statistical limits set.

5.4.1 Detection Confirmation Procedure

Once groundwater analysis results have been collected, checked for consistency, and determined to be above the appropriate statistical level, the results must be confirmed in accordance with the objectives of 40 CFR Part 258.53. Confirmation re-sampling is an integral part of the statistical methodology described by EPA's July 1992 Addendum to Interim Final Guidance Document. Without confirmation re-sampling, much larger statistical limits would be required to achieve Site-wide false positive rates of five percent or less. Furthermore, the resulting false negative rate would be greatly increased. Only compounds that initially exceed their statistical limit will be sampled for confirmation purposes. The use of a "pass 1 of 2" confirmation option will be implemented based on an evaluation by Dr. Robert Gibbons to manage the Site-wide false positive and false negative rates in accordance with the July 1992 EPA statistical guidance document.

5.4.1.1 Volatile Organic Compounds

If one or more VOCs are detected above their statistical limit (i.e. PQL), up to two confirmation resamples will be scheduled. An SSI will be recorded if any single VOC is confirmed in any of

the scheduled resampling events if a concentration is greater than the statistical limit.

5.4.1.2 Inorganic Compounds

If one or more of the inorganic parameters are detected above their statistical limit, up to two confirmation re-samples will be collected with the re-sampling event as discussed in section 5.3 above. An SSI will be recorded if one elevated parameter is confirmed in a concentration greater than the limit for each of the discrete confirmation re-samples. If the re-sampling program confirms that the initial sample represented a laboratory or sampling-induced outlier, the confirmation sample will replace the original reported value to eliminate bias from the statistical calculation, if the statistical method is a Shewart-CUSUM control chart.

~~**21.0DETECTION MONITORING §330.234**~~

~~The Detection Monitoring Program procedure for the Site is summarized and discussed in the following subsections.~~

~~Groundwater Detection Monitoring Parameters §330.234(a)(2)~~

~~Parameters that will be monitored during Detection Monitoring were selected from the listing of organic and inorganic constituents found in Table 1 of 30 TAC §330.241. The detection monitoring list has been included as Table III-11.4, which was compiled pursuant to 30 TAC §330.234.~~

~~In accordance with 30 TAC §330.234(a)(2), those constituents not detected in Site leachate ("not reasonably expected to be in or derived from the waste contained in the unit") may be deleted from the detection monitoring list with approval from the Commission. Under this submittal the entire detection monitoring list (Table III-11.4, constituents 1-62) is initially proposed for detection monitoring. At a future date, when leachate data are compiled and evaluated, the detection monitoring parameter list may be revised to exclude compounds not found in the Site leachate in sufficient quantity for statistical contrast.~~

~~In accordance with 30 TAC §330.234(a)(2), the following general water quality parameters are recommended for inclusion on the detection monitoring list:~~

~~Calcium~~ ~~Magnesium~~ ~~Sodium~~

Potassium	Chloride	Sulfate
Total Alkalinity	Iron	Manganese
	Ammonia, Nitrogen	Total Dissolved Solids

Note: If required, background for total metals will be established semiannually for eight consecutive events.

The above listed parameters provide for a better indication of general changes in groundwater quality. Statistical false positives frequently occur if there are subtle changes in groundwater geochemistry due to flood or drought conditions when these constituents are included in routine statistical analyses. Therefore, statistical analyses for the general water quality parameters listed above will not be performed as described in Section 5.4 of this plan. Additional deletions/additions may occur to the Detection Monitoring List (TABLE III-11.4)as more leachate and groundwater quality data are collected.

21.1Groundwater Detection Monitoring Frequency §330.234 (b)(1)

After the establishment of background groundwater quality (Refer to Section 4.0), the detection monitoring frequency for all constituents identified in Table III-11.4 will be semiannual during the active life, closure, and post-closure care periods of the Site. As described previously in Section 4.0, this sampling frequency meets the appropriate time interval criteria for sample independence.

Reporting Requirements §330.234(c) and (d)

A report containing the analytical results from each site sampling event will be submitted to the executive director within 45 days of the time of sampling in the appropriate format(s).

If an initial statistically significant change (SSC) from background is identified for any monitored constituent at any monitoring well, the TCEQ will be notified within 60 days of the sampling event. If the initial SSC is verified with up to two (2) verification re-samples, a written notice that a verified SSC has occurred will be submitted to the executive director and placed in the site operating record within 60 days of the sampling event. If the verified SSC is identified, then provisions will be made to 1) establish an assessment monitoring program in accordance with 30 TAC §330.235 within 90 days of the notice to the TCEQ or 2) prepare an alternate source demonstration (ASD) within 90 days of the sampling event in accordance with 30 TAC §330.234(d)(2).

For those parameters listed in 30 TAC §330.241 Table 1, verification re-sampling will take place within 90 days of the apparent SSC. The verification re-sampling data will be submitted to the TCEQ no later than 45 days after the verification sampling event. If the SSC is verified by re-sampling, and no other

~~source other than the landfill is identified, then Assessment Monitoring will be initiated under 30 TAC §330.235, within 180 days of the original sampling event.~~

~~However, if the SSC from the background data is believed to be caused by a source other than the landfill, (including but not limited to sampling error, statistical error, laboratory induced error, or natural variation), then the owner/operator will prepare a report that explains the cause of the significant change. This report will be prepared and certified by a qualified groundwater scientist and submitted to the Commission within 90 days after the apparent SSC notice for approval. If the Commission approves the report, then the landfill may return to Detection Monitoring. If the Commission believes a satisfactory explanation is not given, then the Assessment Monitoring Program will be implemented. If a satisfactory demonstration is made after the deadline, then the affected well(s) may return to Detection Monitoring.~~

~~Statistical Analysis – §330.233(f) and (g)~~

~~Statistical analysis will be conducted in accordance with 30 TAC §330.233(f) and (g). The facility Statistical Plan (Plan) was prepared by Dr. Robert Gibbons, Ph.D. The Plan is titled "*Statistical Methods for Groundwater Monitoring at the Williamson County Landfill*" dated March 1999. The Plan is included as Appendix A to this GWSAP, and describes the methodologies and strategies for groundwater analysis based on the site-specific background data set collected from the facility.~~

~~In accordance with §330.233(g)(3), the technique used for intrawell comparisons is the combined Shewhart-CUSUM control chart, using the DUMPStat® program. This control chart procedure will detect releases both in terms of the constituent concentration and cumulative increases. Background data are tested for existing trends using Sen's slope test. Many ground water monitoring parameters are not detected at a frequency great enough to generate the combined Shewhart-CUSUM control charts. For constituents detected less than 25% of the time monitored at a particular well, nonparametric prediction limits are used once sufficient background data are available.~~

6.0 ASSESSMENT MONITORING PLAN

Assessment monitoring will be performed on a Site-specific basis pursuant to this Assessment Monitoring Plan (AMP) whenever it is determined that there has been an SSI over background for one or more of the constituents listed in Table 4-1. The purpose of this AMP is to provide the procedures and a statistical methodology to evaluate inorganic and/or organic compound

detections in groundwater against background and against health-based groundwater protection standards. This AMP is designed to meet the requirements of the §330.409 through §330.411 and federal D (40 CFR Part 258) regulations.

In accordance with 30 TAC §330.409 (b), within 90 days of determining that an SSI has occurred (i.e. after confirmation of the SSI and completion of any alternate source demonstrations, if conducted), and not less than annually thereafter, the groundwater monitoring system will be sampled and analyzed for the full set of constituents in Appendix II to 40 CFR Part 258. Groundwater samples collected as part of assessment monitoring will not be filtered in the field or the laboratory prior to laboratory analysis. If an SSI is confirmed, assessment monitoring will be initiated at the well(s) exhibiting the SSI, and at the immediately adjacent wells on each side of the well(s) exhibiting the SSI, unless an alternative subset of wells is designated by the TCEQ. For any new constituent(s) detected in the point of compliance wells as a result of the complete Appendix II analysis, a minimum of four statistically independent samples from each background well shall be collected and analyzed to establish background levels for the additional constituents. After sampling point of compliance wells for Appendix II constituents, the TCEQ may specify an appropriate subset of wells to be sampled and analyzed for the Appendix II constituents during assessment monitoring and may delete any of the Appendix II constituents if WMTX can document that those constituents removed are not reasonably expected to be in or derived from the waste contained in the unit. All other groundwater wells will continue to be monitored in accordance with the existing detection monitoring protocols and statistical program.

Statistical analysis of the assessment monitoring constituents detected above background is based on the 1989 EPA *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities*. The statistical methodology will closely follow the methods presented in ASTM D7048-04, *Standard Guide for Applying Statistical Methods for Assessment and Corrective Action Environmental Monitoring Programs*, 2004 and includes the following methods: